How to measure students' innovation competences in higher education: Evaluation of an assessment tool in authentic learning environments

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ABSTRACT

In all sectors of the economy, the importance of innovation is underlined. Although education plays a central role in the development of human innovation skills, several studies suggest that higher education institutions cannot fulfill these demands. In such, there is a need to update pedagogical practices and develop assessment tools to measure and develop a person's innovation capacity. The aim of this study is to test and evaluate the functioning of the earlier developed assessment tool to measure students' innovation competences in the authentic learning environments of Finnish higher education institutions. The electronic self-assessment questionnaire was distributed to students (n = 495) from four Finnish universities of applied sciences. The results showed that the questionnaire statements formed a functional innovation competence barometer for self-assessment, including creative problem-solving, systems thinking, goal orientation, teamwork, and networking competences. The assessment tool facilitates the development of teaching, assessing, and curriculum design in higher education.

1. Introduction

Rapid changes in society and working life challenge higher education institutions to respond to new demands. The role of higher education is not only to educate undergraduates for future work but also to train future employees to perform work tasks, and ideally, to generate innovations. A renewed EU agenda for higher education institutions (European Commission, 2017) also highlights the unique role of higher education in contributing innovation, and the demands for effective and efficient training systems. Although education has a central role in the development of human innovation skills, several studies suggest that higher education institutions cannot fulfill these demands (Badcock, Pattinson, & Harris, 2010, 442). Educational practices, especially in higher education, have been criticized for not developing these prerequisites of professional expertise (Tynjälä, 1999, 358; Vila et al., 2012; Virtanen & Tynjälä, 2016). Previous studies have shown that skills needed in participation of innovation activities are not yet part of actual teaching (Edwards-Schacter et al., 2015) or assessment (Kivunja, 2014). Therefore there is a need to update the curricula in higher education and re-design assessment structures (Edwards-Schacter et al., 2015; Kivunja, 2014).

This article responds to the demand, and presents an assessment tool for higher educational institutions to measure students' innovation competences. The study applies earlier innovation theories in the field

of higher education, and continues the development of an assessment tool based on an earlier construction validation study (Marin-Garcia et al., 2013; Pérez-Peñalver, Aznar-Mas, & Watts, 2012; Watts et al., 2012). The aim of this study is to test and evaluate the functioning of the earlier developed tool in the authentic learning environments of Finnish higher education institutions. First, this article describes the theoretical background of innovation competences in higher education and presents main steps and results of earlier development processes for constructing an assessment tool. Then the data and methodology of this study are described. After that, the results of the testing are shown and a valid assessment tool to measure students' innovation competences is presented. Finally, in the concluding section, the main results of the study are discussed and summarized. Also, some examples of how to use the tool in the practice are presented. This article is useful for those who want to train future innovators, and develop and diversify assessment practices of higher education.

2. Theoretical framework

2.1. Innovation competences as learning outcomes in higher education

Innovations can be defined and understood in many ways. According to the general view, innovations are generated by certain abilities to create and commercialize new information. Innovations

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could be incremental or sustainable (remodelling functionality) and radical or disruptive (breakthrough, paradigm shifts). The objects 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, 217). 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, 1151) assert that innovation is an evolutionary and social process of collective learning. Suominen and Jussila (2009) state that organizational innovation capacity constructs of not only organization climate and culture, organization leadership and structure, organization processes, tools for idea and innovation generation, but also people's competencies. Therefore both organizational enablers and barriers for innovation and individual' innovation competences should be taken into account. They argue that innovation capability perspectives of team members could be significantly different in individual capabilities and organizational capabilities and that both perspectives are needed to set collective innovation goals. (see also e.g., Bikfalvi et al., 2010.) 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 for individuals to take part in innovative activities at the workplace requires that they develop a set of specific skills and competencies during their studies. Bath, Smith, Stein, and Swann (2004) state that these skills are best developed when embedded in curricula as objects for the learning process. 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), and that assessment should always be in line with intended learning outcomes. Postareff (2017) states that assessment should also be supportive and students should be involved in assessment. According to her, that means changing from a culture of testing to a culture of supporting learning, from controlling and teacher-centeredness to active agency of the students and student-centeredness, and from assessment of products to assessment of process. Thomas, Martin, and Pleasants (2011) also highlight the importance of holistic assessments, where self and peer assessments are playing a significant role in future learning in higher education. According to Chang, Kantola, and Vanharanta (2007), the student self-evaluation can be considered as an efficient tool for learning. Sturing, Biermans, Mulder, and Bruijn (2011) also present that especially in competence-based education students are challenged to reflect on their own learning by which they further develop their competence. They assert that the study programme or curricula should be structured in a way that the students increasingly self-steer their learning. In order to increase students' active role in assessment of learning outcomes, new and valid self-assessment tools are required.

