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## Applying a self-assessment tool to enhance personalized development of students' innovation competences in the context of university-company cooperation

The aim of this article is to test a novel innovation competences assessment tool (including dimensions of creativity, critical thinking, initiative, teamwork, and networking) in a specific pedagogical context in university-company cooperation and demonstrate how it functions in authentic learning environments from the perspectives of students. The article also studies whether innovative learning environments in university-company cooperation support students' innovation competences development. In this practical case-study, students of a one Finnish university of applied sciences were selected from three required undergraduate courses (15 ECTS). The students were from different engineering degree programmes and study years. In all courses, students worked in teams with authentic problem-based assignments coming from companies and the learning was based on active learning methods under the concept of innovation pedagogy. The study showed that a novel innovation competences assessment tool functions in a natural manner in the authentic learning environments and it has a clear added value in educational settings. Moreover, according to the results of the self-assessments and group interviews, the learning environments of university-company cooperation contributed significantly to students' innovation competences development. This article not only demonstrates examples of university-company cooperation but also shows how the development of students' innovation competences can be boosted by using a valid developmental assessment tool. Consequently, this article is useful for those who want to train innovators and to develop higher educational practices to embody requirements of working life.

**Keywords:** innovation competence, assessment, higher education pedagogy, university-company cooperation

Tämän artikkelin tarkoituksena on testata uutta innovaatiokompetenssien (luovuus, kriittinen ajattelu, aloitteellisuus, tiimityö ja verkostoituminen) arviointiin suunnattua työkalua pedagogisessa kontekstissa korkeakouluyritysyhteistyössä ja osoittaa, miten arvointityökalu toimii aidoissa oppimisympäristöissä opiskelijoiden näkökulmasta. Lisäksi artikkelissa tutkitaan tukevatko korkeakouluyritysyhteistyössä toteutetut oppimisympäristöt opiskelijoiden innovaatiokompetenssien kehittymistä. Tähän tapaustutkimukseen valittiin erään ammattikorkeakoulun opiskelijoita kolmelta pakolliselta opintokokonaisuudelta (15 opintopistettä). Opiskelijat olivat eri insinöörikoulutusohjelmista ja eri vuosikursseilta. Kaikissa opintokokonaisuksissa opiskelijat työskentelivät tiimeissä ratkoen aitoja ongelmalahöisiä kehittämistehäviä yrityksille. Oppiminen perustui toimintalähtöisiin oppimismenetelmiin ja oppimiskokonaisuudet toteutettiin innovaatiopedagogiikan mukaisesti. Tutkimus osoitti, että uusi innovaatiokompetenssien arvointityökalu toimii luontevasti aidoissa oppimisympäristöissä ja sillä on selvä lisäarvo koulutusympäristöön. Lisäksi opiskelijoiden itsearvioinnit ja ryhmähaastattelut osoittivat, että korkeakouluyritysyhteistyössä toteutetut oppimisympäristöt edistävät opiskelijoiden innovaatiokompetenssien kehittymistä. Tämä artikkeli tarjoaa esimerkkejä niin korkeakouluyritysyhteistyöstä kuin siitä, miten kehittävällä arvointityökalulla voidaan tukea opiskelijoiden innovaatiokompetenssien kehittymistä. Artikkeli on hyödyllinen etenkin niille, jotka haluavat kouluttaa innovaattoreita ja kehittää korkeakoulukäytänteitä vastamaan paremmin tämän päivän työelämän vaatimuksiin.

