






# ICT and knowledge management in Teaching and Engineering Students

## TIC y gestión del conocimiento en estudiantes de Magisterio e Ingeniería

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### ABSTRACT

The integration of Knowledge Management (KM) in various fields, including academia and business, has been fostered by the promotion of Information and Communication Technologies (ICTs). The aim of this study was, on the one hand, to understand the key processes of KM in students of the Faculty of Education and the School of Engineering in a Spanish university, and, on the other hand, to evaluate the extent to which ICTs serve as support to these processes. To this end, the designed and validated MAINGC questionnaire was administered to 200 students who entered university in the 2018-2019 academic year. Fourteen ICT tools and four dimensions of KM were analyzed: information management, transformation of information into knowledge, management of the resulting learning, and ICT tools for KM support. The results showed differentiated patterns of technology use and perceptions of KM according to sex, age and degree. Indeed, education degree students reported higher perceptions of competence in KM processes compared to engineering students. Participants' responses regarding ICT tools suggested that the use of these tools has not yet been fully integrated into KM processes and revealed that both groups of students showed different patterns of use within the academic environment.

### RESUMEN

La integración de la Gestión del Conocimiento (GC) en diversos ámbitos tanto académicos como empresariales se ha visto favorecida gracias al impulso de las Tecnologías de la Información y la Comunicación (TIC). El objeto de esta investigación ha sido, por un lado, conocer los procesos clave de la GC en estudiantes de la Facultad de Educación y de la Escuela de Ingenierías en una universidad española, y, por otro lado, evaluar en qué medida las TIC sirven como apoyo a estos procesos. Para ello se aplicó el cuestionario diseñado y validado MAINGC a 200 estudiantes que accedieron a la universidad en el curso 2018-2019. Se analizaron catorce herramientas TIC y cuatro dimensiones de GC: gestión de la información, transformación de la información en conocimiento, gestión del aprendizaje resultante y herramientas TIC en apoyo a la GC. Los resultados muestran patrones diferenciados en el uso de la tecnología y de la percepción de la GC en función del género, la edad y la titulación. Así, se observó que los estudiantes de Magisterio se sienten más capacitados que los de Ingeniería en relación con los procesos de GC. Referido al uso de herramientas TIC, las respuestas ofrecidas por los estudiantes encuestados sugieren que su empleo no está todavía totalmente integrado en los procesos de GC y que existen diferencias en los patrones de uso por parte de ambos grupos dentro el entorno académico.

### KEYWORDS | PALABRAS CLAVE

ICTs, knowledge management, learning, higher education, innovation, education.  
TIC, gestión del conocimiento, aprendizaje, enseñanza superior, innovación, educación.

## 1. Introduction

Knowledge Management (KM) emerges as a discipline whose objective is to process knowledge by acquiring, storing, transforming, distributing and using it, in order to achieve competitive advantages (Maravilhas & Martins, 2019). As a strategic asset, the adequate management of knowledge generates advantages and learning in organizations (Valdez et al., 2016).

Although there have been advances in KM in terms of theoretical models on the creation, storage and distribution of knowledge (Nonaka & Takeuchi, 1995; Raisinghami et al., 2016), there is still a deficit of studies aimed at understanding the applicability of KM for the improvement of competitiveness required by society (Rodríguez-Montoya & Zerpa-García, 2019). In reviewing the literature, we gather from Flores-Quispe (2017), that university students identify KM as a powerful tool that enables their understanding of their own learning model and allows them to generate opportunities for interaction and the creation of knowledge exchange networks (cooperative learning) between people and institutions (Abdolvahabi et al., 2014). It also influences their learning success (García-Martín & Cantón, 2019), with KM processes becoming the basis for the integration of various pedagogical and management practices within the university academic environment (Stukalina, 2012).

On the other hand, ICTs are understood as the means to facilitate KM processes in 21st century organizations (Ocaña et al., 2020). They allow the search, creation, storage, communication and distribution of information, implying new modes of work and communication (Cebrián-Cifuentes et al., 2015). Furthermore, they have brought about social, economic and cultural changes (Aguiar et al., 2019). Therefore, understanding the place of technology and KM within an organization is of vital importance, since its effectiveness will depend, among other aspects, on the choice of technological tools, the activity to be carried out, the available resources and the users of ICTs in each organization (Valle-Castañeda et al., 2019).

But how do university students manage knowledge? What tools do they use? How do they perceive technology for their learning? Are there differences between students in the humanities and those in technical careers? Higher Education Institutions (HEIs), mainly public universities, have been forced to adopt models and strategies to improve their quality and competitiveness (Masa' deh et al., 2017). In spite of this, and their role as entities that generate and transmit knowledge (Abu-Naser et al., 2016; Imamura-Díaz et al., 2020), they show a slow development when it comes to valuing and assigning resources to the production of knowledge (Núñez-Guerrero & Rodríguez-Monroy, 2015). The problem is that not all HEIs have achieved levels of excellence in relation to knowledge management, because not all of them manage it correctly (Herrera, 2019). Therefore, universities must take into account, on the one hand, the social responsibility that requires them to engage with external sectors to foster and expand the knowledge produced (Bedoya et al., 2018) and on the other hand, the importance of the social dimension of KM through communities of practice, collaborative learning or organizational culture (Castro et al., 2019). Studies on ICTs and KM show the diverse perceptions of university students on the subject (Henderson et al., 2017; Englund et al., 2017; Enriquez et al., 2019): they generally recognize a positive effect of ICTs on KM, but do not delve into the tools and processes that are most favorable for its application (Araya et al., 2018), which justifies the importance of this study.

