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Students' learning experience in a multidisciplinary innovation project

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Abstract

Purpose – Collaboration between universities and industry is increasingly perceived as a vehicle to enhance innovation. Educational institutions are encouraged to build partnerships and multidisciplinary projects based around real-world open problems. Projects need to benefit student learning, not only the organisations looking for innovations. The context of this study is a multidisciplinary innovation project, as experienced by the students of an University of Applied Sciences in Finland. The purpose of this paper is to unfold students' conceptions of the learning experience, to help teachers and curriculum designers to organise optimal conditions and processes, and support competence development. The research question was: How do students in higher professional education experience their learning in a multidisciplinary innovation project?

Design/methodology/approach – The study took a phenomenographic approach. The data were collected in the form of weekly diaries, maintained by the cultural management and social services students ($n = 74$) in a mandatory multidisciplinary innovation project in professional higher education in Finland. The diary data were analysed using thematic inductive analysis.

Findings – The results of the study revealed that students' understood the learning experience in relation to solvable conflicts and unusual situations they experienced during the project, while becoming aware of and claiming their collaborative agency and internalising phases of an innovation process. The competences as learning outcomes that students could name as developed related to content knowledge, different personal characteristics, social skills, emerging leadership skills, creativity, future orientation, social skills, technical, crafting and testing skills and innovation implementation-related skills, such as marketing, sales and entrepreneurship planning skills. However, future orientation and implementation planning skills showed more weakly than other variables in the data.

Practical implications – The findings suggest that curriculum design should enable networked, student-led and teacher supported pedagogical innovation processes that involve a whole path from future thinking and idea development through prototyping to implementation planning of the novel solution. Teachers promote deep comprehension of the innovation process, monitor and ease the pain of conflict if it threatens motivation, offer assessment tools and help in recognising gaps in individual competences and development needs, promote more future-oriented, concrete and implementable outcomes, and facilitate in bridging from innovation towards entrepreneurship planning.

Originality/value – The multidisciplinary innovation project described in this study provides a pedagogical way to connect higher education to the practises of society. These results provide encouraging findings for organising multidisciplinary project activities between education and working life. The paper, therefore, has significant value for teachers and entrepreneurship educators in designing curriculum and facilitating projects. The study promotes the dissemination of innovation development programmes in between education and work organisations also in other than technical and commercial fields.

Keywords Higher education, Phenomenography, Learning experience, Innovation competence, Multidisciplinary innovation project, Pedagogical innovation process, Individual innovation competence, Diary research

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Introduction

Today, there is a growing pressure on higher education to act as a mediator for innovation and provide preconditions for growth and new solutions for society (Ankrah and Al-Tabbaa, 2015; Rantala and Ukko, 2018). The collaboration between higher education and working life is increasingly perceived as a vehicle to drive this mission. Educational institutions are encouraged to build partnerships and multidisciplinary knowledge sharing by implementing programs based on real-world problems to develop the innovation competence of future professionals (European Commission, 2012, 2017). Innovation development has been associated with teams of diverse individuals and multiprofessional collaboration (Nandan and London, 2013; Sloep *et al.*, 2014; Van Der Vegt and Bunderson, 2005). The motivation for such organisation often springs from the need to solve complex problems that benefit from diverse perspectives (Jonassen *et al.*, 2006; Kurtzberg, 2005; Van der Vegt and Janssen, 2003).

Given this, multidisciplinary collaborative projects are increasingly becoming a mandatory part of curricula in many colleges and universities in all fields of education (e.g. Taatila and Raij, 2011). This paper focusses on students' learning experience in a multidisciplinary innovation project in professional higher education in Finland. Every student completing a four year bachelor's degree participates in a project called the Minno® Innovation project (Minno® Innovation projects, 2018). The course is mandatory for all students. The project course design places special emphasis on multidisciplinary collaboration, which is supported by teachers as facilitators from the university and commissioned by a work organisation as a customer for student teams. The aim for the students is to build novel solutions, products, services or processes to resolve the open challenges presented by companies and other work organisations.

Although there is a long history of innovation defined as disrupting technological novelties with business benefits (see, e.g. Godin, 2016, 2017), we argue that innovations are important in all professional fields. The value they create is tied to the benefit of the user groups, but it can also be tied to more wide spread value, such as economical, well-being, sustainability or social value. E.g. social innovations (Mulgan *et al.*, 2007; Moulaert *et al.*, 2005; Phillips *et al.*, 2015) would be primarily oriented to generating social rather than economic value. Innovations have been defined as artefacts resulting from social process of collectively creating new knowledge that is brought into reality as concrete, novel solutions that are accepted in their usage to convey value (Peschl *et al.*, 2014; Sawyer, 2006). They can take such forms as new services, products, processes, marketing and organisational solutions (Oslo Manual, 2005).

The opportunity of networked innovation development programs and the need to investigate them further to make them as a widely used educational practise has been recognised (Biffi *et al.*, 2017; O'Brien *et al.*, 2003). Both theoretical and empirical knowledge of the implementation practices and challenges have been called for (Rantala and Ukko, 2018). Therefore, we suggest that creating an understanding on how a multidisciplinary innovation project is experienced by the participating students would promote the understanding of the learning opportunities and pedagogical needs. The purpose of the study was to unfold students' conceptions of the learning experience, to help teachers and curriculum designers to organise optimal conditions and processes, and support competence development. The research question was:

RQ1. How do students in higher professional education experience their learning in a multidisciplinary innovation project?

The study adopted a phenomenographic approach and was conducted during three project course implementations. The research participants were limited to non-technical fields.

Innovation development as a learning experience

While discovering the phenomenon of learning experience in a multidisciplinary innovation project, we first focus on: the nature of innovation processes and competence;

multidisciplinary collaboration; and learning experience and collaborative experimentation in innovation projects.

The nature of innovation processes and competence

When students are involved in creative processes in networked communities aiming at implementable outcomes, they act as dynamic and active agents with their individual experiences and competences (Eteläpelto *et al.*, 2013). These experiences and competences are important resources and opportunities. Agency is practiced and manifested when individuals or communities exert influence, make choices, and take stances in ways that affect their work or their professional identities (Edwards, 2010). As a real-life experience, learning to develop innovations can offer challenging, open task action with opportunities to promote the active agency. However today, in higher professional education, learning outcomes are to be defined in curricula. They are "statements of what the individual knows, understands and is able to do on completion of a learning process" (European Union, 2015). The learning outcomes are connected mainly to context (Pikkarainen, 2014). Competence related to innovations is understood as a synonym for a set of personal characteristics, knowledge, skills (or abilities) and attitudes that are connected to creating concretised and implemented novelties via collaboration in complex processes (Hero *et al.*, 2017). Therefore, the processes potentially leading to innovation must be understood before being able to define the needed competences.

