Analysing knowledge building strategies in personal learning environments

Valoración de estrategias de construcción del conocimiento en los entornos personales de aprendizaje

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ABSTRACT

In a logic of transformation and reformulation of teaching processes in Universities, Personal Learning Environments (PLE) are proposed in order to integrate formal learning into a broader and customizable formative framework based on the resources, interactions and tools used to learn (Adell *et al*., 2018; Chatti et al., 2010; Halimi et al., 2014; Manso-Vázquez & Llamas-Nistal, 2015; Salinas, 2013). This study aims to analyze the learning strategies of higher education students in the PLE. The results show that the formal educational processes of the student body are linked to traditional, face-to-face education with low use of information and communication technologies to complement their education.

Keywords
PLE, ICT, higher education, learning strategies

RESUMEN

A partir de una lógica de transformación y replanteamiento de los procesos de enseñanza en las universidades, se proponen los entornos personales de aprendizaje (PLE, por sus siglas en inglés) a fin de integrar el aprendizaje formal a un entramado formativo más amplio y personalizable basado en los recursos, las interacciones y las herramientas que se emplean para aprender (Adell, Castañeda y Esteve, 2018; Chatti et al., 2010; Chatti, Jarke & Specht, 2010; Halimi, Seridi-Bouchelaghem & Faron-Zucker, 2014; Manso-Vázquez & Llamas-Nistal, 2015; Salinas, 2013). Este estudio tiene como objetivo analizar las estrategias de construcción del conocimiento de los estudiantes de educación superior en sus procesos educativos que les permiten conformar un PLE. Los resultados muestran que esas estrategias están ligadas a planteamientos de una educación tradicional y presencial, con poco uso de las tecnologías de la información y la comunicación para complementar su formación.

Palabras clave
PLE, TIC, educación superior, estrategias de aprendizaje

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INTRODUCTION

We currently live in a society where it is difficult to imagine it without being interrelated with the information and communication technologies (ICTs). The use of Internet and mobile telephones is becoming increasingly common. In Mexico in particular, according to the "ICT Adoption and Use of Internet" report issued by the Federal Institute of Telecommunications (IFT, [Spanish acronym], 2017), 81 million people use mobile telephones, of which 74.8% own a smartphone to access mainly the Internet. This report shows that from the 59.5% of the population that accesses the Internet, a high percentage of users are aged 15 to 34. They mainly use the Internet for communication, social networking and entertainment, while the lowest level of preference corresponds to education and capacity-building despite being necessary competences.

Universities represent a tipping point that fosters the appropriation of ICTs with the intention that the new generations develop competences to influence, modify and transform their reality (Vargas, 2017). This means a substantial change for educational institutions that are involved in the digitalization process since it implies modifications at all levels, including the teaching and learning processes (Adell *et al.*, 2018).

Drawing from this logic of transformation and reassessment of the teaching processes, universities are putting forward personal learning environments (PLEs) to integrate formal learning into a larger and more customizable educational framework based on resources, interactions and tools used for learning (Adell *et al.*, 2018; Chatti *et al.*, 2010; Halimi *et al.*, 2014; Manso-Vázquez & Llamas-Nistal, 2015; Salinas, 2013).

The different theoretical, empirical and pedagogical conceptions in regard to PLEs correspond to an emerging and ever-constructive concept (Álvarez, 2014) that seeks first and foremost to incorporate customizable aspects into formal environments from the intersection of the formal to the informal and nonformal (Castañeda & Adell, 2014; Salinas, 2013). PLEs may be defined more specifically, as a concept strongly conditioned by technology (Casquero *et al.*, 2014). These environments are created by individuals that play an active role in using knowledge construction strategies and development of metacognitive skills. They emerge in different socio-cultural contexts and are benefited by the intersection of different educational environments.

PLEs are enhanced to the extent in which the students have a broad set of tools and resources that help them connect with different nodes and foster the creation of personal learning networks (Casquero *et al.*, 2014; Castañeda and Adell, 2013b; Chatti, Jarke & Specht, 2010; Manso-Vázquez & Llamas-Nistal, 2015; Prendes-Espinosa *et al.*, 2016). Therefore, these characteristics help shaping personal, social, distributed, ubiquitous, dynamic, flexible, non-linear and fluid learning, which nature allows

individuals to adopt lifelong learning (Casquero *et al.*, 2014; Manso-Vázquez & Llamas-Nistal, 2015; Martínez *et al.,* 2016).

