

Construction-validation of the questionnaire: Maturity of knowledge management to educational innovation in universities

Construcción-validación del cuestionario sobre madurez de la gestión del conocimiento para la innovación educativa en universidades

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ABSTRACT

Keywords

Construction;
questionnaire; higher
education; knowledge
management; educational
innovation; level of
maturity; validation

Universities face a permanent process of transformation, so they need to manage internal educational knowledge to accelerate innovation, regardless of their educational modality. However, there are few contributions that address the evaluation of the level of maturity in what they do. Therefore, the questionnaire maturity of knowledge management to innovate in universities was designed and validated. For this purpose, a review of existing instruments was carried out, the questionnaire was designed using a Likert-type structure, which was later analyzed by seven experts, its content was validated by 15 expert judgements with a qualitative-quantitative approach, and it was applied to a pilot group of 15 professors for analysis of comprehension of both items and instructions. The instrument was formed by five dimensions and 48 items. The experts specified improvements and determined the relevance of the dimensions and items; the analysis of Judges evaluation revealed the content validity of items in terms of relevance and writing (V of Aiken > 0.90); the pilot group deemed with a good grade the understanding of instructions, the items and instrument satisfaction with a relevant initial reliability value (Cronbach's alpha: 0.941). It is recommended to apply it to a representative sample for analysis of construct validity, and reliability.

RESUMEN

Palabras clave

Construcción;
cuestionario; educación
superior; gestión del
conocimiento;
innovación educativa;
nivel de madurez;
validación

Las universidades enfrentan un proceso permanente de transformación, por lo que requieren gestionar el conocimiento educativo interno para acelerar la innovación, sin distinción de su modalidad educativa; no obstante, son escasos los aportes que abordan la evaluación de la madurez con la que se gestiona este saber. Por consiguiente, se diseñó y validó el cuestionario sobre madurez de la gestión del conocimiento para la innovación educativa en universidades. Se revisaron los instrumentos existentes y se construyó el cuestionario mediante la estructura tipo Likert, el cual fue analizado por siete expertos; asimismo, se evaluó en juicio por 15 expertos con un enfoque cuali-cuantitativo para validar contenido, y se aplicó a un grupo piloto de 15 profesores para analizar la comprensión de ítems e instrucciones. El instrumento se conformó de cinco dimensiones y 48 ítems. Los expertos sugirieron mejoras y determinaron la pertinencia de las dimensiones e ítems. El análisis de la evaluación de jueces reveló la validez de contenido de ítems en términos de pertinencia y redacción (V de Aiken > 0.90); el grupo piloto ponderó de buen grado la comprensión de instrucciones e ítems, y la satisfacción con el instrumento con valor inicial pertinente de confiabilidad (alfa de Cronbach: 0.941). Se recomienda aplicarlo a una muestra representativa para el análisis de la validez de constructo y de confiabilidad.

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INTRODUCTION

The current socio-economical approach places knowledge and information and communication technologies as structuring principles of change in different sectors and production processes. The success of organizations is measured by the development of productivity, innovation and creation capacities of strategic value, which are achieved inasmuch as they are suitable to create, share and apply knowledge (Alfonso, 2016; Bailey *et al.*, 2017; Begoña, 2015; Jerónimo-Cano & Juárez-Hernández, 2018; Naranjo, González & Rodríguez, 2016; Pedraja, 2012).

In this dynamics, higher education institutions (HEI) have a significant place because of their knowledge generation condition, which implies that several universities of different countries face an “internal organization analytical process to improve the management of their intellectual assets” (Cricely *et al.*, 2018 p. 72) and, by doing so, achieve a transformation. The foregoing is an essential quality for HEI to evaluate and steer their educational methods and practices (Aguilar, Fortanell & Garcia, 2012; Chacon, 2014; Cuevas, 2016; Naranjo *et al.*, 2016; Rengifo-Millan, 2015; Sañudo, 2014).

In this sense, it is through knowledge management (KM) that conditions may be created to foster the creation, storage and transmission of knowledge aimed to improve its circulation within institutions by developing models, strategies, systems, processes, practices and methods to create, acquire, identify, codify, transmit, apply and protect knowledge, and therefore, accelerate innovation processes (Aguilar *et al.*, 2012; Canton & Ferrero, 2016; Galvis & Sanchez, 2014; Sañudo, 2014).

Innovation is an irregular process in institutions because it generally is the result of the idea of one person or of an inspiration moment, something impossible to systematize (Velasco & Zamanillo, 2008). This may be due to the fact that the practice and results of innovation are partly implemented and not institutionalized (Minakata, 2009).