Creativity, innovation and new product development processes are intimately correlated. An "innovation journey" is undertaken when inventing, developing, and implementing new products, programs, services or other new concrete solutions (Cheng and Van de Ven, 1996). It is an exploration into the unknown by which novelty emerges. A literature review of innovation process models and their implications (Eveleens, 2010) summarised that the found models had same kind of phases with some order in them. Main phases were idea generation, selection, developing and prototyping, implementing/launch, post-launch and learning/evaluation. Thus, creativity is one part of the innovation process. The process has also been identified to involve rapid prototyping and testing, manufacturing (making), and implementing the product or service (Baregheh *et al.*, 2009). Idea phases require more creative and free methods while it becomes necessary to subject the ideas to stricter development methodologies when developing the solution towards concrete implementation in a product development process (Cooper, 2001; Kahn, 2004). The importance of the recognition of a future opportunity has also been underlined: The recognised opportunities are developed into new ideas and delivered into widely used practice (e.g. Tidd *et al.*, 2001). Similar to other competences, innovation competence can be learned and developed (Bruton, 2011; Peschl *et al.*, 2014).

The competence potentially related to these collaborative processes on an individual participants' level, i.e. individual innovation competence (Hero *et al.*, 2017), has been defined as, e.g. personal characteristics such as flexibility, motivation, engagement, achievement orientation, self-esteem and self-management; skills and abilities, such as future thinking skills, risk-taking abilities, creativity and learning skills, social skills (such as cooperation, networking and communication skills, project management skills, decision-making skills, making skills and technical skills); and knowledge is related to the mastery of one's own field or discipline and knowledge of other fields or disciplines (e.g. Hero *et al.*, 2017; Nielsen, 2015; Edwards-Schachter *et al.*, 2015; Montani *et al.*, 2014; Waychal *et al.*, 2011; Chatenier *et al.*, 2010; Bruton, 2011; Arvanitis and Stucki, 2012; Avvisati *et al.*, 2013; Vila *et al.*, 2014). As competence gets its meaning in the specific context in which it is used (Gulikers *et al.*, 2017; Wesselink *et al.*, 2017), a difference between the experience of authentic work and classroom assignments is evident. E.g. negotiating with a customer differs from negotiating within a student team, developing a new product for real production and

use differs from mere learning assignment and learning in a company differs from classroom learning. To understand the real-life experience, it is paramount to understand the optimal nature of innovation development activity.

Multidisciplinary collaboration

Professional multidisciplinary collaboration is related to the development of innovations as the need for new solutions springs from complex problems in societies or underlying needs of people (Nandan and London, 2013; Sloep *et al.*, 2014; Van Der Vegt and Bunderson, 2005). Complex problems benefit from diverse perspectives and cannot be solved by a single individual, authority or company (Jonassen *et al.*, 2006; Kurtzberg, 2005; Van der Vegt and Janssen, 2003). The term multidisciplinarity refers to professional heterogeneity that is the extent to which a team consists of members from different educational or professional specialisations (e.g. Morse *et al.*, 2007; Shin and Zhou, 2007). The advantages of such groups are that the team members provide a wider variety of knowledge resources and perspectives (Harrison *et al.*, 2002; Kearney and Gebert, 2009; Van Der Vegt and Bunderson, 2005). One of the principal benefits of networking when developing innovations is the pooling of complementary skills (Pittaway *et al.*, 2004). Reuveni and Vashdi, 2015 suggest that the ability of team members to develop a common understanding of the mission and the way it can be achieved is paramount. When multidisciplinarity is high, team members must elaborate on information and communicate more efficiently, increase openness, respect and the efforts in getting to know each other and the skills, abilities and knowledge in the team (van Knippenberg *et al.*, 2004; Ness and Riese, 2015).

Multidisciplinarity of the collaboration seems to benefit in many phases of innovation development processes. It reinforces creative competencies and allow for rich combinations of otherwise disconnected pools of ideas, even more radical ideas and solutions adjusted to complex problems. Diversity seems to make a contribution not only to creativity phases and development work, but also to the implementation, e.g. in commercialisation phases in innovation development by offering wide beneficial networks. As a down side, multidisciplinary teams may encounter a great deal of difficulty (Derry *et al.*, 2005). While professional heterogeneity enlarges, the diverse professional backgrounds and different terminology of the team members may cause tension, which may badly influence communication, collaboration, and team integration (Ancona and Caldwell, 1992; Harrison *et al.*, 2002).

Learning experience and collaborative experimentation in innovation projects

Real experiences have been the main source of inspiration for many scholars who have participated in an attempt to understand learning (e.g. Illeris, 2007). The importance of experiencing learning as practical, real-life activity have been emphasised since Dewey to enable students to act as valued, equal and responsible members of the society. Already Dewey declared that learning is promoted by gaining understanding of the meaning of present experiences and by growing the ability to direct future experiences (Dewey, 1916/1985, p. 83). As education should empower students to their full capacity and more (Dewey, 1938), it should give the mandate to students to trial and error by experimenting in collaboration: "[…] the only possible adjustment which we can give to the child under existing conditions, is that which arises through putting him in complete possession of all his powers […]. [as it] is impossible to foretell definitely just what civilization will be twenty years from now" (Dewey, 1897, p. 78). In the context of innovation projects, Dewey's thinking seems very timely still today. Experiential learning has later been defined as a process whereby knowledge is created through the transformation of experience, as knowledge results from the combination of grasping and transforming experience (Kolb, 1984, p. 41). In Kolb's experiential learning model,

active experimentation, reflective observation and abstract conceptualisation are structurally associated with concrete learning experience to form a learning cycle (Kolb, 1984). The learning cycle was developed from a variety of sources including Dewey. It has been criticised to be a misinterpretation of Dewey's ideas and that it fails to identify a hypothesis that would link together the phases in the learning cycle (Miettinen, 2000). According to Kolb and Kolb (2017), there is often a chasm between theoretical knowledge and experiential activities in higher education that reduces the effectiveness of both. Kolb and Kolb (2017) defines the role of a teacher as a facilitator, subject expert, evaluator and coach, but refrains from deeper analysis of the integral roles of other participants: customer companies and other work life organisations important in, e.g. innovation projects.

The purpose of innovation projects as educational programs is to enhance the innovative performance of individuals and organisations (Donovan *et al.*, 2013; Maritz *et al.*, 2014). An innovation project is a social phenomenon that brings the competence of several individuals together through social processes through which a novel idea is turned into a practical reality (Taatila *et al.*, 2006). Innovation project activities in higher education are designed and facilitated by teachers, firms and other working life organisations as problem- or project-based development activities and have thus been called pedagogical innovation processes when looked from the teachers point of view (Hero, 2017; Lepistö and Lindfors, 2015). A pedagogical innovation process is understood as an authentic learning activity in which collaboratively created ideas are transformed into a concrete end-result, prototyped and tested, and implemented to convey value in the surrounding world through interactions with several stakeholders (Hero, 2017; see also Sawyer, 2006). At the centre of the activity is a problem or challenge from working life and an object-oriented goal to produce a novel solution for such a problem. According Maritz *et al.* (2014), assessment in these educational innovation programs should cover both process and outcome.