The active role of the students in using PLEs requires skills to organize information, register and control the learning while having the support of digital tools. These skills foster the individual's educational character which he/she supposedly has to develop cognitive and metacognitive skills that make possible the construction of PLE (Chaves, Trujillo & López, 2016).

The PLEs educational character requires to be focused pedagogically in order to promote new teaching and learning methodologies. This focus supposedly modifies the roles traditionally attributed to professors since they now have the responsibility to create scenarios to form students and open opportunities to acquire more knowledge (Villaverde and Delgado, 2015). Moreover, they promote the responsibility among the apprentices to foster skills and strategies to enhance lifelong learning above all (Álvarez, 2014); hence, the university must ensure the development of these skills in their curricula. It is a highly complex task since it consists in knowing the type of students a university has, in offering technology in its different scenarios, and above all, making sure that the students use this tool during their educational formation (Castañeda, Dabbagh & Torres-Kompen, 2017; Prendes *et al.*, 2017).

In general, students have grown immersed in technology and are familiar with it; this generation has even been labeled the generation of "digital natives" (Prensky, 2001); however, in the last decades, it has been proven that the appropriation and use of technology is related to other variables that go beyond age; for example, the individual's socio-demographic, economic, family, gender circumstances among others.

Therefore, the generalizations that describe the use of ICTs based on the age of the individuals do not reflect the reality of educational institutions and, thus, are useless in applying teaching-learning methodologies in the digital era (Gallardo-Echenique *et al.*, 2015). Nonetheless, we can talk about "digital apprentices", a concept coined by Bullen and Morgan (2011) to define the characteristics of university students who have grown immersed in technology without assuming they use it automatically in their academic formation; hence the complexity of educational experiences with technology (Gallardo-Echenique *et al.,* 2015).

From this standpoint, it is important to draw upon the way we appropriate technology to enhance the use of PLEs in formal education and, at the same time, describe to our students understand how they use ICTs in their educational formation, help them understand their needs in appropriating ICTs in this process and decide which strategies can help to construct an environment that allows them to learn.

In a 2017 study, the updated bibliography was checked and according to it, the strategies deemed necessary to form a PLE were classified in three major areas:

- Those that allow the students to classify and manage information and resources; i.e., targeting the organization and administration of resources they use for learning (Prendes *et al.*, 2017).

- Those self-regulating strategies that help the students meet their preparation objectives, create resources to share with others and, assess their own learning process (Rahimi, Van Den Berg & Veen, 2015).

- Those that enable the students develop metacognitive abilities; i.e., pay special attention in reflecting on their own learning (Castañeda and Adell, 2013a; Chaves *et al.*, 2015; Rahimi *et al.,* 2015).

  Developing these strategies based on the use of digital tools fosters the construction of PLEs; hence, the need to know the specific strategies students use in PLEs in order to delve further into them.

OBJECT

The object of this paper is to analyze the perceptions of students of higher education regarding the useful strategies for the construction of knowledge in their formal educational processes in laying out a PLE.

SPECIFIC OBJECTIVES

- Describe the strategies use by students to manage and plan the information in PLEs.
- Describe the strategies used by students to self-regulate their learning in PLEs.
- Describe the strategies used by students to reflect and develop their metacognitive skills in PLEs.

THE DESIGN OF THIS RESEARCH

This analysis corresponds to a quantitative-descriptive cross-sectional design. To collect data, we applied a survey-type technique that describes the students' perception regarding the way they use technology to learn and the strategies they utilize.

This research aims to know the characteristics and the properties that describe more specifically the learning strategies that the students use in PLEs. We chose a descriptive study that allowed us to best detail the

profiles of individuals, groups, communities and processes (Hernández, Fernández and Baptista, 2010).

POPULATION AND SAMPLE

To obtain the sample, we took the total number of students enrolled in a public higher education institution. The total population was of 16,114 students. To calculate the population sample, the stratified cluster probabilistic method. The sample is statistically representative with parameters of ≥95% trust level and a ≤5% error. After applying the corresponding calculation, we obtain an N=376 students sample size.