**Avainsanat:** innovaatiokompetenssi, arviointi, korkeakoulupedagogiikka, korkeakouluyritysyhteistyö

## Theoretical background

### Innovation competences as learning outcomes – How to assess innovative behaviour?

Innovations can be defined and understood in many ways. According to the general view, innovations created with participating organisations improve or create new processes, services or products for organisations and individuals (Tidd, Bessant, & Pavitt, 2001). Innovations could be incremental or sustainable (remodelling functionality), where existing processes, services and products are developed following the principle of continuous improvement. Innovations could also be radical and disruptive (breakthrough, paradigm shifts), which require new processes to produce new services and products, which may face resistance from customers. (Christensen, 1997; van der Panne, van Beers, & Kleinknecht, 2003.) The object of innovation can be defined as things, products and services, or changes in the way we create and deliver products, services and processes (Assink, 2006). Innovation can be the generation, development, and adoption of an idea or behaviour that is considered new by the people or adopting organization; most innovations are based on the use and combination of existing information (Melkas & Harmaakorpi, 2012). Product ideas that seem irrelevant in one context become relevant in another. Innovation can also take the form of social and organizational change. Ronde and Hussler (2005) assert that innovation is an evolutionary and social process of collective learning. Overall, innovation development requires risk taking, new methods and ways to act and think, enthusiastic people, and supportive environments (Assink, 2006).

Vila et al. (2012) highlight that individuals taking part in innovative activities at the workplace requires for them to have already developed a set of specific competencies during their studies. Bath, Smith, Stein, and Swann (2004) state that these kind of skills are best developed when embedded in curricula as objects for learning. 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 recommend that they be clearly observable and measurable (Buss, 2008; Harden, 2002). The theory of constructive alignment (Biggs & Tang, 2011) is used to define objectives that are aligned with the methods of learning, and finally, with the assessment of learning outcomes. Brown, Bull, and Bendlebury (1997) state, “If you want to change student learning, change assessment”.

Learning outcomes can also be seen in the context in which knowledge, skills and attitudes are all integrated (Harden, 2002). Knowledge and skills of knowledge application play a crucial role in the creation of innovations, as well (Bessant, Caffyn, & Gallagher, 2001), which demands innovation competences. 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. It could be described as complex know-how regarding how to act through the effective mobilization and combination of variety of internal and external resources within a set of situations (Marin-Garcia et al., 2013). Instead, Villa and Poblete (2011) define competence as performance in diverse, authentic, problematic context based on the integration and activation of knowledge, standards, techniques, procedures, abilities, skills, attitudes, and values. Overall, the term competence, and its near relatives, such as competency, skill, capacity and ability, can be somewhat problematic. In literature and many studies the definitions of these concepts lack consensus, and the concepts are used for example indeterminately or with overlaps (e.g., Bohlinger, 2012; Mäkinen & Annala; 2010; Pikkarainen, 2014). Despite different classifications and confusions of these concepts, the definition of innovation competence accepted in this study, follows the definitions of Marin-Garcia et al. (2016) and Pérez-Penalver, Aznar-Mas and Montero-Fleta (2018). According to them, innovation competence is defined as the ability to create, introduce, adapt and/or apply beneficial novelty at any organizational level (Marin-Garcia et al., 2016), and it could be described as a cluster of separate or even overlapping competences, capacities and skills, which jointly can be regarded as innovation competence (Pérez-Penalver et al., 2018).

In order to develop that kind of complex multi-faceted behaviours needed in innovation processes, we also need a metric for individual innovation competences. Constructing an innovation competence assessment tool is not easy, but when we refrain from this we run the risk that in higher education, only what can be easily and transparently measured is taught or assessed. Edwards-Schachter et al. (2015, 28) comment that research about the competences that can be taught and learnt to prepare students for innovation-oriented action is still defective. Many studies of students' generic or soft skills, such as critical thinking, problem-solving, and interaction and collaboration skills, have been conducted (e.g., Virtanen & Tynjälä, 2016), but there are fewer approaches to innovation com-

petences (e.g., Bjornali & Støren, 2012; Kasule, Wesselink, Noroozi, & Mulder, 2015; Vila et al., 2012). Marin-Garcia et al. (2016) have shown that there is a research gap in the academic literature related to a person's innovation competence and how to measure and develop it at university and company levels.

