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Conceptualizing academic intellectual capital: definition and proposal of a measurement scale

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Abstract

Purpose – The purpose of this paper is to describe the development and validation of an instrument for measuring intellectual capital in the academic research context. The current research context describes a new paradigm of scientific production characterized by interdisciplinarity, heterogeneity and the intensification of the relations between the generators of knowledge. In this scenario, traditional measures of intellectual capital do not capture all the variables that make up the environment in which the research activities are carried out. This transformation of research processes suggests the need to bring theories of organizational behavior, more appropriate to an organizational context, to the study of scientific context. Thus, the paper contextualizes the intellectual capital approach, thereby explaining how the different attributes that build it influence scientific productivity and providing a measurement instrument to evaluate relative levels of intellectual capital in an academic research context.

Design/methodology/approach – The scale was designed through a double qualitative–quantitative scale development process. The literature on intellectual capital does not provide strong theoretical support for the definition of a specific set of items to be applied in the specific academic research context. Consequently, the scale constructs and observable variables were initially conceptualized through a Delphi panel. This initial set of indicators was empirically validated through a second quantitative stage to a sample of 1,798 Spanish academics. Given that no prior published studies have examined the construct validity of the proposed scale, and the proposed scale is not based on other previously validated scales, the authors used exploratory and confirmatory factor analysis to assess the internal consistency, using Cronbach's α to determine reliability.

Findings – Drawing on the evidence obtained from a double qualitative–quantitative process, a scale consisting of 47 items was proposed to measure the three dimensions of intellectual capital, namely, the researcher's human capital, as well as the nature of the social capital and organizational capital of the team in which the scholar is integrated. The process of identifying and validating indicators of intellectual capital allowed the authors to identify certain intangible elements that are key in the research process and that, therefore, determine scientific productivity. Thus, the proposed scale contributes by conceptualizing new variables that could be used to deepen and broaden the study of the determinants of research performance. The contextualization of intellectual capital approach can also help to assess the value of intangibles, offering an external reporting tool and making universities' social contributions more visible to public and private stakeholders, justifying the efforts made by societies in the generation of academic knowledge.

Research limitations/implications – The empirical analysis was carried out with an initial sample of 1,798 Spanish scholars. The validation of the scale should therefore be confirmed in different national contexts, with larger data sets. Likewise, the use of longitudinal data sets could help to study the effects of intellectual capital in academic research, thereby contributing to the ongoing debate on the determinants of research performance.

Originality/value – From a practical perspective, the instrument could be considered both as a management and an external reporting tool, providing a self-assessment instrument of the levels of intellectual capital. As a management tool, a specific measure of intellectual capital in an academic context could help to identify training needs, the implementation of practices that encourage the capability for building research networks and the development of reports with intellectual capital-related inputs for

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the justification of the resources received. At an institutional level, the proposed set of indicators also identifies the attributes of scholars linked to higher scientific performance, and the scale could be used as an instrument for selection processes in academic institutions, to develop practices related to the distribution of workload or the publication of intellectual capital indicators of its researchers in a healthy exercise of transparency.

Keywords Intellectual capital, Delphi panel, University, Measurement scale, Academic research, Scientific team

Paper type Research paper

1. Introduction

In the context of a knowledge-based economy, university research is fundamental for the generation of scientific knowledge as a resource for competitive advantage and social progress (Fullwood *et al.*, 2013). In fact, the European Commission (2010) considers universities to be key actors in the achievement of the objective of Europe 2020, which engaged Europe in the quest to become the most competitive and dynamic knowledge-based market in the world by 2020. Consequently, the capacity of universities for managing and valorizing their knowledge assets or intellectual capital will influence the competitiveness of individuals, organizations and the regions in which they are located (Vinig and Lips, 2015). Over the last few decades, the European university system has undergone a significant transformation, caused by the structural transformations of the Bologna Process and intended to increase research quality and make academic institutions more comparable, competitive, flexible and transparent (Ramírez-Córcoles *et al.*, 2011; Secundo *et al.*, 2016). In view of this situation, the information transparency of higher education institutions obtains a greater transcendence, placing more emphasis on the disclosure of their intangible assets and processes. This paper starts from the premise that the intellectual capital approach can help to assess this intangible value, making universities' social contributions more visible to public and private stakeholders and justifying the efforts made by societies in the generation of academic knowledge (Ramírez-Córcoles *et al.*, 2011).

On the other hand, the current research context describes a new paradigm of scientific production characterized by the interdisciplinarity, the heterogeneity and the intensification of the relations between the generators of knowledge, for which it demands a specific analysis of the intangibles that participate in the generation of scientific knowledge. Different works affirm that in order to respond to this new context, the institutions dedicated to scientific research must articulate new types of resources and different forms of management that favor their contribution to the processes of socioeconomic development. In addition, nowadays, the scientific work is organized and developed more and more in a context that resembles a purely organizational environment (Shrum *et al.*, 2007; Walsh and Lee, 2015; Lee *et al.*, 2015; Murayama *et al.*, 2015; Shibayama *et al.*, 2015). As some works in the literature point out, this transformation of work and research processes suggests the need to bring theories of organizational behavior and more appropriate to an organizational context to the study of the scientific context (Cummings *et al.*, 2013; Walsh and Lee, 2015; Lee *et al.*, 2015).

Besides, given that scientific productivity is an engine of success in the academic career (White *et al.*, 2012; Seibert *et al.*, 2017), the application and contextualization of new approaches that help to understand the determinants of the generation of knowledge and facilitate new science management tools make important contributions (Van den Brink *et al.*, 2013; Seibert *et al.*, 2017). In this sense, the application of the intellectual capital approach involves the conceptualization of new variables that allow deepening the study of the determinants of research performance. In addition, with the contextualization of the intellectual capital approach to the research environment, we respond to the call for more research on this topic in a specific context, something that facilitates the practical application of intellectual capital approaches (Chiucchi, 2013; Veltri and Bronzetti, 2015).

This is what the literature has described as the performative stream of research in intellectual capital (Mouritsen, 2006; Dumay and Garanina, 2013), which indicates that it is necessary to focus on the research of organizational practices of intellectual capital in specific environments, to improve the understanding and articulation of the dynamics of intellectual capital.

The measurement and management of each of these constituents of intellectual capital are of crucial importance, yet the literature reflects that, in universities, its value is not identified correctly, and very limited tools can be found to create, manage and measure intellectual capital (Bezhani, 2010; Secundo *et al.*, 2016). As suggested by Youndt and Snell (2004), in organizations that develop knowledge-intensive activities, the differences in the provision of intellectual capital determine the efficiency of the processes and the capacity of the units to generate value. The research developed in these institutions depends considerably on the knowledge of the researchers and the network of relations they maintain between these and other intangible factors that are difficult to capture through the traditional and decontextualized measures of intellectual capital that can be found in the literature (Kannan and Aulbur, 2004). Thus, the contextualization of the intellectual capital approach in a research environment is also justified in the particularities and notorious differences between organizations dedicated to research and traditional organizations, which means that traditional measures of intellectual capital do not capture all the variables that make up the environment in which the research activities are carried out. This work, therefore, proposes using the perspective offered by the intellectual capital approach to deepen the identification, conceptualization and measurement of new variables that reflect the competences required to develop research.

This lack is even more evident when we refer to the measurement and management of the intellectual capital of researchers or scientific teams, considering their importance as knowledge-generating units. In fact, the few works that focus on the analysis and measurement of intellectual capital in the university context are limited to the institutional level (Ramírez and Gordillo, 2014; Ramírez *et al.*, 2017). As Van den Brink *et al.* (2013) argued, more research is needed to provide universities with tools to assess and manage their academic staff at the micro level. To do so, a double level of analysis needs to be adopted. Intellectual capital should first be conceptualized and measured at the individual level to describe the specific attributes and skills of researchers that explain superior scientific performance (Barnacle and Dall'Alba, 2011; White *et al.*, 2012; Ulrich and Dash, 2013; Drummond and Fischhoff, 2017). However, the eminently collective condition of scientific research means that researchers' intangible contributions lie not just in their individual competences, skills or attitudes, but also in the combination of these elements at the team level (Rotolo and Messeni Petruzzelli, 2013). As has been argued in the literature, scientific teams can be considered to be fundamental to the knowledge creation processes in academia. These teams are characterized by high levels of self-management, and mainly internal management systems through which they develop their own structure and behavior (Bercovitz and Feldman, 2011; Lee *et al.*, 2015).

In view of the above discussion, this paper sets the objective of providing a measure of academic intellectual capital. Drawing on a review of extant literature, and applying a double quantitative–qualitative methodology, a scale was defined and validated. Through the proposed set of items, academic institutions and research managers assessed: scholars' individual human capital and the extent to which these individual knowledge, skills and abilities are channeled at the group level through the social and organizational capital of the teams in which researchers develop their scientific activity.

The structure of the paper is as follows. First, a conceptual framework is drawn from a review of the literature. In this section, intellectual capital is conceptualized by describing its constituents. To do so, we clarify the concept of academic intellectual capital, explaining

how the different attributes that build it influence scientific productivity. The intellectual capital construct provides theoretical support for reviewing these individual attributes in an integrated way, systematizing the study of the determinants of scientific productivity. In the second section, based on the theoretical framework, a scale is developed for measuring academic intellectual capital. Following Hinkin's (1998) and DeVellis' (2003) suggestions for developing scales, we developed a double process; the first, qualitative, stage defines the scale and the second, quantitative, phase validates it. The paper describes the different steps carried out to identify relevant indicators, including a description of the empirical scale validation process. Finally, the paper concludes with a discussion of the main findings of the research and its limitations.

2. Review of the literature: academic intellectual capital

As Giuliani and Marasca (2011) point out, the empirical definition of the concept of intellectual capital cannot be done in an abstract way, but must be contextualized, depending on the particularities of the unit on which it is applied. In this sense, literature has recognized two basic research trends in the study of intellectual capital: ostensive intellectual capital vs performative intellectual capital (Mouritsen, 2006; Dumay and Garanina, 2013; Veltri and Bronzetti, 2015), and, consequently, two different roles of intellectual capital measurement and conceptualization. The ostensive approach considers that the intellectual capital has a series of fundamental properties that exist before any interaction carried out by the individuals that make up an organization. Under this paradigm, the research that follows this approach focuses on describing the descriptive qualities of intellectual capital and the formula by means of how these intangibles relate to the creation of value. On the other hand, the performative approach, which recognizes that the intellectual capital is part of a knowledge management configuration, so it is firm and completely context specific and dynamic in nature. Research under this focus focuses on interpreting the role that intangibles have on performance in terms of how the actors belonging to the organization mobilize the components of intellectual capital. Performative approaches, therefore, do not consider ostensive models adequate to measure and conceptualize intellectual capital, but generate specific models to show how intellectual capital is mobilized through praxis in a specific contextual situation (Dumay and Garanina, 2013). In the last stages of research on intellectual capital, the need to distance oneself from an ostensive approach to a more performative approach has been recognized (Dumay and Garanina, 2013; Secundo *et al.*, 2018), where new frameworks and models of intellectual capital have been proposed in multiple contexts (Chiucchi, 2013; Veltri and Bronzetti, 2015). Therefore, in our work, following a performative approach, we will focus on the study of intellectual capital in the specific context of academic research in order to deepen how intellectual capital is mobilized in this context, conceptualizing and identifying what measures of intellectual capital are fundamental in the development of research.