For this reason, innovation ought to be articulated in a systemic and systematic mode, by means of academic management and its organizational and pedagogic-curriculum dimensions to have an impact in the whole institution, because, through it, change is sought related with a previously set objective which implies an original situation and a different one which, individually, is interiorized and,

collectively, becomes normality (Aguilar *et al.*, 2012; Barraza, 2006; Guzmán *et al.*, 2015; Laurencio & Farfán, 2016; Matas, Tójar & Serrano, 2004; Ortega *et al.*, 2007).

Implementing KM for educational innovation in institutions is a process that implies a step from one stage to another and that are established on the basis of the efficacy analysis of activities, practices, and organizational methods in the achievement of the assets of knowledge. Resulting effectiveness is known as the level of maturity of KM (De Freitas, 2017), which makes it possible to design a macro-strategy and favor the performance of strategic goals.

KM maturity models have been established in order to evaluate this level, which are understood as reflection schemes that measure the KM of an organization from a strategic macroscopic approach, and which enables evaluation and comparison of initiatives as a function of knowledge created within the organization and, so, the level of maturity is established (De Freitas, 2017; Leon & Ponjuan, 2011; Montañez & Lis, 2015; Montañez & Lis, 2017).

In spite of the relevance of KM and the existence of general models to measure its maturity, there are no specific instrumental proposals to evaluate the KM generated by professors, researchers, academic bodies or inter-institutional networks, as a function of the educational innovation of HEI. Notwithstanding, of the studies under analysis addressing KM and HEI, we consider the proposals of Ansuattigui, Caulliriaux-Pithon & Fernandes (2013), De Freitas (2017), Demching (2015) and Montañez & Lis (2015) for the following general aspects: selection of the maturity model based on a comparative analysis; updating the maturity model as key dimensions or areas are included; adaptation of the instrument to the higher educational context, as well as arranging and constructing items. Specifically, of the authors mentioned herein, Ansuattigui, Caulliriaux-Pithon & Fernandes (2013), focus on the implementation of KM strategies or methods from the perspective of action; on the other hand, the studies of De Freitas (2017), Demching (2015) and Montañez & Lis (2015) address the KM practice and activities from the managing perspective.

In a general manner, the studies mentioned above evaluate the level of maturity of MK in HEI from practices, activities and strategies or methods of MK from the perspectives of management and action, with special attention to normative and descriptive elements, respectively. In order to get a specific understanding of the maturity

level of MK in respect to educational innovation, we start from an integrating focus of academic management which articulates both the organizational and the pedagogic-curricular elements. It links the educational system, the institution and the pedagogic action, and guides tacit and explicit knowledge around education, of professors and researchers considered individually or comprising research teams and inter-institutional networks.

The foregoing is crucial because, as refereed by Sañudo (2014), educational knowledge is abundant and heterogeneous in Mexico, however with little incidence in the improvement of education, therefore, we emphasize on accompanying the process and the results of the research by organizational strategies and KM methods that assure the use by beneficiaries, whether direct or indirect.

Likewise, the works of Gomez-Vargas & Garcia (2015) in Colombia, Magaña *et al.* (2016) in Mexico and Rodriguez-Ponce (2016) in Chile, suggest that the number of studies be increased on the organizational structuring of programs, processes and strategies of KM so that aspects may be integrated that are worked independently or separately, within which we may consider identified key areas, as well as factors of success of KM in HEI presented by De Freitas & Yaber (2017), and therefore, strengthen the culture based on KM.

Clearly, we specify that instrumental proposals are voided to evaluate the maturity of KM both tacitly and explicitly around education, the faculty and research groups. For this reason, it is necessary to have a specialized instrument that allows us to determine the level of maturity from an integrating approach of the organizational and pedagogic-curricular aspects of school management. This provides the basis to design organizational strategies of the educational KM, *ad hoc* to the context of HEI.

Upon considering the above, our study focused on the following goals: to design a relevant and practical questionnaire to determine the maturity level of KM around education to foster innovation in HEI from an integrating approach of school management, to review and improve the instrument based on the analysis of experts, to submit experts to judgment to analyze the validity of content, and to apply it to a pilot group with the purpose of analyzing its accessibility and making an initial internal consistency analysis.

METHODOLOGY

Study type

We have performed an instrumental study which consists of the “development of tests and devices, including both the design (or adaptation) and the study of psychometric properties thereof” (Montero & Leon, 2007, pp. 855-856).

Procedure

The study included the following phases:

1. Theoretical review and analysis of instruments related to the questionnaire that is being constructed. In this first phase, we analyzed 14 studies and instruments related to the maturity of KM which evaluate constructs and dimension or key areas, as well as activities, practices, and strategies or methods, nine of which refer to the context of HEI (see table 1), and the rest, to organizations of the entrepreneurial sector (see table 2). By this analysis, we recognize priority topics and instruments, relevant categories, dimensions and items useful to be retaken, as well as weak areas regarding the evaluation to be considered.

