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Multidisciplinary learning environments generating innovation competences – Some examples from Turku University of Applied Sciences in Finland

Abstract

We live surrounded by new ways of thinking, understanding and acting that simultaneously point to a new step in innovating. We are challenged, more than ever, to be able to combine different kinds of knowledge, skills and attitudes to solve the wicked problems facing our work places, society and the globe, such as changing working methods and environments, digitalization, population growth, or climate change. Consequently, how to educate students provided with such competences is a crucial question to educators.

In our article, we aim to discuss how students' innovation competences can be developed in various multidisciplinary learning environments. Higher education institutions should be able to provide learning environments enabling their students to develop the competences needed in current and future world. The implementation of the change in learning environments is often problematic because there is usually a long tradition to do things 'as they always have been done'. We introduce examples of some learning environments, which can initiate concrete changes in learning culture and are able to develop students' innovation competences, such as teamwork and networking competences, creativity, critical thinking, and initiative. These learning environments share some common elements, being multidisciplinary and social by nature, i.e. bringing students from different study fields together to co-operate and learn, by solving real problems, in real projects, in open environments, in continuous co-operation with businesses and other working-life organizations. The framework for these learning environments is based on innovation pedagogy, a learning approach developing innovation competences of individuals and groups, and socioconstructivistic and sociocultural learning theories. Originating from these backgrounds, we present several case examples how we have developed multidisciplinary learning environments at Turku University of Applied Sciences (TUAS) in Finland, and discuss how these solutions are able to develop innovation competences of the students participating in these. The multidisciplinary learning environments presented are called Project Hatchery, Innocamp, theFIRMA, and Capstone . Our finding is that all these multidisciplinary learning environments presented are able to develop students' innovation competences.

The focus in this article is in higher education, but the approach is applicable and useful for all levels of educational institutions. Ultimately it is not only the students participating but the working life organizations, the educational institution and the society itself which can benefit of innovation competence development contributing to new innovative and sustainable solutions to current and future challenges.

Introduction

The widely shared practices of current higher education were designed for the needs of the industrial era. That world does not exist anymore. We must provide students with skills of global citizenship and cultural sensitiveness, and competences such as critical thinking, initiative, creativity, team working and networking. We live surrounded by new ways of thinking, understanding and acting that simultaneously point to a new step in innovating. We are challenged, more than ever, to be able to combine different kinds of knowledge, skills and attitudes to solve the wicked problems facing our work places, society and the globe. The crucial question is how higher education respond to these challenges and competence requirements.

A strategic approach called innovation pedagogy aims to answer for this challenge and develop innovation competences of individuals and groups, i.e. competences listed above. In higher education, the development of innovation competences alongside with the study field specific competences, provides students not only the ability to participate into the innovation processes in working life, but competences they will need for a society that promotes well-being and sustainability. The core of innovation pedagogy lies in emphasizing interactive dialogue between the educational organization and students as well as the surrounding working life, society, and research. The aim is to educate graduates who can succeed in their future work and life. To reach the aim of innovation pedagogy, students have to develop their innovation competences alongside with their subject field specific competences during their learning path in the university. Different phases in the innovation process emphasize different knowledge and skills so it is necessary that the learning process itself is planned according to the innovation process. The methods and tools of innovation pedagogy are several: *Working life orientation, flexible curricula and multidisciplinary learning environments* are essential requirements for innovation pedagogy to succeed. *Renewing teacher roles* support, encourage and guide students in order to advance learning. Students need good *study skills* to take an active and responsible role in their own learning. Finally, *the methods* used in delivering the education must be activating and versatile. Giving students opportunities to work in real-life assignment and *research & development projects* is essential when aiming to improve their innovation competencies. The *assessment* is development-oriented, i.e. students are able to assess their own competences and know how to develop them. (Konst & Kairisto-Mertanen 2018.)