Cantón and Ferrero (2016) analyze the processes and components of KM in ICT-supported universities in relation to the study of four key dimensions. First, Information Management with the objective of optimizing the usefulness and contribution of IT resources to achieve organizational objectives; transforming information into knowledge from a personal and social dimension (Choo, 2002). Secondly, in the process of transforming information into knowledge, the student uses cognitive processing strategies (Paredes-Gavilanes et al., 2017), using ICTs that enable the flow, creation, transformation, and dissemination of knowledge (Ahedo-Ruiz & Danvilla, 2014). And thirdly, the resulting learning management where, through various processes (know how), individual and institutional learning is transferred to use and apply previously processed knowledge in lessons learned (Leiva & Astorga, 2014). Finally, ICT tools are fundamental for the effective development of all KM processes (Niebles-Núñez et al., 2016; Ruggles, 2017), as they improve process management by becoming catalysts for the flow of knowledge as well as important success factors for students (Zabaleta-De-Armas et al., 2016). There is

a need to provide strategies to create more opportunities for the development of digital competence and processes in students (Colás-Bravo et al., 2019).

This review shows the relevance, pertinence and need for studies on the subject (Rodríguez et al., 2019), highlighting the interest of this topic and at the same time revealing gaps in the practical scope of its use, interest and differences between university students. This gap is the one that this research aims to fill by linking KM with its social dimension through Virtual Learning Environments that enable improvement by helping to place knowledge at the disposal of everyone (Liuska-Martinez, 2019).

### 1.1. Research objectives

In order to determine the starting point and thus try to improve learning processes, the aim is to find out the perception that young higher education students have of KM. On the one hand, it identifies the key processes of KM in universities through the use of ICT tools, and on the other, it seeks to identify differences between two different academic profiles such as Teaching and Engineering students. All this results in two specific objectives:

- 1) Analyze the patterns of ICT use to support KM processes in students of both degrees.
- 2) Ascertain whether the fourteen ICT tools, strategies and KM processes differ or are similar in Teaching and Engineering students.

## 2. Materials and methods

### 2.1. Sample

The selection of the sample was carried out from two traditionally different branches of knowledge (Letters-Sciences, Teaching and Engineering) that do not include KM as a general competence in their curricula. In the academic year 2018-2019, 200 first-year students were surveyed, 28 men and 72 women in the Primary Education Teaching Degree, and 75 men and 25 women in the Industrial Engineering Degree in the specialties of Electronics and Mechanics (teachers: 1st year n=100; engineers: 1st year n=100). The sampling was intentional to distribute the sample evenly between the Faculty of Education and the School of Industrial, Computer and Aerospace Engineering.

### 2.2. Research instrument: Foundations and structure

The instrument used is derived from a first pilot study aimed at the construction of the measurement questionnaire. It is related to ICT tools and KM practices and was based on the four dimensions and indicators defined in the Canton and Ferrero study (2016) shown in Table 2. The questionnaire, designated MAINGC, was designed using a Likert scale (1-4) (Table 1: <https://doi.org/10.6084/m9.figshare.12653942.v1>), and was divided into three parts: the first referred to the personal and academic profile data of students; the second to the frequency of use of fourteen ICT tools that students use in their academic environment; and the last part of the instrument includes 36 items grouped into four blocks that correspond to the four dimensions of KM cited.

<b>Dimensions KM</b>	<b>Processes KM</b>	<b>Items</b>
Information Management	Search, categorization and simplification of information acquired through the use of available information resources.	1-7
Transformation of information into knowledge	Transformation of information into knowledge through different cognitive processing strategies, facilitating storage, structuring and assimilation.	8-17
Management of the resulting learning	Through (know how) processes, individual and organizational learning is transferred to be reused and applied, resulting in lessons learned.	18-27
ICT Tools in Support of KM	Management improvement through knowledge flows and strategies that develop digital competence enabling creation, storage and sharing.	28-36

It was validated by eight university experts (Fox, 1981) using criteria relating to pertinence, univocality and relevance for each item, using as criteria the elimination, permanence or modification in each item of three or more experts. To determine its reliability, the SPSS version 24 statistical package was used. A factorial analysis was performed with the multivariate technique using principal component extraction (PCE). The overall Kaiser-Meyer-Olkin (KMO) measure was 0.867 with individual KMO measures, all values exceeded 0.6, classified according to Kaiser (1974). The data were found to be factorizable, using

the Bartlett sphericity test which was statistically significant ( $p < .0005$ ). With the resulting items, the internal consistency and reliability of the questionnaire were obtained by means of Cronbach's alpha, obtaining 0.8, which gives it a high internal consistency and high reliability. The statistical analyses were conducted using "R" (R Core Team, 2018), specifically applying the "vcd" and "cluster" packages. Measuring, on the one hand, the degree of association between nominal variables by means of Cramer's V coefficient and, on the other hand, the hierarchical cluster analysis of said variables, where the pairing distances have been calculated by means of the Gower metric (suitable for categorical variables). So, the further away they are from each other within the dendrogram (graphical representation of the analysis), the greater the difference between the two. This enables variables with similar behavior to be grouped together. In order to perform a better data analysis, the different ICT tools present in the study were classified according to their nature (Table 3).

