How to Assess the Innovation Competency of Higher Education Students

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Abstract Starting with the definition of innovation, for this paper we selected the INCODE-ICB-v5 questionnaire as the measurement instrument for individual innovation. Given that said questionnaire has not yet been specified or validated in scientific publications, we showed that its measurement model is formative. The measurement model was subsequently validated, so that it can be used in the future to collect data from dependent or independent variables of causal models. It also provides a tool for teaching professionals interested in measuring the innovation competency levels of their students.

Keywords: Innovation, Competences, Higher Education, Validation, Questionnaire

1 Introduction

Innovation is one of the more popular concepts in business management. It is considered one of the essential ingredients of competitive advantage given that it is an intangible component that is difficult for competitors to replicate. This explains why during the current economic crisis, many people look to the innovative capacity of companies as a potential lifeline, and to some, the only one for European business. Broadly speaking, innovation is considered to be of key importance when improving the productivity or efficiency of companies, increasing the quali-

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ty of products, decreasing production costs and reducing manufacturing times (Bessant et al. 2001; Cerinšek and Dolinsek 2009).

The definition of innovation is a well-developed concept for which there is a considerable consensus amongst researchers. Innovation is regarded as a process that facilitates the implementation of a new product or service, production method, the opening-up of new markets, a change in suppliers, business and management models that are perceived as developments within the organization and that aim to improve its performance (Schumpeter 1934; Vaccaro et al. 2012; Goffin and Mitchell 2010; Marin-Garcia et al. 2011; Lehto et al. 2011).

Appearing less frequently however in academic publications is research focusing on the innovative capacity of individuals, how to measure it and how to further develop it (Cerinšek and Dolinsek 2009). And this is the whole focus of our paper. We review the concept of innovation competency of individuals, describing certain models used to measure their degree of development, we select an instrument to measure the innovative competency of university students, specifying the measurement model, and we then validate the measurement instrument using a sample of 332 Spanish university students.

2 Innovation Competency and its Components

According to Villa & Poblete (2007), competency can be defined as, "Good performance in diverse, authentic contexts based on the integration and activation of knowledge, standards, techniques, procedures, abilities and skills, attitudes and values". Recommendations by the European Qualifications Framework for Lifelong Learning (2008) add the terms responsibility and autonomy to the meaning of competency, defining it as "the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development".

Competency can also be defined as complex knowledge resulting from the integration and adaptation of capacities and skills to situations that share common characteristics. Capacity is moderately complex expertise, which incorporates skills that require procedural and conditional knowledge. A skill, on the other hand, is straightforward know-how (Bessant et al. 2001; Drejer 2001).

Although there are alternative classifications to group the different skills together, we have used a model that specifically focuses on innovation competency (Lehto et al. 2011; Penttilä and Kairisto-Mertanene 2012; Watts et al. 2012). According to said model, the capacities and skills that comprise innovation competency can be broken down into three categories: individual, teamwork and networking.

Individual capacity is linked to creativity, persistence, risk taking and personal outlook (See Table 1). These aspects relate to innovation (Ferrari et al., European

Union 2009). The process of generating new ideas is not the same as applying them in practice, and calls for dealing with different critical incidents, problems and tasks that require innovative thinking and responses so as to overcome any difficulties that might arise (Cerinšek and Dolinsek 2009; Berdrow and Evers 2010). The ability to work as part of a team is one of the foundations of communication and team leadership. Communication is an essential part of the process of the collective construction of ideas (Marin-Garcia et al. 2010; Marin-Garcia et al. 2011), as well as for its subsequent processing, assessment and arguments (Berdrow and Evers 2010). The final category, networking, implies a process of transformation, which, once carried out, has an immediate and medium-term effect on society. Innovation must go hand in hand with ethical values and social responsibility, and this includes sustainability (Hamzah and Abdullah 2009; Waychal et al. 2011; Mulder et al. 2007).

Due to limitations of space, we are unable to list the items of the INCOD-ICB-v5 questionnaire in this paper, but requests can be made via email for a copy of the questionnaire in either Spanish or English, as well as for statistical descriptions, correlations, detailed lists of the PLS analysis and the percentage tables of the scales constructed.

3 Specification of a Measurement Model for the Innovation Construct

The relationship between the items and the construct to which they are associated can be described as reflective (the value of the items change reflecting a change in the latent construct whereby all the items will have a high correlation with each other and are interchangeable) or formative (a change in any of the items is what changes the value of the latent construct, the significance of which is defined by the items that comprise it). A single construct can be measured using reflective or formative items. The specification of the measurement model consists of stating explicitly that one has opted for a formative or reflective operationalization of the items used to measure the construct (Petter et al. 2007). The measurement model of the INCODE-ICB-v5 questionnaire (Watts et al. 2012; Marin-Garcia et al. 2011) measures the innovation construct with a series of 25 questions, grouped into three categories (Individual, Interpersonal – teamwork – and Networking). Responses were given a score of between 1 and 5 (1= major improvement needed; 5= excellent).