In this article we focus on learning environments characteristic for innovation pedagogy, i.e. on that how students' innovation competences can be developed in various multidisciplinary learning environments. The implementation of the change in learning environments can often be problematic because there is usually a long tradition to do things 'as they always have been done'. We introduce several examples of some learning environments, which can initiate concrete changes in learning culture and are able to develop students' innovation competences. These learning environments share some common elements, being multidisciplinary and social by nature, i.e. bringing students from different study fields together to co-operate and learn, by solving real problems, in real projects, in open environments, in continuous co-operation with businesses and other working-life organizations. The framework for all these learning environments is based on innovation pedagogy. The innovation pedagogy approach as well as the learning environments presented are developed by Turku University of Applied Sciences, and our empirical findings are based on extensive research material collected during last ten years by applying the innovation pedagogy approach and new learning environments.

The managerial contribution of our findings is that multidisciplinary learning environments are an important tool and even a prerequisite for the development of innovation competences. The focus in this article is in higher education, but the approach and learning environments presented are applicable and useful for all levels of educational institutions. Ultimately it is not only the students participating but the working life organizations, the educational institution and the society itself which can benefit of innovation competence development contributing to new innovative and sustainable solutions to current and future challenges.

Innovation competences as learning objectives

Education has traditionally emphasized individual competence, and innovation has usually been seen as an activity of independently working individuals. As the world is becoming increasingly complex and the amount of information is rapidly growing, it has become evident that only a few can outdo the collective strength of a group or a team through individual actions. (Penttilä et al., 2013.)

Interaction and communication skills are crucial in helping people bounce their thoughts off those of others in a group and receive feedback and, in this way, develop such thoughts into even better ideas. The significance of networking has similarly become more significant. Networks create safety and trust when ideas and actions can be brought forward among people who are not complete strangers. Networks complement the competences of those participating in them with the principle of mutual benefit, safety, trust and shared understanding. (Lehto & Penttilä, 2013.)

If we want students to learn innovation competences already during their studies, we must also embed these competence objectives in curricula. Consequently, we can develop learning environments, which simulate innovation processes and stimulate the development of innovation competences. There are several studies also support these objectives. For example, Vila et al. (2012) have found that working together on solutions to new problems supports the acquisition of innovation competences in higher education students. Keinänen and Oksanen (2017) and Keinänen & Butter (2018) state that specific pedagogical practices in university-company cooperation develop students' learning of innovation competences. Kivunja (2014) emphasizes that the way to learn creativity and innovation skills lies in designing quality learning environments in which learners can solve real-life problems and be inquisitive and open-minded. Similarly, Keinänen and Oksanen (2017) showed that students' project-based learning preference seems to be linked to the learning of innovation competences. Additionally, activating learning and teaching methods have been showed to have association to the students' innovation competences in higher educational context (Keinänen & Kairisto-Mertanen, 2019). Moreover, Keinänen et al. (2018) underline the significance of multidisciplinary learning environments for the development of innovation competences.

Learning environments and multidisciplinarity

The learning environment is a central factor enabling learning in general. According to innovation pedagogy, a learning environment developing especially innovation competences is social and multidisciplinary. Often a learning environment is perceived as a physical or virtual space, which enables learning. In innovation pedagogy, the social aspects of working and learning are emphasized, and an essential part of the entire learning process is the group processes, where learning takes place in multidisciplinary groups and teams. A social learning environment consists of people who have different competences and abilities, and who interact with each other, all this enabling community-oriented learning. Similarly, in working life, representatives from different professional fields are expected and required to cooperate efficiently. In other words, working life tasks often require skills and knowledge that do not represent a single discipline or subject only. (Penttilä & Kairisto-Mertanen 2012; Penttilä & Putkonen 2013.)

Innovation pedagogy underlines learning in real situations and in an authentic working life context. Learning is seen as a social process, where interaction with others has a crucial role, meaning that we learn to think and act together with others. Participation, collaboration and exchange of knowledge and skills are the primary way for learning. In current and future working life, employees are expected to develop their competences continuously, learning new skills, and knowing how to disengage from outdated skills. All this demands interaction; through interaction employees are able to learn from each other, share knowledge and solve more challenging problems than alone.

As working life is getting more and more complex, working life orientation also expects individual expertise developing into communal expertise. The learning environment consists of interacting with people who possess different competences and abilities, which enables community-oriented learning. The concepts of multidisciplinarity, boundary crossing, interdisciplinarity, and transdisciplinarity lack a single comprehensive

term, which would bring together all their variations. However, all these areas share the same goal of producing something new, unexpected and innovative through collaboration of people with different backgrounds. Each individual involved in this type of co-operation contributes one's own knowledge, history, experience, expertise, skills and creativity to the social learning environment.