Previous research on student learning experiences in experiential innovation projects exists primarily with respect to single-discipline contexts (e.g. Gilbert, 2011; Liebenberg and Mathews, 2012; Keinänen and Oksanen, 2017; West and Hannafin, 2011). In the context of business studies, for example, Gilbert (2011) emphasised the powerful learning experience resulting from the authenticity, concreteness and real-life process of developing a novel product and planning, prototyping, and experiencing "the path an innovation (which can be seen, touched, heard or smelt) will take to market" (Gilbert, 2011, p. 162). In the engineering context, Keinänen and Oksanen (2017) found that university-company cooperation with activity-based learning methods can develop students' innovation competences and student's motivation, importance of learning, atmosphere of the course, learning of field-specific contents and project-based learning preferences are related to learning. Networked innovation project programs may develop managerial, behavioural and technical skills and new methods for innovation, and help students to become accustomed to accept discontinuity, conflict and diversity (Biffi *et al.*, 2017; see also Bissola *et al.*, 2017). The combination of lectures, discussions, collaborative project work and reflection has been found effective in multidisciplinary education in the collaboration of engineering, architecture and construction management students (O'Brien *et al.*, 2003). According to Heikkinen and Isomöttönen (2015), multidisciplinary teams enable students to better identify their own expertise, which can lead to increased occupational identity. They further found that learning experiences are not fixed, as team spirit and student attitude play an important role in how students react to challenging situations arising from the multidisciplinarity. Johnsen (2016) found that for individual participants, multidisciplinary innovation development meant navigating through uncertainty while being part of a team. According to Muukkonen *et al.* (2013), the task, learning objectives and

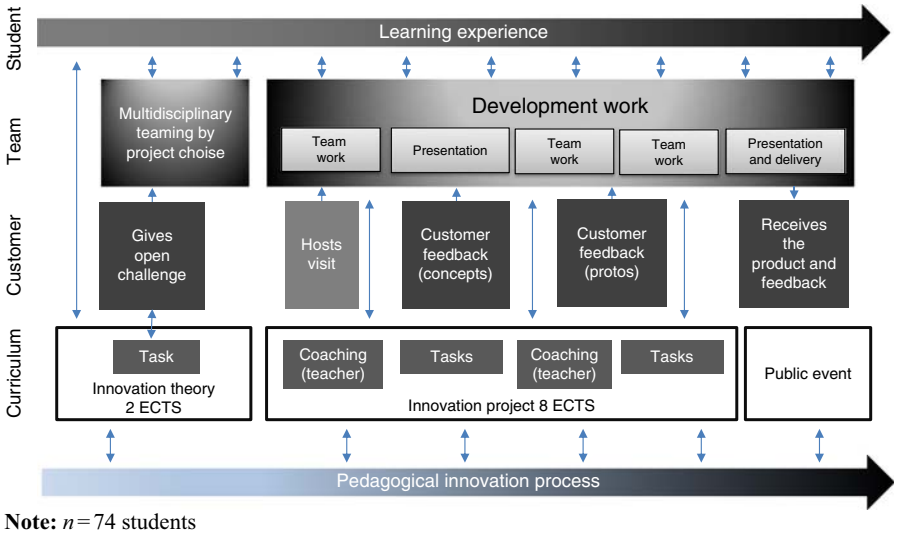
outcomes as well as the appropriate ambition level defined together with the customer have an effect on student motivation, uncertainty and anxiety experiences. To conclude, previous research found the benefits of authentic learning experiences, the active agency of individuals, the positive and negative features of multidisciplinary collaboration, but also left a need for further research concerning authentic learning experiences in multidisciplinary collaboration to help teachers and curriculum designers in all disciplines to organise optimal conditions and processes, and support competence development. Projects need to benefit student learning, not only the organisations looking for innovations.

Research design

Research context

This research focusses on professional higher education in Finland. At Metropolia University of Applied Sciences, every student completing a four year bachelor's degree participates in a mandatory second- or third-year project called the Minno® Innovation project, worth ten European Credit Transfer System credits, equivalent to approximately 270 h of study time. The course is mandatory for all students because, in the university's view, innovation is important in all professional fields. For example, social problems need innovative solutions that produce considerable value in terms of health, well-being, culture, etc. (Minno® Innovation projects, 2018). The project's explicit aim for the students is to build novel solutions, products, services or processes to resolve the open challenges presented by companies and other work organisations. The duration of the project course varies from seven (intensive) to 14 weeks (non-intensive). The course outline in the faculties concerning this study is similar each semester having little variation depending on participating teachers (see Figure 1).

At the centre of the collaborative development activity was a real-world problem or opportunity from working life; the goal was to produce a novel solution to the problem. These tasks or assignments have been referred to as vaguely defined or unclear goals that entail multiple solutions, solution paths or no solutions at all (Voss and Post, 1988; Kitchner, 1983). They involve multiple criteria for evaluation, give no predetermined actions or rules that should be used, require learners to make their own judgements and express



Note: $n = 74$ students

Figure 1. Multidisciplinary innovation project course outline

personal opinions and defend them (Jonassen *et al.*, 2006). Open challenges as tasks for the projects came from companies (42 per cent), public organisations (25 per cent), development projects (21 per cent), associations or foundations (11 per cent) and one social media community. Most of the open tasks came from the health and well-being fields and concerned social problems. The outcome type was not determined in advance. During the 1.5 years of this study, 50 open tasks were given by various organisations. Some examples include: The city for babies; How to maintain well-being in the forest industry?; How to prevent ordinary immigrants from becoming radicalised?; New services for a yoga studio; New simulations for first aid services; How to reduce the loneliness of the youth?; New gaming solutions for a children's hospital.

The teachers formed multidisciplinary teams that were as heterogeneous as possible, according to the students' study discipline and choice of project. The project was divided into theory (20 per cent) and practice (80 per cent). The theoretical section primarily took the form of lectures and materials, either at the beginning or weekly. Course tasks for teams mediated and team collaboration and progress. The school required the teams to produce meeting memos (only in Fall 2015), a project plan, a contract with the customer, package the new product, service, process, etc., produce a video (only in 2016), presentation or an exhibition stand in final event and a poster. The process included orientation and theory, customer presentation and students to choose the project, team project work, a public final event and delivery to customer. Teams received customer feedback on the solutions approximately 2–5 times. In the beginning, the teachers' role was to facilitate a seminar with guest speakers, explain the tasks and aims and teach theory. During project work, the teachers coached the teams 1–3 times a week and organised the first visit to the customer. Teachers helped teams e.g. to realise the way forward by asking critical questions, suggesting ways to test the ideas and reminding of the targets and customer challenge. In the beginning, the teams were presented to their dedicated tutoring teacher or teacher pair. Students could expect the teacher to help in difficult situations, but only a limited time of the week.

Typically, a team's outcome included a preliminary prototype with a planned implementation. The outcomes varied from motion sensor health game prototypes and new type documentary series' episodes to tested event models involving volunteer staff, etc. Some outcomes were productisation manuals with, for example, a depicted production network and branding outline to help the customer implement the solution afterwards. Some of these novel solutions were commercialised and a couple of start-up companies emerged later.