## **Framework for Innovation Competencies Development and Assessment**

To fill the gaps on this topic, the Framework for Innovation Competencies Development and Assessment (FINCODA) project (2014-2017), funded by the European Union, was started. The project aimed to develop a tool for assessing people's performance in authentic innovation processes. In the project, five universities of applied sciences and nine innovation-intensive companies from five countries from the various locations of Europe engaged in university-company cooperation. The project aimed for cooperating for innovation and the exchange of the good practices, improving the quality and efficiency of education, and training and enhancing creativity and innovation. The purpose of the project was to modernise the assessment of learning outcomes, especially in relation to innovation competences in the fields of higher education and business. The project also suggested ways to create a solid path for future innovators from higher education institutions to companies.

The project was aimed at developing a novel innovation competences assessment tool by utilising the existing instrument, called Innovation Competences Barometer (ICB), which has been researched and developed since 2011. The first version of ICB was based on the construction validation study. It was initially constructed on the basis of a broad literature review and analysis of the concepts of innovation, pilot-test, and expert judgment (e.g., Marin-Garcia et al., 2013; Pérez-Penalver, Aznar-Mas, & Watts, 2012; Watts, Marin-Garcia, Carbonell, & Aznar-Mas, 2012). In this version of the tool, innovation competences were grouped into three dimensions: individual, interpersonal, and networking, following the model proposed by, e.g., Kairisto-Mertanen, Penttilä and Nuotio (2011), and Kettunen, Kairisto-Mertanen and Penttilä (2011). Instead, Keinänen, Ursin and Nissinen, (2018) continued developing the ICB in the national context between 2012-2014. They tested and evaluated the functioning of the earlier developed tool in the authentic learning environments of Finnish higher education institutions (N=495), and created and validated a new assessment tool. According to their study, the original three-dimensional model of the ICB was divided into five sublevels describing students' innovation competences in more de-

tail. In the new model, creative problem-solving, systems thinking, and goal orientation are part of the individual scale of the innovation competences; while teamwork and networking skills are connected to the interpersonal and networking scale of innovation competences.

Despite a long-term research and development work behind the assessment tool, there were still some absences and limitations in the previous researches. These studies are based on only the higher educational context and data of students' self-assessments. The development was also mainly informed by academics. Also, the psychometric properties of the assessment tool were not explicitly addressed. Consequently, there was a need to validate a new assessment tool to the context of companies and real innovation processes. Hence, the FINCODA project expanded the use of this assessment tool into companies and increased the knowledge of behaviour-based assessment in universities and business. The project collaborated intensively with the participating companies to identify the factors they are looking for when they want to recruit innovative personnel or enhance existing personnel's innovation competences. The project has selected different types and sizes of enterprises to gain a thorough understanding about innovation competence. Moreover, in the FINCODA project, an extensive psychometric validation study was included, which conducted on a combined set of student data and worker data (see Butter & Van Beest, 2017). This study applies the outcome of the FINCODA project in the specific and authentic educational settings. The aim of the study is to test a novel innovation competences assessment tool in a pedagogical context in university-company cooperation and demonstrate how it functions in authentic learning environments from the perspectives of students. The study also uses the tool to examine whether innovative learning environments in university-company cooperation support students' innovation competences development.

## **Data and methodology**

The used innovation competence assessment tool is based on a literature review and a psychometric validation with mixed-method design including construct validity and criterion validity studies (Butter & Van Beest, 2017; Marin-Garcia et al., 2016; Pérez-Penalver et al., 2018;). Butter and Van Beest (2017) showed that the assessment tool has an adequate reliability and validity. They also showed that there are reasonable correlations between the self-assessment scores and external indicators of innovation competence, such as supervisor ratings of innovative behaviour and real life examples of innovative behaviour. (see Butter & Van Beest, 2017.)

