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Researching learning environments and students' innovation competences

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Received 13 March 2018
Revised 27 May 2018
Accepted 4 July 2018

Abstract

Purpose – The purpose of this paper is to present an example of pedagogical strategy, called innovation pedagogy, and study whether its learning environments (activating teaching and learning methods, working life orientation and research, development and innovation (RDI) integration, multidisciplinary learning environments, flexible curricula, entrepreneurship and internationalization) can be associated with students' innovation competences (creativity, critical thinking, initiative, teamwork and networking).

Design/methodology/approach – In this case study, the electronic self-assessment questionnaire was distributed to third- and fourth-year bachelor students ($n = 236$) from one Finnish university of applied sciences at the end of the Spring semester in 2017.

Findings – Two profiles of students concerning their level of innovation competences can be identified. The level of students' innovation competences is associated with all the six elements of learning environments. The more students have experience with learning environments of innovation pedagogy, the higher they scored when assessed for their innovation competences.

Research limitations/implications – Because of the case study setting and a limited sample, there are limitations to the generalizability of the findings.

Originality/value – Focusing on different levels of innovation competences of students and approaching their study path in more detail, it could be better understood how to develop more effective education, and thus, respond to the demands of an innovation society. This study extends approaches on research in education and innovation and strengthens the understanding that learning environments should be versatile and include many-sided learning opportunities. It also shows that implementing pedagogical strategy needs lot of work to be revealed in practice.

Keywords Higher education, Learning environment, Innovation competence, Innovation pedagogy

Paper type Research paper

Introduction

All sectors of the economy emphasize the importance of innovations. Businesses and organizations are continuously looking for innovative employees. Companies need innovations to create competitiveness and the public sector needs innovations to produce high-quality and cost-efficient services. As a result, there is an urgent need for future professionals who are capable of participating in innovation processes and who can contribute to the creation of innovations. Innovative individuals are the resource of all innovations and higher education represents a critical factor in human capital development (Avvisati *et al.*, 2013; Edwards-Schachter *et al.*, 2015; Vila *et al.*, 2012). The role of higher education is not only to educate undergraduates for future work but also to train future employees to perform work tasks, which then generate innovations. Higher educational institutions, regardless of context, are expected to prepare innovative individuals capable of coping with the twenty-first century demands (Avvisati *et al.*, 2013; Trilling and Fadel, 2009). A renewed EU agenda for higher education institutions (European Commission, 2017)

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Education + Training
Vol. 61 No. 1, 2019
pp. 17-30
Emerald Publishing Limited
0040-0912
DOI 10.1108/ET-03-2018-0064

not only highlights the unique role of higher education in contributing to innovation but also demands effective and efficient higher education systems.

Although education has a central role in developing human innovation skills, several studies suggest that higher education institutions alone cannot fulfill these demands (Badcock *et al.*, 2010; Quintana *et al.*, 2016). Educational practices, especially in higher education, have been criticized for failing to develop these prerequisites of professional expertise. Traditional forms of teaching, like reading, lecturing and working alone, have even shown to be negatively associated with learning the needed competences (Avvisati *et al.*, 2013; Vila *et al.*, 2012; Virtanen and Tynjälä, 2016). Michael (2006) also highlights the importance of evidence-based education. According to him, when reforming education there is a growing call to base educational decision making on high-quality educational research and pedagogical practices generating efficient learning (Michael, 2006).

To respond to these claims, the aim of this paper is to present an example of pedagogical strategy, called innovation pedagogy, and study whether learning environments built according to it can be associated with students' innovation competences. This study focuses on examining whether there are different student profiles concerning their level of innovation competences and how these students differ based on their study experience of varying learning environments. Focusing on different levels of innovation competences of students and approaching their study path in more detail, it could be better understood how to develop more effective education and learning environments, and thus respond to the demands of working life. Through studying these approaches, important information about how the chosen pedagogical strategy is revealed from students' perspectives during their studies is also gained. First, this paper describes a pedagogical strategy called innovation pedagogy. Then, the data and methodology of this study are described. Finally, the results of the study are presented, discussed and summarized. The paper is especially useful for those who want to train future innovators and to develop higher educational institutions and pedagogical practices that embody the requirements of working life.