In the academic context, intellectual capital has been used to describe, in an integrated way, all the non-tangible assets of the institution, including processes, innovation capacity, patents, tacit knowledge of its members and their abilities, talents and skills, the recognition of society, and its network of collaborations (Ramírez and Gordillo, 2014, p. 175). In this work, the application of the intellectual capital approach contributes to the identification and conceptualization of the variables of intellectual capital that determine the generation of scientific knowledge in the context of a scientific team, which will help us to establish specific measures of intellectual capital in a research context. The models and definitions reviewed in the literature, from different perspectives, share the same notion that intellectual capital is a multidimensional construct that contains different but interrelated elements (Edvinsson and Malone, 1997; Bontis, 1998; Youndt and Snell, 2004; Kong and Thomson, 2009). However, when it comes to identifying the different elements that make up the

construct, there is no consensus, especially when the analysis is focused on measuring intellectual capital at the individual and team levels. In an academic context, at the individual level, most studies have paid attention to the analysis of specific attributes in scientific activity and their effect on scientific productivity (Barnacle and Dall'Alba, 2011; White *et al.*, 2012; Ulrich and Dash, 2013; Seibert *et al.*, 2017). To conceptualize these competencies at both individual and collective levels, we will focus on a widely accepted conceptualization of intellectual capital proposed by Youndt and Snell (2004), which summarizes previous views, and constitutes a solid basis for the description of the attributes of intellectual capital in the specific context of academic research (Edvinsson and Malone, 1997; Leitner, 2004; Bezhani, 2010; Casanueva and Gallego, 2010; Ramírez and Gordillo, 2014). This conceptualization distinguishes between three dimensions of intellectual capital: human capital, social capital and organizational capital. Multiple works in the literature have used and continue to use this categorization of intellectual capital, both in an organizational context (Edvinsson and Malone, 1997; Subramaniam and Youndt, 2005; Sharabati *et al.*, 2010; Bontis *et al.*, 2018), as in the specific case of research focused on academic and university research (Leitner, 2004; Bezhani, 2010; Ramírez-Córcoles *et al.*, 2011; Secundo *et al.*, 2016). Therefore, in order to conceptualize and propose different measures of intellectual capital in the context of academic research, we conceived a double dimension related to the different categories of intellectual capital present in the literature. On the one hand, an individual category related to the researcher's human capital, that is, their individual research competences and attributes. On the other hand, a collective or team dimension, which includes the intangible elements categorized as collective, in this case the social capital and the organizational capital of the research team to which the researcher belongs. Below, in this section, we review the literature to identify the different attributes of intellectual capital that can be considered key in the development of research activity.

2.1 *The researcher's human capital*

Different works have coincided in defining human capital as the collective capacity of an organization to develop the best solutions based on the combination of knowledge, capabilities and competencies of the individuals that compose an organization, as well as the way in which they are managed and used (Edvinsson and Malone, 1997; Bontis, 1998). Most of the models proposed during the development of human capital theory draw on the premise that the training, skills, capacities and creativity of the individuals that make up an organization are among the rare, valuable, inimitable and non-replaceable intangible resources that allow the organization to increase its value (Wright *et al.*, 2014). Following this approach, different research studies have provided empirical evidence, demonstrating the influence of human capital on different dimensions of organizational results (Youndt and Snell, 2004; Cabello-Medina *et al.*, 2011; Ployhart and Moliterno, 2011). These same arguments can be contextualized to the scope of universities, by considering their particularities as organizations based on the generation and transmission of knowledge. Considering this definition in the specific context of academic research, different studies have approached the analysis of the skills and abilities necessary for the performance of research activities. In this sense, Bozeman *et al.* (2001) define scientific human capital as the skills and technical resources of researchers at a specific time in their academic career. Lee *et al.* (2010) suggest that research human capital consists of the generic knowledge of the researcher, specific knowledge of the area of knowledge or topic of research, and analytical skills, communicative competencies or the ability to process data. Ramírez and Gordillo (2014, p. 175) consider it to be “the sum of tacit and explicit knowledge of university members (professors, researchers, managers, administration and services) acquired through education and training.” Likewise, Ulrich and Dash (2013) describe a set of individual attributes – scientific competences, team and project management skills, or personal and

interpersonal skills such as creativity or motivation – to be necessary for researchers. However, these conceptualizations of an integrated set of attributes have not been explored in detail. Åkerlind (2008) and McNie *et al.* (2016) have revealed a shortage of literature, explaining that studies have normally focused on specific isolated attributes or dimensions. To integrate the different perspectives gathered in the academic literature, we will draw on the most common definition of the composition of human capital at the individual level, distinguishing between knowledge, skills and competences or abilities (Becker, 1975; Ployhart and Moliterno, 2011; Nyberg and Wright, 2015). This taxonomy will help us to systematize the study of the concept, providing a theoretical criterion to classify and identify the attributes that describe the researcher's human capital.

The first of the dimensions of human capital, knowledge, is integrated both by the theoretical and methodological notions acquired through formal education, as well as the specific training received during the academic career (Bozeman *et al.*, 2001). Ployhart and Moliterno (2011) define knowledge as one of the dimensions of academic human capital that involves the understanding of principles, facts and processes. Some authors, such as Jacob and Lefgren (2011), have shown how the knowledge gained in training can determine the number of publications or citations of a researcher. Specifically, we can differentiate the theoretical body necessary when developing any research in a specific discipline, the specific knowledge of a research topic, and the methodological knowledge about the research techniques used in the area. In this sense, Bazeley (2010) or Mooken and Sugden (2014) suggest that, without a deep knowledge of the topic investigated, and without methodological and statistical knowledge of the area, the research generated would normally be considered trivial and open to meaningful criticism. Finally, Wang *et al.* (2006) and Durette *et al.* (2016) emphasized the skills related to both verbal and written expression of knowledge in English as the facilitators of scientific productivity. Mastering English is essential to access research results, because most of them are published in this language. Durette *et al.* (2016) point out that knowledge of technical English language is one of the most relevant attributes to be emphasized during PhD training for non-English-speaking scholars.

On the other hand, competences or abilities refer to the individual's capacity to act correctly in a particular profession, in this case, tasks related to scientific research (Barnacle and Dall'Alba, 2011; Lindberg and Rantatalo, 2015). Thus defined, competences are not generic in nature, but specific to a profession, comprising the interaction between the individual and the profession practised (Lindberg and Rantatalo, 2015). Therefore, research competences reflect the expertise, aptitude or suitability that any researcher needs to competently carry out the tasks of the scientific activity (Barnacle and Dall'Alba, 2011). Following the distinction suggested by McNie *et al.* (2016), we conclude that every researcher must possess some necessary competences or "hard academic skills," which must be acquired during the specific doctoral training. According to McNie *et al.* (2016), these "hard skills" refer to attributes that imply scientific rigor, as well as specialized academic skills such as the ability to formulate hypotheses, and the communication of research results through publication. In this sense, Durette *et al.* (2016) identified competences as those attributes in which doctoral students must be trained to act competently in the development of research. Different papers have described these competences, confirming their relevance for scientific performance. The literature widely recognizes the importance of cognitive competences related to the ability to analyze data to address research questions, and the ability to communicate and disseminate research results (Marie, 2008; Timmerman *et al.*, 2011; Drummond and Fischhoff, 2017). Likewise, different works have also reflected the need for competencies related to teamwork and scientific collaboration, which are particularly important in the current context of social generation of scientific knowledge (Bozeman *et al.*, 2013; Kyvik, 2013).

Finally, in contrast to competences, skills are usually of a generic nature; not specifically related to the performance of research, but relevant for helping and simplifying the execution of scientific activities (Heijde and Van Der Heijden, 2006). Following McNie *et al.* (2016), we can describe skills as attributes that allow better performance of research, such as communicative and idiomatic skills research, leadership and management abilities or creative skills. This definition gives research skills a facilitating role in the performance of scientific tasks (Wang *et al.*, 2006). For instance, skills to organize research will enable the researcher to design and co-ordinate the development of the different stages of research more efficiently (Kyvik, 2013). In this sense, some studies have shown that time management in research planning determines the productivity of the researcher (White *et al.*, 2012; Agarwal and Ohyama, 2013). Similarly, the researcher's ability to create networks can also play a critical role in academic career development. Numerous studies have emphasized the benefits of developing research mobility with the objective of establishing research networks (Azoulay *et al.*, 2017). Likewise, the literature recognizes creativity as a skill that influences the results and impact of research (Marie, 2008; Whitelock *et al.*, 2008; Lee *et al.*, 2015). The individual's creative thinking or intuition provides the flexibility to adapt and seek new directions during the development of research (Bazeley, 2010). In addition, different works have also emphasized the relevance of vocation and passion, because of their strong impact on performance in the academic career (Neumann, 2006; Thunnissen and Van Arensbergen, 2015; Ulrich and Dash, 2013; White *et al.*, 2012).

2.2 *The social and organizational capital of scientific teams*

The eminently collective condition of scientific research means the intangible value of researchers lies not just in their individual competences, skills or attitudes, but also in the combination of those elements at the team level (Rotolo and Messeni Petruzzelli, 2013). The researcher's human capital alone does not guarantee the achievement of efficient research. Although the generation of scientific knowledge has been traditionally described from an individual perspective, the majority of scientific projects and activities have a marked team nature (Wuchty *et al.*, 2007). It has been argued that a team can be considered to be the base of the knowledge creation process because its capacity to innovate and perform complex tasks surpasses that of an individual (Wuchty *et al.*, 2007; Lee *et al.*, 2015). We therefore assume that it is necessary to deepen the roles of other collective dimensions, such as the social and organizational capital of the scientific team in which the researcher is involved, to provide a comprehensive measure of intellectual capital.

Social capital. Social capital represents a valuable asset derived from the access to the resources that other members of the team possess, through network or relationship structures (Nahapiet and Ghoshal, 1998; Kwon and Adler, 2014). This concept has acquired importance in the literature as a construct to describe and characterize the content of social relations, and the benefits derived from them for generating greater innovations and organizational performance (Nahapiet and Ghoshal, 1998). Several works have indicated that a high level of social capital, associated with affective ties and connections between the agents that compose the organization, lead to greater levels of creativity and innovation (Andrews, 2010; Kwon and Adler, 2014). In an academic context, the social generation of scientific knowledge means the intangible value provided by researchers does not lie exclusively in individual competences, skills or attitudes, but also lies in the combination of these elements at the team level (Casanueva and Gallego, 2010). Collaboration and relationship development are seen as means for sustaining the process of knowledge creation, achieving common goals by sharing workloads and fostering economies of scale through the exchange of knowledge, skills, resources or experience (Bozeman *et al.*, 2013;

Villanueva-Felez *et al.*, 2013; Lee *et al.*, 2015). Knowledge generation in academia depends on the debate, discussion and critical exposition of research ideas at the team level (Bercovitz and Feldman, 2011). A high level of social capital indicates that researchers make their human capital available to others, which in turn contributes to joint knowledge creation through the exchange of ideas between the individuals that make up the team (Wang *et al.*, 2006). Therefore, academic social capital can be conceptualized as the strategic resources of intangible nature located in social relations between researchers, in addition to the potential benefits that these relations grant in terms of access to diverse research resources (Salaran, 2010; Bozeman *et al.*, 2013).

