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How to assess innovation competence in services: The case of university students
¿Cómo medir la competencia en innovación?: aplicación a estudiantes universitarios

Juan A. Marin-Garcia [1], M. José Pérez-Peñalver [2], Frances Watts [3]

[1] Grupo IEMA y ROGLE. Departamento de Organización de Empresas. Universidad Politécnica de Valencia (UPV) Camino de Vera s/n, 46022 Valencia. España.
[2] Grupo IEMA. Departamento de Matemática Aplicada. Universidad Politécnica de Valencia (UPV) Camino de Vera s/n, 46022 Valencia.España.
[3] Grupo IEMA y Di-AAL. Departamento de Lingüística Aplicada. Universidad Politécnica de Valencia (UPV) Camino de Vera s/n, 46022 Valencia. España.
jamarin@omp.upv.es, mjperez@mat.upv.es, fwatts@upv.es

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Abstract: The main purpose of this paper is to review the concept of innovation capacity in higher education students, proposing constructs for a measurement model of innovation capacity as a second-order formative model and validation of measurement scales with 332 students from a Spanish university. The proposed model can be considered to meet, in general, the criteria for content validity and the validation tests suitable for the formative model. Thus, the academic community can benefit from a validated measurement instrument that can be used in the future to collect data on dependent and independent variables in causal models. The paper also presents a contribution for teaching professionals interested in measuring the degree of development of innovation competence in their students.

Keywords: questionnaire validation, innovation, competence, capacity, skills, assessment, higher education, PLS.

Resumen: Este trabajo presenta una definición de la capacidad de innovación de los estudiantes universitarios. Para ello se propondrá el modelo de medida de las variables latentes, considerando la capacidad de innovación como un modelo de segundo orden formativo. Las escalas se han validado con una muestra de 332 estudiantes universitarios españoles. Podemos considerar que el modelo propuesto cumple, en general, con los criterios de validez de contenido y las pruebas de validación de escalas formativas. Ofrecemos a la comunidad académica un instrumento validado que puede ser usado, en el futuro, para medir variables dependientes o independientes de modelos causales. También representa una contribución para los profesores universitarios interesados en evaluar el grado de desarrollo de la competencia de innovación en sus alumnos.

Palabras clave: validación de cuestionario, innovación, competencia, capacidad, habilidades, evaluación, universidad, PLS.

1. Introduction

Innovation is one of the concepts currently in vogue in business management. It is considered relevant to obtaining a competitive edge because, among other reasons, it is an intangible component that is difficult for competitors to imitate (Bessant et al. 2001; Cerinšek y Dolinsek, 2009; Klippel et al. 2008). In moments of crisis such as the present, many heads turn towards the capacity for innovation as one of the last resorts – if not the only one – for European businesses (Hyland et al. 2007; Middel et al. 2007). Broadly speaking, innovation is taken as the main factor in improving productivity or efficiency in companies (de Benito Valencia, 2000; Grütter et al. 2002; Rapp y Eklund, 2002) as well as quality of products (Albors, 2002; Grütter et al. 2002), and decreasing production costs (Bond, 1999; de Benito Valencia, 2000; Modarress et al. 2005; Terziovski and Sohal, 2000) or even manufacturing time (de Benito Valencia, 2000; Grütter et al. 2002).

The definition of innovation is a mature concept on which researchers have reached a consensus. Innovation can be considered to be the process that allows for the introduction of a new product or service, production methods, openings of new markets, changes in suppliers, business models or management models which are perceived by the organization as novel in the pursuit of enhanced performance by or within the organization (Comisión Europea, 1995; Gee, 1981; Goswami y Mathew, 2005; Jordá Borrell, 2007; Lawson y Samson, 2001; Lyons et al. 2007). Therefore, innovation starts with the proposal and generation of new ideas and finishes with the use or commercial exploitation of the outcomes (Goffin and Mitchell, 2010; González Pernía and Peña-Legazkue, 2007; Klippel et al. 2008; Lehto et al. 2011; Marin-Garcia et al. 2011a; Mol and Birkinshaw, 2009; Schumpeter, 1934; Tonnessen, 2005; Vaccaro et al. 2012).