Theoretical background

Employees who participate in innovative activities at the workplace are expected to have acquired specific skills and competencies already during their studies (Kivunja, 2014; Quintana *et al.*, 2016; Vila *et al.*, 2012). Kivunja (2014) states that the key to teaching creativity and innovation skills lies in creating quality learning environments in which learners can solve authentic, real-world problems and be inquisitive and open-minded. Vila *et al.* (2012) show that collaborating on solutions to new problems improves the acquisition of innovation capabilities in higher education students. Furthermore, it has been shown that an innovative curriculum improves students' innovative performance (Hu *et al.*, 2016). The development of innovation calls for a continuous questioning of beliefs and behavior, new methods and perspectives, enthusiastic people and supportive environments (Assink, 2006). The same elements should be required in education, as well. In order to train future innovators, alternative pedagogical paradigms are needed to bring education into closer alignment with innovative practices. However, previous studies have shown that skills needed in participation of innovation activities are hardly part of actual teaching or assessment (Badcock *et al.*, 2010; Chung, 2011). Kasule *et al.* (2015) show that teacher performance in the role of innovating, knowledge society facilitating, collaborating and networking, higher education developing and entrepreneurship could not be considered as satisfactory.

Innovation pedagogy as a learning approach

In order to match better with future needs and develop students' working life skills, higher educational institutions have started to develop different pedagogical strategies and practices (Nykänen and Tynjälä, 2012). Although competence-based learning approaches and working life skills are widely cited in pedagogical strategies (Nurmi and Mahlamäki-Kultanen, 2015),

little attention has been paid to innovation competences. In innovation pedagogy, a model to redevelop pedagogy in higher education institutions, innovation competences are functionally integrated into learning systems designs from the beginning of students' studies. Innovation pedagogy is a strategic choice that permeates through the entire organization and its activities, and supports the development of students' competences to participate in the processes of creating innovations (Penttilä, 2016). Competence is a holistic concept that describes a person's ability to manage in a specific context (Mulder, 2012). According to Marin-Garcia *et al.* (2013), competences, capacities and skills can be considered as 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 prerequisites for increasingly complex professional performance. Competence could be described as complex know-how regarding how to act through the effective mobilization and combination of a variety of internal and external resources within a set of situations (Marin-Garcia *et al.*, 2013). Edwards-Schachter *et al.* (2015) add a perspective of learning in the competence approach. They highlight that all the competences can be learned and taught as part of the process of personal development embedded in educational environments.

In innovation pedagogy, both study program-specific competences and innovation competences represent a new sphere of expertise (Penttilä, 2016). To achieve this desired expertise, students must gain necessary study field competences and innovation competences during their learning process. This requires that the pedagogical practices in higher education enable the application of theory to practice and emulate working life and innovation activities. In innovation pedagogy, these are called meta-innovations. According to Kairisto-Mertanen *et al.* (2011), meta-innovations could be defined to include the six cornerstones: activating learning and teaching methods; multidisciplinary learning environments; working life orientation and research, development and innovation (RDI) integration activities; flexible curricula; entrepreneurship and internationalization. As demonstrated in Figure 1, these elements are essential for learning when the aim is training future professionals who are capable of participating in innovation processes and who can contribute to the creation of innovations. The cornerstones are narrowing the gap between the demand for professional skills and the skills that students acquired in the classroom (Kairisto-Mertanen *et al.*, 2011, 2012). The pedagogical roots of innovation pedagogy can be found, e.g., in constructivism, pragmatism, collaborative learning and learning from experience (Kettunen, 2011). It also includes elements of the concept of three dimensional learning presented by Illeris (2009).