Table 1. Studies related to the maturity of knowledge management in higher education institutions

Studies and authors	Dimensions and Items	Adapted from	Psychometric property analyzed
Development and application of a general knowledge management maturity model; Teah, Pee & Kankanhalli (2006)	People-organization, processes and technology (27 items)	Adapted from and based in several authors; Knowledge Journey, KPQM, and KMCA	Validation by focus group
Nivel de madurez en sistemas de gestión del conocimiento en instituciones de educación superior: un estudio de caso desde un enfoque holístico. [<i>Maturity level in knowledge management systems in post-secondary education</i>]	QM Strategy, people, processes, technologies, networks and information management (35 items)	Pee and Kankanhalli (2009); Chu <i>et al.</i> (2011)	Face validity

<i>institutions: a case study from a holistic approach</i>]; De Freitas (2017)			
Knowledge management capability level assessment of the higher education institutions: Case study from Mongolia; Demching (2015)	Exchange culture, lessons learned, expertise, archives and data (14 items)	Kulkarni y St. Louis (2003); Kulkarni y Freeze (2004)	Validation by focus group
Measurement of the maturity of knowledge management in the school of basic sciences, technology and engineering of the UNAD. [<i>Medición de la madurez de la gestión del conocimiento en la escuela de ciencias básicas, tecnología e ingeniería de la UNAD</i>]; Montañez-Carrillo and Lis-Gutiérrez (2015)	QM Strategy, people, processes, technology (37 items)	G-KMMM of Teah et al. (2006)	Validation by experts
Practices of knowledge management in a public research institution. The case of the technological center of the army in Brazil. [<i>Práticas de gestión del conocimiento en una institución pública de investigación. El caso del centro tecnológico del ejército en Brasil</i>]; Ansuattigui et al. (2013)	People, processes and systems (20 items)	Organizational Knowledge Assessment	Validation without data
Exploratory study of the impact of knowledge management in the quality of universities. [<i>Estudio exploratorio del impacto de la gestión del conocimiento en la</i>	Creating, sharing and applying knowledge (14 items)	Rodríguez Ponce (2007)	Reliability

<i>calidad de las universidades</i>]; Rodríguez-Ponce (2016)			
Influential factors in knowledge management in the context of university research. [<i>Factores influyentes de la gestión del conocimiento en el contexto de la investigación universitaria</i>]; Gómez-Vargas and García (2015)	People, processes, contents and technologies (19 items)	Centre Européen de Normalisation (2004)	Validation by expert and trial test
Knowledge management in Mexican public universities [<i>Gestión del conocimiento en universidades públicas mexicanas</i>]; Luna, Reyes and Jiménez (2017)	Knowledge as a strategic factor, strategic direction of knowledge and intellectual capital (items: no data)		Validation by expert judgement, construct validity and reliability
Knowledge management in technological university institutes. [<i>Gestión del conocimiento en institutos universitarios de tecnología</i>]; Ureña y Villalobos (2011)	Generation, conversion and strategies for the transferring of knowledge (27 items)	Ureña (2009) citado en Ureña y Villalobos (2011)	Content validation by experts judgement and reliability

Table 2. Studies related to the maturity of knowledge management in the entrepreneurial sector

Studies and authors	Dimensions and Items	Adapted from	Psychometric property
An approach to the measurement of business knowledge management. [<i>Aproximación a la medición de la gestión del conocimiento empresarial</i>]; Bernal, Turriago and Sierra (2010)	Knowledge relevance management (KRM): appropriation, application, generation, and index of organizational intelligence	IIO taken from Arbonés and Aldázabal (2005)	Validation without data

	(IOI): memory, abilities, culture and perspective (12 items for KRM and 42 for IOI)		
The role of knowledge-oriented leadership in knowledge management practices and innovation. [<i>The role of knowledge-oriented leadership in knowledge management practices and innovation</i>]; Donate y Sánchez (2015)	Practices of creation, storing, transference, application of knowledge, leadership, innovation and expense in R&D (39 items)	Zahra and Das (1993); Zahra and Bogner (1999) cited in Donate and Sánchez (2015)	Validation without data
A proposal of an instrument to know the activities of knowledge management and the organizational factors which influence it. [<i>Propuesta de un instrumento para conocer las actividades de gestión del conocimiento y los factores organizativos que la influyen</i>]; Mul, Mercado and Ojeda (2013)	Knowledge management, organizational culture, leadership and technologies (94 items)		Validation by five experts and reliability
Leadership styles, knowledge management and strategy design: an empirical study in small and medium-sized business. [<i>Estilos de liderazgo, gestión del conocimiento y diseño de la estrategia: un estudio empírico en pequeñas y medias empresas</i>]; Pedraja-Rejas and Rodríguez-Ponce (2008)	Leadership and knowledge management: transformational style; transactional style; creating, sharing and applying knowledge; designing the strategy (26 items)	Adapted from and based in several authors	Reliability
Organizational knowledge management, technological innovation and results. An empirical study. [<i>Gestión del conocimiento organizativo, innovación tecnológica y resultados</i>]. <i>Una investigación empírica</i>]; Donate and Guadamillas (2010)	Practices, exploration and exploitation of knowledge, protection methods, product innovation, process innovation, economic result (48 items)		Reliability