<b>Communication tools</b>	Institutional email address (IEA)
	Personal email address (PEA)
	Chat (CHT)
	WhatsApp (WAP)
<b>Tools to create and share resources</b>	Weblogs (WLG)
	Wikis (WKS)
	Tutorials (TUT)
	Web platforms (WPT)
	Conceptual maps (CTM)
	Hashtags (HST)
<b>Social Media</b>	Facebook (FBK)
	Twitter (TWT)
	Instagram (ITG)
	YouTube (YTB)

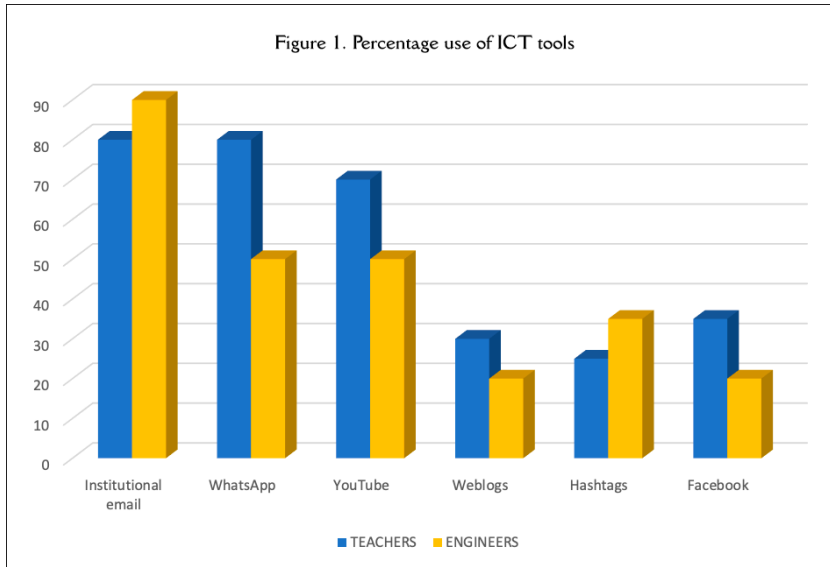
### 2.3. Procedure

The questionnaire was applied in the first semester from November to January 2018, when the respective university courses began. Student teacher's questionnaires were sent to their institutional e-mails using Google Forms; engineering students were provided with in-person paper-based questionnaires. The reason for the difference was the presence or lack of the faculty participating in the research.

## 3. Analysis and results

### 3.1. Descriptive analysis

Firstly, descriptive statistics were analyzed for the variables corresponding to the four dimensions mentioned and the ICT tools. The results show a high level of agreement among students of both degrees in the dimensions involving information management, the transformation of information into knowledge and the management of resulting learning (Figure C1: <https://doi.org/10.6084/m9.figshare.12653942.v1>); this is evident in the use of knowledge to solve problems (over 88%), knowledge sharing (90%) and the organization of content through the use of ICTs (over 80%). In fact, in the vast majority of items contained in these dimensions (items 1 to 27), the percentage of students who reported they "agree" or "completely agree" exceeded 60% in all cases, standing on average at around 80%. It is also significant that in many of the items included in the fourth dimension (ICT tools in support of KM) this trend is broken, and the sum of students who "agree" or "completely agree" falls to around 40% for both degrees. This is especially true for items 31 to 36, where the degree of proactivity for students in using ICTs in activities related to information management and knowledge transfer is measured.



With regard to ICTs, a first analysis of the results offered in Figure 1 and Figure C2 (<https://doi.org/10.6084/m9.figshare.12653942.v1>) shows that the most frequent tools used by students in the academic environment are institutional email, WhatsApp and YouTube (more than 50% use them daily). Others such as Weblogs, Hashtags and Facebook are typically less popular with students (less than 35%).

### 3.2. Analysis of the association of nominal variables with Cramer's V coefficient

In order to systematically identify and quantify these differences (and similarities), Cramer's V was used to measure the strength of the association between nominal variables. These variables are, in this case, the degree of agreement for KM items and the frequency of use for ICTs. In short, Cramer's V offers information on the existence of a correlation (either positive or negative) between the responses offered by students of one degree and another. The results of this analysis are collected in Tables 4, 5 and 6, which include only items and ICTs in which differences between both groups of students were observed with a significance level  $p < 0.05$ .