To identify the constituents and advance the proposal of a social capital measure, we will focus on the traditional multidimensional definition of social capital, which is composed of three interconnected dimensions: structural, relational and cognitive (Nahapiet and Ghoshal, 1998; Andrews, 2010). In particular, we can conceptualize the structural dimension as the attributes describing the networks or links and the particular arrangement of each network, in the sense of its structure or pattern of existing connections (Nahapiet and Ghoshal, 1998). In an academic context, this dimension has an important influence on the functioning of scientific teams, because the configuration of networks represents a valuable source of benefits for the achievement of knowledge and information (Li *et al.*, 2013; Gonzalez-Brambila, 2014; Rodriguez and Gonzalez-Brambila, 2016). Moreover, in this dimension, we can also emphasize the importance of the strength of the established links between researchers. In this sense, it is necessary to assess the existence of a frequent and lasting relationship between the components of the team, that is, the configuration, or the density and frequency of the relationships established in the team. Several empirical studies have shown the role of the privileged position of the actors in the network structure as a factor that positively influences their individual capacity for innovation (Lee *et al.*, 2015). Similarly, the frequency and strength of social relations between researchers, which allow the constant expansion of knowledge itself, provide the opportunity for the research generated to have a greater impact (Rotolo and Messeni Petruzzelli, 2013; Gonzalez-Brambila *et al.*, 2013). On the other hand, the relational dimension is related to the nature and characteristics of the connections between individuals, in terms of trust, commitment, reciprocity or reliability within the collective (Nahapiet and Ghoshal, 1998; Andrews, 2010). Specifically, in the case of social research capital, this dimension is linked to the nature of the connections established between the team members, described by a certain social climate, and specific levels of trust and reliability. When researchers trust each other, they will be more open to collaborating and sharing resources without concerns that they will be opportunistically exploited by their colleagues (Li *et al.*, 2013). Likewise, a good interpersonal climate in a context of knowledge generation and transfer gives greater security to the researcher with respect to the rest of the team as a source of reliable knowledge (Holste and Fields, 2010; Gonzalez-Brambila *et al.*, 2013). Finally, the cognitive dimension of social capital refers to aspects related to the understanding between individuals, which improves the interpretation and meaning of the relationships carried out among members (Nahapiet and Ghoshal, 1998). This dimension would be linked to the codes, languages and rules of communication shared within the unit (Nahapiet and Ghoshal, 1998). The ease of access to other researchers and their knowledge depends on the extent to which language is shared by the individuals. A joint vision can promote the willingness of its members to exploit their social capital toward individual and team objectives at the same time (Salaran, 2010). Likewise, a scientific team with strong links and a shared vision would have more opportunities to take advantage of the benefits of sharing and pooling resources within the team network (Fullwood *et al.*, 2013).

The social capital of the scientific team is not solely formed by the internal relations between the researchers integrated in the unit. It is also composed of knowledge, resources or

research ideas embedded in the relationships that scholars maintain with external agents (Nahapiet and Ghoshal, 1998; Leana and Pil, 2006). In the working environment of a scientific team, these relationships would be established with professionals and with researchers from other disciplines outside the scientific team, in environments such as scientific conferences or colloquia. The literature has shown that the number of contacts, which describes the dimension of the network held by a scientific team, can determine the impact and productivity of knowledge generation (Liao, 2011; Abbasi *et al.*, 2011). Likewise, research collaborations combining several disciplines can generate new approaches and new solutions to specific problems (Bercovitz and Feldman, 2011; Liu and Xia, 2015). In addition, attendance at congresses, workshops or research colloquia are other fundamental components for the establishment of external relations with other researchers. Besides having a social function, they also contribute to communicative purposes, helping to refine results and conclusions, and put them in the context of other ongoing research (Barjak, 2006).

Organizational capital. In a pragmatic way, Edvinsson and Malone (1997) define organizational capital as everything that remains in the organization when the individuals that compose it are not present. Organizational capital can be conceptualized as a set of tools and architectures that retain, reinforce and transfer knowledge throughout the organization's activities. Thus defined, this dimension is embedded in the organization itself and expressed in the culture, routines and organizational structures, as well as in information systems, and any other type of support for human capital (Bontis, 1998; Aramburu and Sáenz, 2011). In a university context, organizational capital would be related to the internal procedures of dissemination and management of scientific and technical knowledge, organizational routines and the academic culture, along with technological resources such as bibliographic repositories, archives, patents, software or databases (Ramírez and Gordillo, 2014). If we contextualize these elements at the scientific team level, organizational capital would be represented by the knowledge or experience codified and stored by the team, which is accumulated in databases, routines, procedures, manuals and structures, as well as by values or culture, team philosophy and the ethics shared by team members. The organizational capital of the team provides the necessary support so that the human capital of the organization can work efficiently, which in turn will affect the individual scientific performance of each researcher (Bontis, 1998; Kong and Thomson, 2009). Thus, as Kong and Thomson (2009) argued, organizational capital could be considered to be the support structure for human capital in the development of its tasks. However, because of their small size, the informal nature of their structures, and the fact that most processes are tacitly developed, the research team's efforts to build organizational capital are normally inferior in comparison to other dimensions (Bezhan, 2010). Despite this, as empirical studies have confirmed, the development of organizational capital can be a determining factor for the maintenance of the scientific productivity of teams, because it can influence their capacities to innovate and consolidate human and social capital structures (Youndt and Snell, 2004; Carmona-Lavado *et al.*, 2010).

To propose a conceptualization that provides theoretical support for this construct, we will focus on the traditional description of the basic dimensions of organizational capital, which distinguishes between the shared culture of the team, the documentation of knowledge and the structure of the team (Bontis, 1998; Youndt and Snell, 2004; Subramaniam and Youndt, 2005; Carmona-Lavado *et al.*, 2010; Martín-de-Castro *et al.*, 2011). The culture of the scientific team could be described in terms of the level of coherence, acceptance and general commitment to cultural values, team philosophy and shared ethics (Martín-de-Castro *et al.*, 2011). The literature has shown that the type of organizational culture established in a university can both facilitate and limit the scientific performance of its researchers (Deem and Lucas, 2007; Siadat *et al.*, 2012; Wang *et al.*, 2014). Likewise, different studies have argued that

the most productive scientific teams value the existence of a strong shared culture in the department, because culture affects the performance of the scientific team (Edgar and Geare, 2013). We can also highlight a second dimension of this construct, the documentation of knowledge, through means that make the information shared by the researchers within the team explicit. Wang *et al.* (2006) highlight the importance of access to information and the maintenance of a good research infrastructure by the facilitator of scientific productivity, because these documented resources can determine the quality of the information obtained by the researcher. In the same way, Carmona-Lavado *et al.* (2010) provide empirical evidence of the importance of knowledge documentation, confirming that appropriate accumulation of up-to-date, reliable and accessible internal knowledge has a positive impact on organizational innovation success. Finally, the structure of the research team is related to its formal organizational design, which is concretized in aspects such as the number of hierarchical levels, the division of labor, the degrees of delegation and the protocols and routines through which the work in the unit is organized. Different works suggest that certain types of organizational structures or design facilitate the exchange of knowledge, and the establishment of knowledge creation processes (Chang *et al.*, 2009; Aramburu and Sáenz, 2011; Murayama *et al.*, 2015). In contrast, an inefficient organizational structure can be an inhibitor of productivity and efficiency in the generation of scientific knowledge (Wang *et al.*, 2006). Therefore, we can conclude that a scientific team that develops standardized and formalized work processes, based on stable research routines, can facilitate research skills to combine the knowledge available in the team.

3. Methodology

Having reviewed the different attributes that describe the researcher's intellectual capital, we must now concretize the observed indicators, and verify the appropriateness of the selected items for measuring the underlying theoretical construct. To accomplish this purpose, the scale was designed through a double qualitative–quantitative scale development process. As has been previously observed, literature on intellectual capital does not provide strong theoretical support for the definition of a specific set of items to be applied in the academic context. In these situations, the triangulation of qualitative and quantitative methods has been highly recommended (Hinkin, 1998; DeVellis, 2003). As Jick (1979) argued, the combination of two or more research methods in the study of a singular phenomenon contributes to a deeper interpretation, understanding and convergence of the results obtained. Table I gives an overview of the different phases of the research process developed in this paper. Our study starts with a qualitative process, building the scale from the expert perspective of a group of scholars representing the different fields of research. To perform this task, the Delphi methodology was applied to extract participant consensus

Table I.
Overview of the different phases of the proposed measurement scale

Research phase	Objectives	Results
Previous phase: Literature review	Review of the different indicators for intellectual capital Review and categorization of different attributes that determine academic performance	Identification of intellectual capital indicators Identification of attributes that are key in the development of the research activity
Phase 1: Delphi panel and development of the questionnaire	Narrow the literature analysis Contextualize the proposal of indicators to the academic field	Phase 1: 76 proposed indicators Phase 2: 50 proposed indicators Design of the research questionnaire
Phase 2: Development of the empirical study and validation of relevant indicators	Elimination of invalidated items Methodological evaluation and validation of measurement instrument	Validated measurement instrument: 47 items

around the items that need to be introduced in the scale to capture academic intellectual capital. In the second stage, the scale extracted from the Delphi panel was empirically validated, by applying exploratory and confirmatory factor analyses to data obtained from a sample of Spanish academics from different fields of research.

The review of the literature summarized in the previous sections of the paper gave us an overview of the efforts made by previous researchers to measure academic intellectual capital. This review revealed there was a lack of tools and scales to assess the construct in the scientific context. In an academic context, the studies that proposed scales of measurement for intellectual capital focused mostly on an institutional point of view, adopting the university as their unit of analysis (Bezhani, 2010; Ramírez and Gordillo, 2014; Ramírez *et al.*, 2017). This lack is even more evident when we refer to the measurement and management of the intellectual capital of researchers or scientific teams. At the individual level, the literature has focused on analyzing isolated attributes and skills only, with the aim of studying their particular effect on scientific performance (Barnacle and Dall'Alba, 2011; White *et al.*, 2012; Ulrich and Dash, 2013; Drummond and Fischhoff, 2017). Therefore, to build an initial set of indicators, we needed to draw on the generic literature that addressed intellectual capital in the broader organizational context (Bontis, 1998; Youndt and Snell, 2004; Subramaniam and Youndt, 2005; Sharabati *et al.*, 2010). The scales proposed by these authors provide a notion of the most usual indicators for intellectual capital that could serve, by analogy, as a basis for contextualizing the measures in the academic field in subsequent stages of the research process. Considering this lack of theoretical support, we decided to complement the deductive approach that provides the literature review with additional inductive evidence (Hinkin, 1998). To do so, the Delphi panel was organized with the objective of seeking consensus from a group of scholars from different fields of research about the relevance and completeness of the initial set of indicators.