2. Designing the instrument and review by experts. During this phase, and as a result of the analysis, we selected the studies and instruments of Ansuattigui *et al.* (2013), De Freitas (2017),

Demching (2015), Donate & Guadamillas (2010), Gómez-Vargas & García (2015), Liberona & Ruiz (2013), Luna *et al.* (2017), Montañez & Liz (2015), Mul *et al.* (2013), Pedraja-Rejas & Rodríguez-Ponce (2008), Rodríguez-Ponce (2016), Teah *et al.* (2006), and Ureña & Villalobos (2011). From this analysis we chose dimensions and items to be included in the instrument and we were careful to see that they were theoretically argued and *ad hoc* regarding the characteristics and needs of the topic. It is important to clarify that, for the selection of these studies, we pondered that they denoted some kind of validation, as shown in Tables 1 and 2. The questionnaire was designed under the Likert frequency scale, consisting of a category, seven dimensions and 49 items (see table 3).

Table 3. Initial structure of the questionnaire

Category	Dimensions or key area	No. of items
Maturity of knowledge management for the promotion of education innovation	Dimension 1: Establishing the strategy	5
	Dimension 2: Supporting the strategy	5
	Dimension 3: Implementing the strategy	5
	Dimension 4: Generation of conditions for the exchange and creation of knowledge	5
	Dimension 5: Formalization of knowledge processes	5
	Dimension 6: Technological support	5
	Dimension 7: Strategies or methods of knowledge management implemented	19

After the construction of the instrument, it was submitted to the review of seven experts (see table 4) with the purpose that they verified the category and dimensions proposed, as well as items comprising them, their relevance and pertinence with the

dimensions and aspects related with instructions and wording of the questionnaire. To characterize the profile of experts, we used the personal data instrument (CIFE, 2017), whose goal is to gather information on the following aspects: sex, role, academic degree, professional and labor experience, research activity or academic production, among others.

Table 4. Characterization of experts and expert judges

Variable	Experts	Expert reviewers
Sex	Men: 71%	Men: 53%
	Women: 29%	Women: 47%
Role	Researcher: 14%	Research professor: 87%
	Teacher: 71%	Professor: 13%
	Administrative: 14%	
Highest level of education completed	Ph. D.: 14%	Ph. D.: 73%
	Master: 86%	Master: 27%
Areas of professional expertise	Teaching: 100%	Teaching: 100%
	Psychological processes: 43%	Psychological processes: 20%
	Social processes: 14%	Social processes: 33%
	Organizational processes: 86%	Organizational processes: 40%
	Statistical processes: 29%	Education: 60%

	Instrument design: 100%	Instrument design: 66%
Years of professional experience (median)	11	20
Year of research-teaching experience (median)	9	15
Number of published papers (median)	5	15
Number of presentations in the area (median)	4	15
Number of books published in the area (median)	1	2
Number of book chapters published in the areas of professional experience		6
Experience in revision, design or validation of a determined research instrument	100%	100%

3. Survey on the validity of content. In order to determine validity of content of the instrument, we used the judgment of experts. The concept of validity of content or validity of logic allows us to identify the degree of a representative measure of contents, as well as the scope of each element or dimension of the construct (Ruiz, 2002). In this sense we performed a judgment of experts with a qualitative-quantitative approach regarding the criteria of relevance and wording. The judgment was formed by 15 judges (see table 4), and in selecting them we followed formal criteria and relevant variables (Juarez-Hernandez & Tobon, 2018), as well as higher education teachers and researchers with knowledge and experience in the topic, academic master or doctorate degree, publications, as well as experience in the design and instrument validation.

It is important to note that we sent an invitation to 24 national judges and four foreign judges by email, 16 and three answered,

respectively. Notwithstanding, of the national judges, two did not evaluate the instrument within the set period; in addition, we discarded two registries, because there were consistency mistakes on the professional information in one, and the other one evaluated the instrument from a different approach to the established set in the research.

As stated, the judgment of experts had a qualitative-quantitative evaluation approach. Regarding the qualitative evaluation, we asked each judge for suggestions to eliminate, improve or add items or questions, as well as wording aspects. For the quantitative evaluation we gave a polytomous scale named scale of expert judges, ranging from zero to four, and by means of which each judge gave a score to the wording and another one to relevance.