ICT use	ICT tools	Degree Teaching (T) Engineering (E)	Cramer's V	Knowledge Management	Items (Table 1)	Cramer's V
	Institutional email	E	0.265*		3	0.245**
Personal email	T	0.206**	5	0.315*		
Wikis	E	0.309*	6	0.302*		
Tutorials	E	0.275*	11	0.280*		
Conceptual maps	T	0.263*	13	0.282*		
Hashtag	T	0.259*	15	0.280**		
Facebook	T	0.527*	16	0.319*		
Twitter	T	0.278*	17	0.370*		
Instagram	T	0.387*	18	0.268*		
YouTube	T	0.238*	23	0.296*		
			24	0.377*		
			26	0.264 *		
			29	0.293**		
			31	0.276*		
			34	0.282*		

Note. Only those variables with a level of significance are included (\*\* $p < 0.05$ ; \* $p < 0.01$ ).

Results reveal that, in both degrees, more than 70% of students agreed or strongly agreed with all

the items included in the first dimension (information management). However, it is observed that there are significant differences between the two degrees in terms of student perception in items 3, 5 and 6, with student teachers always offering the most positive responses [e.g.  $V_{item3}=0.245$ ,  $p<0.05$ ;  $V_{item5}=0.315$ ;  $p<0.01$ ;  $V_{item6}=0.302$ ;  $p<0.01$ ].

With regard to the second dimension (transformation of information into knowledge) this turned out to be the most controversial, since a greater number of KM items were detected, where the perception of the students of both degrees differs significantly. Thus, in items 11, 13, 15, 16 and 17, student teachers again showed a greater internalization of these processes [e.g.  $V_{item11}=0.280$ ,  $p<0.01$ ;  $V_{item13}=0.282$ ;  $p<0.01$ ;  $V_{item15}=0.280$ ;  $p<0.05$ ;  $V_{item16}=0.319$ ;  $p<0.01$ ;  $V_{item17}=0.370$ ;  $p<0.01$ ]. As in the previous one, in the third dimension (management of the resulting learning), a considerable number of discrepancies were observed between the two degrees. This is the case of items 18, 23, 24, and 26, which once again positively highlight the perception of student teachers in their responses [e.g.  $V_{item18}=0.268$ ,  $p<0.01$ ;  $V_{item23}=0.296$ ;  $p<0.01$ ;  $V_{item24}=0.377$ ;  $p<0.01$ ;  $V_{item26}=0.264$ ;  $p<0.01$ ].

As mentioned above, student responses to the fourth dimension (ICT tools in support of KM) showed much lower levels of agreement than those observed in the other dimensions. Significant differences exist in items 29, 31, and 34, where student teachers again clearly showed a higher degree of agreement with the questions posed [e.g.  $V_{item29}=0.293$ ,  $p<0.05$ ;  $V_{item31}=0.276$ ;  $p<0.01$ ;  $V_{item34}=0.282$ ;  $p<0.01$ ]. With regard to the differences in the degree of ICT use, results suggest that the usage pattern of these tools depends significantly on the degree program in which the student is enrolled. Thus, the use of concept maps, Hashtags, Facebook, Twitter, Instagram and YouTube for academic purposes was more frequent among student teachers than among engineering students [e.g.  $V_{conceptmaps}=0.263$ ,  $p<0.01$ ;  $V_{hashtag}=0.259$ ;  $p<0.01$ ;  $V_{facebook}=0.527$ ;  $p<0.01$ ;  $V_{twitter}=0.278$ ;  $p<0.01$ ;  $V_{instagram}=0.387$ ;  $p<0.01$ ;  $V_{youtube}=0.238$ ;  $p<0.01$ ]. In contrast, it was observed that, despite the infrequent use of Wikis and Tutorials in both degrees, engineering students used them most frequently [e.g.  $V_{wikis}=0.309$ ,  $p<0.01$ ;  $V_{tutorials}=0.275$ ;  $p<0.01$ ].

There is a disparity in the use of email, with differences found in both degrees. Indeed, while student teachers make greater use of personal mail [e.g.  $V_{persemail}=0.206$ ,  $p<0.05$ ], engineering students consult and use institutional email more often [ $V_{instemail}=0.265$ ;  $p<0.01$ ].

**Table 5. Gender Correlation**

	Items	Gender	Cramer's V	ICT	Gender	Cramer's V
TEACHERS	4	Female	0.245**	Institutional	Male	0.362 *
	11	Female	0.315**	Email		
ENGINEERS	12	Male	0.268**	Personal	Male	0.417*
	13	Female	0.319**	Email	Male	0.340 *
	20	Female	0.376*	WhatsApp		

Note. Only those variables with a level of significance are included (\*\* $p < 0.05$ ; \* $p < 0.01$ ).

In relation to gender, in the first dimension and in the case of student teachers, there is a significant discrepancy with regard to item 4 (I identify, analyze and classify the most appropriate sources of information for each task), where women show a greater degree of agreement [e.g.  $V_{item4}=0.245$ ,  $p<0.05$ ].

In the second dimension, female student teachers show greater agreement on item 11 (I make summaries, graphs, diagrams or tables to organize the course material) [e.g.,  $V_{item11}=0.315$ ,  $p<0.05$ ], while female engineering students reveal a significantly higher degree of agreement on item 13 (when I have a lot of information on a subject I know how to organize and systematize it) [e.g.  $V_{item13}=0.319$ ,  $p<0.05$ ].