INSTRUMENTS

The project questionnaire "Competences for Permanent Learning Based on the Use of PLEs" (Prendes-Espinosa *et al.*, 2016) has a validation and reliability process that guarantees scientific accuracy. It focuses on a complex perspective of PLEs that considers both technological and pedagogical aspects. The questionnaire includes eight nominal questions and 35 frequency questions at a five-level scale (Prendes-Espinosa *et al.*, 2016). Moreover, there are five questions with contextual characteristics of the population (age, gender, faculty, area of studies and campus).

It is worth clarifying that to reach the object of this study we formulated dimensions other than the original questionnaire. The variables were classified in the three dimensions previously mentioned: those describing the information management and planning strategies, those describing the learning process self-regulating strategies and those describing the reflection and metacognitive skills development strategies.

To verify the reliability of the questionnaire, we applied a Cronback Alpha that corresponds to the dimensions proposed in this paper (See Table 1) that shows the acceptable levels according to the requirements of our knowledge environment.

Table 1. Cronbach Alpha for N=376

Dimension	Cronbach Alpha
Information management and planning strategies	.844
Learning self-regulating strategies	.849
Skills development strategies	.727

Source: Self development.

PROCEDURE

The research was carried out in three stages; the first consisted in choosing the questionnaire; the second, in applying the data collection instrument; and the third, in analyzing the data with the SSPS (Statistical Package for the Social Sciences) statistical program to describe the students' profiles provided by the variables offering relevant information for our study.

We used the Kolmogorov-Smirnov test for Normality and sought significant differences between gender, knowledge area and age (we did not consider this last one relevant since most of our sample was aged 19 to 24).

In this study, the Normality test cast a $p \leq 0.05$ result for every one of the variables analyzed. This indicates that the sample does not follow a normal distribution. Even though the clusters exceed the 30-informant threshold, and it would have been possible to apply the central limit theory to admit any variance test, we preferred to proceed in a conservative mode and carry out non-parametric tests.

To assess the students, we classified them based on the five areas of knowledge of the National Association of Universities and Higher Education Institutions of Mexico, which are: Health Sciences, Natural and Exact Sciences, Social Sciences and Administration, Education and Humanities, and Engineering and Technology.

For the area of knowledge, we chose the square Chi test for independent K samples and the Mann-Whitney u test to analyze gender. We did so to verify if there are any significant differences according to the students' gender.

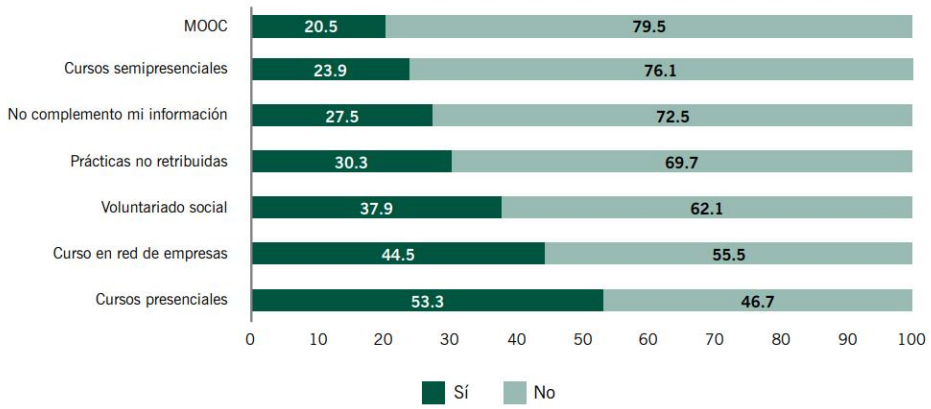
RESULTS

It is relevant to analyze the students' motivation in performing a formative task. The study shows that it is important for students to know the purpose of the assignment (88.5%), and to have the resources necessary to carry it out (79.4%). However, the students' stimulus to carry out an assignment does not depend necessarily on the difficulty of said assignment (38.2%) or the knowledge they have of the requirements (42.8%); i.e., it indicates that the motivation towards an assignment may not depend of its difficulty.