Much has been written on the capacity of businesses or nations to innovate; ways to measure this by

way of different indicators; the premises, barriers or facilitators of innovation; and the results of having innovative organizations (Goswami and Mathew, 2005; Länsisalmi et al. 2004; Marin-Garcia et al. 2010a). However, the level of analysis of the research has been regional groupings (Dawid et al. 2008; Herrmann y Peine, 2011; Hussler and Ronde, 2005), businesses by sector (Albors-Garrigos and Hervas-Oliver, 2012; Evangelista and Savona, 2003; Ko and Lu, 2010; Leiponen, 2005a; Mulder et al. 2007; Schneider et al. 2010) or the business as a whole (Atuahene-Gima and Wei, 2011; Bayo-Moriones et al. 2008; Freel, 2005; Isik et al. 2009; Lonnqvist, 2006; Mishra and Shah, 2009; Nobre, 2011; Oster, 2009; Söderlund, 2005; Wu and Lee, 2007).

The competencies necessary to take on a profession that requires a university degree have also been studied (Armengol Asparo et al. 2011; Díaz-Fernández et al. 2009; Govender and Parumasur, 2010; Leiponen, 2005b; Lettl, 2007; Nahuis, 2004; OECD, 2011; Siller et al. 2009; Walsh and Linton, 2002), as has how these competencies evolve over time and affect innovation according to age (Allaart et al. 2002; Welch and Ureta, 2002) and other factors (Berdrow and Evers, 2011; Länsisalmi et al. 2004; Leiponen, 2005b; Lerouge et al. 2005).

But there is still a research gap in the academic literature related to a person's innovation capacity and how to measure it (Cerinšek and Dolinsek, 2009; Lerouge et al. 2005) and how to develop it (Berdrow and Evers, 2010; Drejer, 2001; Shoikova and Denishev, 2009). That, precisely, is the objective of our paper. We shall review the concept of innovation capacity in a person, propose three constructs to measure innovation capacities based on skills and validate a questionnaire with a sample of 332 students from a Spanish university.

This paper presents a contribution for researchers on the topics of innovation, business administration or human resource management, as it fulfils the need for a valid, reliable instrument for measuring the degree of innovation in people. The instrument may later be used to measure independent or dependent variables in research that aims to test explicative or causal models. We also present an explicit specification of the measurement model in the design phase of the questionnaire. This phase is frequently disregarded in articles published on the validation of measurement instruments.

For university teaching professionals, the contribution is also valuable because it offers a simple instrument that is valid to assess a set of transversal subcompetencies customary in Spanish university degree programmes for which instructors nonetheless do not have the support of assessment tools. Our objective is to continue this research in the future to develop a protocol for training and use of the instrument so that any university instructor who wishes can rely on a standardized questionnaire and a scale of reference to measure innovation competence in students.

2. Innovation competence and its components

According to Villa and Poblete (2007), competence 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 competence, describing 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'.

Competence can also be defined as complex know-how resulting from the integration and adaptation of capacities and skills to situations having common characteristics (Fernández March, 2010; Lasnier, 2000), 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. Tardif (2006) establish that competence is combinatorial, ongoing, contextual and evolutionary as well. We can consider competencies, capacities and skills as the three categories of complexity in contextualized know-how. A competency is formed by a set of capacities and these, in turn, are formed by a number of skills, all of which are required for a more and more complex professional performance. A competence uses many resources, making it necessary to limit the types of learning outcomes in educational programmes, and is also the dynamic organization of many types of resources. Its development requires time and continues throughout a career. Situations are the frameworks that trigger the need to choose and combine resources, leading to conscious, reflective learning. By working in increasingly complex situations, the mobilization and combination of resources becomes more and more effective. The capacity is a medium

complex know-how that integrates skills which require procedural and conditional knowledge. The skills are simple know-how (Bessant et al. 2001; Drejer, 2001; Fernández March, 2010).

Although there are alternative classifications for grouping the different skills (Berdrow and Evers, 2010; Cerinšek and Dolinsek, 2009; de Jong and Kemp, 2003; Kessler, 2004), we have followed a model focused specifically on innovation competencies (Lehto et al. 2011; Penttilä and Kairisto-Mertanene, 2012; Watts et al. 2012). In this model, the capacities and skills that make up innovation competence can be classified in three dimensions: individual, interpersonal and networking (figure 1).