Assessing learning outcomes can 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 et al., 2001), which demands innovation competences. Competence is a holistic concept, which describes a person's ability to manage in a specific context (Mulder 2012, 36). According to Marin-Garcia et al. (2013, 49), competences, capacities and skills can be considered as the three categories of complexity in contextualized know-how. A competence is formed by a set of capacities and these, in turn, are formed by several skills, all of which are required for a more complex professional performance. It could be described as complex know-how resulting from the integration and adaptation of capacities and skills to situations having common characteristics, or as complex know-how regarding how to act through the effective mobilization and combination of a variety of internal and external resources within a set of situations. (Marin-Garcia et al. 2013, 49.) Villa and Poblete (2011, 148) define competence as performance in a diverse, authentic, problematic context based on the integration and activation of knowledge, standards, techniques, procedures, abilities, skills, attitudes and values.

How, then, can one measure the complex cognitive behaviour needed in the creation of innovations? Is there a risk that only what can be easily and transparently measured is taught or assessed in higher education? In the light of previous studies there seems to be still a lot to improve as regards research into the competences that can be taught and learnt to prepare students for innovation-oriented action. This deficiency has been pointed out by many scholars saying, for instance, that such research is hard to find (Bjornali & Støren, 2012), it is scattered and poor with theoretical background (Edwards-Schachter et al., 2015, 28) or it is based only on a retrospective assessment of graduates (e.g., Avvisati et al., 2013; Bjornali & Støren, 2012; Paul, 2011; Vila et al., 2012). Naturally, a number of attributes similar to those apt for innovation competences can be found in many generic skills or work roles. We acknowledge that many studies of students' generic or "soft" skills, e.g., critical thinking, problem-solving, and interaction and collaboration skills (e.g. Virtanen & Tynjälä, 2016), and professional competences, such as competences of project managers (e.g. Kantola, Karwowski & Vanharanta, 2005; Bikfalvi et al., 2007; Chang et al., 2007; Chang et al., 2009; Makatsoris, 2009) and entrepreneurs (e.g. Achcaoucaou et al., 2012), have been conducted, but there are fewer and narrower approaches focusing only to innovation competences in the context of higher education (e.g. Edwards-Schachter et al., 2015; Hu, Horng & Teng, 2016; Kasule et al., 2015). In these previous studies innovation competences have been defined narrowly and with inadequate variables, such as focusing only on creativity skills (Hu et al., 2016) or measuring a competence of teachers (Kasule et al., 2015) or dealing with students' self-perceptions, not with their action or behaviour (Edwards-Schachter et al., 2015).

Instead, there are some encouraging case studies on competence models of student action or behaviour – including also innovation competences – in pedagogical contexts (such as Kantola, et al., 2005; Bikfalvi et al., 2007; Chang et al., 2007; Chang et al., 2009; Makatsoris, 2009; Achcaoucaou et al., 2012). However, many of these studies are focused only on university students and based on limited samples. In addition, a wide range of studies on other subjects of innovation already exist, dealing with e.g. innovation-based competence models, but focusing on organisations and their employees (e.g. Bikfalvi et al., 2010; Suominen & Jussila, 2009). Therefore, valid comprehensive research frameworks are still scarce when it comes to student behaviour or action needed in different phases of innovation processes developed especially in educational contexts and based on innovation theories. Marin-Garcia et al. (2013, 6) have also shown that there is a research gap in academic literature related to a person's innovation competences, and how to measure and develop it. To fill in the gap, Marin-Garcia et al. (2013), Pérez-Peñalver et al. (2012), and Watts et al. (2012) conducted a validation study to measure students' innovation competences in higher education by following the steps of the Instrument Development and Construct Validation methodology. This article continues these earlier validation studies and evaluates the functioning of the three-dimension model instrument in authentic learning environments of Finnish higher education institutions. Therefore the earlier development and research work is described more detailed in the next chapter.

2.2. Measuring students' innovation competences: the three-dimension model

Firstly, Pérez-Peñalver et al. (2013) defined and operationalised innovation competences. The definition work was based on a literature