Regarding the third dimension, we found that in Item 20 (my knowledge is really accessible to other students), female engineering students showed a significantly higher degree of agreement than male students [e.g.  $V_{item20}=0.376$ ,  $p<0.01$ ]. In the fourth and final dimension, the results reveal that, for student teachers, institutional mail is consulted more often by men than by women [e.g.  $V_{instemail}=0.362$ ,  $p=0.004$ ]. However, in the case of engineering students, personal mail is the most commonly used [e.g.  $V_{persemail}=0.417$ ,  $p=0.004$ ].



Table 6. Correlation in relation to age						
	ICT	Age	Cramer's V	Items	Age	Cramer's V
TEACHERS	Instagram	>23	0.329*	2	>21	0.280**
				19	>21	0.282**
ENGINEERS	Facebook	21 a 23	0.419*	12	>21	0.377**

Note. Only those variables with a level of significance are included (\*\*p < 0.05; \*p < 0.01).

With regard to the age range, and continuing with student teachers, in the first dimension, those over 21 years of age show a greater degree of disagreement in item 2 (I consult specialized information through the Internet, email, as well as external and internal university databases), and are also more reluctant to use ICT tools than their under-21 colleagues [e.g.  $V_{item2}=0.280$ ,  $p<0.05$ ]. On the other hand, engineering students over 21 years old in the second dimension mostly disagree in item 12 (I discard information that is not relevant to the task) [e.g.  $V_{item12}=0.377$ ,  $p<0.05$ ].

As for the third dimension, student teachers over the age of 21 showed greater disagreement in item 19 (in my opinion, it is more important to share knowledge than to possess knowledge) [e.g.  $V_{item19}=0.282$ ,  $p<0.05$ ].

In relation to the use of ICT tools, the use of Facebook is more frequent in the 21-23 age group [e.g.  $V_{facebook}=0.419$ ,  $p<0.01$ ], while Instagram turned out to be a social network rarely used in the academic environment among students over 23 [e.g.  $V_{instagram}=0.329$ ,  $p<0.01$ ].

### 3.3. Cluster analysis

To deepen the study of the similarities and differences between the results in both degrees, a cluster analysis was performed (Figures C3 y C4: <https://doi.org/10.6084/m9.figshare.12653942.v1>). This statistical analysis seeks to group together a number of individuals according to their similarities. In this case, similarities appear in the response patterns offered to KM items and in the patterns of ICT use. The results are represented in the form of dendrograms, in which the length of the vertical bars represents the distance between individuals or groups.

The response patterns to the items included in the different KM dimensions were also very similar among the students of both degrees. Thus, items 31, 33, 34 and 35 are included within the same cluster, both for teaching and engineering students (Figures C3: <https://doi.org/10.6084/m9.figshare.12653942.v1>). A certain tendency is also observed (although not as clear as in the previous case) to group within the same cluster items 7, 9, 18, 21 and 29 (Figures C3: <https://doi.org/10.6084/m9.figshare.12653942.v1>).

For the rest of the items it is more difficult to find a general common pattern, but it can be said that, as we have seen in the previous cases, the weakest part in the KM process is the third dimension that corresponds to the management of the resulting learning, the application, creation and dissemination of the new knowledge.

The usage frequencies for personal email, web page, YouTube, institutional email, and WhatsApp have very similar patterns among student teachers and tend to recur quite clearly among engineering students (Figures C4: <https://doi.org/10.6084/m9.figshare.12653942.v1>). This is the most superficial phase of ICT use so this result is not surprising.

## 4. Discussion and conclusions

The purpose of the study was, on the one hand, to analyze the usage of fourteen ICT tools by novice students of Education and Engineering in their learning processes and, on the other hand, to know which are the key KM processes for each degree. As shown by the results, both groups of students present a high degree of agreement in all the dimensions of KM except in the fourth one (ICT tools in support of KM). This means that students perceive themselves as capable of collecting data, transforming it into information and later into knowledge at their different learning levels (Choo et al., 2007). Both degrees seem to have clearly assumed the first phase of organizational learning as defined by Slater and Narver (1995), and that relates to the first dimension (information management).

The same occurs in the second dimension (transformation of information into knowledge), which brings together those processes that involve the transformation of information into tacit knowledge, and

from this into explicit knowledge (Nonaka & Takeuchi, 1995). The high degree of agreement shown with regard to the questions posed in this dimension reveals a high degree of maturity in students, in terms of their exercise of cognitive skills such as intuition, interpretation, forms of reasoning, etc. The high percentage of agreement in the third dimension (management of the resulting learning), is related to the organization of learning and to the way in which this allows the application, creation and dissemination of new knowledge. This result agrees with Leiva and Astorga (2014), as it shows that students recognize the importance of processes related to the establishment of explicit knowledge.

In contrast, in the fourth dimension (ICT tools in support of KM), the number of positive responses falls significantly, showing that the degree of total integration of ICT use by teachers is not achieved, as reflected in studies by Manca and Ranieri (2016) as well as Ocaña et al. (2020). This means that there seems to be a lack of adequate strategies in both degrees that allow the value of the knowledge acquired in the university academic environment to be placed within the framework of the information society.