A group of decision rules allows researchers to decide what type of association exists between the latent variable and its items, and in doing so they can correctly specify the measurement model (Jarvis et al. 2003; Petter et al. 2007). The items included in the INCODE-ICB-v5 questionnaire to measure each of the competencies are clearly formative. Furthermore, the three competencies are in turn a form-

ative definition of the second-order construct to measure the innovation competence, creating a type 4 multidimensional model: specified as formative for both the first order constructs and the second-order construct (Jarvis et al. 2003).

4 Methodology

Given that we have established the formative measurement model specification, the main goal of the paper is to validate said model. During the analysis of the statistical descriptions, special attention is given to missing values, skip patterns, range of responses, skewness and kurtosis. We also analyze the inter-item correlation to see if any of them are greater than 0.4 (Petter et al. 2007). We check the collinearity, regressing the items on a construct and checking that VIF values are below 3.3 and condition indices below 30. To assess the formative constructs, we use PLS (Ringle et al. 2005) using non-parametric bootstrapping (300 cases, 5000 samples and individual sign changes) and we analyze the weights for the outer model (>0,1) and bootstrap significance (>1.66).

The population comprises 506 university students from 3 centers: a Faculty of Business Administration and two university schools (Industrial Engineering and Design Engineering). To get students to complete the web questionnaire, invitations were sent out via email to students enrolled in the 2012-13 academic year studying a series of six different first-semester subjects. The average response rate was 66%, ranging between 56% and 100% depending on the subject. The size of the sample complies with the requisite that the number of cases should be at least ten times the number of items of the construct. In our case, the individual construct has 12 items, therefore the sample was required to have more than 120 cases.

5 Results and Discussion

Practically all the individuals responded to all 25 items on the questionnaire, so any missing values are not due to the characteristics of an item, nor do they present a problem for the data collected as a whole. For the majority of the items, the response distribution average is located in the medium to high part of the scale. The standard deviation is not very high, for a scale with 5 response levels, the asymmetry is low for all items and are moderately platykurtic. In other words, the majority of responses are spread out across the scale (more uniform than a normal one), with a slightly higher concentration in the upper levels of the scale. Items ICB15, ICB16, ICB17, ICB18 and ICB23 have a “floor effect” (second value of

the scale), although none have a "ceiling effect", whereby the range of answers remains at 5 for the majority of items (20 of the 25).

The correlations of the items are, for the most part, significant and positive although moderate or very low. The maximum correlation value is 0.55 (between ICB18 and ICB19) with only 7 correlations registering a value greater than 0.40 (in addition to the one already mentioned, the correlations between ICB01-ICB02; ICB14-ICB15; ICB15-ICB17; ICB16-ICB17; ICB16-ICB18; ICB19-ICB20; ICB21-ICB22). The majority of these high correlations occur in the teamwork category (although these only account for 5 of the 26 correlations). The collinearity statistic values are lower than the cut-off values. All items have VIF values of below 1.75 and the condition indices are 23.16 for the individual, 22.18 for teamwork and 10.53 for networking. Furthermore, the VIF values for the constructs are below 1.30 with a condition index of 12.37.

Following analysis of the Partial Least Squares, for individuals, 9 of the 12 items have weights of greater than 0.1 while 8 of them are significantly different from zero. For teamwork, 6 of the 8 items have a significant weight with 4 of them significantly different from zero. In the case of networking, 4 of the 5 items are relevant with 3 of them significantly different from zero. Lastly, the weights of the latent variables in the second-order construct, which represent the innovation competency of students are all relevant and significant.

Figure 1 represents the measurement model of the second-order innovation construct, comprising three categories: individual, teamwork and networking. It includes the weights of the items and constructs.