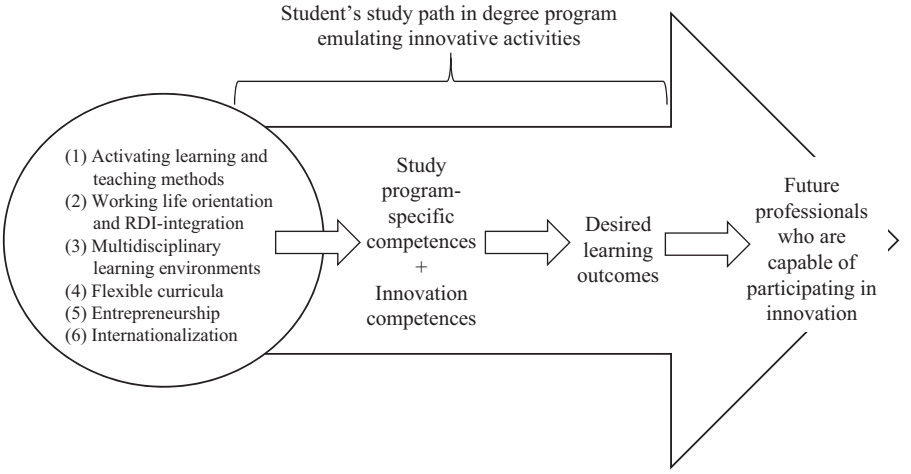

Figure 1.
Student profiles of innovation competences and cornerstones of innovation pedagogy

According to this theory, all learning is a complicated completeness which will always involve content representing knowledge and skills, and incentive representing feelings and attitude. In addition, in learning these two dimensions are always initiated by impulses from the interaction between individual and environment (Illeris, 2009).

The cornerstones of innovation pedagogy

The six cornerstones are essential requirements for innovation pedagogy to succeed and produce the desired learning outcomes. They form the basis of the everyday application of innovation pedagogy, as they are enabled in the learning environments. The aim of learning and teaching methods used in innovation pedagogy is to activate the students. The learners are expected to actively construct knowledge and meaning from the situations they meet. Working life orientation and integration between studies and RDI activities are needed to ensure that learning takes place in dynamic and changing authentic learning environments through real-life situations, assignments and projects, together with working life partners meeting the demands of 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. In an innovation process, different types of knowledge are needed and used. Therefore, the learning environments should also be multidisciplinary. In addition to a physical space, a learning environment is also virtual and social, enabling people with different talents and competences to interact with each other.

A curriculum is one of the key elements in implementation of innovation pedagogy. A flexible curriculum enables students to take various alternative learning paths. Flexibility means that the curriculum can be reformulated and developed during the years of study and according to the needs and motivation of each individual learner. According to innovation pedagogy, education should also offer studies that promote entrepreneurial thinking, as it is needed in working life regardless of the tasks or study field. This involves managing risks connected to innovations and having the courage to seize the opportunity gained through competence. The globalization and multiculturalization of the world and working life require language skills and cultural literacy. The aim of internationalizing teaching is that students develop both professional and working life skills needed to act and work in the global world.

Although there are many theoretical articles and practical cases on how to implement innovation pedagogy in practise (e.g. Kairisto-Mertanen *et al.*, 2012; Kettunen *et al.*, 2013; Konst and Scheinin, 2018; Penttilä, 2016), less empirical studies or statistical analyses are published on how these elements of learning environments can be associated with the students' innovation competences. Similarly, previous studies also comment that research about the competences that can be taught and learnt to prepare students for innovation-oriented action is still defective (e.g. Bjornali and Støren, 2012; Edwards-Schachter *et al.*, 2015) or it is based on only a retrospective assessment of graduates (e.g. Avvisati *et al.*, 2013; Bjornali and Støren, 2012; Paul, 2011; Vila *et al.*, 2012).