In the instrument, innovation competences are presented to include five dimensions: 1) creativity, 2) critical thinking, 3) teamwork, 4) initiative, and 5) networking, which are operationalized for 34 items (see Appendix 1) describing a behaviour or action needed in different phases of innovation processes (Butter and Beest, 2017). Definitions of the 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/outside stakeholders outside the team. (Marin-Garcia et al., 2016; Pérez-Penalver et al. 2018.)

The present study is a practical case study, which seeks evidence in the case setting (Gillham, 2000), and in which a mixed methodology is used. Students of one Finnish university of applied sciences were selected from three mandatory undergraduate courses (15 ECTS). The students (N=69) were from different engineering degree programmes and study years. Most of the respondents were second-year students, 53.60% (n=37), and third-year students, 31.90% (n=22); the rest, 14.40% (n=10), were first- and fourth-year students. Most of the respondents were male, 82.60% (n=57), and 17.40% (n=12) were female. The criteria for selected courses were that all the courses are similar in extension, carried out in university-company cooperation during autumn semester of 2016, and implemented by different lecturers.

The framework for all courses was innovation pedagogy, which is a pedagogical strategy permeating the entire organization and its activities, including also teaching and learning activities (Penttilä, 2016). Innovation pedagogy enables the development of students' competences to participate in the processes of creating innovations. The learning environments of innovation pedagogy enable the application of theory to practice, thereby emulating working life.

It aims to narrow the gap between the demand for professional skills and the skills that students acquired in the classroom. (Kairisto-Mertanen et al., 2011; Kairisto-Mertanen, Räsänen, Lehtonen, & Lappalainen, 2012; Kettunen, 2011.) In all selected courses, the students worked with authentic, problem-based assignments, and innovated solutions for the companies. The contact lessons combined e.g. theory, working with the assignments, learning in teams and different active learning methods that supported the performing of the development assignment, although courses differed in their content and detailed implementation.

The data regarding students' innovation competences was collected through electronic questionnaires, both in Finnish and English. The data collection took place in two phases: at the beginning (N=87) of the course and at the end (N=77) of it. The data was based on students' self-assessments. Only those students who completed both pre- and final assessments were included in the final analysis (N=69)<sup>1</sup>. In the inquiries, students assessed their innovation competences on a 5-point scale: 1 = Very poor, 2 = Need to improve, 3 = Pass, 4 = Good and 5 = Excellent. In addition, in the pre-assessment, there was also the option, 'I can't assess/Not observed', which was excluded from the analysis. Moreover, in the final assessment, in addition to the 34 items of the instrument, there were some background questions in the inquiry (for example, gender, study year, and work experience). Based on the previous psychometric validation work of the FINCODA project (Butter & Van Beest, 2017), five sum scales were created of the 34 items on innovation competences. The FINCODA scales were ensured to be reliable (Cronbach's alphas in pre- and final assessments are .67 and .74, on average), and paired samples t-tests were used to compare two dependent samples with five scales.

In addition to quantitative self-assessment data, the qualitative data was collected. At the halfway point in the course, one of the student groups (in total, 12 teams) was chosen for an interview. Approximately 30 students from nine teams (three teams were absent) were divided in three interview groups. One interviewer had students from at least two teams and approximately eight to ten interviewees in a group. All the interviews were recorded and transcribed. The aim of the interviews was to gather qualitative information about the function of instrument, and the development of students'

<sup>1</sup> In the pre assessment students were asked to assess their innovation competences and in the final assessment students were asked to assess their learning of innovation competences during the course. Although there were differences in the instructions (and it was acknowledged that it might set certain conditions for the results), the items (see Appendix 1) and a 5-point scale were the same in the both assessment times. This supported, with the consistent results of the interview data, the final decision to compare the assessments in the two conditions.