3.1 Phase 1: Delphi panel and development of the questionnaire

The Delphi technique is developed through a structured and iterative process in which a set of experts in a specific subject anonymously share their judgments and ideas during subsequent rounds (Okoli and Pawlowski, 2004). Two aspects are essential in this type of analysis (Okoli and Pawlowski, 2004). First, the question to be analyzed must be delimited in a way that provokes discussion and subsequent consensus among the experts. The topics to be discussed in this case were the attributes of intellectual capital and the determinants of research performance. To inspire the debate, a survey composed of eight open questions covering all aspects traditionally raised by the intellectual capital literature was designed. The second key element is the identification of the experts who should participate in the panel. In this case, the panel consisted of a group of Spanish research team leaders who were experts in different scientific fields. In the selection of the members of the panel, we followed Okoli and Pawlowski's (2004) recommendations, trying to avoid response biases and the problems of subjectivity derived from this type of technique. To establish a criterion that allowed us to obtain an objective and diverse sample of Spanish scientific teams, we selected leaders of scientific teams who met two conditions: being recognized by the Spanish National Plan for Scientific Research, Development and Technological Innovation (National R+D+i Plan) and having active and continued research activity, according to their performance records. Once the database was set up, we contacted the leaders of these scientific teams by telephone: to inform them about the objective of the investigation, to request their active participation and to communicate the expected date of the survey. After several rounds of surveys were sent to participants, valid responses from 62 Spanish research team leaders from different scientific areas were obtained. From these answers, we extracted a total of 76 items; 40 items corresponded to human capital, 28 corresponded to social capital and 8 corresponded to organizational capital. A new document was designed to show the 76 grouped items and was

sent to the 62 leaders who had responded to the original survey, with the request that they select all those factors that they considered relevant in relation to each of the questions asked. A total of 45 valid responses were obtained in this round. By synthesizing the different judgments and opinions after each round, we tried to reach consensus within the panel of experts, consistent with the objectives of the Delphi technique (Okoli and Pawlowski, 2004). A scale including 50 items was finally built with 22 items related to human capital, 20 to social capital and 8 to organizational capital.

Analysis of the information obtained from the Delphi panel experts allowed us to design a final questionnaire. This instrument served as the basis of the second phase of the study to analyze the validity of the proposed scale (empirical analysis). Before doing so, the survey was pretested by sending it to the 62 team leaders who actively participated in the study. In order to enhance item and survey clarity and data validity, revisions and changes in survey instructions or procedures were made based on feedback received. The 50 selected indicators were concretized in a survey instrument, following Hinkin's (1998) design recommendations. All the items were measured using Likert scales ranging from 1 (total disagreement) to 5 (total agreement). In order to capture the collective variables of the intellectual capital (social capital and organizational capital), it was explicitly specified that the collective items were answered based on what they could consider their "scientific team," considering them as those individuals who currently participated regularly in the development of the research were co-authors or not.

3.2 Phase 2: development of the empirical study and validation of relevant indicators

Sample and data collection. Because we wanted to develop a measurement tool suitable for a broad range of academic knowledge fields, the survey was distributed to academic researchers from different Spanish universities in all the areas classified as scientific activity by the Spanish Ministry for Science and Technology. As a data collection method, a self-administered questionnaire was sent via e-mail to the vice-chancellors for research and department directors at Spanish universities for their subsequent distribution among researchers. The questionnaire was sent with a cover letter describing the main goal of the research, and it emphasized on the confidentiality of the responses. The fieldwork took place during the period January–October 2017. After a period of intensive follow-up of the responses, 1,798 valid responses were included in our analyses. In terms of professional academic category, 903 of the responses (50.3 percent) were tenured academics; 325 (18.1 percent) were pre-tenure academics and 169 (9.4 percent) were junior researchers. In terms of the field of knowledge to which the researchers belonged, 325 (18.1 percent) of the researchers belonged to the arts and humanities area; 338 (18.8 percent) belonged to science; 353 (19.6 percent) to social and legal sciences; 200 (11.1 percent) to health sciences; and 326 (18.1 percent) to engineering-related fields.

Analyses. Having defined the observed attributes for each intellectual capital dimension, we verified the suitability and validity of the selected items to measure the underlying theoretical constructs. In this section, we will discuss the analytics and results for each intellectual capital dimension separately (human capital, social capital and organizational capital), because previous literature has widely accepted the multidimensionality of the intellectual capital construct (Youndt and Snell, 2004). Building on scale development and constructive validation literature (Hinkin, 1998; DeVellis, 2003), and given that no prior published studies have examined the construct validity of the proposed scale and that the proposed scale is not based on others previously validated scales, we used exploratory and confirmatory factor analysis (CFA) to assess internal consistency, using Cronbach's α to determine reliability (Hair *et al.*, 2006). Considering the most recommended current trend (Lloret-Segura *et al.*, 2014), we used both types of analysis sequentially. The sample size

allowed the random division of the sample into two subsamples. The first was used to explore the factor structure underlying the items through exploratory factor analysis (EFA). The results of this first analysis were later confirmed in the second half of the sample through CFA (Brown, 2014; Lloret-Segura *et al.*, 2014). Therefore, first, in the case where the literature has not previously evaluated the construct validity of the proposed scale, it is advisable to carry out a prior examination on the factor structure using EFA techniques (Tabachnick and Fidell, 2013). However, although EFA is valid for examining the dimensionality of the instrument, it only offers evidence about the theoretical factor structure. Therefore, EFA should be followed by CFA to evaluate and refine the resulting scales (Gerbing and Anderson, 1988; Lloret-Segura *et al.*, 2014; Farooq, 2016). CFA methods, applied on a parallel sample, are recommended in order to endorse the factor structure and provide further evidence of construct validity (Worthington and Whittaker, 2006; Cabrera-Nguyen, 2010).

Therefore, the analysis started by applying EFA to each of the intellectual capital dimensions, to identify and eliminate unrelated items. We used IBM SPSS 23 to conduct this analysis. The applicability of the factor analysis of the variables studied and the joint significance of the model was tested through the Kaiser–Meyer–Olkin (KMO) test and Bartlett’s test of sphericity.

To determine the factor number, we chose the latent root criterion (Hair *et al.*, 2006). According to this criterion, the eigenvalues are ordered according to their size, in order to retain those with a value equal to the unit (1) or larger. We considered a solution representing at least 60 percent of the total variance to be satisfactory (Hair *et al.*, 2006). Items that loaded insufficiently onto one factor were removed if different items measured similar realities, or they did not have strong theoretical or qualitative relevance as the indicators of intellectual capital. Since we did not estimate that there was a clear and consistent correlation between the different items, the method of rotation was a varimax (orthogonal) rotation (Hinkin, 1998). Specifically, since among our data we did not expect *a priori* a dominant factor over the rest, we have used the varimax rotation as an orthogonal rotation method (Lloret-Segura *et al.*, 2014). We built on the results of the EFA to specify the factor models used in the CFA. CFA was used to assess construct validity, the reliability of subjective measurement instruments and to check the goodness-of-fit of the measurement scales (Hair *et al.*, 2006; Brown, 2014). To carry out the analysis, we constructed a second-order model for each intellectual capital dimension with reflective indicators through structural equation modeling, using the statistical program EQS 6.3 for Windows. Considering the nature of Likert scales, and the multivariate non-normal distribution of the variables, we used the elliptical least squares estimator (Brown, 2014). Therefore, we operationalized the human, social and organizational capital as a multidimensional concept, depending on each of the factors obtained and described in the previous EFA. In this sense, for instance, we considered how the researcher’s knowledge and skills reflected the degree of academic human capital they had.

The fit of each model was assessed by examining conventional fit indices (Brown, 2014; Kline, 2015). Thus, we report the standardized root mean square residual (SRMR), the root mean square error of approximation (RMSEA), the comparative fit index (CFI), the goodness-of-fit statistic (GFI) and the Tucker–Lewis index (TLI). In addition, we also reported the χ^2 test statistic, dividing it by the degrees of freedom (χ^2/df) (Hair *et al.*, 2006). To evaluate the model fit, we relied on the guidelines on the cut-off values described by Hair *et al.* (2006) and Kline (2015). For the χ^2/df ratio, Schumacker and Lomax (2004) suggested a value lower than 5. For the SRMR, Hair *et al.* (2006) argue that values lower than 0.08 indicate a good fit with the data. For the RMSEA, Brown (2014) suggests the cut-off value of 0.06, which the range of 0.8–0.1 indicates a mediocre fit, and that models with RMSEA over

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0.1 should be rejected. For the CFI, GFI and TLI, different authors indicate that values in the 0.9–0.95 range indicate an acceptable fit, with values closer to 1.0 indicating good fit (Hair *et al.*, 2006; Brown, 2014). To evaluate the convergent validity, the loadings factor provides evidence of adequate convergence of the constructs. Convergent validity is accepted whenever factorial loads are higher than 0.5, and t coefficients are significant ($p < 0.001$) (Kline, 2015). Finally, we assessed the internal consistency or reliability of the scales by reporting Cronbach's α (Hair *et al.*, 2006; Kline, 2015). Cronbach's α values as low as 0.6 are considered acceptable in social sciences, according to Hair *et al.* (2006).

Results on human capital measures. Based on the Delphi panel, and in line with the theoretical arguments reviewed, 22 indicators were selected to assess the human capital of researchers (Table II). We conducted a principal component EFA using varimax rotation on the 22 items of the scale. The results are shown in Table II. The applicability of the factor analysis to the variables studied was confirmed, with a KMO index value of 0.91

Items	F1 Research competences	F2 Research knowledge	F3 Dynamism capacity	F4 Working capacity	F5 Critical thinking
CH10: I can expose and communicate my research results	0.802				
CH8: I can autonomously develop research	0.766				
CH9: I know how to conduct research (thesis, research projects, etc.)	0.763				
CH7: I can relate the observed facts to the results obtained and draw conclusions	0.754				
CH11: I have the ability to interact fluently with other researchers	0.671				
CH6: I am able to identify research topics in my research context	0.663				
CH12: I am able to adapt to changes in my research context	0.642				
CH5: I master the language usually used in journals/books and in scientific meetings in my academic field		0.686			
CH3: I know the most relevant publications in my scientific field		0.674			
CH4: I have the required capacity to obtain and manage the information necessary for the research		0.650			
CH2: I have the necessary training in research methodologies and techniques		0.640			
CH1: I have the theoretical training necessary to research in my scientific field		0.605			
CH18: I consider myself a creative person			0.793		
CH21: I consider myself a person with initiative			0.714		
CH16: I consider myself an observer			0.664		
CH17: I consider myself a person motivated by research			0.577		
CH22: I consider myself a disciplined person				0.885	
CH15: I consider myself an organized person				0.831	
CH19: I consider myself a persevering person				0.663	
CH13: I consider myself a self-critical person					0.832
CH14: I consider myself a person with the ability to accept criticism from others					0.788

Note: Principal component factor analysis, varimax rotation

Table II.
Human capital
EFA: items and
item loadings

(excellent results in values between 0.9 and 1). Bartlett's test of sphericity shows significance values below 0.05, confirming that the factor model obtained would be adequate to explain the data. The results show five factors explaining 63.55 percent of the variance, corresponding to the theoretical arguments reviewed in the theoretical framework. Considering the latent root criterion, only the first four components or factors should be retained, as they have eigenvalues greater than 1. Nevertheless, according to the practical rule of accepting solutions explaining at least 60 percent of the total variance, we opted for the retention of the first five factors, given that eigenvalues were close to 1 and the total variance explanation increased from 55.58 to 63.55 percent. This option also provided a greater theoretical sense to the solution obtained.

Factor 1 was labeled "research competences" and included seven items (CH6, CH7, CH8, CH9, CH10, CH11 and CH12). Factor 2 comprises five variables (CH1, CH2, CH3, CH4 and CH5) corresponding to the knowledge necessary for the development of scientific activities, so it was labeled "research knowledge." Factor 3 was labeled "dynamism capacity" and included four items related to initiative, creativity and motivation skills (CH16, CH17, CH18 and CH21). Factor 4 includes three items (CH15, CH19 and CH22) corresponding to the attitudes towards work, which were labeled as "working capacity." Finally, Factor 5 was labeled "critical thinking" and included two items related to objective and critical thinking (CH13 and CH14). Item CH20 did not load sufficiently in any of the factors and was, therefore, excluded from the CFA. The other items adequately loaded onto one single (expected) factor.