Once this evaluation was performed, we employed Aiken's V content validity coefficient for the analysis, in accordance with the model proposed by Penfield & Giacobbi (2004), and we considered a minimum value of 0.80 for the acceptance of an item to be valid (Bulger & Housner, 2007; Penfield & Viacobbi, 2004). By the results of previous evaluations, the questionnaire was adjusted and improved.

4. Application of the test with a pilot group. The instrument was applied to a pilot group which included 15 higher education professors (see Table 5). There were two objectives in this phase: one, to analyze by means of the satisfaction degree of the instrument, understanding instructions and items, as well as the relevance of the questions evaluated by means of the satisfaction questionnaire with the instrument (CIFE, 2017); specifically, for satisfaction purposes, we included aspects related with amenity, extension and time to answer the instrument; the item related to understanding instructions and items conforms with clarity of the wording employed and, in the relevance, it is established whether the item has contributed to evaluate the concept. The second objective was to make an initial analysis and with a guiding purpose for internal consistency by means of Cronbach's Alpha coefficient (Cronbach, 1951). We considered a general rule that the coefficient value ought to be above 0.80 (Quero, 2010).

Table 5. Information of the pilot group

Variable	Information
Sex	Women: 6 (40%); men: 9 (60%)

Roles	Research professor: 13 (87%); professor: 2 (33%)
Highest level of education completed	Ph. D.: 8 (53%); master: 7 (47%)
Area of academic education	Pedagogy: 2; Computing Sciences: 2; Education: 3; Statistics: 1; Information Technologies: 2; Anthropology: 1; Social work: 1; Psychology: 2; Organizations: 1

Ethical aspects

To design and validate the questionnaire, we respected the following research ethical criteria: we refer to the studies that are taken into account for designing the questionnaire and updating the general model of maturity by the inclusion of the key area; KM methods or strategies; analysis of experts, evaluation of judges and application to the pilot group, we sent them a written invitation for their participation, respectively, and we shared the link once we received their acceptance; and applied personal data protection.

RESULTS

From the review and analysis of instrumental history, we identified the relevant criteria for the construction of the questionnaire, as well as general aspects, dimensions and items to be included. In this sense, studies and instruments selected that may be analyzed by KM in institutions, we identified key areas such as the organizational strategy (planning and administration, leadership, teamwork and communication), persons-organization (capacities, culture and internal perspective), knowledge processes (create, acquire, store, transfer, apply and protect), technologies (systems and networks), and information management (data and contents).

Management processes that are not considered in the instruments, but that are part of KM are: planning, evaluation, coordination, control and analysis to assure management activities of the processes of knowledge, and strategies or methods of KM, that correspond to the strategic design of process and practices of knowledge for the attainment of objectives.

From the theoretical review, we recognized five key areas of KM: 1) persons-organization, which represents organizational conditions for persons to exchange knowledge; 2) knowledge processes, which refer to social or technological activities that favor the development of knowledge; 3) technologies, as facilitators in the exchange of information, skills and resources to accelerate the cycle of knowledge (Teah *et al.*, 2006); 4) organizational strategy, where initiatives and processes of KM are aligned with the objects of the institution (De Freitas, 2017; Demching, 2015; Montañez-Carrillo & Liz-Gutierrez, 2015) the methods, which correspond to strategic design of knowledge processes of the organization for the attainment of the objectives (Anusattigui *et al.*, 2013; Donate & Guadamillas, 2010; Ureña & Villalobos, 2011), incorporated or formed by the organizational and pedagogic-curricular level, and knowledge typologies: exploitation and exploration, of Vazquez-Gonzalez & Jimenez-Macias (2018).

To prepare KM items fit to the educational innovation approach in HEI, we analyzed previous questionnaires and studies, in addition to those of Bernal *et al.* (2010), Donate & Sanchez (2015), Gomez-Vargas & Garcia (2015), Liberona & Ruiz (2013), Luna *et al.* (2017), Mul *et al.* (2013), Pedraja-Rejas & Rodriguez-Ponce (2008) and Rodriguez-Ponce (2016).

After the construction of the instrument, we submitted it to the review of experts. This phase allowed us to improve different aspects, such as the dimensions and items, presentation, general data and instructions. Regarding the dimensions, we grouped the first three ones, as they belong to the KM's organizational strategy; regarding the items, we improved the wording of 70% of them. For the presentation, we synthesized the message and pointed out the public it is addressed to; regarding general data, we redefined the ranges of age and oldness; likewise, we reduced the number of activities of the participants as a function of the accuracy of the sector it is addressed to; and regarding instructions, we improved the wording.