The results of the questionnaire also showed the existence of significant differences in a good number of KM items, since student teachers seem to have a more positive perception (higher level of agreement) and are more capable of seeking, collecting and synthesizing relevant information. In addition, they are more skilled at organizing such information and using it to solve tasks. On the other hand, they are more aware of the importance of organizing and sharing the knowledge acquired; they are more prone to collaborative learning and recognize the importance of an adequate exploitation and management of the resulting learning. Furthermore, they are more active in the processes of creation, application and dissemination of new knowledge. However, it should be noted that these are self-perceptions that may be due to the tendency to provide the expected response that is given in humanities degrees and not in engineering, and that has to do with the honesty and veracity of the responses (Llorens, 2018).

Differences were detected by degree and gender, with female student teachers leading the way in organizing subjects of study, using summaries, graphs or diagrams, while female student engineers are better at organizing and systematizing information. This shows that women have been better at assuming the processes of knowledge integration, showing a greater acceptance in those phases that imply training, routines and systematization of work as defined by Hislop et al. (2018).

Differences were also observed according to the age of the students. It is significant that, for example, student teachers over the age of 21 gave greater importance to possessing knowledge than to sharing it, which is evidence of a more individualistic perception. This is related to the fact that students over 21 tend to be repeaters and are often less integrated with new first-year students. Similarly, engineering students over 21 disagreed with the dismissal of information that was not relevant to the task, again leaving certain deficiencies in the organizational learning process evident in students of this age range.

As far as ICTs are concerned, the importance of these tools for both groups of students is evident, revealing their academic potential as support in the first three dimensions of KM. The most common tools used in the academic environment (more than 50% of students use them daily) were institutional email, WhatsApp, and YouTube. Others such as weblogs, hashtags, and Facebook are less popular among students. Even so, no pattern of ICT use was found in any of the degrees in their first year, so there is a clear deficit in their digital competence (Díaz-García et al., 2015). Furthermore, coinciding with Cabero-Almenara (2015), it is observed that they use ICTs as technological and instrumental tools, but not as training instruments for KM.

To conclude, the lower scores obtained by Engineering students compared to those of Teaching students could be revealing a weakness in the former in terms of KM procedures and methodologies acquired during at least the first year at university. At this point, it is worth asking whether this deviation could be of a conjunctural nature, so that it can be corrected as the student advances in his or her training, or whether, on the contrary, we are faced with a structural situation whose rectification would demand a study of the causes, in order to subsequently design strategies to redirect the situation. One possible cause could be greater insecurity in the choice of studies by engineering students as suggested by Esquivel-Alcocer and Pinto-Sosa (1994). We can also note here the low sense of self-efficacy, accompanied by high rates of absenteeism, which engineering students tend to present during the first years as a result of the difficulty of the studies themselves (López-Fernández et al., 2014).



This work has some limitations, firstly, in relation to self-reported data, as the questionnaire could contain certain types of bias (cultural and/or emotional aspects, voluntarism) that could influence the sincerity of the responses and, secondly, the use of email provides truthfulness, but could limit responses in some students.

In future work, different branches of knowledge should be considered, including a longitudinal study to follow up with the sample in subsequent courses. In addition, it would be advisable to carry out more studies in this line that guarantee an improvement in quality in the university environment.