STRATEGIES FOR INFORMATION MANAGEMENT AND PLANNING

Students use the following strategies to manage all the information they have access to, whether from digital or analogical resources; they embrace only the resources they need to supplement their educational formation; they trust the information they receive; they select it, organize it and use or not the information coming from others.

We observed that students use few resources to supplement their educational formation and they prefer the in-class mode (53.3%) to the *massive open online courses* (MOOC) (20.5%). Graph 1 gives details on these choices.

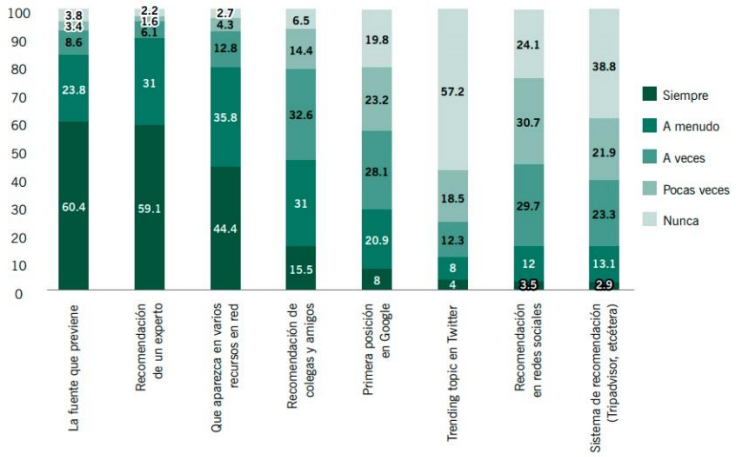


Graph 1. Resources to Supplement the Academic Formation.
Source: Self development.

One of the characteristics of the PLEs is that the students have synergy with the formal and informal educational context generated by the different instruments and resources offered to them. We observed that the students do not appropriate digital tools to establish connections and interact with others within their formation (Rahimi et al., 2015).

The credibility of the information the students have access to depends on its "source": 60.4% of the choices correspond to the "always" option ($\bar{X}$ = 4.35, DS = 1); 59.1%, to the experts' recommendation ($\bar{X}$ = 4.43, DS = .851) and, 44.1%, to the disposition of the information in the different resources on the network ($\bar{X}$ = 4.15, DS = .982).

The scant attention given to the recommendations of other users drew our attention. Whether these recommendations came from Google, with 8% in the "always" option ($\bar{X}$ = 2.75, *DS* = 1.22); or Trending on Twitter, 4% ($\bar{X}$ = 1.83, *DS* = 1.16); or a suggestion coming from a social network, 3.5% ($\bar{X}$ = 2.40, *DS* = 1.08). In Graph 2, we specify the students' choices regarding this variable.



Graph 2. Credibility on the information received.
Source: Self development.

We did not find any significant differences regarding gender; we did however in the areas of knowledge in the perception the students have of the credibility of the information. Along these lines, engineering and technology are the two areas preferred within the expert recommendations (See Table 2).The area of Natural Sciences is also preferred when it comes to the disposition of the information in different network resources, and in Twitter, the areas of Social Sciences and Administration.

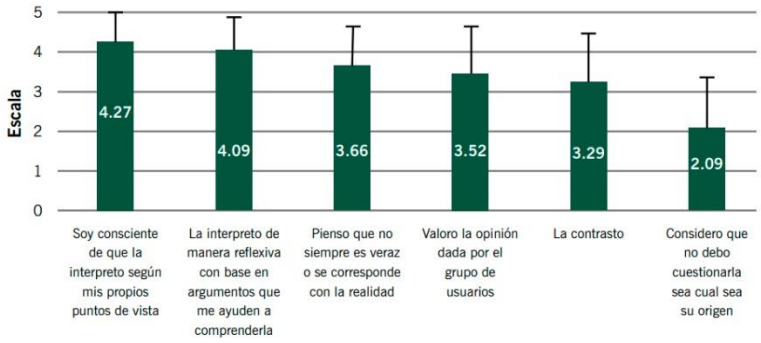
Table 2. Differences per areas in the credibility of the information