Researching students' innovation competences

Instead, many studies of students' generic or soft skills, such as critical thinking, problem solving, and interaction and collaboration skills (e.g. Ballantine and MCourt Larres, 2007; Virtanen and Tynjälä, 2016) and professional competences, such as competences of project managers (e.g. Chang *et al.*, 2007, 2009; Kantola *et al.*, 2005) or entrepreneurs (e.g. Achcaoucaou *et al.*, 2012; Taatila and Down, 2012), have been conducted. However, there are fewer and narrower approaches to innovation competences (e.g. Chang, 2014; Edwards-Schachter *et al.*, 2015; Hu *et al.*, 2016; Kasule *et al.*, 2015). For example, in previous studies, innovation competences have not only been defined narrowly, such as having focus only on the creativity skills, measuring a competence of teachers or as a perspective of students' self-perception and not based on action or behavior, but also approaches to learning environments are limited, like examining only teaching techniques or general perceptions of

training or education. Naturally, the attributes that resemble innovation competences are found in many generic skills or work roles, and there is a wide range of other subjects of innovation, such as innovation-based competence models for organizations and their employees, e.g., Bikfalvi *et al.* (2010), Suominen and Jussila (2009). However, a valid comprehensive framework to study students' behavior or action needed in different phases of innovation processes developed also in an educational context and based on innovation theories is missing. Moreover, Marin-Garcia *et al.* (2013) have shown that there is a research gap in academic literature related to a person's innovation competence, and how to measure and develop it.

Therefore, the purpose of this study is to respond to the lack of research on the topic and bring a new insight to the field of higher education and innovation. This paper combines both educational environments and students' innovation competences and approaches both themes from a more versatile perspective. The aim of this research is to study whether the six cornerstones of innovation pedagogy enabled in the learning environments can be associated with students' innovation competences. Adopting this framework, this study concentrates on examining whether there are different student profiles concerning their level of innovation competences and how these different students differ based on their experiences of learning environments. Focusing on different levels of innovation competences of students and examining their study path in more detail, it could be better understood how to develop more effective pedagogical practises, and thus respond to the demands of working life. Through studying these approaches, important information concerning how the chosen pedagogical strategy is revealed from students' perspectives in their studies is also gained. The research questions are the following:

RQ1. What is the level of innovation competences of third- and fourth-year bachelor students? Are there different groups of students based on their level of innovation competences?

RQ2. Are there differences between different groups of students concerning their study experience of all the six elements of learning environments built according to innovation pedagogy?

RQ3. How innovation pedagogy is revealed from students' perspectives during their studies based on the six elements of learning environments?

Data and methodology

In order to establish students' innovative ability, a novel assessment tool to measure their innovation competences was used. The tool has been developed in the Framework for Innovation Competencies Development and Assessment (FINCODA) project (2014–2017) funded by the European Union. The purpose of the project is to modernize the assessment of learning outcomes, especially in relation to innovation competences in higher education institutions and companies. In the tool, innovation competence is presented to include five dimensions: creativity, critical thinking, teamwork, initiative and networking, which are operationalized for 34 items describing a behavior or action needed in different phases of innovation processes (Butter and van Beest, 2017). Definitions of the five dimensions are:

(1) Creativity: ability to think beyond existing ideas, rules, patterns or relationships, ability to generate or adapt meaningful alternatives, ideas, products, methods or services regardless of possible practicality and future added value.

(2) Critical thinking: ability to analyze and evaluate advantages and disadvantages and estimate the risks involved for a purpose.

(3) Initiative: ability to influence/make decisions that foster positive changes, ability to influence creative people and those who have to implement the ideas.

(4) Teamwork: ability to work effectively with others in a group.

(5) Networking: ability to involve external/outside stakeholders outside the team (Marin-Garcia *et al.*, 2016; Perez-Penalver *et al.*, 2018).

In this case study, the data were collected by inquiring third- and fourth-year bachelor students from one Finnish university of applied sciences. This university of applied sciences was chosen to research object because it has accepted innovation pedagogy as its pedagogical strategy and it has set innovation competences as targeted learning outcomes for all its students. Furthermore, the research focused only on third- and fourth-year bachelor students because it was presupposed that these students, based on their pedagogical understanding and experience, can widely approach their study experiences and also assess their innovation competences. Consequently, the electronic self-assessment questionnaire was distributed to students ($n = 236$) at the end of the Spring semester in 2017. Students came from four different study fields: 11.4 percent ($n = 27$) from culture; 14 percent ($n = 33$) social sciences, business and administration; 35.2 percent ($n = 83$) from social services, health and sports; and 39.4 percent ($n = 93$) from technology, communications and transport; and represented 17 different degree programs. Most of the respondents were female, 61.4 percent ($n = 145$), and 37.7 percent ($n = 89$) were male. Third year students were 67.8 percent ($n = 160$) and fourth year students were 32.2 percent ($n = 76$).