Table 1 provides more detail on the model shown in figure 1. The innovation competence is structured around three dimension (abilities) and each in built based on certain skills. The individual dimension has to do with creativity, perseverance, risk taking and personal attitude. These aspects are related to innovation. The process of generating new ideas is not the same as applying these ideas in practice, and it is necessary to deal with different critical incidents, problems or tasks that demand innovative thinking and reactions in order to overcome the difficulties that may arise (Berdrow and Evers, 2010; Cerinšek and Dolinsek, 2009; Mulder et al. 2007; Washer, 2007). The interpersonal capacity is rooted in communication and team leadership. Communication plays an essential part in the process of collective construction of ideas (Marin-Garcia et al. 2010b; Marin-Garcia et al. 2011b), as well as in subsequent processing, evaluation or argumentation (Berdrow and Evers, 2010; Mulder et al. 2007; Washer, 2007). The last dimension of innovation implies a process of transfor-

Table 1
Innovation competence in the INCODE- ICB-v5 questionnaire (Spanish version in Annex A)

Capacity	*Cod*	*Skill*
Individual (Berdrow y Evers, 2010; de Jong y Kemp, 2003; Marin-Garcia et al., 2011a; Mulder et al., 2007; Washer, 2007)	ICB01	I make proposals appropriate to the demands of the task
	ICB02	I offer ideas that are original in content
	ICB03	I offer new ways to materialize the ideas
	ICB04	I critically evaluate the fundaments of contents and actions
	ICB05	I identify relationships among different components of the task
	ICB06	I approach the task from different perspectives
	ICB07	I use resources ingeniously
	ICB08	I foresee how events will develop
	ICB09	I show enthusiasm
	ICB10	I am tenacious
	ICB11	I take intelligent risks
	ICB12	I orient the task towards the target
Interpersonal (Berdrow y Evers, 2010; de Jong y Kemp, 2003; Marin-Garcia et al., 2011a; Marin-Garcia y Zarate Martínez, 2008; Mulder et al., 2007; Ritala et al., 2009; Washer, 2007)	ICB13	I transmit ideas effectively
	ICB14	I listen to teammates
	ICB15	I use dialogue to establish constructive group relationships
	ICB16	I collaborate actively
	ICB17	I contribute to group functioning
	ICB18	I take initiatives
	ICB19	I move others to act
	ICB20	I confront problems constructively in order to reach a consensus
Network (de Jong y Kemp, 2003; Mulder et al., 2007)	ICB21	I apply ethical values
	ICB22	I add social impact to tasks
	ICB23	I can work in cooperation in multidisciplinary/multicultural contexts
	ICB24	I speak foreign languages
	ICB25	I make working relationships with actors engaged in local, regional or international endeavours

mation that, once it is carried out, has an immediate and medium-term effect on society. Innovation must go hand in hand with ethical values and social responsibility, which includes sustainability. This last dimension also takes into account the ability to work cooperatively with people from different countries, with different cultures and backgrounds, and the ability to get or create a network of contacts (Hamzah and Abdullah, 2009; Mulder et al. 2007; Waychal et al. 2011).

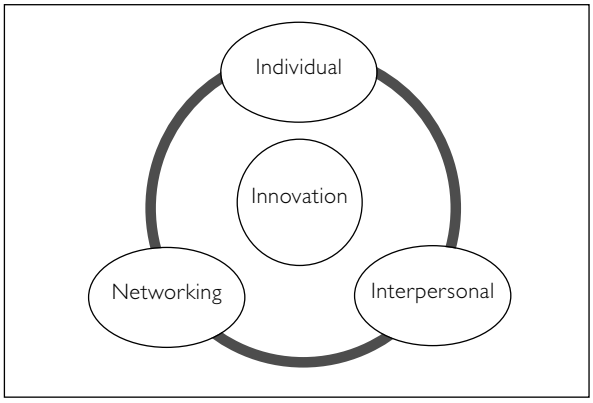

Figure 1
Innovation competency model

3. Specification of a measurement model for the construct of innovation

A latent construct is a variable that is not going to be measured directly in the research. Rather, researchers are going to estimate it by virtue of the responses obtained to a series of questions (items) related to that construct. The relationship between the items and the construct to which they are associated can be specified in two ways. It can, as stated, be reflective – i.e. the value of the items changes because they reflect a change that is produced in the latent construct; therefore, all the items will have a high correlation to one another and are interchangeable – or it can be specified as formative, i.e. the change in each of the items is what changes the value of the latent construct, the meaning of which is defined by the items that compose it. This relationship does not normally depend on the nature of the construct but on the way in which the researchers choose to measure it (Wilcox et al. 2008). That is to say, the same construct can be measured with reflective or formative items. The specification of a measurement model entails opting explicitly for a reflective or formative operationalization of the items with which the construct will be measured (Coltman et al. 2008; MacKenzie et al. 2005; Petter et al. 2007; Roberts and Thatcher, 2009).