The contribution of learning should have an impact on real work in practice. Educational research terms this as transfer of learning, which means that learning can be recalled and applied in working life (Illeris 2009). Learning in one specific type of setting is not necessarily accessible when the learner is moved to another setting. This transfer problem can be solved by creating identical elements in education and working life (Kettunen, 2009, 2011). The tasks in workplaces also often require knowledge and skills that do not belong within the scope of only single subject field. Boundary crossing during studies is one efficient tool for solving the transfer problem – the situation where the knowledge and skills acquired during studies are not converted into knowledge and skills applicable in working life. When students, during their studies, become used to working with people from different disciplines and study fields, and learn to understand that they must be interested topics belonging to many different disciplines, the transfer of knowledge at a workplace becomes easier. The situational context is important as well; the transfer of learning takes place more efficiently if learning takes place in a context similar to the future situation where learning should be put into practice. Additionally, efficient utilization of learning requires that it is expressed at a more general level, in other words, by detaching it from its immediate context of use. Then it is possible to learn to find, define and conceptualize the phenomenon and apply it in new situations. (Konst & Kairisto-Mertanen 2018, p. 56.)

Higher education institutions should shift their focus on improving boundary crossing and multidisciplinary collaboration, for example, by offering courses and study modules that are really multidisciplinary (Max-Neef, 2005). Multidisciplinary education can expose students to research in multiple disciplines, train them in collaborative methods through team research and promote new forms of communication and collaboration among disciplines (Graybill et al., 2006). The aim of innovation pedagogy is to generate environments in which innovation competences can be developed by combining different kinds of knowledge and skills, since in a multidisciplinary environment, it is possible to generate sustainable new innovations through research and development. Also the aim towards sustainability means, that we should develop silo breaking, cross-institutional spaces for students and other university community members to learn and collaborate to develop and test promising social and technological innovations that address real-world problems while reducing the need of natural resources. In addition, the transfer of knowledge from university environment to working environment becomes more efficient. In the end, one of the biggest challenges for innovation pedagogy in practice is to support the students to step out of familiar, help them to tolerate insecurity and be open to new ideas, consider sustainable well-being in all decisions, and not to be afraid of making mistakes. (Penttilä, Kairisto-Mertanen & Väänänen, 2014; Glasser, 2018).

Multidisciplinary learning environments in action

In following, we introduce several examples of some learning environments, which can initiate concrete changes in learning culture and are able to develop students' innovation competences. These learning environments share some common elements, being multidisciplinary and social by nature, in other words, they bring students from different study fields together to co-operate and learn, to solve real problems, in real projects, in open environments, in continuous co-operation with businesses and other working-life organizations.

Project hatchery

Project hatchery is one of the multidisciplinary learning environments applied at Turku University of Applied Sciences. As shown in figure 1 including three different layers, project hatchery offers studies for students coming from different study programs and from different levels of academic studies. (Kairisto-Mertanen, Räsänen, Lehtonen & Lappalainen, 2012.)