The questionnaire consisted of the 34 operationalized items of innovation competence in which the respondents were asked to rate their own level of competence on a five-point scale: 1 = very poor, 2 = need to improve, 3 = pass, 4 = good and 5 = excellent. In addition, there was the option, "I can't assess" which was excluded from the final analyses. The questionnaire included also some background questions, e.g., on the respondents' gender, study field and work experience, and several questions of students' studying, motivation and learning environments concerning their three to four study years. These questions were scored along a five-point scale, where 1 = not at all and 5 = very much. There was also the option, "I can't say," which was excluded from the final analyses.

Before further analysis, a confirmatory factor model was fitted to the data to test the validation of the assessment tool (χ^2 (481) = 825.14, CFI = 0.90, TLI = 0.89, RMSEA = 0.06, SRMR = 0.06). The test showed that the data form a functional model based on earlier validation studies (Butter and van Beest, 2017), and only one item from the teamwork dimension was removed from the model. After that, five sums scales were created of the 33 variables on innovation competences (Table I). Moreover, on the basis of the theoretical premises of Kairisto-Mertanen *et al.* (2011), variables describing learning environments were selected, and created either as sum scales or were used as a single variable to measure the six cornerstones of innovation pedagogy (Table I).

In order to explore different profiles of students based on their level of the five innovation competences, K-means cluster analysis was conducted. Cluster analysis is the task of grouping a set of objects in such a way that objects in the same group, called a cluster, are more similar to each other than to those in other groups, or clusters (Nummenmaa, 2006). In the follow-up phase of the study, nonparametric Mann–Whitney's *t*-tests were used to compare these student groups concerning their study experience of innovation pedagogy based on the six elements of learning environments. In addition, the effect size of student groups' means was calculated in order to ascertain the intensity of associations, based on Cohen's (1988) standards.

Results

At first, the level of innovation competences of third- and fourth-year bachelor students was determined. After that, it was determined whether these students differ based on their innovation competences. The results of K-mean cluster analysis showed that two different groups of students with different profiles could be identified. The first cluster (Group 1)

Variable	Cronbach's α	Number of items	Examples of items
Creativity	0.92	9	"I generate original solutions for problems or to opportunities" "I show inventiveness in using resources"
Critical thinking	0.84	6	"I face the task from different points of view" "I challenge the status quo"
Initiative	0.83	6	"I systematically introduce new ideas into work practices" "I convince people to support an innovative idea"
Teamwork	0.75	6	"I invite feedback and comments" "I work well with others, understanding their needs and being sympathetic with them"
Networking	0.82	6	"I build relationships outside the team/organization" "I meet people with different kinds of ideas and perspectives to extend my own knowledge domains"
Activating learning and teaching methods	0.60	4	"In the courses which I have taken, the role of student has been active; searching, applying and combining information independently, in a team or group" "In the courses which I have taken, the teacher has used activating learning and teaching methods in the lessons, for example group work, oral presentations, ideation or problem solving tasks, discussions or debates"
Working life orientation and RDI integration	0.71	6	"In the courses which I have taken, external stakeholders, e.g. a company or another organisation, have played a part" "I have done my studies in the RDI-projects in my university's research groups"
Multidisciplinary learning environments	0.76	3	"In the courses which I have taken, there have been exercises where I have collaborated with students from different study fields" "I have studied in multidisciplinary hatchery or project courses for example, as a team member, project manager, advisor or mentor"
Flexible curricula	A single variable	1	"I have carried out my curricula in a flexible way (includes a few examples of cases)"
Internationalization	A single variable	1	"I have studied in an international environment during my studies (includes a few examples of cases)"
Entrepreneurship	A single variable	1	"The studies have supported creating, developing or founding a business idea"

Table I.
Examples of items of innovation competences and cornerstones of innovation pedagogy

consists of students who report the level of their innovation competences being higher, and the second cluster (Group 2) comprises students who report the level of their innovation competences being lower (Table II).