In our research we use the questionnaire INCODE-ICB-v5 (Marin-Garcia et al. 2011a; Watts et al. 2012) to measure the constructs shown in figure 1. This questionnaire has not been specified in previous publications. The measurement model in the INCODE-ICB-v5 questionnaire includes 25 questions (table 1) that are grouped into three dimensions (individual, interpersonal and networking). To check if the constructs should be considered as reflective or formative, researchers are aided in decision-making by a set of rules that makes it possible to decide how the latent construct is related to its items and, thus, enables a precise specification of the measurement model. The rules are summarized in table 2 (Diamantopoulos and Winklhofer, 2001; Diamantopoulos et al. 2008; Diamantopoulos and Siguaw, 2006; Jarvis et al. 2003; Petter et al. 2007):

Table 2
Rules to decide formative or reflective specification

	Formative operational definition	*Reflective operational definition*
Following the conceptual definition, what is the direction of causality between construct and items?	Changes in the construct do not cause changes in the items	Changes in the construct cause changes in the items
Interchangeability of the items	Dropping an item changes the content of the construct	Items are interchangeable. It is possible to drop an item and the domain of construct does not change
Correlations among items	Not necessary	Items should present high inter-item correlations
Item antecedents and consequences	Items need not have the same antecedents	Items need to have the same antecedents

The table of rules will be used to review each of the constructs. The items included in the questionnaire define the way in which the competence has been characterized through multiple abilities which, if not taken into account, change the meaning or nuances of the conceptual definition of the construct. For this reason, the items are not interchangeable. For example, in the individual dimension of the questionnaire, making a proposal is not the same as a proposal being original or creative. Equally, it is evident that there are people who have a greater facility for proposing creative ideas than for devising a way to materialize them or for critically analysing the ideas – all clearly differentiated roles (Aritzeta et al. 2005; Belbin, 1993). If any of these abilities disappeared, the approach to analysing the individual dimension would change. This same conclusion can be reached for any of the other items of the individual dimension, but also for the items in the networking dimension. For example, the items on applying ethical values, working cooperatively in multidisciplinary environments or establishing relationships with persons that participate in local initiatives are not interchangeable.

In the interpersonal dimension there are items that clearly are not interchangeable, such as the "transmission of ideas effectively" or "listen to teammates" or "moving others to act"; they define the capacity for teamwork. However, item ICB17 ('I contribute to group functioning') seems to have a reflective connotation, which probably means that it correlates well with the other items of the construct. The remaining items in this dimension may or may not correlate, since they refer to different abilities that may be possessed independently of the others.

To continue with the exploration of possible associations between items, we can observe that high correlation between items is improbable, as the items – as we have already highlighted – are not interchangeable. We reach the same conclusion in analysing the pairs of items in the networking dimension.

Finally, the antecedents of the items are different. For example, making 'appropriate proposals' has to do with the willingness to participate and the understanding of the task, while offering 'original ideas' has creativity as a premise – which often leads to offering ideas that apparently have nothing to do with the task, particularly if deferred judgement techniques are used (De bono, 1994).

On the other hand, 'materializing ideas' has its origin in the role of the implementer (Belbin, 1993), while 'critical analysis' comes from the role of monitor/evaluator (Aritzeta and Ayestarán, 2003; Belbin, 1993). In the interpersonal dimension, 'transmitting ideas' originates in a person's capacity to deliver or express ideas, while 'listening' refers to a person's capacity for reception. None share an origin with other skills, such as 'confronting problems' – the origin of which has to do with an integrator or combative personality – or 'moving others to act', which has its origin in leadership qualities. Similarly, we can take examples of interpersonal competence and confirm that the premises and consequences of 'applying ethical values' are different from the skills involved in 'speaking foreign languages' or establishing 'relationships with local, regional or institutional actors'.