Research question

In this paper we suggest that creating an understanding on how a multidisciplinary innovation project is experienced by the participating students would promote the understanding of the learning opportunities and pedagogical needs. The practical purpose of the study was to unfold students' conceptions of the learning experience, to help teachers and curriculum designers to organise optimal conditions and processes, and support competence development. The research question was:

RQ1. How do students in higher professional education experience their learning in a multidisciplinary innovation project?

Method

Due to the emphasis on the learning experience, the study took a phenomenographic approach. Phenomenography explores the qualitatively different ways in which people potentially experience certain phenomena they meet in their worlds (Marton, 1986; Marton and Pong, 2005). This method was chosen, as phenomenographers understand a learning experience as a

"nondualist model of experience" (Linder and Marshall, 2003, p. 272), very much like Dewey (Dewey, 1897, 1938; Dewey, 1916/1985) and Kolb (1984), rather than depicting it in the form of abstract mental models. Conceptions are the central units of description of the experiences. Phenomenographic interviews were first considered for collecting the data, but eventually a diary method was chosen to enable grasping the conceptions of the experience during the project, not only after. Diaries provided an opportunity to examine participants' activities and reflections in their daily environment (Iida *et al.*, 2012). The diary was a Word template with the following columns to be completed on a weekly basis: "Date and process phase"; "What we did", "What I learned"; "What affected my learning"; "Observations and Work hours". The form concluded with several open-ended questions for self-assessment of cooperation within the team and with the customer, as well as what more the student would have liked to learn. The diaries were maintained during the whole course varying from seven to 14 weeks and collected after the course. The length of the diary text was not specified in advance. Students were informed that they will not be given feedback nor marks on diaries. Students understood that the diary was first read by the tutor, after which the diaries were collected for research purposes as confidential material in which student identity could not be recognised.

Material

The material was collected in a mandatory multidisciplinary innovation project in professional higher education in Finland over the course of three semesters in 2015 (Spring and Fall) and 2016 (Fall). In total, 530 students that participated in 132 different multidisciplinary teams returned their diaries. Students came from health care disciplines, cultural and well-being disciplines and some from information technology disciplines. As the collected sample (530 diaries) was very large for complete analysis, social sciences and cultural management students were first chosen based on their heterogeneity in curricula and content. This ensured variety in the sample. The exact final sample size was decided only after the first reading of the material and the first coding rounds: Thirty-seven diaries in each group (cultural management and social sciences students) of students seemed to reach the saturation point in thematisation. The final sample comprised 74 diaries in total (80 per cent female, 12 per cent male and 8 per cent did not specify their sex). Of these, 84 per cent were aged 20–29 years and 12 per cent were aged 30–39 years old. Three students did not specify their age. The final diary material included 1,480 weekly entries and 370 open question answers. Diaries were typically 600–1600 words or 4–7 pages long. Before the course, cultural managers (CMs) had studied some teamwork and project management, but social services (SS) students only some team work.

Analysis

The diary data were analysed using a data-driven, thematic inductive analysis (Krippendorff, 2013). The analysis was conducted by first reading the diaries twice, and then inductively thematising the content piece by piece to themes identified according to content. The NVivo 10 programme was used to encode the reference units and track the stages of the analysis to ensure the rigor of the process. One reference unit was a sentence, group of sentences, or a part of a sentence discussing the same topic. First, the identified variation in meanings was categorised by description (e.g. Marton, 1981). In line with phenomenographic principles, these categories were not predetermined but were constituted on the basis of the collected data. The first phase of the analysis focussed on identifying and describing the participants' ways of experiencing or understanding the phenomenon in general terms by reading and rereading the data. Repeated readings afforded greater familiarisation with the data. By focussing on the similarities and the differences in the expressed meanings, the cases of variation were identified and themed accordingly. The initial categories of description were further elaborated, adjusted and defined according

to the most characteristic features of each category. In the second phase, the second author acted as the "devil's advocate", probing the preliminary categories (Bowden and Green, 2010). The purpose of such probing was to guard against subjectivity bias and blind spots, and to avoid drawing conclusions too early. Finally, conceptions of the learning experience were categorised according to qualitatively distinct descriptions.

Findings

CM and SS students' conceptions of the learning experience in a multidisciplinary innovation project comprised three categories. These were: solvable conflicts and unusual situations (SCUS); becoming aware of and claiming collaborative agency (CCA); and internalising phases of the innovation process. From all the coded references (in total, $n = 2{,}176$), 31 per cent ($n = 684$) concerned the conceptions of learning experience related to SCUS, 34 per cent ($n = 729$) related to the experience of becoming aware of and CCA and 35 per cent ($n = 763$) were related to internalising an innovation process (IIP).

Category 1 – getting through SCUS

The category of Getting through SCUS consisted of $n = 684$ references and was formed with five sub-categories (Table I). These were: content knowledge that is not specified in advance; team cooperation within a network; outcome not defined in advance – set by team; personal development; and new types of environments.

Content knowledge that is not specified in advance was understood as: learning from other disciplines and industries; and applying one's own discipline knowledge in a new context. The practical application of prior disciplinary knowledge was regarded as useful and as forming new type of content knowledge in the new context. In the same paragraph, a student could describe learning about many different content areas of knowledge, like

Main category	Category	Sub-category	References (f)	References (%)
Conceptions of the learning experience	Getting through solvable conflicts and unusual situations	Team co-operating within a network	233	10.7
		Content knowledge that is not specified in advance	163	7.5
		Personal development	141	6.5
		Outcome not defined in advance – set by team	100	4.6
		New types of environments	47	2.2
	Becoming aware of and claiming collaborative agency	Work independently and responsively	251	11.5
		Actively building team competence	244	11.2
		Collaborating by communicating	130	6.0
		Competence awareness	104	4.8
	Internalising an innovation process model	Innovation theory, methods, tools	156	7.2
		Development project management	134	6.2
		Creative thinking	131	6.0
		Future orientation	25	1.1
		Concepting	55	2.5
		Making a prototype and testing it	156	7.2
		Planning implementation	45	2.1
		Getting and giving feedback	61	2.8
			2,176	100.0

Table I.
Students' conceptions of learning experience

Notes: $n = 74$ students; $n = 2{,}176$ unique references

illnesses, hospital practices and game consoles, which were not the daily contents of their own discipline: "I learned about hospital practices and various diseases by looking for general information about them. Together we also searched information about various game consoles and examples of existing options" (32SS – SCUS).

Team cooperation within a network was understood as: presenting together in an unusual way; limited customer contact; collaborating with other teams; external networks and end-users; and teacher's role was small. The most meaningful situation seems to have been the many opportunities to present by orally pitching ideas, concepts, prototypes and project outcomes to different audiences, including the customers. "I learned a professional pitch" (3CM – SCUS). This was clearly new to most of the students. Students reported that the collaboration with the customer was successful, but considered inadequate:

> As a producer in the team I was in contact with the customer and aided the mutual consultation. The outcome of our project was relatively optimal in the sense that it showed the teams' handprint and customers' wishes – this reflects the good collaboration (11SS – SCUS).