In the next step, we used CFA to test the five factors extracted as a second-order model. Specifically, we checked whether the results of the EFA were confirmed, and the extent to which the five detected factors loaded onto a second-order factor measuring "researcher's human capital." The results, reported in Figure 1, show good fit indices, with $\chi^2/df = 3.89$; CFI = 0.96; TLI = 0.95; RMSEA = 0.06; GFI = 0.97 and SRMR = 0.05. All factor loadings were significant ($p < 0.05$) and indicate strong factor loadings. These results show the appropriate convergent validity of the constructs. Moreover, the results indicate that the five factors are relevant for measuring the researcher's human capital. Finally, the internal consistency of the scale used to measure "researcher's human capital" by calculating Cronbach's α was verified. The results reflect a strong scale reliability ($\alpha = 0.89$).

Results on social capital measures. Drawing on the results of the Delphi panel, 20 indicators were proposed to assess the social capital of the scientific teams in which the researcher was involved (Table III). Following the methods described above, we conducted a principal component EFA using varimax rotation. The results of the EFA applied to the initial set of 20 items are shown in Table III. The KMO also confirmed the applicability of the factor analysis, showing a value of 0.943. Bartlett's test of sphericity shows significance values below 0.05, confirming that the factor model obtained would be adequate to explain the data. Based on the results of EFA, we distinguished three factors explaining 74.68 percent of the variance. Factor 1 was labeled "social climate" because it contained items that referred to the characteristics of social relations, the joint vision or the interpersonal climate (items CS10, CS11, CS12, CS13, CS14, CS15, CS16 and CS18). Factor 2 also comprised eight variables (CS1, CS2, CS3, CS4, CS5, CS7, CS8 and CS9), which jointly describe the behavior of internal relations within the scientific team. Considering this, the factor was named "internal relations." Finally, factor 3 was labeled "external relations," as it included two items related to the type of relations established by the scientific team outside the unit (CS19 and CS20). Items CS6 and CS17 did not load sufficiently in any of the factors and were therefore excluded from the subsequent CFA.

The result of the EFA was tested by a CFA in which we tried to confirm the extent to which the "social capital" construct could be explained as a second-order model. Figure 2

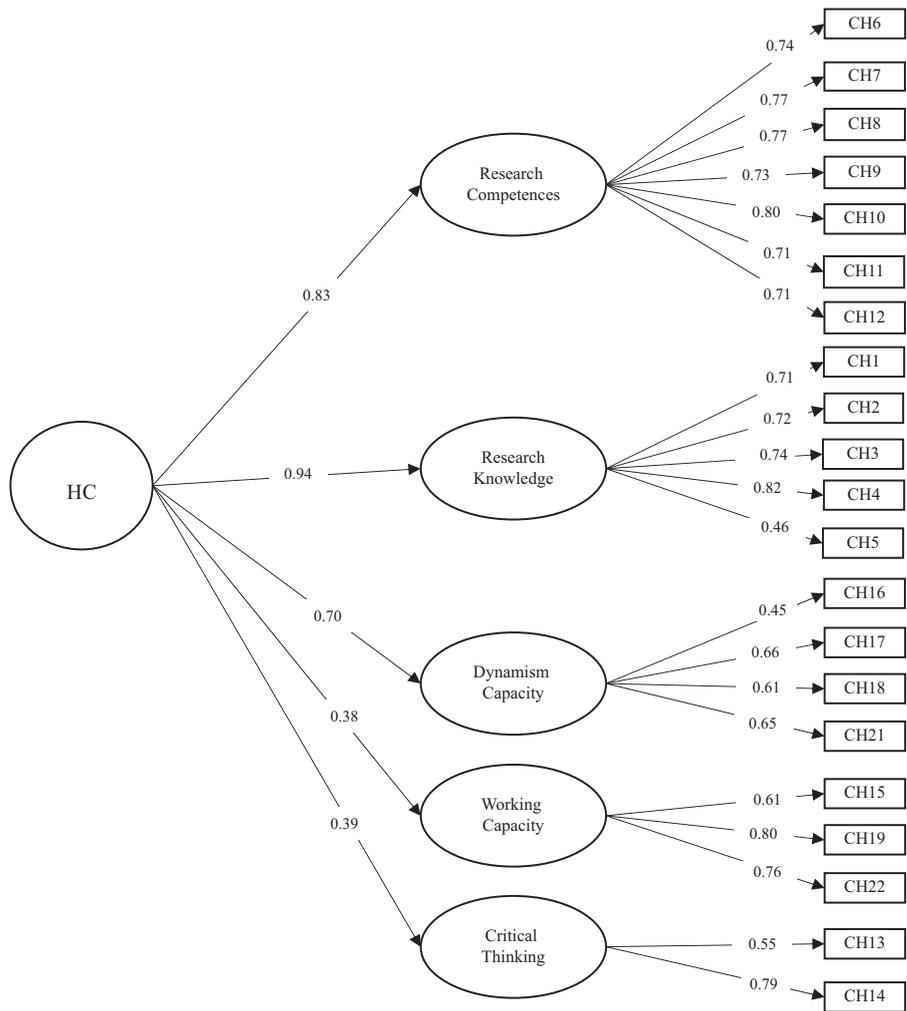


Figure 1.
Human capital
CFA: items and
item loadings

gives an overview of the CFA results, showing good fit indices, with $\chi^2/df = 4.43$; CFI = 0.96; TLI = 0.96; RMSEA = 0.09; GFI = 0.99 and SRMR = 0.04. All factor loadings were significant at $p < 0.05$, with strong factor loadings. These results reflect evidence on the appropriate convergent validity of the constructs. Thus, the results indicate that the three factors extracted were relevant for measuring the “social capital” of the scientific teams in which researchers are involved. To check the internal consistency of the scale used to measure “social capital,” we calculated Cronbach’s α , which indicated strong scale reliability ($\alpha = 0.95$).

Results on organizational capital measures. The experts participating in the panel suggested eight items to measure organizational capital, which were also introduced in the questionnaire using five-point Likert scales.

Table IV reports the results of the principal component EFA developed on these eight observable variables. In this case, the applicability of the factor analysis of the variables studied

Items	F1 Social climate	F2 Internal relations	F3 External relations
CS15: Team members can trust that others will help them if necessary	0.834		
CS16: Team members can trust that others will make work easier	0.822		
CS10: Team members enjoy a good interpersonal climate	0.799		
CS14: Team members try to help each other if they have any difficulty	0.795		
CS11: The team members agree on what was important in the research work	0.786		
CS12: Team members share the same ambitions and visions in the research work	0.736		
CS13: Team members are excited to achieve the goals and objectives of the team	0.709		
CS18: Team members maintain interpersonal relationships very often	0.560		
CS7: Team members hold regular meetings to advance the team's research activity		0.792	
CS3: Team members exchange our knowledge and experiences		0.789	
CS1: Team members share our advances in research		0.788	
CS4: Team members share information		0.780	
CS5: Team members look for and take advantage of synergies		0.741	
CS8: Team members hold meetings to define and design new research projects		0.689	
CS2: Team members share resources		0.657	
CS9: The members of the team meet to discuss the progress of the doctoral theses directed by team members		0.638	
CS20: Team members exchange ideas with a large number of professionals from outside our institution			0.893
CS19: Team members exchange ideas with a large number of colleagues outside the team			0.878

Note: Principal component factor analysis, varimax rotation

Table III.
Social capital
EFA: items and
item loadings

was confirmed, with a KMO index of 0.88. Bartlett's test of sphericity shows significance values below 0.05, confirming that the factor model obtained would be adequate to explain the data. The results yielded an initial single factor, drawing on the latent root criterion, as only this factor showed eigenvalues greater than 1. Nevertheless, this solution did not meet the practical criterion, as it did not explain 60 percent of the total variance. Considering this, we opted for the retention of the two first factors, given that the second factor had eigenvalues close to 1, and this helped to increase the total variance explained to 69.36 percent. Factor 1 was labeled "team's functioning," as it included five items related to the work routines and procedures followed (CO3, CO4, CO5, CO6 and CO8). Factor 2 included the other three items (CO1, CO2 and CO7) designed to describe the research culture of the team, and was labeled "research culture."

Following the proposed methodology, we checked whether the results of the EFA were confirmed by CFA and the extent to which the two detected factors loaded onto the second-order factor "organizational capital." The results are reported in Figure 3. Although they are within acceptable levels, they show that the fit of the model is not as strong as in the analysis of human and social capital ($\chi^2/df = 6.43$; CFI = 0.95; TLI = 0.93; RMSEA = 0.11; GFI = 0.99 and SRMR = 0.04). Results for two of the indicators (χ^2/df and RMSEA) did not show a good fit: something that could be explained by considering the behavior of the variables used. First, we must consider that the assumption of multivariate normality is violated, with variables presenting a certain degree of asymmetry. The literature has revealed the limitations of the RMSEA under these circumstances, and advised caution with its interpretation, because it tends to be overestimated as the distribution of responses increases asymmetry (Chen *et al.*, 2008; Kline, 2015). Therefore, following the criteria established in the literature, we consider the results for this CFA to be acceptable, although it is important to note that goodness-of-fit measures for this model show a weaker overall fit. The organizational capital measure should be used and interpreted with caution, and further analyses are required to explore the constituents of this construct.

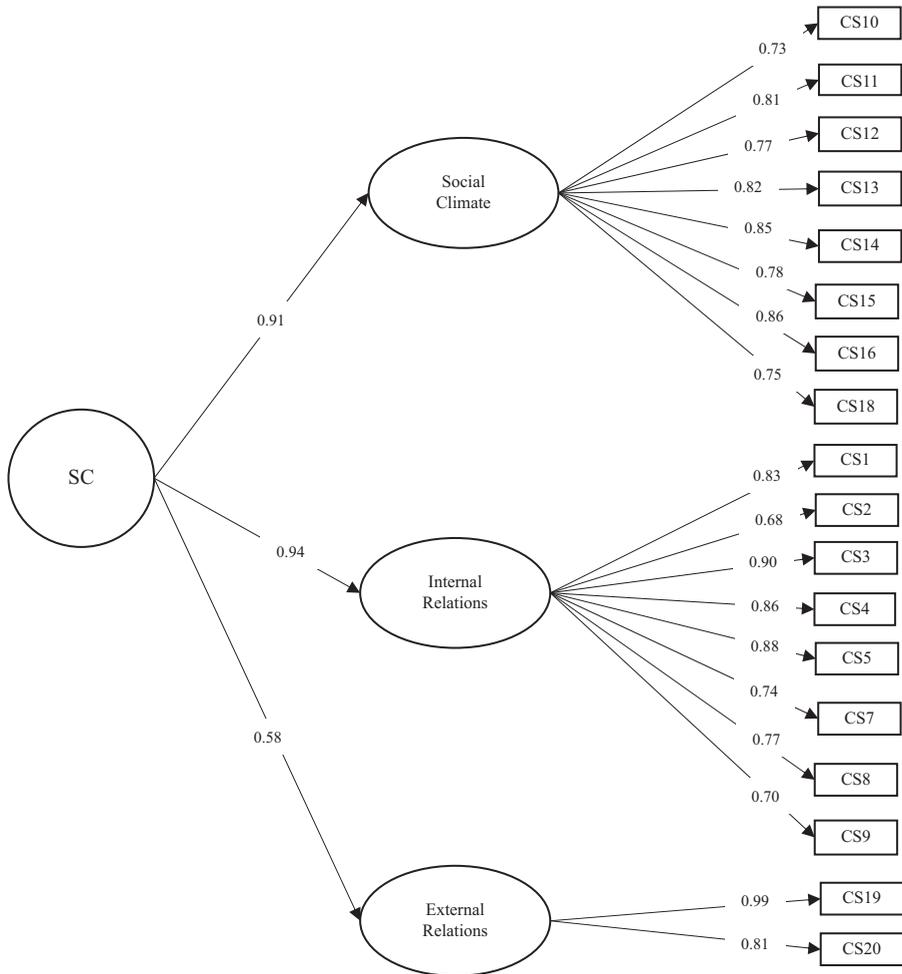


Figure 2.
Social capital
CFA: items and
item loadings

All factor loadings of the items were strong and significant ($p < 0.05$). These results reflect evidence on the appropriate convergent validity of the constructs. The results confirm that the two factors are relevant for measuring the “organizational capital” of the scientific teams in which researchers are involved. Results also indicated an acceptable scale reliability ($\alpha = 0.88$), so the internal consistency of the two constructs defined to measure “organizational capital” could be also confirmed.