innovation competences in order to complement the picture arising from the quantitative score differences data and to enhance understanding of the learning process of innovation competences. Interviewers discussed with students about the chosen items of innovation competences (three to four items per student team). In the interviews, students were also asked how they understand these competences, if these competences have been brought up in their development assignments with companies, what kind of meaning these kind of competences would have in their future profession or working life in general, what kind of meaning these competences have at the moment concerning students' studies, and if they see any connections between these competences and innovations. Items 19-21 and 28-30 were not discussed in as much detail as other chosen items because three of the teams were absent from the group interviews. Although there were items chosen as focuses in the discussions, in some part of interviews, students also discussed all innovation competences in general, not only chosen items. Students were also able to see the whole list of items during the discussions.

## Results

The first aim of the study was to test a novel assessment tool in a specific pedagogical context in university-company cooperation and demonstrate how it functions in authentic learning environments from the perspective of students. The students' interviews showed that a novel innovation competences assessment tool functions in a natural manner in authentic learning environments, and thus strengthened the validity of the instrument. The results from three different group interviews were entirely consistent. All teams understood what the chosen items of innovation competences meant, and students were also able to give several explanations and examples of items. Only item number 18 experienced challenges, as the student team did not understand the content of that item. Furthermore, in the interviews with the help of an assessment tool students were able to recognize and demonstrate different kind of situations where students were able to use their innovation competences. For example, students showed several concrete examples of how the items of innovation competences have been brought up in their development assignment.

Example of creativity: I think differently and adopt different perspectives.

*"During this project [a development assignment] you have to of course try to apply different perspectives and find the right solutions there. (—) You of course have to think of different target audiences, for which purpose of*

*use something will be, you have to look from the perspective of each person or of many different target groups, how the product will be used by them, and so that it would benefit as many as possible" (Member of team 1).*

Example of critical thinking: I'm asking "Why?" and "Why not?" and "What if?" with a purpose.

*"Well, we have at any rate posed questions there at the restaurant [subject of the experiment] about why this is necessary and why not and what if it was like this, would it be better. (—) And the representatives [of the company] have at any rate asked us why you do it that way" (Member of team 11).*

Example of initiative: I take an acceptable level of risk to support new ideas.

*"That scales [the development product] of our group, as we really from the beginning have known that it exceeds the budget, but it is in a way a risk that we still consider the idea equal to, as a reasonable option, because it is a good option (—) and of course some reasonable risk-taking may generate this kind of a new, very good idea which can be for example developed in the future" (Member of team 3).*

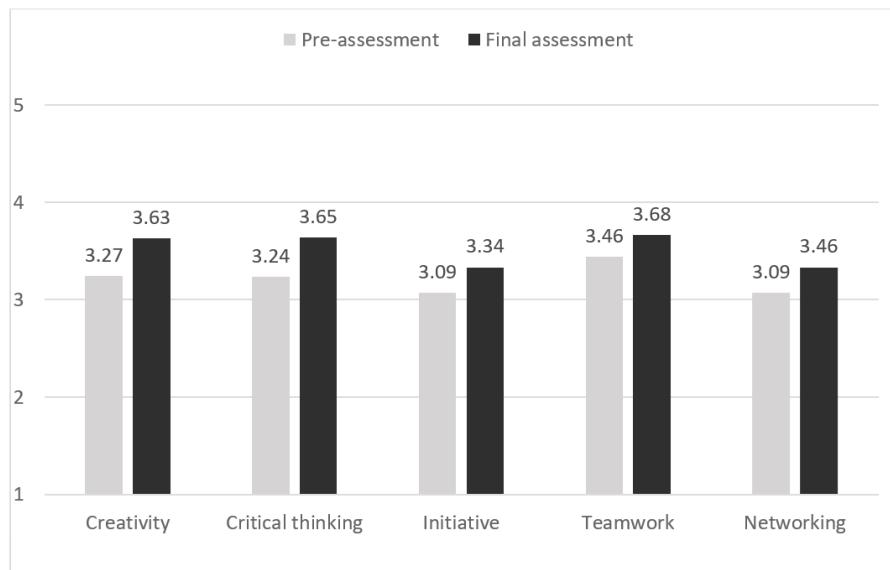
Example of teamwork: I obtain constructive comments from colleagues.