It was not sufficient to have only a couple of opportunities to meet the customer. "Cooperation was low (lions cave and contract writing), but in those situations I acted professionally, and I did not make the project's challenges affect in these meetings" (21CM – SCUS).

The teacher was mentioned in only a few diaries. The teacher seemed to have multiple roles, but did not stand out as a central point in either delivering information or giving direction to project work. Still, there were a few mentions of too much or too little instruction and direction. The teacher seemed to act as a facilitator of joint events and an "encourager" or an "accelerator" of motivation to the team. Otherwise, the student teams' network seemed to be rather wide and unspecified in advance. External networks comprising several partnering companies or freelancers were needed to prototype or launch the solution, e.g., performers and services companies when the novel solution was a new type of event, or musicians to produce soundtrack or encoders if the novel solution was a new type of a game. The meaning of other multidisciplinary teams for learning seems to have been significant. Teams seemed to have opportunities to meet other teams during several phases of the process and they were obviously encouraged to keep in contact and seek advice from them. The role of the end-user (the person who would finally take the novel artefact into use) was minimal and was only referred to as target segment or research informant.

Personal development was understood as: tolerating uncertainty; self-management; flexibility; self-esteem; and taking initiative. Students reported on the development of their own personal identity and attitude. The many situations in which they had to tolerate uncertainty made the process very challenging, but for most people it was the most insightful learning experience. "The first big disappointment in the project. [I learned] to deal with disappointments and get over them" (29SS – SCUS). These occurrences were mainly identified as obstacles in development work, but also as problems in teamwork. Problems in team collaboration were reported to originate mainly from differences between people and their opinions. Some students highlighted their role as "mediator" in these situations. Self-management was evident in the difficult situations in which there was an opportunity to jointly reflect on problems. Students had experienced the need to be flexible in such a large and intensive project, but within the limits of the rules set by the team. "I learned how much flexibility is needed for such a large group work" (3SS – SCUS). The development of self-esteem shows in the acts needing more courage than usual. "I may have learned to trust myself more" (8CM – SCUS). Students learned how to take initiative, as the situations were often unclear and there was nobody who would have the right answer ready. Developing a novel solution required their full capacity to take initiative to be able to proceed in their development work. "Still a bit of ambiguity, but when I was struggling to figure things out, working became easier" (34CM – SCUS).

Outcome not defined in advance – set by team was understood as: effect of motivation; collaborative problem solving; and achievement orientation. The effect of motivation was seen in enthusiasm and excitement that unfolded as the students got started and found viable ideas and sustainable concepts. However, as the outcome was not specified by the customer, the students had to set the goal themselves. This required negotiations in many different phases. The openness or lack of clarity of the task was frequently difficult to cope with and students tried to find solutions to their frustration by laying blame on unclear instructions and poorly explained assignments from the customer. Frustration and excitement alternated, and the teams seemed to be forced to repeatedly reset the goal. If the customer was dissatisfied with the solution or found it difficult to execute, or it was already on the market, the students felt they had to produce a new concept. Many students seemed to find their result or achievement orientation in collaboration. "We thought that now back to business and get on with it. I am pleased with our group" (2CM – SCUS).

Nevertheless, contradictions related to the responsibility of setting goals on their own and the multitude and magnitude of possible directions were clearly visible in the diary entries. "Networked project work has been somewhat familiar to me from working life, but the most challenging thing for me in this project was initially the so-called "playing without notes", i.e. aiming towards an unknown target" (7CM –SCUS):

> Our idea experienced several changes and our goal was often unclear, but my own work was still determined and forwarded to that end. I would also like to thank the group because, although opinions differed widely between us, we always came to a common understanding and a common goal (36CM – SCUS).

New types of environments were understood as: team decided places for teams to meet; attending events; and visiting the company. Stepping out from the school building seemed to be very motivating. Students mentioned the places where they had team meetings, such as cafes and team members' homes. They also found meaning in visiting the customer and describing the meaning of good preparation and professional behaviour. Some students took the opportunity to take their solution to external innovation tournaments, such as hackathons, with the opportunity to win big money or products. Students referred to these events as "networking events", as they mainly attended to find possible partners to continue the development work afterwards. These projects seemed to develop technical solutions, like digital games and mobile applications. The university organised a public final event in which the students were expected to present their solutions both on stage and in a stand set up to enable one-to-one presentations for the fair attendees.

Category 2 – becoming aware of and CCA

The second category, becoming aware of and CCA, comprised $n = 729$ references and was formed with four sub-categories: work independently and responsibly; competence awareness; actively build team competence; and collaboration through communication (Table I).

Work independently and responsibly was understood as: independent team collaboration; taking responsibility as individuals and as a team; working methods decided upon by the team; and freedom to choose one's project. Independent team collaboration was valued and regarded as a source of learning. Students reported that they had learned to take responsibility as individuals and as a team not only because they could do it, but also because they perceived others had challenges in acting responsibly. Only a few admitted that they should have been more active and taken more responsibility. The independence to organise the work was shown as learning new ways of working remotely and as appreciation of physical meetings. Only a few mentioned freeriding to be irritating or disturbing. Freedom to choose the project was found to increase motivation.

Competence awareness was understood as: team members have different competences than mine; working outside one's comfort zone; and understanding myself and my own competence. The most meaningful factor in the project seemed to be the multidisciplinarity of the team. Students emphasised the meaning of different competences than their own and how that helped them to work outside their comfort zone, how they learned from others and how competences were complemented in the practical work. E.g. "I learned that team members with different roles complement each other in the group. It was great to note in practice how these roles were visible when we started to innovate" (13SS – CCA). Students found that they learned to recognise and express their strengths, weaknesses and development needs. A lot of energy was directed towards finding out what team members could do and what skills they had. This was found to be important in many phases: "Where I can develop more, where I want to develop more, what are my strengths. My own and others' perception of myself" (21CM – CCA) and "[…] and that growth is always in the discomfort area if one wants to develop himself" (27SS – CCA):

> I realised that I am very interested in the innovations of the various sectors related to Finnish economic growth and the general economic efficiency. I noticed that I could also have something to give to other work areas than the social sector (2SS – CCA).

Actively building team competence was understood as: deliberately creating team spirit and atmosphere; encouraging and coaching others; division of labour; and consciously changing one's own attitude. Team spirit as a special atmosphere was found to derive from openness, friendliness and confidentiality. "Like the previous meeting, gathering together integrated our work. The group also seemed to relieve accumulated stress and fatigue resulting in the air being cleansed" (10SS – CCA). Students felt they could speak their mind openly and trust others. This did not come naturally only from collaboration; in addition, students felt they had actively sought and built it. "I was deliberately trying to create an inspiring and constructive atmosphere" (21CM – CCA). Some students reported that they had learned how to consciously change their attitude for the benefit of the team's well-being. Many students deliberately gave up leadership positions to help others learn, as they felt they already were experienced in project management work. This reflects the emerging leadership skills students had to adopt in the project:

> I think I acted as a motivator to others. Even though I new and could do a number of things in before, I was not like "yeah, I'll take care of it as I can and you don't". Vice versa. I constantly encouraged others to take on challenges and offered help if needed (21CM – CCA).