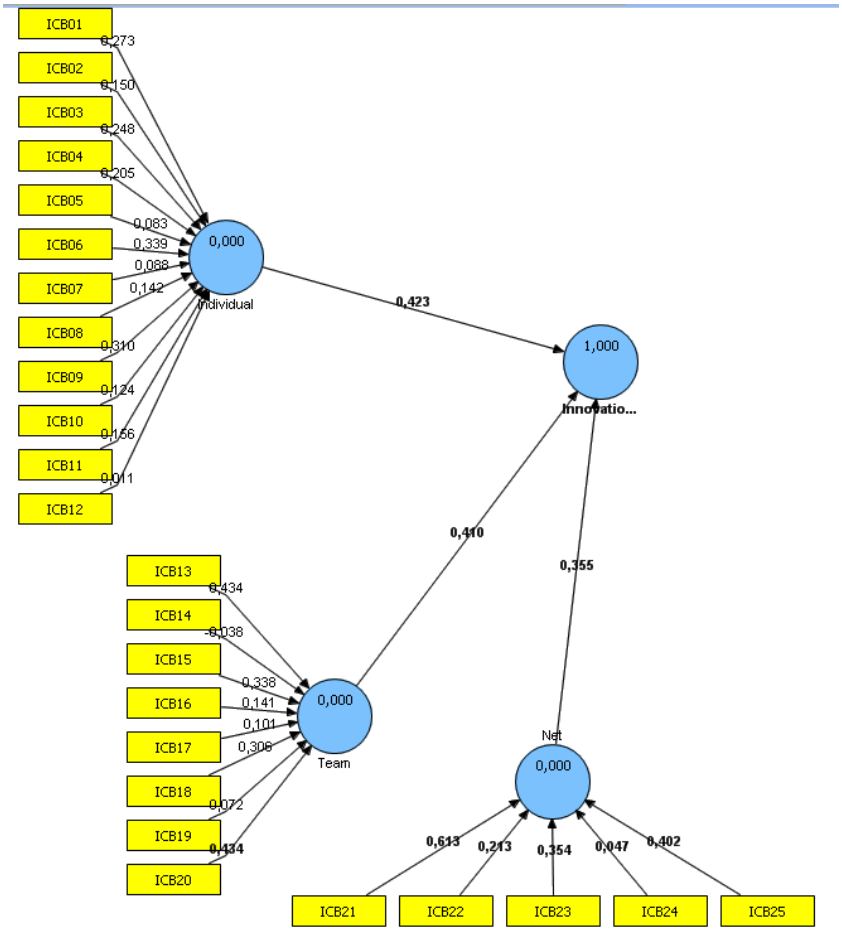

Fig. 1 Weights of the measurement model

6 Conclusions

This paper sets out the specification and subsequent validation of a formative measurement model to measure the innovation competency of university students. It can generally be regarded that the proposed model adequately complies with the content validity and validation test criteria for formative models. Items relating to teamwork have been the most problematic, probably due to the correlations that exist between them, as well as certain special characteristics in the definition of item ICB16 and more importantly ICB17. These will require additional detailed

analysis in the future. In the individual category, it would be advisable to review items ICB05, ICB07 and above all ICB12 to determine if these are essential for defining the construct and if they can be substituted, modified and added to a multidimensional index (Petter et al. 2007; Jarvis et al. 2003; Diamantopoulos et al. 2008). It might also be useful in future research to increase the sample to include a wider variety of qualifications, courses and universities, thereby overcoming the current limitation, namely the fact that the proposed scale can not be extrapolated to all Spanish universities given the limited population of the original study.

Nevertheless, and taking into account the logical precautions in the initial stage of developing and validating measurement scales, one could consider that this paper brings with it a number of contributions to the academic community.

This work provides contributions to researches in the fields of innovation, business and human resource management as it fills a void by providing a valid and reliable instrument for measuring the degree of innovation of individuals. This instrument can then be used to measure dependent and independent variables in research that aims to test explanatory and causal models. Furthermore, we provide an explicit specification of the measurement model at the design stage of the questionnaire – a stage frequently overlooked in articles published on validating measurement instruments.

For university teachers too, it provides a valuable contribution by providing a simple yet satisfactory instrument for assessing a group of transversal subcompetences, customary in Spanish university curricula, although teachers do not have the support tools to be able to measure them. In the future, our aim is to further expand the work to develop training and the use protocol for this instrument, at which point there will be a standardized questionnaire and a corresponding reference scale allowing university teachers to be able to measure the innovation competence of their students.

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Annex

Innovation competence in the INCODE- ICB-v5 questionnaire (Spanish version)

Capacity	Cod	Skill
Individual	ICB01	Hago propuestas adecuadas a las exigencias de la tarea
	ICB02	Ofrezco ideas que son originales en contenido
	ICB03	Ofrezco nuevos modos de materializar las ideas
	ICB04	Evalúo críticamente los fundamentos básicos de las tareas y acciones
	ICB05	Identifico las relaciones entre los diferentes aspectos de las tareas
	ICB06	Exploro diferentes puntos de vista
	ICB07	Utilizo hábilmente los recursos disponibles
	ICB08	Anticipo cómo se pueden desarrollar los acontecimientos
	ICB09	Muestro entusiasmo
	ICB10	Soy perseverante
	ICB11	Tomo riesgos inteligentes
	ICB12	Oriento las tareas hacia el objetivo final
Interpersonal	ICB13	Transmito ideas de manera efectiva
	ICB14	Escucho a las otras personas del grupo
	ICB15	Utilizo el diálogo para establecer relaciones constructivas en el grupo
	ICB16	Colaboro activamente
	ICB17	Contribuyo a que el grupo funcione bien
	ICB18	Tomo iniciativas
	ICB19	Muevo a los otros a actuar
	ICB20	Afronto los problemas constructivamente para alcanzar consenso
Network	ICB21	Aplico valores éticos en las decisiones del grupo
	ICB22	Intento que las tareas tengan un impacto en la sociedad
	ICB23	Puedo trabajar cooperativamente en entornos multidisciplinares o multiculturales
	ICB24	Soy capaz de comunicarme usando idiomas extranjeros
	ICB25	Establezco relaciones básicas con personas que participan en iniciativas a nivel local, regional o institucional