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### References

- Abdolvahabi, M., Sofiyabadi, J., Abdolvahabi, M., & Valmohammadi, C. (2014). Case on e-learning and knowledge management practices. *Asian Journal of Research in Business Economics and Management*, 4(12), 264-264. <https://doi.org/10.5958/2249-7307.2014.01022.6>
- Abu-Naser, S.S., Al-Shobaki, M.J., & Abu-Amuna, Y.M. (2016). Knowledge management maturity in universities and its impact on performance excellence. Comparative study. *Journal of Scientific and Engineering Research*, 3(4), 4-14. <https://bit.ly/33GTWTH>
- Aguiar, B.O., Velázquez, R.M., & Aguiar, J.L. (2019). Innovación docente y empleo de las TIC en la educación superior. *Espacios*, 40(2), 8-20. <https://bit.ly/2WH4fFS>
- Ahedo-Ruiz, J., & Danvilla, I. (2014). Las nuevas tecnologías como herramientas que facilitan la educación formativa en la educación. In *Estrategias innovadoras para la docencia dialógica y virtual* (pp. 25-40). <https://bit.ly/2xkzlbx>
- Araya, S., Henríquez, C., Ramírez, & Barra, A. (2018). Explorando la relación entre gestión del conocimiento y el rendimiento organizativo en instituciones de educación superior universitaria. *RISTI*, 17, 947-959. <https://bit.ly/2ZAVa0Q>
- Bedoya, E.A., Behaine, B., Severiche, C.A., Marrugo, Y., & Castro, A.F. (2018). Redes de conocimiento: Academia, empresa y estado. *Espacios*, 39(8), 16-30. <https://bit.ly/2JbVWolb>
- Cabero-Almenara, J. (2015). Reflexiones educativas sobre las tecnologías de la información y la comunicación (TIC). *Tecnología, Ciencia y Educación*, 1, 19-27. <https://bit.ly/3bllxwb>
- Cantón-Mayo, I., & Ferrero-de Lucas, E. (2016). Knowledge management in education journals. *Educar*, 52, 401-401. <https://doi.org/10.5565/rev/educar.757>
- Castro, J., Castellanos, E., Fonseca, L., & Lugo, J. (2019). Gestión del conocimiento en universidades públicas. *Revista Científica*, 4(14), 182-204. <https://doi.org/10.29394/scientific.issn.2542-2987.2019.4.14.9.182-204>
- Cebrián-Cifuentes, S., Suárez-Rodríguez, J., & Aliaga-Abad, F. (2015). Perfiles de competencias tecnológicas y pedagógicas de los/as estudiantes de ingeniería y su relación con el uso de las TIC y algunas variables personales y contextuales. In *Investigar con y para la sociedad*. Vol. 3, volume 3 (pp. 1445-1456). Bubok. <https://bit.ly/2ZHilqy>
- Choo, A.S., Linderman, K.W., & Schroeder, R.G. (2007). Method and context perspectives on learning and knowledge creation in quality management. *Journal of Operations Management*, 25(4), 918-931. <https://doi.org/10.1016/j.jom.2006.08.002>
- Choo, C.W. (2002). *Information management for the intelligent organization: The art of scanning the environment*. Information Today, Inc.
- Colás-Bravo-Bravo, P., Conde-Jiménez, J., & de Cózar, S.R. (2019). The development of the digital teaching competence from a sociocultural approach. [El desarrollo de la competencia digital docente desde un enfoque sociocultural]. *Comunicar*, 61, 21-32. <https://doi.org/10.3916/c61-2019-02>
- Díaz-García, M.I., Belloch-Ortí, C., Suárez-Rodríguez, J., & Aliaga-Abad, F. (2015). Perfiles de competencia tecnológica y pedagógica en estudiantes universitarios de titulaciones del ámbito educativo. In AIDIPE (Ed.), *Investigar con y para la sociedad* (pp. 1513-1522). Bubok. <https://bit.ly/2ZHilqy>
- Englund, C., Olofsson, A.D., & Price, L. (2017). Teaching with technology in higher education: Understanding conceptual change and development in practice. *Higher Education Research & Development*, 36, 73-87. <https://doi.org/10.1080/07294360.2016.1171300>
- Enríquez, A. (2019). Gestión de conocimiento y universidad, visión prospectiva a partir de sus expertos. *Revista CS*, 29, 273-297. <https://doi.org/10.18046/recs.i29.2687>
- Esquivel-Alcocer, L.A., & Pinto-Sosa, J.E. (1994). Toma de decisiones: Autoreporte de los factores que influyen en la elección de una carrera profesional. *Ciencia*, 3(9), 37-53. <https://bit.ly/3drBzXf>
- Flores-Quispe, M. (2017). *La Gestión del Conocimiento educativo en una organización que aprende*. [Tesis de Maestría, Universidad Cesar Vallejo]. <https://bit.ly/3gHx37R>
- Fox, D.J. (1981). *El proceso de investigación en educación*. EUNSA.
- García-Martín, S., & Cantón-Mayo, I. (2019). Use of technologies and academic performance in adolescent students. [Uso de tecnologías y rendimiento académico en estudiantes adolescentes]. *Comunicar*, 59, 73-81. <https://doi.org/10.3916/c59-2019-07>
- Henderson, M., Selwyn, N., & Aston, R. (2017). What works and why? Student perceptions of 'useful' digital technology in university teaching and learning. *Studies in Higher Education*, 42(8), 1567-1579. <https://doi.org/10.1080/03075079.2015.1007946>