The second aim of the research was to study in more detail these groups of students with different profiles concerning their study experience of innovation pedagogy. The further analyses with Mann–Whitney's tests showed that there were significant differences in the two student groups based on their experience of all the six elements of learning environments. The students who assessed higher in their level of innovation competences report having studied more in learning environments including all the six elements of innovation pedagogy, than those students who assessed lower in their innovation competence levels (like illustrated in Figure 2). In other words, those

students who have studied more in the courses where activating learning and teaching methods have been used, $U = 3{,}597.50$, $z = -3.97$, $p < 0.001$, $d = 0.55$, who reported that their studies have been more working life connected and RDI integrated, $U = 3{,}977.50$, $z = -2.47$, $p = 0.014$, $d = 0.41$, and who have implemented their curricula more in a flexible way, $U = 5{,}034.00$, $z = -2.82$, $p = 0.005$, $d = 0.44$, assessed higher in all five dimensions of innovation competences than those students who reported having studied less in this way. Similarly, those students who have studied more in international, $U = 4{,}787.50$, $z = -3.65$, $p < 0.001$, $d = 0.50$, and multidisciplinary learning environments, $U = 5{,}063.00$, $z = -2.62$, $p = 0.009$, $d = 0.34$, and who perceived more that their studies have been supporting entrepreneurship, $U = 4{,}923.00$, $z = -2.75$, $p = 0.006$, $d = 0.39$, assessed higher in all five dimensions of innovation competences than those students who did not have same kind of perceptions. In addition, the effect sizes of variables, based on Cohen's (1988) standards, confirm the result that there are clear associations between the elements of learning environments and students' innovation competences in the two student groups, albeit at different intensities. From these six factors, especially activating learning and teaching methods and internationalization, seem to have the strongest relations to the competences.

Finally, information about how a chosen pedagogical strategy is revealed from students' perspectives during their studies was approached. As shown in Figure 2, it was discovered that, interestingly, from the perspective of students, the cornerstones of innovation pedagogy have been revealed varied and quite little in the students' studies during the past three to four years. For example, students in both groups perceived that their studies have not, or have only slightly, supported entrepreneurship, and the students' experiences from multidisciplinary learning environments were minor. Instead, activating learning and teaching methods were revealed most in students' studies.

Table II.
Student groups concerning the level of innovation competences

Variable	Group 1 ($n = 130$) Mean	Group 1 ($n = 130$) SD	Group 2 ($n = 102$) Mean	Group 2 ($n = 102$) SD
Creativity	3.75	0.52	2.74	0.52
Critical thinking	3.81	0.46	2.89	0.55
Initiative	3.66	0.49	2.70	0.48
Teamwork	3.92	0.38	3.21	0.48
Networking	3.65	0.50	2.77	0.52