Collaborating by communicating was understood as: negotiating within the team; negotiating with customers; writing together; and new communications tools to collaborate. Negotiation skills were learned by actively listening to others and expressing one's own ideas and opinions. "I'm usually bad in saying my opinions out loud, but I feel that I developed in this area considerably during the project" (34SS – CCA). "Listening to and responding to other people with respect, even if you disagree!" (8CM – CCA). "If a customer rejects some idea you believe in strongly, you should not throw the axe to the pit, but re-present the idea again and better it" (10SS – CCA). Students also valued the opportunity to learn English when the exchange students on the team offered the opportunity and required it. Literary products, such as concept papers, a project or communication plan, project report and communication or marketing materials, were often jointly produced. "[I] learned about writing together" (35CM – CCA).

Category 3 – internalising an innovation process

The third category, IIP model, consisted of $n = 763$ references and was formed with eight sub-categories. These are: innovation theory, methods, tools; creative thinking; future orientation; concepting; making a prototype; planning implementation; getting and giving feedback; and development project management (Table I).

Innovation theory, methods and tools: students understood the concept of innovation as something that it is not an idea or an invention, but a concrete artefact that is taken into use to benefit people. Students reported learning and understanding process models and methods. Some of the students could name different types of ideation, concepting and concretisation methods, such as "world cafe" for idea development and "service blueprinting" for concretising an abstract service artefact.

The internalised innovation process entailed several recognised phases. In relation to creative thinking, students primarily recognised the phases where idea production and development had taken place, along with critical thinking as a reflection of ones' own activity. "Defining the idea, advancing the development of it, critically thinking about what works and what does not" (31CM – IIP). Future orientation, or thinking towards the future, related to envisioning the product or service under development and preparing for a coming situation in anticipation of its arrival. Concepting was recognised and mainly referred to as learning how to write a concept paper by concretising, specifying and finding out whether the idea was viable and how useful it would be. Several ideas were concretely rationalised to be presented to the customer. Making a prototype and testing it was seen as crafting a product model or designing a non-material service idea in a concrete and functional sample. "[…] I crafted a woollen wig and tassels" (3SS – IIP), "[…] Creating a 3D keychain design template" (1CM – IIP) and "What kind of materials should be avoided. Different colours can also be annoying stimuli. Developing a versatile space for brain-damaged persons is challenging" (37SS – IIP). The services' prototyping showed as making deals with service providers to an event or by making a blueprint, i.e., a visual representation of how the service would function in practise. "I learned to make a service blueprint" (3CM – IIP).

Many students reported that they had learned technical skills, e.g., new design software and shooting and editing photos and video; a couple of students had even learned a little coding of a game. Learning how to do research was reported as testing a prototype with a limited group of potential users, by searching research information and by making surveys and interviews. Here, the role of the end user is seen as a source of information to be able to develop the novel artefact further. Planning implementation was seen as how the team would deliver the product, service or a novel process into use by specifying budgeting, sales, branding and marketing planning actions. E.g. "Budgeting and profitability calculations" (9CM – IIP), "We made an ad copy text to the marketing team for a press release, a budget, and a social media campaign" (34SS – IIP) and "[…] and I think we branded it well" (1SS – IIP). These were concretised, for example, as a marketing plan and an innovative social media campaign rolled out during the execution of a pilot event. Some students mentioned entrepreneurship literally. "The idea of starting a startup company. The foundation of a company" (37SS – IIP). After succeeding in an external event like a hackathon pitch for investors, some students mentioned that the team had discussed the details of establishing a company. Also, some customers had presented their models of entrepreneurship.

Getting and giving feedback: students highlighted the meaning of getting and giving feedback in many different process phases as well as with both customer and team members. Students had received feedback from customers in the idea, concept, prototyping and end phases of the project. "Real partner from working life and feedback from them contributed significantly to my learning" (37SS – IIP). Students had received personal feedback from their team members. Students mostly recognised the feedback sessions that were formally facilitated, such as pitching concepts to customers, commenting on other teams' work, the final event and when teams had the opportunity to meet the other teams. The value of learning to give and get feedback is clear in the data; it is mentioned by some as inadequate in relation to success in product development work. Facilitated peer-assessment is mentioned as a crucial learning opportunity. Teachers' course assessment was not mentioned.

Development project management: students reported either to have learned or applied previous knowledge in leading a team. CMs reported they already knew process planning and management, but a development project was not that familiar. They also reported several types of difficulties in project management, but did not recognise a relation of these difficulties to their own management skills. E.g. "We used a lot of time to sort out things that should have been clear already some time ago" (1CM – IIP) and:

> All the members of the group, except one, attended our meeting. Me and the other cultural manager ended up to do almost all the work while the two others stared and did nothing. They did not bother to get excited nor throw ideas into the air. Perhaps this difference is due to the field of education? I started feeling annoyed that I did not urge them to equal work input (34CM – IIP).

Still, they could apply previous knowledge and the SS students seemed to learn from them.

Discussion

As the university–working life collaboration is increasingly perceived as a vehicle to enhance innovation, educational institutions should build partnerships and multidisciplinary activities based around real-world problems to develop the innovation competence of students (e.g. Ankrah and Al-Tabbaa, 2015; Rantala and Ukko, 2018; European Commission, 2017). This research aimed at unfolding the range of ways students conceptualise their learning experience in a multidisciplinary innovation project carried out in networked collaboration. By applying a phenomenographic approach, it was possible to form a three-category outcome space of students' conceptions of the learning experience and draw conclusions regarding the competencies, process and the encountered challenges students recognised related to the experience. The findings suggest that students' learning experience was multidimensional and versatile, and that students could recognise their competence development and agency in the process (Figure 2).

First, much of the students' experienced learning related to SCUS related to multidisciplinarity and open tasks. The multidisciplinarity gave opportunity to learn content that was not possible to define in advance. Many students found the customers' role too small, and teachers were mentioned only a few times. The most meaningful network comprised serendipitous meetings with other teams' members from different fields and those external professional networks that were needed to complete the product in practise. Contradictions in teamwork were related to positively experienced personal identity development of flexibility, self-esteem and self-management, but also to learning collaborative problem solving. This finding supports the personal characteristics found in Hero *et al.*, 2017. The open task required a lot of proactive initiative, responsibility, motivation and achievement orientation; most students found that they learned how to tolerate uncertainty. This also supports the findings of Johnsen (2016), who found that although innovation is promoted by teamwork, multidisciplinary collaboration and external partnerships, for an individual students' learning experience it means navigating in uncertainty. However, in our data, this was often seen as an initiator of learning. This finding adds to the previous multidisciplinary collaboration research as it was not referred to as a bad influence to communication, collaboration and team integration (Ancona and Caldwell, 1992; Harrison *et al.*, 2002), but understood as a personal growth and learning opportunity.