- Herrera, Z.C. (2019). La gestión del conocimiento en las universidades experimentales de Venezuela. *Revista Científica*, 4(11), 380-395. <https://doi.org/10.29394/Scientific.issn.2542-2987.2019.4.11.20.380-395>
- Hislop, D., Bosua, R., & Helms, R. (2018). *Knowledge management in organizations: A critical introduction*. Oxford University Press.
- Imamura-Díaz, J.I., Keeling-Alvarez, M., & Barreto-Gelles, I. (2020). La gestión del conocimiento como plataforma para socializar la producción científica. *Ingeniería Industrial*, 41(1), 1-9. <https://bit.ly/3drqEwy>
- Kaiser, H.F. (1974). An index of factorial simplicity. *Psychometrika*, 39(1), 31-36. <https://doi.org/10.1007/bf02291575>
- Leiva, M.V., & Astorga, D.E. (2014). Condiciones de desarrollo institucional en los centros escolares de Chile. *REDIE*, 16(2), 35-51.
- Liuska-Martínez, N. (2019). Las redes sociales para la gestión del conocimiento. *REFCaIE*, 7(3), 203-211. <https://bit.ly/2y6J1qA>
- Llorens, J. (2018). Autopercepción de los estudiantes acerca de la adquisición de las CTs y su contribución a la mejora de las actividades de aprendizaje. In J. A. Llorens-Molina (Ed.), *IN-RED 2018. IV Congreso Nacional de Innovación Educativa y Docencia En Red* (pp. 1159-1161). <https://doi.org/10.4995/INRED2018.2018.8595>
- López-Fernández, D., Alarcón-Cavero, P., Rodríguez-Sánchez, M., & Casado-Fuente, M. (2014). Motivación en estudiantes de ingeniería: Un caso de estudio con teorías e instrumentos para su medida y desarrollo. *REDU*, 12(4), 343-343. <https://doi.org/10.4995/redu.2014.5627>
- Manca, S., & Ranieri, M. (2016). Facebook and the others. Potentials and obstacles of Social Media for teaching in higher education. *Computers & Education*, 95, 216-230. <https://doi.org/10.1016/j.compedu.2016.01.012>
- Maravilhas, S., & Martins, J. (2019). Strategic knowledge management in a digital environment: Tacit and explicit knowledge in Fab Labs. *Journal of Business Research*, 94, 353-359. <https://doi.org/10.1016/j.jbusres.2018.01.061>
- Masádeh, R., Shannak, R., Maqableh, M., & Tarhini, A. (2017). The impact of knowledge management on job performance in higher education. *Journal of Enterprise Information Management*, 30(2), 244-262. <https://doi.org/10.1108/jeim-09-2015-0087>
- Niebles-Núñez, W.A., Hernández-Palma, H.G., & Cardona-Arbeláez, D. (2016). Gestión tecnológica del conocimiento: herramienta moderna para la gerencia de instituciones educativas. *RIDI*, (pp. 25-36). <https://doi.org/10.19053/20278306.v7.n1.2016.5633>
- Nonaka, I., & Takeuchi, H. (1995). *Knowledge and management*. Oxford University Press.
- Núñez-Guerrero, Y., & Rodríguez-Monroy, C. (2015). Gestión de recursos intangibles en instituciones de educación superior. *Revista de Administração de Empresas*, 55(1), 65-77. <https://doi.org/10.1590/s0034-759020150107>
- Ocaña, Y., Valenzuela, A., Gálvez, E., Aguinaga, D., Nieto, J., & López, T.I. (2020). Gestión del conocimiento y tecnologías de la información y comunicación (TIC) en estudiantes de ingeniería mecánica. *Apuntes Universitarios*, 10(1), 77-88. <https://doi.org/10.17162/au.v10i1.419>
- Paredes-Gavilanes, J., Calvopiña-Andrade, D., Velasco-Samaniego, V., & Álvarez Román, J. (2017). La Gestión del conocimiento y su pertinencia de en la Educación Universitaria. *Revista Científica Hermes*, 19, 475-475. <https://doi.org/10.21710/rch.v19i0.374>
- R Core Team (Ed.) (2018). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. (version 3.5.3). [Software]. <https://bit.ly/33HgALs>
- Raisinghani, M.S., Bekele, R., Idemudia, E., & Nakarmi, A. (2016). Managing knowledge in organizations: Tools & techniques for competitive advantage. *Journal of Business Management and Economics*, 4(2), 9-13. <https://doi.org/10.15520/jbme.2016.vol4.iss2.175.pp09-13>
- Rodríguez, C., Sanz, M., & Alonso, S. (2019). Technology and higher education: A bibliometric analysis. *Education Sciences*, 9(3), 169-169. <https://doi.org/10.3390/educsci9030169>
- Rodríguez-Montoya, C., & Zerpa, C.E. (2019). Gestión del conocimiento en programas de postgrado: Un modelo prescriptivo. *Pixel-Bit*, 55(55), 179-209. <https://doi.org/10.12795/pixelbit.2019.i55.10>
- Ruggles, R. (2017). *Knowledge management tools*. Routledge. <https://doi.org/10.4324/9780080509846>
- Slater, S.F., & Narver, J.C. (1995). Market orientation and the learning organization. *Journal of Marketing*, 59(3), 63-74. <https://doi.org/10.2307/1252120>
- Stukalina, Y. (2012). Addressing service quality issues in higher education: The educational environment evaluation from the students' perspective. *Technological and Economic Development of Economy*, 18, 84-98. <https://doi.org/10.3846/20294913.2012.658099>
- Valdez, L., García-Pérez, D., & Maldonado-Guzmán, G. (2016). Management of knowledge, Innovation and Performance in SMEs. *Interdisciplinary Journal of Information, Knowledge, and Management*, 11, 141-176. <https://doi.org/10.28945/3455>
- Valle-Castañeda, W., Camejo-Puentes, M., & Vilaú-Aguilar, Y. (2019). La gestión del conocimiento en el Licenciado en Educación Primaria. *Mendive*, 17(3), 409-420. <https://bit.ly/31U3KuA>
- Zabaleta-De-Armas, M.I., Brito-Carrillo, L.E., & Garzón-Castrillón, M.A. (2016). Knowledge management system in the it area for a university in the Colombian Caribbean. *Revista Lasallista de Investigación*, 13(2), 136-150. <https://doi.org/10.22507/rli.v13n2a13>