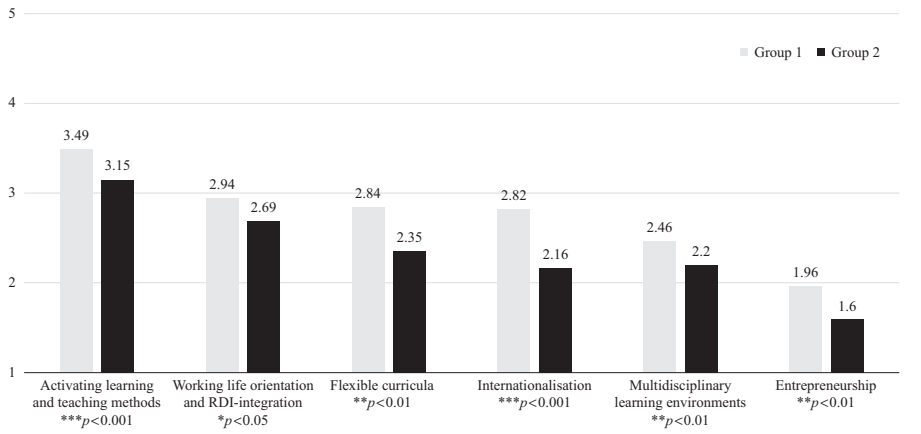

Figure 2.
The outcomes, competences and cornerstones of innovation pedagogy

Conclusion and discussion

Summary and discussion

Innovation pedagogy has an aim to train future professionals who are capable of participating in innovation processes and who can contribute to the creation of innovations. This requires that students have acquired specific competences already during their studies based in qualitative and versatile learning environments. Therefore, the aim of this paper was to study whether learning environments built according to innovation pedagogy can be associated with students' innovation competences.

This study researched what is the level of students' innovation competences of third- and fourth-year bachelor students, whether there are different student profiles concerning their level of innovation competences, and how these students differ based on their experiences studying in different learning environments. Through studying these approaches, important information concerning how the chosen pedagogical strategy is revealed from students' perspectives in their studies was also gained. Focusing on different levels of innovation competences of students, who are close to graduation and the transition to working life, and approaching their study path in more detail, it can be better understood how to develop effective education and learning environments, and thus respond to the demands of working life and an innovation society.

This research shows that there are two profiles of students concerning their innovation competences; students who assessed their competence level higher and students who assessed their competence level lower. When examining these different student profiles further, the results show that students' study experiences based on learning environments of innovation pedagogy play a significant role regarding the level of their innovation competences. The students who have more experience studying in different learning environments of innovation pedagogy assessed their innovation competences higher than those students who have had less experience. In that case, it could be cautiously assumed that those students who have higher level of innovation competences and more experience of learning environments of innovation pedagogy have also higher probability to be innovative at work. Although causal interpretations of this association is not granted with these data, the conclusion is supported by the research works of Avvisati *et al.* (2013), Bjornali and Støren (2012) and Paul (2011), who studied graduates five years after graduation and showed that when graduates' study programs had emphasized, e.g., group assignments, participation in research projects, internships, work placement, project- and/or problem-based learning and entrepreneurial skills, the probability of having introduced innovations or participated in innovation processes at work increased. Vila *et al.* (2012) also highlight that for individuals to take part in innovative activities at the workplace requires that they develop a set of specific skills and competencies during their studies. Bath *et al.* (2004) state that these kinds of skills are best developed when embedded in curricula.

In addition, the results are also supported by previous studies. These studies suggest that specific pedagogical practices, e.g., activating teaching methods, cooperative learning, opportunity to integrate theories with practice, university–company cooperation, emphasizing of entrepreneurship and practice, are developing students' learning of innovation competences (Keinänen and Butter, 2018; Keinänen and Oksanen, 2017), or attributes that resemble innovation competences (Ballantine and MCourt Larres, 2007; Chang, 2014; Henrico, 2012; Hu *et al.*, 2016; Kivunja, 2014; Levine and Guy, 2007; Michael, 2006; Quintana *et al.*, 2016; Rossano *et al.*, 2016; Tynjälä, 1999; Vila *et al.*, 2012; Virtanen and Tynjälä, 2016). On the other hand, a possible explanation for this might be that the students who assessed their innovation competences higher could be described as active players in their studies. In other words, innovative students may be attracted to innovative learning opportunities, and they may have also utilized more different kinds of learning opportunities during their studies because of their, e.g., initiative or networking capacities of innovation competences.

Avvisati *et al.* (2013) highlight that a diverse offering of pedagogies is the most effective way to foster all skills for innovation in the working population. This study also strengthens the understanding that learning environments and opportunities should be versatile and include many-sided elements. All the six cornerstones of innovation pedagogy: activating learning and teaching methods; multidisciplinary learning environments; working life orientation and RDI integration; flexible curricula; entrepreneurship and internationalization are more or less associated with the level of students' innovation competences. Especially, the dimension of activating learning and teaching methods has the most and strongest association with the students' innovation competences. Comfortingly, this result indicates that students' innovation competences could also be supported effectively in quite simple ways. This dimension was also the most visible element in learning environments of innovation pedagogy, although, surprisingly, during the three to four years, the students did not have many experiences studying in learning environments based on innovation pedagogy. This was evident especially among students belonging to Group 2.