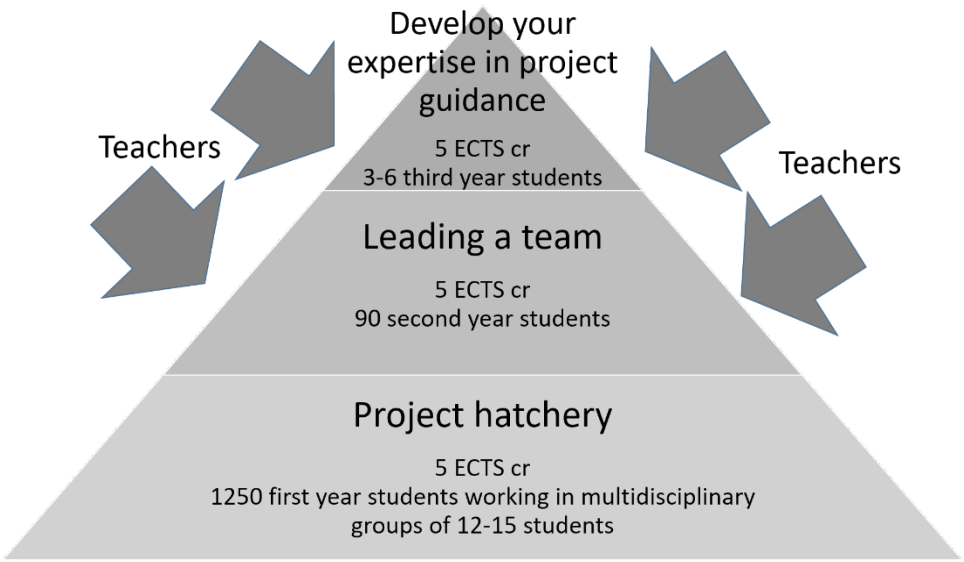

Figure 1. Project hatchery with its three layers

The basic idea is to make students from different study programs and study fields work together in groups of 12 -15 students towards a common aim, which they tailor by themselves during the working process. The group assignments represent real life cases, stemming from the enterprises in the university's network or from the research, development and innovation projects of the university. The work setting resembles a real-life situation and combines real-life assignments, peer counselling and working in multi-disciplinary groups while including the international aspect in all work and giving the groups plenty of room to design their own way of working. In the biggest faculty of TUAS, Faculty of Technology and Business (all faculties being multidisciplinary by nature), all incoming students take part in the project hatchery, meaning approx. 1250 students year 2019.

The work includes that the groups start bonding with each other and creating new ideas as they work with people who have versatile agendas and ways of thinking. According to teacher reports, this study unit influences the general atmosphere in the faculty by creating situations where different students start hanging around and working together as well as by introducing new students a new learning culture.

Learning goals must be discussed with the students in the beginning of the project hatchery study unit. During the whole implementation, learning must be made visible by reflecting about the desired learning goals, as new students do not always notice the progress they are making or understand that soft skills referred to as innovation competences or 21st century skills are important goals for learning.

Hatchery work includes scheduled meetings and independent work, organized learning sessions based on readings and introductions to several topics needed by the groups. The aims and outcomes of the study the unit are defined to include learning how to tolerate insecurity, how to define aims and targets for one's own work, how to effectively present ideas and make presentations. It is important that students start working in a critical research-based way, which requires one's own activity in teams and networks. The students are also expected to develop a creative and enthusiastic attitude towards learning and start taking responsibility for their future studies.

The second layer (figure 1), of the hatchery concept is a study unit meant for second year students who already had a first year experience of project hatchery. The aim of this "Leading a team" study unit is to prepare the students to act as tutors for project hatchery groups and learn about group dynamics, leadership and group behaviour in general. They get constant support in weekly meetings with their teacher tutor who always has several, usually four, student tutors to counsel and coach. The role of the teacher tutors is mostly to help the student tutors; although when needed, they are accessible for the project hatchery students as well.

The third layer, the study unit called "Develop your expertise in project guidance" (figure 1) is targeted for advanced students who find leadership and teaching positions interesting and who have plans to develop their skills in these further. The students act as assisting teachers and this way have more responsibilities than student tutors.

Different students profiles were identified in a research conducted among third and fourth year students having experience on different learning environments, among them project hatchery. The results show that those students who have more experience studying in different learning environments built according to the principles of innovation pedagogy assessed their innovation competences higher than those students who has less experience. It can be assumed that those students who have higher level of innovation competences and more experience of learning environments like project hatchery also have higher probability to be innovative at work. (Keinänen & Kairisto-Mertanen, 2019)

Innovation camp (Innocamp)

Innovation camps aim to give students an opportunity to develop their innovation competences at participating in innovation processes, i.e. the skills needed in working life and required by the current and future society. Throughout an innovation camp, participants can experience the steps of an intense innovation process.

In addition to the camp itself, this learning method can include readings, advance assignments as well as joint meetings. The duration of innovation camps varies, with the usual duration being one or two intensive camp days. The number of participating students is often between 20 and 60, guided by one or several coaching teachers. Students work in teams that consist of members from different study fields and disciplines. The organization of an innovation camp can be delegated to a student group, but a teacher/coach should always supervise the process and be responsible for its implementation. The camp is led by coach/coaches who spar and encourage the participants to achieve the goals they have set together.