Variable	**$\bar{X}$/DS**					**X^2**	**gl***	**p**
	Salud	C.N.	C.SyA.	HyE	IyT			
The source of the information	4.42	4.71	4.30	4.22	4.34	8.970	4	.062
	1.10	.596	.992	1.16	.963			ns*
Expert recommendation	3.90	4.69	4.49	3.75	4.63	17.08	4	0.002
	1.12	.468	.865	.927	.549			

Present in several network resources	4.15 1.07	4.36 .983	4.12 .990	3.25 .989	4.24 .794	18.94	4	0.001
Recommendation from colleagues and friends	3.33 1.11	3.05 1.22	3.41 1	3.38 1.19	3.34 1.13	3.55	4	.470 ns*
First position in Google	2.52 1.3	2.86 1.24	2.78 1.20	2.61 1.15	2.84 1.26	2.55	4	.635 ns*
Trending topic in Twitter	1.88 1.21	1.33 .687	2.45 1.23	1.80 1.22	1.63 .984	16.53	4	0.002
Recommendation on social networks	2.23 1.15	2.24 1	2.56 1.12	2.43 1.07	2.30 1	4.91	4	.296 ns*
Recommendation System (Tripadvisor, etcétera)	2.23 1.18	1.74 1.10	2.63 1.18	2.28 1.20	2.03 1.03	11.45	4	0.22 ns*

Source: Self development.

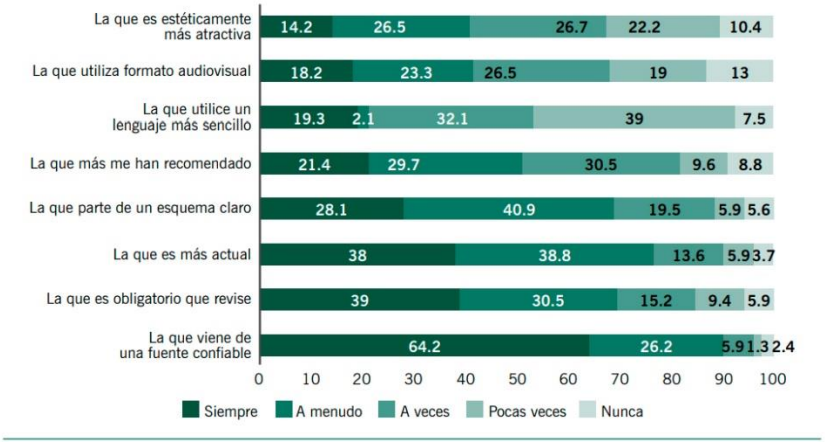
It is interesting to know the actions taken by the students when they receive new information since said actions reflect their skill on the network. Their strategies allow them to make adequate decisions with the information they receive. The students are aware they interpret the information according to their standpoint, which results in a mean of 4.27 (*DS* = .784). They have also declared that they interpret it in a reflexive mode, with a means of 4.09 (*DS* = .829), and that they value the opinion of other users, with a mean of 3.52 (*DS* = 1.14). Lastly, they consider that the information they receive is not always true or does not correspond to the reality, with a mean of 3.66 (*DS* = 1.03), and that they contrast the information, with a mean in the "sometimes" option of ($\bar{X}$ = 3.29, *DS* = 1.19). The scale is from 1 to 5, where 1 is "never" and 5, "always" (See Graph 3).



Graph 3. Strategies regarding the information received.
Source: Self development.

In this category we did not notice any significant differences regarding gender, with p≥0.05. In the area of knowledge, there were dissimilarities exclusively in the variable of comparing the information the students received (p = 0.006, gl, X^2 = 14.34), with preference in the Health area, with a mean of 4 (*DS* = 1.21).

In regard to the information found by the students, the study shows that they prefer to choose the information that according to them, comes from a more reliable source ($\bar{X}$ = 4.48, *DS* = .859) or that the information be updated ($\bar{X}$ = 4.01 *DS* = 1.044). The assessment of the students lowers when choosing the information that has been recommended ($\bar{X}$ = 3.45, *DS* = 1.18) or if it is presented in a simple language (19.3%).