Second, students found they had learned how to work responsibly and independently, both as a team member and as an individual, how to explicate and make use of other peoples' competence in new situations, ways to actively build and develop the team towards the best possible outcome and how to collaboratively communicate and negotiate within the team and with external customers. The agency of the students was clearly strengthened during the project as students had to act in the collaboration as dynamic and active agents by bringing their individual experiences and competences to the fore

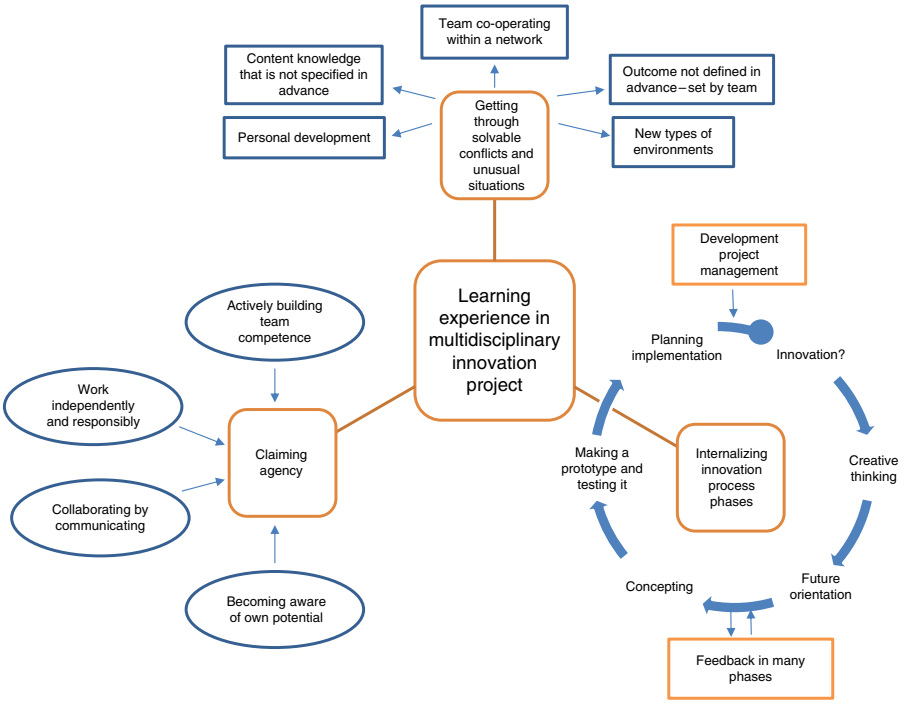


Figure 2.
Students' conceptions of their learning experience in a multidisciplinary innovation project based on diary data

(Eteläpelto *et al.*, 2013; Edwards, 2010). This study also supports the findings of Ness and Riese (2015), who found that a multidisciplinary innovation project benefits from the ability to recognise each other's competences and previous experience. Students also found that they had learned to recognise and express their own strengths, weaknesses and development needs. This study thus supports the results of Heikkinen and Isomöttönen (2015), who found that multidisciplinary teams enable students to better identify their own expertise. This potentially enhances students' own ability to set learning goals by themselves and teachers to identify competence gaps for more targeted tutoring.

Third, students showed clear understanding of innovation as a concept, that is not only an idea, but a concrete, implemented artefact that convey real value to its users (cf. Sawyer, 2006; Peschl *et al.*, 2014). The innovation concept seems to be internalised as something that students can participate in making, but it requires many different people and wider networks. Based on the findings, this experiential way of learning was a pedagogical innovation process supported by the teachers as it allowed creative idea generation, selection, developing and prototyping, implementing, post-launch and learning assessment phases (Eveleens, 2010; see also Hero, 2017; Lepistö and Lindfors, 2015), but adds to this definition also futures thinking for opportunity recognition (category 3; Tidd *et al.*, 2001) and concrete implementation phases (category 3; Baregheh *et al.*, 2009; Cooper, 2001; Kahn, 2004), such as productisation, sales, marketing and entrepreneurship planning phases. The students found that they had learned innovation process phases such as idea development and future visioning, as well as advances towards more reasoned concepts. These are crafted to a product or service prototype that is tested. A plan is developed as to how it can be taken to the market or otherwise into use to convey value by producing branding, sales, marketing and budgeting and finally considering whether there would be a business or

other type of entrepreneurship opportunity (see category 3). Thus, these findings mainly support Gilbert (2011) while promoting the meaning of a direct experience resulting from a "path to innovation" as recognised process phases, but adds to the process models presented by Eveleens (2010) as assessment was not understood as a phase only in the end of the learning process, but as integrated to all phases from beginning to end of the project. Giving feedback to others and getting it in many phases was of utmost importance to students' learning experience. Students emphasised the meaning of methods and tools that helped the necessary work and development project management.

The competences students recognised as developed related mainly to: innovation theory, their own and others' discipline content knowledge (category 1: content knowledge that is not specified in advance); personal characteristics (category 1: tolerating uncertainty, self-management, flexibility, self-esteem, take initiative and responsibility); emerging leadership skills (category 3: development project management; actively building team competence, encouraging and coaching others and division of labour); social skills (team co-operating within a network (category 1: collaborating and networking) and collaborating by communicating (category 2: communicating); creativity (category 3); future orientation (category 3); technical, crafting and researching skills (category 3: concepting, making a prototype and testing it); and several types of marketing, sales and entrepreneurship planning skills (category 3: implementation planning, commercialisation). What may have caused these findings? The most interesting findings are those that are lacking. Future orientation and implementation planning skills showed more weakly than other variables in the data (see Table I). This may indicate a competence gap in coaching. SCUS may have been caused by the multidisciplinarity and open tasks. The ability to understand and claim collaborative agency may have been caused by the independence of the team, but also by the fact that there was no other choice than to just try to cope in difficult situations. IIP may have been caused by the theory lectures and materials, but also by the integrated coaching and customer feedback in many phases. The programme seems to have offered an authentic development experience that a more theoretical part of the programme has been able to explicate (Kolb and Kolb, 2017) and vice versa.

These finding add to previous research on innovation education programs that assessment should cover process and outcome (Maritz *et al.*, 2014), but also the competence development during the process. In addition, these findings add to previous research on individual innovation competence (e.g. Hero *et al.*, 2017; Nielsen, 2015; Edwards-Schachter *et al.*, 2015; Montani *et al.*, 2014; Waychal *et al.*, 2011; Chatenier *et al.*, 2010; Bruton, 2011; Arvanitis and Stucki, 2012; Avvisati *et al.*, 2013; Vila *et al.*, 2014) the meaning of "being responsible" personal characteristic, and building team competence by encouraging and coaching others as special leadership skills. In addition, innovation theory as specific content knowledge and the content knowledge that cannot be specified in advance are supported as innovation competences in this study, but not in previous studies presented in this paper. In addition, implementation skills, such as marketing, sales and entrepreneurship planning skills show clearly in the data, but not in previous research presented. Students' agency as a learner thus seems to relate not only to "my own learning", but also to the responsibility for other students' learning. Surprising as it is, the previous research on individual level innovation competence has not emphasised the competences related to implementation phases (see Hero *et al.*, 2017).