In practice, an innovation camp means that students from different study fields work together in multidisciplinary teams solving assignments. These authentic assignments are given by companies or other working life organizations. The assignments can be based on a specific challenge or a problem faced by the company/organization, and the students aim to find various new approaches or solutions to the problem. The camp gives them an opportunity for an intensive and unbroken working period focusing on a specific topic. Multidisciplinary teams make it possible to discuss the topic from different viewpoints, get new perspectives, learn from others and share expertise from different fields. As a result of working, students will get new insights, ideas and solutions. According to follow-up studies, innovation camps are amazingly efficient method to develop innovation competences. Despite their very short duration, they seem to be able to provide students with better innovations competences especially improving their interpersonal/team working and networking competences. (Konst & Jagiello-Rusilowski, 2017.)

TheFIRMA

TheFIRMA is a learning environment in the Information and Communication Technology (ICT) unit of Turku University of Applied Sciences. In theFIRMA, students work in real customer projects, which can vary from web development and graphical design to end-user trainings and Lego robot camps. Customers are mainly small and medium sized enterprises (SMEs) in Southwest Finland (Säisä, Tiura & Roslöf, 2018).

TheFIRMA project office operates like a real company: student CEO is responsible of coordinating the projects and resourcing and student project managers are responsible of the management of customer projects. Customer projects are done by student teams while teachers merely act as mentors in case students need help in the project. Learning method in the project office is learning by doing in multidisciplinary and multicultural teams. Moreover, work done in theFIRMA is integrated in the curriculum so that the students gain credits for the introductory course, work placement, thesis or alternative choice studies (Säisä, Määttä & Roslöf, 2017). In addition, it is possible to complete tailored advanced professional studies in theFIRMA as well (Säisä et al. 2017). In theFIRMA, around 50 customer projects are implemented annually by 120-160 students. Some of the students study only a couple of credits in theFIRMA, whereas other students complete a significant part of their degree there.

Various TUAS staff members are involved in theFIRMA's operation: staff project manager, responsible teacher and technical consultants. The staff project manager has the overall responsibility of theFIRMA's administration and its operations. In addition, staff project manager negotiates the contract details (such as price and contents) of customer projects. Responsible teacher oversees the learning process of students and gives the credits and grades for the students. Various technical consultants mentor the students in difficult engineering tasks in customer projects in case students need help. (Roslöf, 2016; Säisä, Määttä & Roslöf, 2017)

Students need to develop both disciplinary and interdisciplinary knowledge during their studies in order to succeed in the future working life. TheFIRMA project office enables students to develop their competences in real and authentic customer projects. Students co-operate and learn together in continuous co-operation with businesses and other working-life organizations. Usually, one team consists of student project manager, senior-level student and junior-level students. Senior-level students mentor the junior-level students with the project and thus, junior-level students gain technical as well as team working skills. Senior-level students gain technical skills and mentoring skills. Student project manager gains team leading skills as well as customer relationships skills, among others. Solving real problems in real customer projects is a great motivator to students to do their best, since they see the result in use in a real company.

Capstone (Innovation project course)

Education has to promote creativity and adopt methods from work life: experimenting with others without the fear of making a mistake will be encouraged. The future education has to focus on skills in addition to knowledge and working in groups. Furthermore, versatile learning methods prepare students for changing work life. Innovation pedagogy, the learning approach developed by Turku University of Applied Sciences, and The CDIO approach, originating from engineering education, are both focusing on these relevant and important issues in education. As a result, it has been developed a multidisciplinary learning environment called Capstone, which integrates the CDIO method and innovation pedagogy.

The CDIO approach is a worldwide collaborative network of developing engineering education. The CDIO collaboration network is based on a commonly shared premise that engineering graduates should be able to Conceive – Design — Implement — Operate complex value-added engineering systems in a modern team-based engineering environment to create systems and products. At TUAS, the CDIO approach has been adapted on other fields of education too, not only engineering.

In Capstone, which can be called an innovation project course as well, tight integration between research and practice combined with methods of innovation pedagogy develop the students' abilities to meet actual situations that occur in working life. The result is future workers who are more skilled and more realistic. The primary task of the Capstone Innovation Project is to produce a prototype of a product or service that a company needs, or a potential solution to an as yet unsolved problem. Capstone encourages the companies to boldly try new approaches, test new ideas in a user-centred way and engage potential customers with the designing process. A 6-7 person team of students from different fields and international students bring a new aspect to new ideas and solutions and give a good starting point to bring out new products or services.