From changes of the last two aspects, we adjusted the structure of the questionnaire and of the items. For the organizational strategic dimension, we integrated ten items into four, accordingly. For the persons-organization dimension, we eliminated one item because it was considered in the background area; and disregarded five items from one containing aspects related with exchange, creation, formation and collaboration. For knowledge processes, we separated three items because they contained several aspects each: knowledge and skills; good practices, lessons learnt, stories of success and efficacy; authorized uses and knowledge protection, in that order.

For the technologies dimension, we disregarded two items, as they contained policies and use of internal and external tools, and infrastructure and systems, respectively. Lastly, in the KM strategies or methods dimension, we integrated four items because they were related in respect to the virtual environment topic; also, we eliminated one about KM monitoring, which we considered in the organizational strategy. In table 6, column A, we show the structure of the questionnaire from the analysis of experts.

Table 6. Structure of the questionnaire from A) analysis of experts, B) judgment of experts and C) final version.

Dimensions	A) No. of items	B) No. of items	C) No. of items
Dimension 1: Organizational strategy	10	10	9
Dimension 2: People-organization	8	7	7
Dimension 3: Knowledge processes	12	10	9
Dimension 4: Technology	8	8	8
Dimension 5: Strategies of knowledge management for the promotion of innovation of post-secondary education institutions	14, plus one open-ended item	14, plus one open-ended item	14, plus one open-ended item
Total	53	50	48

Judgment of experts

Once the improvements mentioned by experts on the questionnaire were made, we submitted it to the judgment of experts. The qualitative evaluation allowed us to improve presentation aspects, general data and items. In the case of the presentation, we specified the importance of the topic before the purpose of the instrument, and added a brief definition of this; regarding general data, we added to fields: participant's institution and country. Regarding the items, qualitative improvements are mentioned per key area in table 7.

Table 7. Improvement of items from the judgment of experts

Dimensions	Item	Improvements
Dimension 1: Organizational strategy	1, 2 and 3	Wording
Dimension 2: People-organization	12	Wording
	17	Wording; example added
	18	Wording; example added
	13 and 14	Affinity. Put together because both belong to the creation of knowledge
Dimension 3: Knowledge processes	22, 23 and 24	Affinity. Put together with a form of registry of knowledge
	20, 21 and 29	Wording
Dimension 4: Technology	32, 33 and 34	Change of verb
	36	Example added
Dimension 5: Strategies of knowledge management for the promotion of innovation of post-secondary education institutions	39 y 46	Change of verb
	41	Example added

In table 7, it is seen that, for the organizational key strategy, we improved the wording of items 1, 2 and 3; for the persons-organization, we adjusted the wording of items 12, 17 and 18; for the

latter two, we also included examples; likewise, we combined items 13 and 14, as they address the same aspect of knowledge creation; in knowledge processes, we integrated items 22, 23 and 24, as they refer to a manner or means to record knowledge, and we improved the wording of items 20, 21 and 29; in technologies, we changed the verbs of items 32, 33 and 34, in addition to including an example in item 36; finally, in the KM strategies or methods area, we changed the verb of items 39 and 46, in addition to including an example in item 41.

On the other hand, the quantitative evaluation analysis disclosed the validity of content of items on pertinence and wording criteria (Aiken's $V > 0.80$); regarding this, we noticed that more than 80% of the items have an Aiken's V value greater than 0.90, and a single item has a value close to the minimum value established (item 2) (see Table 8). The latter agrees with the qualitative evaluation, where improvements were noted in the review and adjustment of the wording, as well as integration of items 13 and 14, as well as 22, 23 and 24, which gathers information in the same sense in the instrument and reduces its extension (see table 6, column B).

Table 8. Content validity index (Aiken's V) per item for the pertinence and wording criteria

Dimensions	Item number	Relevance	Wording
Organizational strategy	1	0.87	0.87
	2	0.87	0.83
	3	0.87	0.87
	4	0.87	0.88
	5	0.87	0.88
	6	0.87	0.88
	7	0.87	0.88
	8	0.87	0.88
	9	0.87	0.88
	10	0.87	0.88

People-organization	11	0.95	0.92
	12	0.95	0.90
	13	0.93	0.92
	14	0.93	0.92
	15	0.95	0.92
	16	0.95	0.92
	17	0.93	0.92
	18	0.85	0.92
Knowledge processes	19	0.95	0.98
	20	0.95	0.97
	21	0.95	0.97
	22	0.95	0.93
	23	0.95	0.93
	24	0.95	0.93
	25	0.95	0.98
	26	0.95	0.98
	27	0.95	0.98
	28	0.95	0.98
	29	0.95	0.97
	30	0.95	0.98
Technology	31	0.93	0.97
	32	0.93	0.92
	33	0.93	0.95
	34	0.93	0.95
	5	0.93	0.97
	36	0.93	0.95

	37	0.93	.097
	38	0.93	0.95
Strategies or methods of knowledge management for the promotion of innovation of post-secondary education institutions	39	0.92	0.90
	40	0.92	0.95
	41	0.92	0.93
	42	0.92	0.95
	43	0.92	0.95
	44	0.92	0.95
	45	0.92	0.95
	46	0.92	0.93
	47	0.92	0.95
	48	0.92	0.95
	49	0.92	0.95
	50	0.92	0.95
51	0.92	0.95	
52	0.92	0.95	
53	0.92	0.95	

Pilot group

Perception of teachers showed proper weighting on understanding questions and items, as well on the relevance of questions. Generally, a good degree of satisfaction was indicated for the instrument (see Table 9). Regarding the internal consistency analysis, there was an optimal level (Cronbach's alpha: 0.941).