Conclusions and implications to practise

The purpose of this study was to unfold students' conceptions of the learning experience, to help teachers and curriculum designers to organise optimal conditions and processes, and support competence development. The data shows an image of the students' agency in a multidisciplinary innovation project, the contradictions students encountered, the innovation

process phases they could conceptualise, and the competences they could recognise. A multidisciplinary innovation project described in this study is a pedagogical way to connect school to the practises of society and work life. Working at the boundaries of different disciplines and networks seems to push students to act creatively and proactively and take responsibility for their actions and learning. The negative experiences related to unevenly distributed workload, inadequate input from the customer and feelings of uncertainty and unclarity of the task. Frustration was expressed, but there were also many references to solve these problems and learning related to it. Contradictions and tensions occur and students have to solve them. Findings indicate that conflicts and contradictions do not have a drastically negative effect, but offer a collaborative problem solving environment and opportunity for personal development. The multidisciplinarity of the innovation process seemed to promote this. Most of the students seem to have been very engaged in the project work, but some diaries expressed lack of motivation. A couple of students lacked interest or time in writing diary during some weeks. Nevertheless, the diaries provided a rich view of students' reflections. The findings show a picture of a real-life learning experience of active experimentation (Kolb, 1984), where the learning outcome is impossible to be defined in advance in much detail, where the immersion and engagement to project work is obvious and the problem space is unlimited and unpredictable (cf. Johnsen, 2016; Gilbert, 2011; Biffi *et al.*, 2017; see also Dewey, 1938, 1916/1985).

The dependability and confirmability of this qualitative study has been advanced by trying to conduct and report the research process as explicitly as possible and by offering access to the original data with many citations from the diaries. However, three limitations concerning the credibility and transferability (Guba and Lincoln, 1994) have to be considered before applying this research. First, the diaries offered access only to SS and cultural management students' views, in only one Finnish university of applied sciences with a special course outline. The transferability of the results to other contexts can be limited. Second, studying the phenomenon without active involvement might have provided different results. The first author was involved as a teacher in the three project courses. This could be considered a major limitation, if the aim and methods would have been different, i.e. observations or one-to-one interviews. There were 530 students in total, it is not likely that she tutored exactly the same students that participated in this research as the diaries were anonymous and the sampling was randomized. Third, the phenomenographic method has limitations even it makes no claims about "the truth" of its results (Åkerlind, 2005), as other scholars would most likely have found different categories. However, the two-reviewer analysis process offered more careful considerations with several discussion and joint reflection opportunities. The method naturally produced a large number of experiences compared, for example, to materials where students would crystallise the most essential learning at the end of the project. This made it hard to conclude the most important learning experience, but offered visibility to deeper sensations and feelings during the project.

Several implications for pedagogy and curriculum development can be deduced. The pedagogical innovation process supported by teachers should allow the learning of content knowledge of innovation theory, creative thinking, future orientation, concepting, making a prototype and testing it and planning implementation (cf. Eveleens, 2010; Hero, 2017; Lepistö and Lindfors, 2015). In addition, the process could allow assessment opportunities in many phases of the process to make competence development transparent to benefit the development work and learning as the facilitated peer-assessment was mentioned as a crucial learning opportunity (see category 3). The curriculum design could enable such activities that promote the entire process, from future thinking all the way to implementation of the novel solution. Without the possibility to grasp all the critical phases, it resembles ideation or invention processes and many opportunities for learning are omitted. This study also shows that the role of tutoring is implicitly critical in many senses.

It was surprising that the students did not recognise the role of the teachers, but emphasised the meaning of their own and the team's competence and could name the phases of an innovation process. Teachers should have their "fingers on the pulse" of teams to ensure optimal learning outcomes.

We will make five recommendations based on the theoretical and empirical evidence of this research. First, the teachers seem responsible for the deep comprehension of the innovation process so that it can be transferred later to working life with these future professionals. Based on the frequencies (Table I), there are gaps in the ability to conceptualise future thinking as well as plan the implementation of the solution. Students would possibly benefit from help from teachers in these phases, at least to grasp the opportunities. Second, the teachers have the opportunity to monitor and control the experience and ease the pain of conflict and contradiction if needed. Too much conflict and new situations might cause a decrease in motivation and affect performance (Biffi *et al.*, 2017; Bissola *et al.*, 2017; Derry *et al.*, 2005). This is particularly true of leadership skills, like coaching others, the ability to recognise competencies, building team spirit and negotiating the division of labour; all these areas can be underdeveloped and need support in recognition. Third, the teacher can translate practical work into understanding the professional competence developed during the project. To promote learning, tutoring and integrated assessment could operationalise the meaning of the competencies within the specific situation more clearly (Gulikers *et al.*, 2017; Wesselink *et al.*, 2017), not regard them as quantitatively measurable absolutes that are tested in the end of the project (cf. Keinänen and Oksanen, 2017). Teachers and students should have the skills and tools to recognise individual competence, competence gaps and learning needs to be able to determine their own ends for the learning experience (Dewey, 1916/1985). Students reported that the team used much energy in trying to understand what the team is capable of developing. An individual's sense of his own competence could be aided by making individual strengths, weaknesses and development needs more easily and openly understandable to all team members. Pedagogical tools are thus needed to make the competences in team more transparent (see van Knippenberg *et al.*, 2004; Ness and Riese, 2015). Assessment tools can be developed based on the understanding of the competence needed for innovations (cf. Hero *et al.*, 2017). Fourth, teams could be capable of more future oriented, concrete and more implementable outcomes, if students were tutored more in first phases, such as future orientation, and in final phases like productisation, production and marketing planning (Table I). Students expressed learning in a multitude of ways even though the outcomes were most often only implementation plans, not implemented innovations. Therefore, the most important factor for learning seems to be the process (Cheng and Van de Ven, 1996; Gilbert, 2011), not the actual outcome or whether it is an innovation or not by the definition of the word. Fifth, it can be recommended that teachers would take an active role in bridging the innovation process towards entrepreneurship as students did not seem to recognise entrepreneurship planning skills (Table I). Entrepreneurship can be identified as an important innovation implementation opportunity. (cf. Taatila, 2010) If students have internalised practical innovation development processes during their studies, they can be more ready to apply the same process models later in working life as entrepreneurs. Entrepreneurs would benefit from the innovation competence and more routine in developing new implementable solutions in networked collaboration.

Compared to previous research, this study contributes thus to the multidisciplinary innovation pedagogy research era by unfolding the student conceptions of the learning experience in detail and as a whole, as the students were capable of reflecting on their experience from many angles. However, this study raises future research needs on team collaboration and learning, collaborative assessment opportunities and methods and teachers roles to give more insight on multidisciplinary innovation pedagogy.

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