4. Discussion and conclusion

This paper proposed a specific tool for measuring the intellectual capital of academics in the specific context of scientific teams, as shown in the capital scale provided below. From the literature review, we developed and applied a scale grounded in a questionnaire with quantifiable variables. In doing so, we tried to address the limitations of previous studies in the field that had focused on identifying and offering measures of intellectual capital at an institutional level. Instead, in this work we have focused more deeply on the specific

Academic intellectual capital

Items	F1 Team's functioning	F2 Research culture	
CO4: The members of the team have databases in which the knowledge generated by the members of the group is documented	0.818		
CO5: Team members use computer resources to share relevant knowledge for the group's operation	0.810		
CO3: Team members have predefined work methods	0.735		
CO8: The members of the team have formalized protocols for the development of the research activity (procedure manuals, formalized processes, etc.)	0.728		
CO6: Team members develop research activities according to routines that could be considered stable	0.703		
CO1: The members of the team hold meetings oriented to scientific training (seminars, workshops, etc.)		0.876	
CO2: The members of the team meet to decide aspects related to the management of the team		0.794	
CO7: The members of the team have a strong culture, focused on research, which guides the behavior of team members		0.685	
Note: Principal component factor analysis, varimax rotation			

Table IV.
Organizational capital
EFA: items
and item loadings

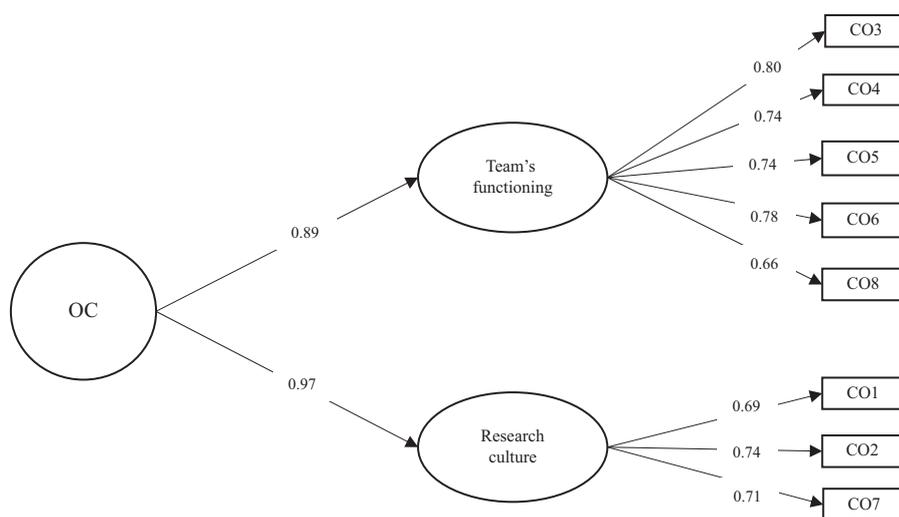


Figure 3.
Organizational capital
CFA: items and
item loadings

attributes of scholars and research teams that are key in the development of scientific activities. The proposed instrument emphasizes the importance of intangible assets as a foundation for the construct of academic intellectual capital.

Academic intellectual capital scale (definitive items):

(1) Academic human capital:

- Research knowledge:

- I have the theoretical training necessary to research in my scientific field.
- I know the most relevant publications in my scientific field.

-
- I have the necessary training in research methodologies and techniques.
 - I have the required capacity to obtain and manage the information necessary for the research.
 - I master the language usually used in journals/books and in scientific meetings in my academic field.
 - Research competences:
 - I can expose and communicate my research results.
 - I am able to identify research topics in my research context.
 - I can relate the observed facts to the results obtained and draw conclusions.
 - I know how to conduct research (thesis, research projects, etc.).
 - I can autonomously develop research.
 - I have the ability to interact fluently with other researchers.
 - I am able to adapt to changes in my research context.
 - Dynamism capacity:
 - I consider myself a creative person.
 - I consider myself a person with initiative.
 - I consider myself a person motivated by research.
 - I consider myself an observer.
 - Working capacity:
 - I consider myself a disciplined person.
 - I consider myself an organized person.
 - I consider myself a persevering person.
 - Critical thinking:
 - I consider myself a person with the ability to accept criticism from others.
 - I consider myself a self-critical person.
- (2) Academic social capital:
- Social climate:
 - Team members can trust that others will help them if necessary.
 - Team members can trust that others will make work easier.
 - Team members enjoy a good interpersonal climate.
 - Team members try to help each other if they have any difficulty.
 - The team members agree on what was important in the research work.
 - Team members share the same ambitions and visions in the research work.
 - Team members maintain interpersonal relationships very often.
 - Team members are excited to achieve the goals and objectives of the team.
 - Internal relations:
 - Team members hold regular meetings to advance the team's research activity.

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- Team members exchange our knowledge and experiences.
 - Team members share resources.
 - Team members share information.
 - Team members share our advances in research.
 - Team members look for and take advantage of synergies.
 - Team members hold meetings to define and design new research projects.
 - The members of the team meet to discuss the progress of the doctoral theses directed by team members.
- External relations:
 - Team members exchange ideas with a large number of colleagues outside the team.
 - Team members exchange ideas with a large number of professionals from outside our institution.
- (3) Academic organizational capital:
- Team's functioning:
 - Team members use computer resources to share relevant knowledge for the group's operation.
 - Team members have predefined work methods.
 - The members of the team have databases in which the knowledge generated by the members of the group is documented.
 - The members of the team have formalized protocols for the development of the research activity (procedure manuals, formalized processes, etc.).
 - Team members develop research activities according to routines that could be considered stable.
 - Research culture:
 - The members of the team hold meetings oriented to scientific training (seminars, workshops, etc.).
 - The members of the team meet to decide aspects related to the management of the team.
 - The members of the team have a strong culture, focused on research, which guides the behavior of team members.

The scale development process required the proposed instrument to meet the four criteria demanded by Claes *et al.* (2010): robustness, understanding, utility and relevance. We can consider that the proposed scale is robust, since the psychometric qualities of the scale were confirmed and we evaluated the internal consistency of the instruments used to measure the variables. Understanding, related to how the construct should be assessed and interpreted, was confirmed by a qualitative phase from which we extracted the expert opinion of leading academics from different fields of research. Finally, as we will be discussed in the next paragraphs, we consider that the proposed instrument complies with the standards of utility, since the conceptualization of intellectual capital and the use of the tool proposed to measure it could be considered relevant for research management and university decision-making, inspiring human

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resource management practices in academic institutions and information disclosure beyond financial statements.

Figure 4 summarizes the different uses and practical implications of the proposed measurement tool, differentiating between the institutional/organizational and the scientific team level. From a practical perspective, the instrument could be considered a management tool, providing a self-assessment instrument for evaluating the levels of intellectual capital. The way in which intellectual capital affects the scientific productivity of the researcher and the scientific teams will depend to a large extent on the way in which it is managed. Through different policies, the management of the team leader and the management of the institution, it will be possible to influence the generation of intellectual capital and its use. As can be seen from the literature, human resource management policies do not directly affect the productivity of work groups (Youndt and Snell, 2004; Subramaniam and Youndt, 2005; Kong and Thomson, 2009). Therefore, we highlight the relevance of the proposed tool and note that it is particularly important in identifying and measuring intermediate variables that allow us to explain the incidence of these practices. For example, in the management of a scientific team, a specific measure of the human capital of its researchers could help in identifying training needs and designing talent management initiatives. This could facilitate the implementation of human resource development practices, through the promotion of the participation of team members in training activities that favor not only the intensity of individual training but also its expansion so that it broadens the range of skills and knowledge available to the unit. In the same way, this occurs with the collective variables of intellectual capital, because knowing its levels in a scientific team allows the implementation of practices that encourage the construction of social capital through the establishment of a collaborative and egalitarian working environment and the establishment of flat structures, where information flows as freely as possible (Youndt and Snell, 2004; Kwon and Adler, 2014). Moreover, teams could also assess their own capability for building research networks. Likewise, its implications are also relevant in the case of organizational capital management, inspiring research team leaders to organize processes and promote internal cohesion. By applying the scale as a competence assessment tool, the internal composition and scientific work process of the team can be explicitly configured, while paying attention to complementarities and synergies at the different stages of each research project's development.

Institutional Level	<ul style="list-style-type: none"> • Design of selection processes • Design of reward systems • Design of talent management processes 	<ul style="list-style-type: none"> • University quality indicators • Informative transparency • Research funding application • Social responsibility reports • Comparative analysis and studies
Scientific Team Level	<ul style="list-style-type: none"> • Competence self-assessment • Organization of research processes • Identification of training needs 	<ul style="list-style-type: none"> • Research funding application • Promote building of research network
	Management	Reporting

Figure 4.
Practical
implications of the
intellectual capital
measurement scale

This tool could be used to evaluate the establishment of practices developed at an institutional level, such as those related to the remuneration or promotion of researchers, which have a notable impact on the development of human capital, by conditioning the skills and motivations of the individuals (Youndt and Snell, 2004). For example, it could be used to develop practices related to the distribution of workload, particularly in universities, where researchers have to combine their scientific activity with teaching responsibilities. In the same way, van den Brink *et al.* (2013) have highlighted the importance of organizational capacity to attract and retain scientific talent in the management of university human resources. In this sense, the proposed set of indicators identifies the attributes of scholars linked to higher scientific performance, and the scale could be used as an instrument for selection processes in universities and research institutions (Prüfer and Walz, 2013). For the university, the evaluation of the intellectual capital of its scientific teams also allows the development of support practices for these units, which emerge in training, information or technical support programs for the proposal and development of projects. The establishment of these types of support systems allows the reinforcement of intellectual capital research in its three dimensions, favoring not only the acquisition of skills but also the positioning of teams and the establishment of external links.

A second practical implication of the intellectual capital scale could be derived from its use as an external reporting tool. At the scientific team level, we could highlight the potential of this tool as an instrument that allows the development of reports both for the justification of the resources received and in the allocation of resources for research projects. Assessment instruments such as the scale proposed could help show the research capabilities of a scientific team to external parties, something that could be particularly useful when applying for research funding. Researchers and scientific teams face increasing competition due to lower levels of funding (Hicks, 2012), which puts them under greater pressure to communicate and justify their results. Research assessment has been recently criticized because of its almost exclusive emphasis on publication outputs (Fochler *et al.*, 2016). Instruments such as the proposed scale could help to overcome this limitation, complementing its evaluation and justification with intellectual capital-related inputs.