*"Well, also as a team, inside the team, we have asked for feedback and comments, or for example if we do a bit different tasks so we ask for feedback from others (—) The comments from others always help, as long as you can just assimilate them" (Member of team 2).*

Example of networking: I engage outsiders of the core work group from the beginning.

*"We have specifically from the beginning connected outside quarters here. In the project, we started by visiting the kitchens [subject of the experiment] and asking what they will need, what kind of information they will need (—) because we don't really know anything about the matter. (—) And specifically, the thing that you can't be expert on all fields but you have to search for the expertise somewhere else and consult others depending on the need" (Member of team 12).*

Moreover, all the student teams experienced that the innovation competences are meaningfully related to the success of their development project



**Figure 1.** Students' self-assessments of innovation competences during the courses

for the company and they are essential in their future work. Students also saw that all the items of innovation competences have connection to the creation of innovations. They were also able to support their opinions with concrete examples. On the other hand, for some of students the items of assessment tool also raise awareness of the innovation process.

*"We had the situation that each item [of innovation competences] indicates that [creation of innovations]" (Member of team 8).*

*"We, too, especially item 16, as those innovations can be really small though, like what is the crucial point. Or at any rate, what comes to my mind of innovations, is a finished package [product], which has been done and that's it. And the innovation can be a solution for the problem, even of a small detail [solution]" (Member of team 6).*

The second aim of the study was research whether the innovative learning environments of university-company cooperation support students' innovation competences development by utilizing the qualitative and quantitative data. According to the results of interviews, there seem to be several learning opportunities in the learning environments of university-company cooperation where students were able to use their innovation competences. From the students' perspective, especially an authentic assignment and cooperation with a company worked as a natural platform for learning of innovation competences. Moreover, that kind of learning environment not only offered to learners personal experiences but also activated and challenged them to try ideas and think diversely. During

the interviews, some of the teams realized that these kinds of competences can't be learned via books or through traditional teacher-centered lectures. Moreover, some of the students started to reflect on their own learning process from a wider perspective and they found connections between the items and other project studies in their degree programs.

*"Lecture-based courses are usually such that you go there and listen and then there is an exam. In a way it's not [that kind of studying] about inventing something new and there isn't any innovation aspect" (Member of team 5).*

*"This is a different learning experience compared to that if we had read books about what product development is. Now that we have had to do something, we have personal experience of what it is and how you do it [in the future]" (Member of team 11).*

*"This is concretely much closer to kind of real work than the normal studying is. (—) And this challenges to think differently" (Members of team 12).*

Furthermore, the consistent results of interviews gave evidence and support also for the results of quantitative self-assessments. As demonstrated in Figure 1, according to the pre- and final self-assessments based on the results of paired samples t-test, students developed all five innovation competences during the specific courses, creativity:  $t(63) = -5.91$ ;  $p < 0.001$ , critical thinking:  $t(61) = -5.95$ ;  $p < 0.001$ , initiative:  $t(62) = -3.94$ ;  $p < 0.001$ , teamwork:  $t(61) = -3.42$ ;  $p = 0.001$  and networking:  $t(51) = -4.58$ ;  $p < 0.001$ . There are statistically

significant differences between means of pre- and final assessments in all five dimensions of innovation competences.