In sum, the items included in the INCODE-ICB-v5 questionnaire to measure each of the competences have a clear formative formulation. In addition, the three dimensions are, in turn, a formative definition of the second-order construct to measure innovation competence, thereby creating a type 4 multidimensional model, specified as formative in the first-level constructs as well as in the second-level construct (Jarvis et al. 2003).

4. Methodology

To measure the constructs of innovation, we use the questionnaire INCODE-ICB-v5 (Marin-Garcia et al. 2011a; Watts et al. 2012). The personal dimension is measured with 12 items, the interpersonal dimension with eight items and the networking dimension with five items. Responses are coded between 1 and 5 (1= I need to improve a lot; 5= Excellent).

The study population is composed of 506 university students distributed across three colleges – a Faculty of Business Administration and two engineering schools (Industrial and Design Engineering). In order to have them fill out a web questionnaire, at the end of September e-mail invitations were sent out to all students registered in the academic year 2012-13. Students were enrolled in one of six different courses in the first semester. The courses are taken in different years of the programme. The average rate of response was 66%, varying between 56% and 100% depending on the course (see table 3).

As the model has been specified as formative, the main objective of this paper is to validate it. To that end, the following steps will be taken. In the descriptive statistics analysis, special attention will be paid to missing values, patterns of no response, range

Table 3
Description of the sample

Code of course	*Population*	*College*	*Year in programme*	*Responses*	*Rate of response*
4633	130	FADE	5	82	63%
10279	104	ETSID	4	58	56%
11486	83	ETSII	2	69	84%
11498	52	ETSII	3	35	67%
12012	124	ETSID	3	75	60%
31982	13	FADE	Master	13	100%
Total	506			332	66%

in response values, skewedness and kurtosis (Doval Dieguez and Viladrich Segués, 2011; Viladrich Segués and Doval Dieguez, 2011). Inter/item correlations will also be analysed to detect if any are higher than 0.4 (Petter et al. 2007). Collinearity of the items on a construct will be analysed, checking that VIF values are below 3.3 (Diamantopoulos and Winklhofer, 2001; Hair et al. 1999; Henseler et al. 2009; Wilcox et al. 2008) and that condition indices are below 30 (Coltman et al., 2008; Thongrattana, 2010). To evaluate the formative constructs, we shall use PLS (Ringle et al. 2005) with nonparametric bootstrapping (300 cases, 5000 samples and individual sign change) and we shall analyse the weights of the outer model (>0.1) and bootstrapping significance (>1.66) (Christophersen and Konradt, 2008; Hair et al. 2012; Henseler et al. 2009).

The size of the sample is sufficient for the rule of thumb that the number of cases should be 10 times the number of items of the construct with more items (Christophersen and Konradt, 2008; Henseler et al. 2009). In our case, the individual construct has 12 items; therefore the sample must be greater than 120 cases.

5. Results and discussion

Practically all of the students responded to the 25 items on the questionnaire (table 4). The missing data, therefore, are not due to the characteristics of the item and do not cause problems in the set of data collected. In most items, the distribution of responses has an average that is medium-to-high on the scale. Standard deviation is not high for a scale of five levels of response, skewedness is low in almost all items and kurtosis is moderate. That is to say, most of the responses are distributed throughout the scale (more uniformly than in normal distribution), and are concentrated a little more in the higher part of the scale. Items ICB15, ICB16, ICB17, ICB18 and ICB23 have a floor effect (the second value on the scale); none have a ceiling effect, which maintains the range of five different levels of responses for most items (20 out of 25).

The correlations between items are mostly significant and positive, although moderate or low. The maximum correlation value is 0.55 (between ICB18 and ICB19) and there are only seven correlations higher than 0.40 (in addition to those already mentioned, correlations between ICB01–ICB02; ICB14–ICB15; ICB15–ICB17; ICB16–ICB17; ICB16–ICB18; ICB19–ICB20 and ICB21–ICB22). Most of these high correlations are in the interpersonal dimension (although there are only five out of 26 possible correlations).

The values of the collinearity statistics are lower than the cut-off values. All items have VIF values below 1.75 and the condition indices are 23.16 for the individual, 22.18 for the interpersonal and 10.53 for the networking dimension. Moreover, the VIF values for the constructs are less than 1.30 and the condition index is 12.37.