Our experience is that the CDIO approach can be integrated with innovation pedagogy successfully in Capstone learning environment, and this approach is able to provide the students with innovation competences, which enable them to participate in the innovation processes in their future working places. As a result of Capstone, graduating students have professional skills and qualifications that are both innovative and development-oriented. Innovation pedagogy strengthened with CDIO approach moves further from traditional theoretical learning to the application of learned skills to practical development challenges.

Integrating multidisciplinary learning environments

The above presented multidisciplinary learning environments are all four implemented in the faculty of Technology and Business. They all interconnected, and form a logical continuum for students to develop their competences in increasingly demanding tasks (Figure 2). The first multidisciplinary learning environment, project hatchery, is obligatory for all incoming students. It is also an introduction to the learning approach, innovation pedagogy, applied at TUAS, getting student acquainted with working together with people with different backgrounds to solve real problems in authentic projects and environments. After project hatchery, student can continue their studies in its later stages as student tutors or assisting teachers. They can also participate in other multidisciplinary studies such as Innocamps or TheFIRMA. In addition, all degree programmes have projects and real assignments integrated with degree studies. Capstone is an obligatory study unit for third year students. Again, student can further develop their competences by participating in more advance RDI projects of the university.

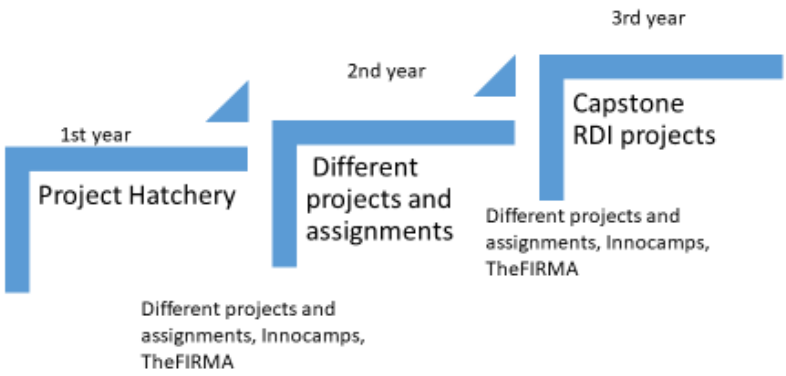

Figure 2. Continuum of multidisciplinary learning environments during studies

Discussion

Higher education institutions have a crucial role in training innovative professionals for their future occupations, and which finally are the source of all innovations. This requires that students have developed innovation competences and acquired needed experience already during their studies. To succeed in this it requires designing new kind of learning environments, wherein innovation competences are needed in the performance of the academic activities. Hakkarainen (2017) also attentions that every person has potential to develop and achieve a high-level intellectual competence if he or she has opportunities to work and interact with experts and with innovative practices. The aim of this article was to introduce examples of some innovative learning environments applied at Turku University of Applied Sciences. These learning environments, project hatchery, Innocamp, TheFIRMA and Capstone presented in this article, offer ideas how to design educational concepts being multidisciplinary and social by nature, bringing students from different study fields together to co-operate and learn, by solving real problems, in real projects, in open environments, in continuous co-operation with businesses and other working-life organizations.

This article also demonstrates that with specific learning environments we can support students' innovation competences development when they are versatile and include many-sided elements. However, designing learning environment requires lot of preplanning and cooperation with teachers. To be an effective teacher in this new learning paradigm requires a move from teacher-directed to student-centered learning and renewing teachers' skills. Certainly, it requires also from students' more active and responsible role as a learner. Innovation development requires risk taking, novel methods and ways to act and think, enthusiastic people, and supportive environments (Assink, 2006), and the same elements should be required in education as well.

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Bios

Dr. Taru Konst is one of the pioneers of the development of innovation pedagogy, and she has published numerous scientific articles and publications about the topic. She is the senior advisor in innovation pedagogy and education development at Turku University of Applied Sciences and acts as one of the key consultants and experts of the topic.

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