## Conclusions and discussion

This practical case study tested a novel innovation competences assessment tool in a specific pedagogical context in university-company cooperation and demonstrated how it functions in authentic learning environments from the perspective of students. The results of different group interviews were entirely consistent and they show that the instrument functions in a natural manner and it is understandable and usable from students' perspectives. Students understood what the items of innovation competences mean and could show several concrete examples from the course how the innovation competences were demonstrated therein. They also experienced that competences have an important meaning concerning the success of their development project for the company but also in their future professions or working life in general. To participate effectively in innovation projects, it is important that a student in higher education has a clear picture of the innovation competences that are needed in a specific project, and the extent to which he possesses these. This study indicates that, using the developed assessment tool, innovation competences can be made familiar for students already during their studies. With the assessment tool students were also able to recognize different kind of learning situations, and describe and reflect not only their innovation competences but also their learning and expertise from versatile perspectives. Moreover, the study also suggests that the assessment tool raises students' awareness of the innovation process. Consequently, the instrument offers a clear added value in educational settings. Butter (2013) has also shown that, an online self-assessment tool, such as the innovation competence assessment tool, supports the self-reflections and choices of students at a distance, but in a sound and rigorous manner.

The other aim of this practical case-study was to use the instrument to measure effectiveness of pedagogical practices, and find out whether innovative learning environments of university-company cooperation support students' innovation competences development. The results of pre- and final self-assessments and students' interviews showed that the learning environments of university-company cooperation offer several learning opportunities and contribute significantly to students' innovation competences development. Students developed their creativity, critical thinking, initiative, teamwork, and networking competences during the courses. The results are supported by previous studies, which suggest that especially university-com-

pany cooperation emphasises the prevalence of proactive teaching and learning styles that instil capacities required to lead innovation (Quintana et al., 2016; Rossano, Meerman, Kesting, & Baaken, 2016). Vila et al. (2012) also show that collaborating on solutions to new problems improves the acquisition of innovation competencies for higher education students. Kivunja (2014) states that the key to teaching creativity and innovation skills lies in creating quality learning environments that give learners the opportunity to solve authentic, real-world problems and to be inquisitive and open minded. According to him, in this kind of learning environments, learners are supported to use higher-order thinking skills that require thinking outside the square, analysing, evaluating, elaborating and creating. Students are challenged to spread their imagination so as to come up with new ideas, to open the minds of learners, to encourage them to build networks and to share their own ideas and to seek feedback on their ideas to improve them. As creative and innovative thinkers students realize that process of coming up with something new includes many trials, errors and mistakes, they learn that failure or mistakes are important part of the creative and innovative processes. They learn to reflect on and evaluate their experiences and to work with others to improve on those experiences. Consequently, graduates will be more ready to apply acquired skills in the workplaces and occupations that they will enter on graduation. (Kivunja, 2014.) This article shows one example of that kind of innovative learning environment.

Especially, the results of students' interviews support perceptions that traditional teacher-centred learning environments or forms of university teaching, like reading, lecturing, and working alone, do not necessarily encourage engaged learning and developing needed skills of professional expertise (Tynjälä, 1999; Vila et al., 2012; Virtanen & Tynjälä, 2016). To achieve meaningful and in-depth learning, the focus should be on learning from effortful practice and lived experience, where students can revisit ideas, ponder them, try them out, play with them, and use them (Kettunen, 2011; Levine & Guy, 2007). This practical case study seems to support the impression that the competence to take part in the different innovation processes cannot solely be learned through books. It also needs practicing and learning by doing. Therefore, pedagogical practices in higher education should be formed more to mirror the innovation processes and to connect strongly to working life (Kairisto-Mertanen et al., 2012; Kettunen et al., 2013).

In order to implement these kind of innovative learning environments, the innovation competence assessment tool, presented in this article, can also be used as a framework for designing and developing curriculums or courses. Similarly, the instrument can give for learning team coaches or teachers

concrete suggestions for counseling their students, which further enhances its practical relevance. For example Konst and Scheinin (2018) highlight the importance of the new guidance skills of teacher profession of today, and this article presents a one concrete tool for that. Applying a self-assessment tool further accelerates these learning processes in a personalized way. The innovation competence assessment tool 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. Therefore, it also raises awareness of the innovation process and innovation-related personal development points. Understanding one's own level of innovation competences prepares students better for a more complex life and work environment. Moreover, participating companies in university-company cooperation will benefit, because it allows them to scout innovative potentials at an early stage. Later, they also might benefit from the professionals who will possess better qualifications and who will be better prepared to act in the diverse innovation processes in workplaces. Accordingly, the innovation competences assessment tool can serve as a boundary object between the worlds of education and working life.