After analysing the Partial Least Squares calculations (PLS) in table 5 in the individual dimension, 9 of 12 items show weights higher than 0.1 and eight of them are significantly different from zero. In the interpersonal dimension, six of the eight items have relevant weights and four are significantly different from zero. In the networking dimension, four of the five items are relevant and three are significantly different from zero. Finally, the weights of the latent variables in the second-order construct, which represents the innovation competence of the students, are all relevant and significant. Since any weight exceeding 0.1 and having a significant value other than zero indicates

Table 4
Descriptive statistics of the variables

Code	*N*	*Min*	*Max*	*Mean*	*Std. Deviation*	*Skewness*	*Kurtosis*
ICB01	332	1	5	3.69	0.724	0.840	0.798
ICB02	332	1	5	3.58	0.853	0.412	0.194
ICB03	332	1	5	3.39	0.843	0.143	0.552
ICB04	332	1	5	3.61	0.832	0.184	0.337
ICB05	332	1	5	3.58	0.810	0.290	0.216
ICB06	332	1	5	3.75	0.866	0.560	0.030
ICB07	332	1	5	3.72	0.831	0.365	0.172
ICB08	332	1	5	3.40	1.001	0.088	0.542
ICB09	332	1	5	3.96	0.866	0.737	0.346
ICB10	332	1	5	3.77	1.005	0.569	.283
ICB11	332	1	5	3.26	0.902	0.044	0.494
ICB12	332	1	5	3.95	0.754	0.563	0.549
ICB13	329	1	5	3.59	0.880	0.577	0.121
ICB14	329	1	5	4.11	0.843	0.879	0.547
ICB15	329	2	5	4.07	0.738	0.565	0.274
ICB16	329	2	5	4.03	0.809	0.675	0.180
ICB17	329	2	5	4.05	0.757	0.595	0.251
ICB18	329	2	5	3.73	0.912	0.335	0.653
ICB19	329	1	5	3.56	1.008	0.172	0.903
ICB20	329	1	5	3.72	0.804	0.415	0.011
ICB21	329	1	5	3.63	0.786	0.339	0.046
ICB22	329	1	5	3.19	0.929	0.114	0.360
ICB23	329	2	5	3.90	0.910	0.459	0.596
ICB24	329	1	5	2.94	1.281	0.091	1.071
ICB25	329	1	5	3.10	1.012	0.114	0.650

Table 5
PLS analysis, weights and Bootstrapping values

Latent variable	*Code*	*Weight*	*Mean Weight Value*	*Standard Error*	*T_value*
Individual	ICB01	0.273	0.195281	0.098350	2.001213
	ICB02	0.150	0.128528	0.086025	1.484685
	ICB03	0.248	0.201487	0.084754	2.459299
	ICB04	0.205	0.170721	0.081588	2.088084
	ICB05	0.083	0.087205	0.061870	1.088521
	ICB06	0.339	0.290612	0.107240	2.730089
	ICB07	0.088	0.086807	0.065889	1.109870
	ICB08	0.142	0.141027	0.080734	1.753695
	ICB09	0.310	0.253532	0.084454	3.174425
	ICB10	0.124	0.126949	0.075299	1.649559
	ICB11	0.156	0.140612	0.080988	1.727921
	ICB12	_0.011	_0.077364	0.055943	0.150239
Interpersonal	ICB13	0.434	0.358579	0.093614	4.042467
	ICB14	_0.038	_0.094108	0.071072	0.442055
	ICB15	0.338	0.249637	0.117101	2.116788
	ICB16	0.141	0.125690	0.084631	1.337762
	ICB17	0.101	0.108559	0.079424	0.959529
	ICB18	0.306	0.261738	0.118799	2.332457

(continue)

Table 5
PLS analysis, weights and Bootstrapping values *(continuation)*

Latent variable	*Code*	*Weight*	*Mean Weight Value*	*Standard Error*	*T value*
	ICB19	0.072	0.109749	0.079043	0.915492
	ICB20	0.434	0.348537	0.109260	3.169677
Networking	ICB21	0.613	0.468552	0.134511	3.556113
	ICB22	0.213	0.203071	0.124979	1.573955
	ICB23	0.354	0.306985	0.135892	2.353427
	ICB24	0.047	0.116468	0.088439	0.680245
	ICB25	0.402	0.388011	0.151441	2.661911
Innovation	Individual	0.423	0.414644	0.011900	35.582194
	Teamwork	0.410	0.402432	0.011340	36.173301
	Network	0.355	0.356821	0.009552	37.202483

that the item is relevant to the construct, the results presented in table 5 validate, overall, the proposed model. As for the items that do not exceed the cut-off values, it is advisable to keep them if they represent a unique aspect of the construct in question, which is not shared by other items of the construct (Diamantopoulos et al. 2008; Jarvis et al. 2003; Petter et al. 2007).