In the same way, at the institutional level, universities and research institutions have recently been asked to improve their informative transparency. Different stakeholders, such as university governors, staff, students and public administrators, now demand more information about the use of public funds (Ramírez-Córcoles *et al.*, 2011). Transparency in academic institutions has been traditionally focused on financial information, with insufficient attention given to other types of information, such as data on the social responsibility of their activities, or the value generated by key intangible elements (Hicks, 2012; Secundo *et al.*, 2016). The publication of intellectual capital indicators of its researchers and scientific teams would be a healthy exercise in transparency for academic institutions, providing a variety of information relevant to decision-making, which could improve the articulation of public policies. Information about the accumulation of intellectual capital could contribute in this sense, highlighting the effect that research policies and funding have on the creation of scientific competences in academic institutions. In addition, these indicators of intellectual capital could facilitate comparative analyses and studies between researchers and scientific teams within the organization itself to help decision-making processes and to promote competition and excellence.

4.1 Limitations

Finally, some limitations should be considered when interpreting the results and using the proposed scale. First, the empirical analysis was carried out with an initial sample of 1,798 Spanish scholars. The validation of the scale should therefore be confirmed in different national contexts, with larger data sets. Comparative analyses would be particularly

interesting in this sense, to explore the possible effect of differences in national science systems. In addition, in some cases, larger data sets would allow better factorial solutions that would explain higher variance percentages. Future studies should also establish the discriminant validity of the scale, exploring alternative measures of the construct. In this sense, it would also be interesting to evaluate or compare the predictive power of the scales proposed in our work as reflexive vs formative constructs, through the partial least squares two-construct model. Likewise, the use of longitudinal data sets could help to study the effects of intellectual capital in academic research, contributing to the ongoing debate on the determinants of research performance.

References

- Abbasi, A., Altmann, J. and Hossain, L. (2011), "Identifying the effects of co-authorship networks on the performance of scholars: a correlation and regression analysis of performance measures and social network analysis measures", *Journal of Informetrics*, Vol. 5 No. 4, pp. 594-607.
- Agarwal, R. and Ohyama, A. (2013), "Industry or academia, basic or applied? Career choices and earnings trajectories of scientists", *Management Science*, Vol. 59 No. 4, pp. 950-970.
- Åkerlind, G.S. (2008), "An academic perspective on research and being a researcher: an integration of the literature", *Studies in Higher Education*, Vol. 33 No. 1, pp. 17-31.
- Andrews, R. (2010), "Organizational social capital, structure and performance", *Human Relations*, Vol. 63 No. 5, pp. 583-608.
- Aramburu, N. and Sáenz, J. (2011), "Structural capital, innovation capability, and size effect: an empirical study", *Journal of Management & Organization*, Vol. 17 No. 3, pp. 307-325.
- Azoulay, P., Ganguli, I. and Graff Zivin, J. (2017), "The mobility of elite life scientists: professional and personal determinants", *Research Policy*, Vol. 46 No. 3, pp. 573-590.
- Barjak, F. (2006), "Research productivity in the internet era", *Scientometrics*, Vol. 68 No. 3, pp. 343-360.
- Barnacle, R. and Dall'Alba, G. (2011), "Research degrees as professional education?", *Studies in Higher Education*, Vol. 36 No. 4, pp. 459-470.
- Bazeley, P. (2010), "Conceptualising research performance", *Studies in Higher Education*, Vol. 35 No. 8, pp. 889-903.
- Becker, G.S. (1975), *Human Capital*, 2nd ed., Chicago University Press, Chicago, IL.
- Bercovitz, J. and Feldman, M. (2011), "The mechanisms of collaboration in inventive teams: composition, social networks, and geography", *Research Policy*, Vol. 40 No. 1, pp. 81-93.
- Bezhan, I. (2010), "Intellectual capital reporting at UK universities", *Journal of Intellectual Capital*, Vol. 11 No. 2, pp. 179-207.
- Bontis, N. (1998), "Intellectual capital: an exploratory study that develops measures and models", *Management Decision*, Vol. 36 No. 2, pp. 63-76.
- Bontis, N., Ciambotti, M., Palazzi, F. and Sgro, F. (2018), "Intellectual capital and financial performance in social cooperative enterprises", *Journal of Intellectual Capital*, Vol. 19 No. 4, pp. 712-731.
- Bozeman, B., Dietz, J. and Gaughan, M. (2001), "Scientific and technical human capital: an alternative model for research evaluation", *International Journal of Technology Management*, Vol. 22 No. 8, pp. 716-740.
- Bozeman, B., Fay, D. and Slade, C.P. (2013), "Research collaboration in universities and academic entrepreneurship: the-state-of-the-art", *Journal of Technology Transfer*, Vol. 38 No. 1, pp. 1-67.
- Brown, T.A. (2014), *Confirmatory Factor Analysis for Applied Research*, Guilford Publications, London.
- Cabello-Medina, C., López-Cabrales, Á. and Valle-Cabrera, R. (2011), "Leveraging the innovative performance of human capital through HRM and social capital in Spanish firms", *International Journal of Human Resource Management*, Vol. 22 No. 4, pp. 807-828.

- Cabrera-Nguyen, P. (2010), "Author guidelines for reporting scale development and validation results in the journal of the society for social work and research", *Journal of the Society for Social Work and Research*, Vol. 1 No. 2, pp. 99-103.
- Carmona-Lavado, A., Cuevas-Rodríguez, G. and Cabello-Medina, C. (2010), "Social and organizational capital: building the context for innovation", *Industrial Marketing Management*, Vol. 39 No. 4, pp. 681-690.
- Casanueva, C. and Gallego, Á. (2010), "Social capital and individual innovativeness in university research networks", *Innovation*, Vol. 12 No. 1, pp. 105-117.
- Chang, Y.C., Yang, P.Y. and Chen, M.-H. (2009), "The determinants of academic research commercial performance: towards an organizational ambidexterity perspective", *Research Policy*, Vol. 38 No. 6, pp. 936-946.
- Chen, F., Curran, P.J., Bollen, K.A., Kirby, J. and Paxton, P. (2008), "An empirical evaluation of the use of fixed cutoff points in RMSEA test statistic in structural equation models", *Sociological Methods & Research*, Vol. 36 No. 4, pp. 462-494.
- Chiucchi, S.M. (2013), "Intellectual capital accounting in action: enhancing learning through interventionist research", *Journal of Intellectual Capital*, Vol. 14 No. 1, pp. 48-68.
- Claes, C., Van Hove, G., van Loon, J., Vandevelde, S. and Schalock, R.L. (2010), "Quality of life measurement in the field of intellectual disabilities: eight principles for assessing quality of life-related personal outcomes", *Social Indicators Research*, Vol. 98 No. 1, pp. 61-72.
- Cummings, J.N., Kiesler, S., Bosageh Zadeh, R. and Balakrishnan, A.D. (2013), "Group heterogeneity increases the risks of large group size: a longitudinal study of productivity in research groups", *Psychological Science*, Vol. 24 No. 6, pp. 880-890.
- Deem, R. and Lucas, L. (2007), "Research and teaching cultures in two contrasting UK policy contexts: academic life in education departments in five English and Scottish universities", *Higher Education*, Vol. 54 No. 1, pp. 115-133.
- DeVellis, R.F. (2003), *Scale Development: Theory and Applications*, Sage Publications, Thousand Oaks, CA.
- Drummond, C. and Fischhoff, B. (2017), "Development and validation of the scientific reasoning scale", *Journal of Behavioral Decision Making*, Vol. 30 No. 1, pp. 26-38.
- Dumay, J. and Garanina, T. (2013), "Intellectual capital research: a critical examination of the third stage", *Journal of Intellectual Capital*, Vol. 14 No. 1, pp. 10-25.
- Durette, B., Fournier, M. and Lafon, M. (2016), "The core competencies of PhDs", *Studies in Higher Education*, Vol. 41 No. 8, pp. 1355-1370.
- Edgar, F. and Geare, A. (2013), "Factors influencing university research performance", *Studies in Higher Education*, Vol. 38 No. 5, pp. 774-792.
- Edvinsson, L. and Malone, M. (1997), *Intellectual Capital: Realizing your Company's True Value by Finding its Hidden Brainpower*, Collins, New York.
- European Commission (2010), *Europe 2020: A Strategy for Smart, Sustainable and Inclusive Growth*, COM (2010) 2020 Final, CEC, Brussels.
- Farooq, R. (2016), "Role of structural equation modeling in scale development", *Journal of Advances in Management Research*, Vol. 13 No. 1, pp. 75-91.
- Fochler, M., Felt, U. and Müller, R. (2016), "Unsustainable growth, hyper-competition, and worth in life science research: narrowing evaluative repertoires in doctoral and postdoctoral scientists' work and lives", *Minerva*, Vol. 54 No. 2, pp. 175-200.
- Fullwood, R., Rowley, J. and Delbridge, R. (2013), "Knowledge sharing amongst academics in UK universities", *Journal of Knowledge Management*, Vol. 17 No. 1, pp. 123-136.
- Gerbing, D.W. and Anderson, J.C. (1988), "An updated paradigm for scale development incorporating unidimensionality and its assessment", *Journal of Marketing Research*, Vol. 25 No. 2, pp. 186-192.
- Giuliani, M. and Marasca, S. (2011), "Construction and valuation of intellectual capital: a case study", *Journal of Intellectual Capital*, Vol. 12 No. 3, pp. 377-391.