Table 9. Satisfaction level of the pilot group with the instrument

Questions	Answers
Degree of understanding of instructions	Excellent (4) 27%; Good (5) 33%; Acceptable (5) 33%; Regular (1) 7%; Poor (0)
Degree of understanding of questions or items	Excellent (0); Good (9) 60%; Acceptable (4) 27%; Regular (2) 13%; Poor (0)
Degree of satisfaction with the instrument	Excellent (2) 13%; Good (5) 33%; Acceptable (6) 40%; Regular (2) 13%; Poor (0)
Degree of relevance of the questions	Excellent (4) 27%; Good (6) 40%; Acceptable (4) 27%; Regular (1) 7%; Poor (0)

Finally, from the phases described above (judgment of experts and pilot group), we eliminated item 1, of the organizational strategy dimension; as well as 27, of knowledge processes; the foregoing because they were stated in general manner, and they were already considered in other items of the same scales (see table 6, column C).

DISCUSSION

In this study, we address the maturity of KM as a construct to foster educational innovation, which consists on the efficacy of the organizational capacity to generate conditions that encourage the creation, storage and transmission of knowledge so that it is better disseminated within the institutions by means of the development of models, strategies, systems, processes, practices and methods for the creation, acquisition, identification, codification, transmission, application and protection of knowledge, and thus, accelerate the innovation processes (Aguilar *et al.*, 2012; Cantón & Ferrero, 2016; Galvis & Sánchez, 2014; Sañudo, 2014).

Determining the maturity level of KM will allow HEI to face the educational transformation in accordance with the strategic purposes, institutional goals and directives of the current society, by means of the acceleration of innovation processes (Aguilar *et al.*, 2012; Cricelli *et al.*, 2018; Cuevas, 2016; Chacón, 2014; Naranjo *et*

al., 2016; Rengifo-Millán, 2015; Sañudo, 2014) and the implementation of initiatives to manage knowledge with pertinence (Ortegón, Lasso & Steil, 2016).

In other words, HEI ought to define what to do with tacit and explicit knowledge about education, both of their professors and researchers and research groups and inter-institutional networks; likewise, how to implement it for the effective improvement of organizational behavior (Canton & Ferrero, 2016) and educational innovation. Unless it is done, there will be a negative repercussion on the incidence of educational improvement, as the impact and use of results of the research are questioned, in addition to the policy, the object, the method and the dissemination which complicate the decision-making process and the performance of significant changes of processes and educational practices (Sañudo, 2014).

In order to evaluate the maturity level of the organizational KM, we examined different questionnaires, but none specifically for the construct we are surveying, since the selected instrument analyzes activities, practices and strategies in separate, with special attention to the perspective, whether it be a business, management or action of KM. Also, some studies are specifically oriented to the description of the characteristics of the organization at a maturity level or towards the normative aspect, that is, the most employed practices and strategies.

Consequently, the proposal of this research consists in the construction and validation of a questionnaire to determine the tacit and explicit maturity level of KM about education, both of professors and researchers, considered individually or formed in research groups or inter-institutional networks, to foster educational innovation in HEI from the management and action perspectives, and the descriptive and normative aspects, that is, as a function of the state of maturity it is in and of KM strategies as they are implemented to support educational innovation processes, these latter classified in exploration and exploitation sub-processes of knowledge, and the areas of organizational and pedagogic-curricular influence of academic management. The above shall provide the bases for designing a KM organizational strategy, *ad hoc* to the context of HEI.

Through the theoretical review, we recognized five key areas of KM: 1) persons-organization, which represents the organizational conditions for persons to exchange information; 2) knowledge

processes, which refer to social or technological activities favoring the development of knowledge; 3) technologies, as facilitators to exchange information, skills and resources accelerating the cycle of knowledge (Teah *et al.*, 2006); 4) organizational strategy, where the initiatives and KM processes are in line with the objectives of the institution (De Freitas, 2017; Demching, 2015; Montañez & Lis, 2005); 5) methods, which correspond to the strategic design of knowledge processes of the organization for the attainment of objectives (Ansuattigui *et al.*, 2013; Donate & Guadamillas, 2010; Ureña & Villalobos, 2011), incorporated and formed by the organizational and pedagogic-curricular level, and knowledge typologies: exploitation and exploration of Vázquez-González & Jiménez-Macías (2018).