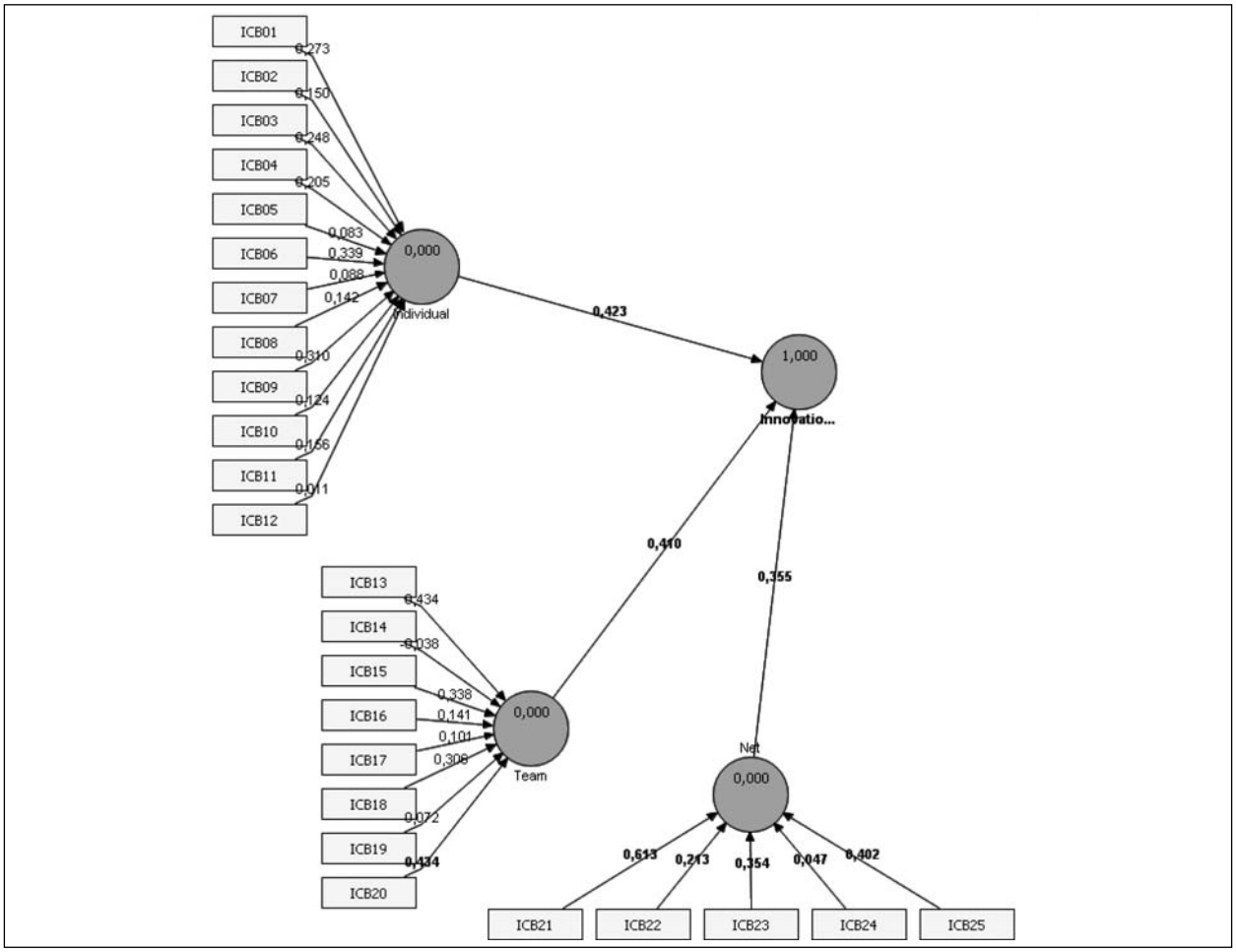

Figure 2
Weights of the measurement model

To more clearly represent the data in table 5, figure 2 shows the model of the second-order construct of innovation, composed of individual, interpersonal and networking dimensions. The weights of each of the items or constructs (third column of table 5) are included in figure 2.