However, because of the case study setting and a small sample in this study, there are limitations to the generalizability of findings, as well as a possible bias with self-assessment. On the other hand, although the nature of self-assessment results is complex and there is criticism on the validity of that, numerous advantages support the use of self-report, e.g. people possess better quality of information about themselves (Paulhus & Vazire, 2007). Furthermore, the validation study (Butter & Van Beest, 2017) shows there are reasonable correlations between the self-assessment scores and external indicators of innovation competence. Of course, this research theme needs further investigation. At the same time, we think that the present study presents a nice qualitative example of enhancing innovation competences in a real-life and personalized learning environment, and as such, will promote further study. In future investigations, a larger number of respondents and students from different study fields are needed, and more statistically controlled studies with exact instructions are necessary. Because this study was focused only on the students' perception of learning, lecturers' or company representatives' perceptions could also be considered. Future research should also concentrate more on the differences between individuals' innovation competences, which external and internal factors influence competences, how innovation competences are developing during the whole degree program, if these

competences are connected to employment after graduating, and how these competences are developing in working life.

Although there are some limitations in the study, the results are encouraging and give important and useful information to those who want to train innovators and to develop higher educational practices to embody requirements of working life. This article also presents examples of how university-company cooperation at the operational level is possible on many ways, as part of strategic partnerships or pedagogical practices. University-company cooperation, as part of the course, could be a good starting point for universities and regions with a less developed structure for university-business cooperation.

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## Appendix 1

**Table 1.** Items of the innovation competences assessment tool.

No.	Dimension	Item
1	CT	I think differently and adopt different perspectives
2	TW	I'm attentive when others are speaking, and respond effectively to others' comments during the conversation
3	CT	I use intuition and own knowledge to start actions
4	TW	I invite feedback and comments
5	IN	I foster improvements in work organization
6	TW	I obtain constructive comments from colleagues
7	CT	I find new ways to implement ideas
8	TW	I identify sources of conflict between oneself and others, or among other people, and to take steps to overcome disharmony
9	IN	I take an acceptable level of risk to support new ideas
10	IN	I go beyond expectations in the assignment, task, or job description without being asked
11	NW	I meet people with different kinds of ideas and perspectives to extend your own knowledge domains
12	IN	I convince people to support an innovative idea
13	IN	I systematically introduce new ideas into work practices
14	IN	I act quickly and energetically
15	CT	I generate original solutions for problems or to opportunities
16	CT	I use trial and error for problem solving
17	CT	I develop and experiment with new ways of problem solving
18	NW	I acquire, assimilate, transform and exploit external knowledge to establish, manage and learn from informal organisational ties
19	CT	I challenge the status quo
20	CT	I face the task from different points of view
21	CR	I make suggestions to improve current process products or services
22	CR	I present novel ideas
23	CT	I forecast impact on users
24	CR	I show inventiveness in using resources
25	CR	I search out new working methods, techniques or instruments
26	TW	I provide constructive feedback, cooperation, coaching or help to team colleagues
27	TW	I work well with others, understanding their needs and being sympathetic with them
28	NW	I share timely information with the appropriate stakeholders
29	TW	I consult about essential changes
30	NW	I build relationships outside the team/organization
31	CR	I refine ideas into a useful form
32	NW	I engage outsiders of the core work group from the beginning
33	CT	I ask "Why?" and "Why not?" and "What if?" with a purpose
34	NW	I work in multidisciplinary environments

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