- Gonzalez-Brambila, C.N. (2014), "Social capital in academia", *Scientometrics*, Vol. 101 No. 3, pp. 1609-1625.
- Gonzalez-Brambila, C.N., Veloso, F.M. and Krackhardt, D. (2013), "The impact of network embeddedness on research output", *Research Policy*, Vol. 42 No. 9, pp. 1555-1567.
- Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. and Tatham, R.L. (2006), *Multivariate Data Analysis*, Prentice Hall, Upper Saddle River, NJ.
- Heijde, C.M. and Van Der Heijden, B.I. (2006), "A competence-based and multidimensional operationalization and measurement of employability", *Human Resource Management*, Vol. 45 No. 3, pp. 449-476.
- Hicks, D. (2012), "Performance-based university research funding systems", *Research Policy*, Vol. 41 No. 2, pp. 251-261.
- Hinkin, T.R. (1998), "A brief tutorial on the development of measures for use in survey questionnaires", *Organizational Research Methods*, Vol. 1 No. 1, pp. 104-121.
- Holste, J.S. and Fields, D. (2010), "Trust and tacit knowledge sharing and use", *Journal of Knowledge Management*, Vol. 14 No. 1, pp. 128-140.
- Jacob, B.A. and Lefgren, L. (2011), "The impact of NIH postdoctoral training grants on scientific productivity", *Research Policy*, Vol. 40 No. 6, pp. 864-874.
- Jick, T.D. (1979), "Mixing qualitative and quantitative methods: triangulation in action", *Administrative Science Quarterly*, Vol. 24 No. 4, pp. 602-611.
- Kannan, G. and Aulbur, W.G. (2004), "Intellectual capital: measurement effectiveness", *Journal of Intellectual Capital*, Vol. 3 No. 5, pp. 389-413.
- Kline, R.B. (2015), *Principles and Practice of Structural Equation Modeling*, Guilford Publications, London.
- Kong, E. and Thomson, S.B. (2009), "An intellectual capital perspective of human resource strategies and practices", *Knowledge Management Research & Practice*, Vol. 7 No. 4, pp. 356-364.
- Kwon, S.W. and Adler, P.S. (2014), "Social capital: maturation of a field of research", *Academy of Management Review*, Vol. 39 No. 4, pp. 412-422.
- Kyvik, S. (2013), "The academic research role: enhancing expectations and improved performance", *Higher Education*, Vol. 65 No. 4, pp. 525-538.
- Leana, C.R. and Pil, F.K. (2006), "Social capital and organizational performance: evidence from urban public schools", *Organization Science*, Vol. 17 No. 3, pp. 353-366.
- Lee, H., Miozzo, M. and Laredo, P. (2010), "Career patterns and competences of PhDs in science and engineering in the knowledge economy: the case of graduates from a UK research-based university", *Research Policy*, Vol. 39 No. 7, pp. 869-881.
- Lee, Y.N., Walsh, J.P. and Wang, J. (2015), "Creativity in scientific teams: unpacking novelty and impact", *Research Policy*, Vol. 44 No. 3, pp. 684-697.
- Leitner, K.H. (2004), "Intellectual capital reporting for universities: conceptual background and application for Austrian universities", *Research Evaluation*, Vol. 13 No. 2, pp. 129-140.
- Li, E.Y., Liao, C.H. and Yen, H.R. (2013), "Co-authorship networks and research impact: a social capital perspective", *Research Policy*, Vol. 42 No. 9, pp. 1515-1530.
- Liao, C.H. (2011), "How to improve research quality? Examining the impacts of collaboration intensity and member diversity in collaboration networks", *Scientometrics*, Vol. 86 No. 3, pp. 747-761.
- Lindberg, O. and Rantatalo, O. (2015), "Competence in professional practice: a practice theory analysis of police and doctors", *Human Relations*, Vol. 68 No. 4, pp. 561-582.
- Liu, P. and Xia, H. (2015), "Structure and evolution of co-authorship network in an interdisciplinary research field", *Scientometrics*, Vol. 103 No. 1, pp. 101-134.
- Lloret-Segura, S., Ferreres-Traver, A., Hernández-Baeza, A. and Tomás-Marco, I. (2014), "El análisis factorial exploratorio de los ítems: una guía práctica, revisada y actualizada", *Anales de Psicología*, Vol. 30 No. 3, pp. 1151-1169.

- McNie, E.C., Parris, A. and Sarewitz, D. (2016), "Improving the public value of science: a typology to inform discussion, design and implementation of research", *Research Policy*, Vol. 45 No. 4, pp. 884-895.
- Marie, J. (2008), "Postgraduate science research skills: the role of creativity, tacit knowledge, thought styles and language", *London Review of Education*, Vol. 6 No. 2, pp. 149-158.
- Martin-de-Castro, G., Delgado-Verde, M., López-Sáez, P. and Navas-López, J.E. (2011), "Towards 'an intellectual capital-based view of the firm': origins and nature", *Journal of Business Ethics*, Vol. 98 No. 4, pp. 649-662.
- Mooken, M. and Sugden, R. (2014), "The capabilities of academics and academic poverty", *Kyklos*, Vol. 67 No. 4, pp. 588-614.
- Mouritsen, J. (2006), "Problematising intellectual capital research: ostensive versus performative IC", *Accounting, Auditing & Accountability Journal*, Vol. 19 No. 6, pp. 820-841.
- Murayama, K., Nirei, M. and Shimizu, H. (2015), "Management of science, serendipity, and research performance: evidence from a survey of scientists in Japan and the US", *Research Policy*, Vol. 44 No. 4, pp. 862-873.
- Nahapiet, J. and Ghoshal, S. (1998), "Social capital, intellectual capital, and the organizational advantage", *Academy of Management Review*, Vol. 23 No. 2, pp. 242-266.
- Neumann, A. (2006), "Professing passion: emotion in the scholarship of professors at research universities", *American Educational Research Journal*, Vol. 43 No. 3, pp. 381-424.
- Nyberg, A.J. and Wright, P.M. (2015), "50 years of human capital research: assessing what we know, exploring where we go", *The Academy of Management Perspectives*, Vol. 29 No. 3, pp. 287-295.
- Okoli, C. and Pawlowski, S.D. (2004), "The Delphi method as a research tool: an example, design considerations and applications", *Information & Management*, Vol. 42 No. 1, pp. 15-29.
- Ployhart, R.E. and Moliterno, T.P. (2011), "Emergence of the human capital resource: a multilevel model", *Academy of Management Review*, Vol. 36 No. 1, pp. 127-150.
- Prüfer, J. and Walz, U. (2013), "Academic faculty governance and recruitment decisions", *Public Choice*, Vol. 155 Nos 3-4, pp. 507-529.
- Ramírez, Y. and Gordillo, S. (2014), "Recognition and measurement of intellectual capital in Spanish universities", *Journal of Intellectual Capital*, Vol. 15 No. 1, pp. 173-188.
- Ramírez, Y., Manzanque, M. and Priego, A.M. (2017), "Formulating and elaborating a model for the measurement of intellectual capital in Spanish public universities", *International Review of Administrative Sciences*, Vol. 83 No. 1, pp. 149-176.
- Ramírez-Córcoles, Y., Santos-Peñalver, J.F. and Tejada Ponce, Á. (2011), "Intellectual capital in Spanish public universities: stakeholders' information needs", *Journal of Intellectual Capital*, Vol. 12 No. 3, pp. 356-376.
- Rodriguez, J. and Gonzalez-Brambila, C.N. (2016), "The effects of external collaboration on research output in engineering", *Scientometrics*, Vol. 109 No. 2, pp. 661-675.
- Rotolo, D. and Messeni Petruzzelli, A. (2013), "When does centrality matter? Scientific productivity and the moderating role of research specialization and cross-community ties", *Journal of Organizational Behavior*, Vol. 34 No. 5, pp. 648-670.
- Salaran, M. (2010), "Research productivity and social capital in Australian higher education", *Higher Education Quarterly*, Vol. 64 No. 2, pp. 133-148.
- Schumacker, R.E. and Lomax, R.G. (2004), *A Beginner's Guide to Structural Equation Modelling*, 2nd ed., Lawrence Erlbaum Associates, London.
- Secundo, G., Dumay, J., Schiuma, G. and Passiante, G. (2016), "Managing intellectual capital through a collective intelligence approach: an integrated framework for universities", *Journal of Intellectual Capital*, Vol. 17 No. 2, pp. 298-319.
- Secundo, G., Massaro, M., Dumay, J. and Bagnoli, C. (2018), "Intellectual capital management in the fourth stage of IC research: a critical case study in university settings", *Journal of Intellectual Capital*, Vol. 19 No. 1, pp. 157-177.

- Seibert, S.E., Kacmar, K.M., Kraimer, M.L., Downes, P.E. and Noble, D. (2017), "The role of research strategies and professional networks in management scholars' productivity", *Journal of Management*, Vol. 43 No. 4, pp. 1103-1130.
- Sharabati, A., Naji Jawad, S. and Bontis, N. (2010), "Intellectual capital and business performance in the pharmaceutical sector of Jordan", *Management Decision*, Vol. 48 No. 1, pp. 105-131.
- Shibayama, S., Baba, Y. and Walsh, J.P. (2015), "Organizational design of university laboratories: task allocation and lab performance in Japanese bioscience laboratories", *Research Policy*, Vol. 44 No. 3, pp. 610-622.
- Shrum, W., Genuth, J. and Chompalov, I. (2007), *Structures of Scientific Collaboration*, MIT Press, Cambridge.
- Siadat, S.A., Hoveida, R., Abbaszadeh, M. and Moghtadaie, L. (2012), "Knowledge creation in universities and some related factors", *Journal of Management Development*, Vol. 31 No. 8, pp. 845-872.
- Subramaniam, M. and Youndt, M.A. (2005), "The influence of intellectual capital on the types of innovative capabilities", *Academy of Management Journal*, Vol. 48 No. 3, pp. 450-463.
- Tabachnick, B.G. and Fidell, L.S. (2013), *Using Multivariate Statistics*, Pearson, Boston, MA.
- Thunnissen, M. and Van Arensbergen, P. (2015), "A multi-dimensional approach to talent", *Personnel Review*, Vol. 44 No. 2, pp. 182-199.
- Timmerman, B.C., Feldon, D., Maher, M., Strickland, D. and Gilmore, J. (2011), "Performance-based assessment of graduate student research skills: timing, trajectory, and potential thresholds", *Studies in Higher Education*, Vol. 38 No. 5, pp. 1-18.
- Ulrich, W. and Dash, D.P. (2013), "Research skills for the future: summary and critique of a comparative study in eight countries", *Journal of Research Practice*, Vol. 9 No. 1, pp. 1-21.
- Van den Brink, M., Fruytier, B. and Thunnissen, M. (2013), "Talent management in academia: performance systems and HRM policies", *Human Resource Management Journal*, Vol. 23 No. 2, pp. 180-195.
- Veltri, S. and Bronzetti, G. (2015), "A critical analysis of the intellectual capital measuring, managing, and reporting practices in the non-profit sector: lessons learnt from a case study", *Journal of Business Ethics*, Vol. 131 No. 2, pp. 305-318.
- Villanueva-Felez, A., Molas-Gallart, J. and Escribá-Esteve, A. (2013), "Measuring personal networks and their relationship with scientific production", *Minerva*, Vol. 51 No. 4, pp. 465-483.
- Vinig, T. and Lips, D. (2015), "Measuring the performance of university technology transfer using metadata approach: the case of Dutch universities", *Journal of Technology Transfer*, Vol. 40 No. 6, pp. 1034-1049.
- Walsh, J.P. and Lee, Y.N. (2015), "The bureaucratization of science", *Research Policy*, Vol. 44 No. 8, pp. 1584-1600.
- Wang, J., Peters, H.P. and Guan, J. (2006), "Factors influencing knowledge productivity in German research groups: lessons for developing countries", *Journal of Knowledge Management*, Vol. 10 No. 4, pp. 113-126.
- Wang, Z., Wang, N. and Liang, H. (2014), "Knowledge sharing, intellectual capital and firm performance", *Management Decision*, Vol. 52 No. 2, pp. 230-258.
- White, C.S., James, K., Burke, L.A. and Allen, R.S. (2012), "What makes a 'research star'? Factors influencing the research productivity of business faculty", *International Journal of Productivity & Performance Management*, Vol. 61 No. 6, pp. 584-602.
- Whitelock, D., Faulkner, D. and Miell, D. (2008), "Promoting creativity in PhD supervision: tensions and dilemmas", *Thinking Skills and Creativity*, Vol. 3 No. 2, pp. 143-153.
- Worthington, R.L. and Whittaker, T.A. (2006), "Scale development research: a content analysis and recommendations for best practices", *The Counselling Psychologist*, Vol. 34 No. 6, pp. 806-838.
- Wright, P.M., Coff, R. and Moliterno, T.P. (2014), "Strategic human capital: crossing the great divide", *Journal of Management*, Vol. 40 No. 2, pp. 353-370.

Wuchty, S., Jones, B.F. and Uzzi, B. (2007), "The increasing dominance of teams in production of knowledge", *Science*, Vol. 316 No. 5827, pp. 1036-1039.

Youndt, M.A. and Snell, S.A. (2004), "Human resource configurations, intellectual capital, and organizational performance", *Journal of Managerial Issues*, Vol. 16 No. 3, pp. 337-360.

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