The values of the latent constructs can be calculated as the sum of the product of the response value of each item of the questionnaire by the weights of the item, in the PLS analysis. Analogously, we could calculate the value of the second-order construct (innovation) from the sum of the values of the first-order constructs multiplied by the corresponding weight. According to the number of items in each dimension and their weights, the minimum and maximum possible values of each variable are: 2.1 and 10.5 for the individual dimension; 1.6 and 8.2 for the interpersonal dimension; 1.8 and 9.0 for the networking dimension; and 2.2 and 11.0 for innovation competence as a whole. The values of the descriptive statistics and the correlation between scales are summarized in table 6. It can be seen that, in the sample, there is some minimum floor effect because the students' score for each variable is greater than the minimum. For example, in the individual dimension the minimum value of the sample is 4.35, while the minimum allowable value is 2.1. However, there is no ceiling effect. The maximum values in the sample are very close to the maximum value in each construct. The average values of the sample are located in the upper-middle part of the scale. The constructs of the first order (individual, interpersonal and network) exhibit moderate–low correlation between themselves and a high correlation of each with the second order (innovation).

Finally, table 7 presents the scales broken down into the tenth, twenty-fifth, fiftieth, seventy-fifth and ninetieth percentiles for each dimension and innovation competence as a whole. These values can be used as cut-off points to identify the relative intensity of competency for innovation (or its constituent skills) in the student, indicating what percentage of the sample have scores lower than theirs.

4. Conclusions

This paper has presented the specification and validation of a formative model of measurement of innovation competence in university students. The proposed model can be considered to meet, in general, the criteria for content validity and the validation tests suitable for the formative model. The interpersonal items are the most problematic, probably due to the correlations existing between them and certain special characteristics in the definition of items ICB16 (collaborate) and, especially, ICB17 (contribute to group functioning), which will have to be analysed in greater detail in the future.

Table 6
Descriptive statistics in diagonal: mean, (standard deviation), min and max. Pearson correlations are shown above the diagonal

	Individual	*Interpersonal*	*Networking*	*Innovation*
Individual	7.66 (1.00) 4.35 10.31	0.509**	0.711*	*0.895**
Interpersonal		5.67 (1.01) 2.69 8.15	0.439**	0.751**
Network			6.77 (1.01) 4.05 8.98	0.866**
Innovation				8.03 (1.01) 5.13 10.80

** Correlation is significant at 0.01 (bilateral).

Table 7
Sample scores for scales

		Individual	*Interpersonal*	*Networking*	*Innovation*
	Valid	332	329	329	329
	Missing	1	4	4	4
Pertenciles	10	6.3469	4.2740	5.4160	6.6689
	25	6.9842	5.0280	6.1495	7.3291
	50	7.6385	5.6900	6-8320	8.0240
	75	8.3190	6.4205	7.4750	8.7295
	90	8-9454	6.9170	8.0720	9.3679

In the individual dimension, it would be advisable to revise ICB05 (identify relationships), ICB07 (use resources ingeniously) and, above all, ICB12 (orient the task towards the target) to determine if they are essential to the definition of the construct or if they can be substituted, modified or incorporated into a multidimensional index (Diamantopoulos et al. 2008; Jarvis et al. 2003; Petter et al. 2007). The same can be said of item ICB24 (speak foreign languages) in the networking dimension. Another aspect to work on in the future is the extension of the response scale to avoid concentration of responses in only a few values and to compare the measurements of the ICB with those of other standardized questionnaires.

It would also be advisable in future research to enlarge the sample to include a larger set of degree programmes, levels and universities, in order to overcome the current limitation that prevents generalization to all Spanish universities because of the original limited population under study. It would be of equal interest to analyse non-university populations to see if the tendency to score higher on the ICB is due to the fact that university students are more innovative than other types of people.

Nonetheless, taking into account the logical precautions of the initial stage in the development and validation of measurement scales, this paper can be considered to offer several contributions to the academic community. On the one hand, it proposes a formative measurement model – which is not usual in field research in business management, in spite of its being suitable for certain objectives. On the other, it validates a measurement instrument that can be used in the future to collect data on dependent and independent variables in causal models. It also presents a contribution for teaching professionals interested in measuring the degree of development of innovation competence in their students.

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5. 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