To prepare KM items appropriate to the educational innovation approach in HEI, we analyzed previous questionnaires and studies, in addition to those of Bernal *et al.* (2010), Donate & Sánchez (2015), Gómez-Vargas & García (2015), Liberona & Ruiz (2013), Luna *et al.* (2017), Mul *et al.* (2013), Pedraja-Rejas & Rodríguez-Ponce (2008) and Rodríguez-Ponce (2016).

Therefore, as elements of other studies were taken, it is necessary to have the construction or conjunction of these validated to the construct under evaluation. Therefore, we traced a methodological scheme formed by serial phases that would allow approving the instrument and verifying its accessibility to the objective population. In this respect, the review of experts or *facie* validation is with the purpose of verifying of the items of the construct, their relevance, how they were prepared, the wording and understanding (Kerlinger & Lee, 2002).

In order to assure the process, we selected experts by their profile and professional career, as well as their experience in designing instruments. This selection is an essential element in the review or valuation of an instrument (Blasco, López & Mengual, 2010; Cabero-Almenara & Infante-Moro, 2014; Juárez-Hernández & Tobón, 2018). This is confirmed by the remarks and proposed suggestions, which provide a significant improvement of different aspects of the questionnaire, for example, syntax and wording of the presentation, instructions and items, better accuracy of personal information data of participants and of verb selection for some items.

In some cases, this implied integrating several items per relevance, disregarding others as they contained several elements and

eliminating items we considered in another key area. From these improvements to the questionnaire, we reorganized the dimensions and items in each of them.

In order to guarantee suitability of the instrument, we presented two criteria: reliability and validity (Gonzalez-Ortega, 2008). As indicated, the way to do the validity of content analysis is the judgment of experts (Escobar-Perez & Cuervo-Martinez, 2008). In this sense, for the judgment of experts, we considered different methodological aspects of relevance. The first one was the selection of and the number of experts, which is important for the evaluation of an instrument (Juarez-Hernandez & Tobon, 2018). The selection was based on formal criteria which report the experience in the area and career, and which are crucial for the construction, design and evaluation of an instrument (Escobar-Pérez & Cuervo-Martínez, 2008; Cabero-Almenara & Infante-Moro, 2014). Additionally, we sought that the judgment was formed by more than ten experts (Juárez-Hernández & Tobón, 2018; Lynn, 1986) and the participation of a greater number of judges; thus, we achieved the participation of 15 national and foreign judges.

Finally, a basic element is the approach we followed (qualitative-quantitative), as is referred by Hynes, Richard & Kubay (1995), the validity of content study ought to be a multiple method process; in accordance to this, qualitative evaluation allowed us to improve the presentation, general data and items, both regarding wording and syntax; in addition, we adjusted verbs, included examples in some of them and, in other cases, we combined them as they referred to the same aspect. On the other hand, the quantitative evaluation and using Aiken's V confirmed that the instrument has validity of content, and that the elements of the instrument are relevant and representative of the objective construct (Haynes *et al.*, 1995).

From the methodological framework, we described the results of the pilot group, which are satisfactory as we verified understanding of instructions and items, as well as the relevance of the questions and the satisfaction level of the instrument. These aspects are important, as an erroneous understanding of the instructions and the items affects the psychometric properties of an instrument (Haynez *et al.*, 1995).

Another evaluated aspect was the level of satisfaction, which, as indicated, integrates elements related with the extension of the instrument and the time required to answer it; this is to be

considered, because a too extensive or complex instrument could condition objectivity to answer it, or rather, determine that the questionnaire is not answered completely. Regarding the analysis of internal consistency, although we obtained an optimal value (0.94), which is translated in the correlation degree among items and the representation of the construct at hand (Hernández, Fernández & Batista, 2003; Welch & Comer, 2001), we have to make it clear that this value should only be seen as an initial analysis, since the coefficient we employed tends to be unstable with small samples (Charter, 2003).

CONCLUSIONS

The instrument presented herein has the objective to evaluate the maturity level of KM to foster educational innovation in HEI. These aspects, through the validation process, showed to pertain to, to be relevant to, and representative to the evaluation object. The validation process enabled the progressive improvement of the instrument and the adaptation of the wording, which was seen in the pilot group, where a convenient understanding and satisfaction level with the instrument became manifest. Finally, although the *facie* and content validity are relevant properties in the analysis of an instrument, the study of the construct validity is required, which refers to the evidence of consistency between the referential profile and the test, where the accent consists in substantiating the degree whereby the scores of the test represent the measure of the attribute which is allegedly assessed (Leyva, 2010).

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