Recommendations for the universities

The results of this study suggest that it is extremely important that learning environments and opportunities in higher education are versatile and include many-sided elements. The study also recommends that higher educational institutions ascertain the right methods of how to support different kinds of students in their study path to be more active and encourage them to utilize several learning opportunities. For example, according to Henrico (2012), it is one of the teacher's responsibilities to make students understand what will be needed and necessary in their professional lives. Therefore, discussion of individual learning preferences, how to develop them, and explain why specific learning environments are essential for learning, and what is expected from student as a learner, is important to maximize powerful learning. Kasule *et al.* (2015) state that teachers' innovation competence in a contemporary education system is paramount for the realization of better student learning achievement and outcomes. Kivunja (2014) also reminds that new requirements of professional development are needed to ensure that those charged with the privilege of educating learners for the twenty-first century are themselves well skilled and can in turn teach them effectively to their learners. To be an effective teacher in this new paradigm requires a move from teacher-directed to student-centered learning and renewing teachers' skills (Konst and Scheinin, 2018; Trilling and Fadel, 2009). Certainly, this requires also from students' more active and responsible role as a learner.

However, making the change can be demanding. This study shows that pedagogical strategy demands plenty of work in order to be visible in practice for all the students. Therefore, the study encourages universities for long-term development work and goal-oriented staff training in order to put a pedagogical strategy into practice. Kivunja (2014) also claims that educators and institutions need to educate themselves for change. Moreover, Ramos *et al.* (2012) emphasize training for teachers but remind of how difficult it is to change old habits of teaching staff. Above all, it needs changes in teachers' and educational designers' mindset to realize the important role universities have in producing innovative individuals. For university management this means showing the right direction and encouraging faculty to update their education to be able to implement new ways of delivering education. This could be, for example, emphasizing the importance of small development steps, such as developing and increasing activating learning and teaching methods in the courses. Moreover from the perspective of an individual teacher, it might also be easier to start the change with small steps, like teaching techniques or methods, than with wider structural changes, like curricula or multidisciplinary and international learning environments. From this perspective, the findings of activating

learning and teaching methods in this study raise intriguing reasoning that maybe the direction of the paradigm change toward a new pedagogical strategy has started.

Overall, this study shows that universities have an important and responsible role in training innovative individuals, which finally are the source of all innovations. The findings of this study have a number of important implications for future practice, not only when it comes to developing effective pedagogical practises but also when responding to the demands of an innovation society.

Limitations and future research

However, because of the case study setting and a limited sample, there are limitations to the generalizability of the findings. Also, there is always a risk of possible bias with self-assessments. Even though the validity of self-assessment is contested, e.g., people often respond in such a way that presents them in a more favorable light, numerous advantages support the use of self-report, e.g., people possess better quality of information about themselves (e.g. Paulhus and Vazire, 2007). On the other hand, based on previous studies, validity of expert assessment is also conflicting. It has shown to be elusive and uncertain (Ward *et al*., 2002). Furthermore, the validation study (Butter and van Beest, 2017) of the innovation competence assessment tool used in this research shows that there are reasonable correlations between the self-assessment scores and external indicators of innovation capacity.

This paper suggests that further research should use mixed research methods to increase especially the validity and transferability of the results. In the next studies, different perspectives of key players, such as teachers or peers, and a larger number of respondents are also needed. With qualitative data, e.g., from interviews in-depth description or best practices of innovation pedagogy could also be showed. Moreover, further study could assess long-term effects, for example, how these different students are succeeding in innovation activities at work or how this pedagogical strategy is revealed for new students after extensive staff training or other strategical activities. Notwithstanding some limitation of this study, the results are encouraging and introduce new knowledge about the limited research topic. It also brings new knowledge on the field of higher education and innovation from a wider perspective and new insight for future research, which is an urgent issue when one wants to produce innovations.

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