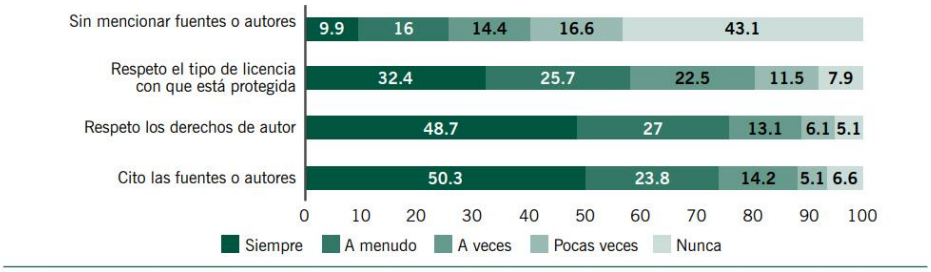


Graph 4. Assessment of the information received.
Source: Self development.

There is no significant difference for gender or for the area of knowledge, with a p≥0.05.

In regard to the strategies used when receiving information, we observed that the students analyze it, with 60.2%, in the "always" section ($\bar{X}$ = 4.48, DS = .881); they relate it to other information already known, 50% ($\bar{X}$ = 4.36, DS = 1.01); they interpret it, 50.3% ($\bar{X}$ = 4.29, DS = 1.03); new doubts arise, 49.7% ($\bar{X}$ = 4.24, DS = 1.03); they compare it with what they already know, 43% ($\bar{X}$ = 4.12, DS = 1.14), and with other sources, 29.7% ($\bar{X}$ = 3.72, DS = 1.20). Neither is there any significant difference in the gender variable or area of knowledge with p ≥ 0.05.

Graph 5 shows the students respect the copyrights of third parties' information, with 48% ($\bar{X}$ = 4.08, *DS* = 1.14) in the "always" option; they do quote the sources or the authors, with 50.3% ($\bar{X}$ = 4.07, *DS* = 1.19) in the "always" position". The frequency in the "always" position diminishes when it is a question of respecting the license that protects the information, with 32.4%.



Graph 5. Actions taken with third parties' information.
Source: Self development.

The area of knowledge had significant differences (See Table 3). Students from Humanities and Education tend to respect copyrights; those from Engineering and Technology, are less inclined to do so. Social Sciences and Administration students are those who respect most the programs and software licenses, unlike those from Engineering and Technology who tend to have less respect. Lastly, students from the areas of humanities and education are those who mostly quote sources and authors unlike those of engineering and technology.

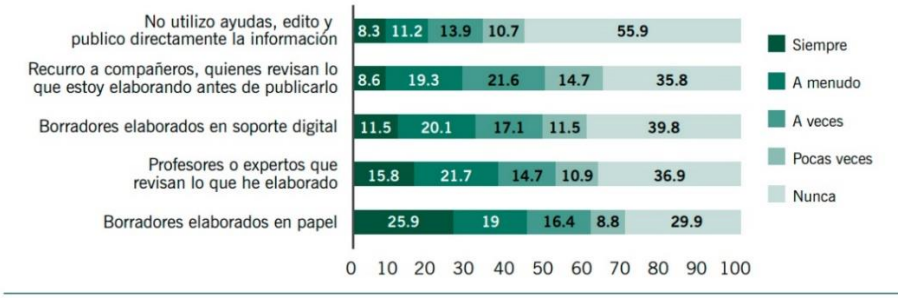
Table 3. Differences between the areas of knowledge of actions taken regarding to third parties' information

Variable	$\bar{X}$/DS					X^2	gl*	p
	Salud	C.N.	C.SyA.	HyE	IyT			
Copyrights are respected responsibly	3.83 1.27	4.19 1.21	4.21 1.01	4.33 1.08	3.04 1.22	24.69	4	0
The type of license that protects the area of knowledge is respected	3.51 1.41	3.52 1.27	4.02 1.10	3.89 1.21	3.02 1.24	24.62	4	0
Sources or authors are not mentioned	2.99 1.57	1.67 1.20	2.59 1.45	2.03 1.34	2.33 1.19	24.52	4	0
Sources or authors are mentioned	3.81 1.4	4.17 1.41	4.13 1.08	4.28 1.10	3.34 1.16	14.05	4	.007

Source: Self development.
*ns No significativa p ≥ 0.005
*gl: grados de libertad

This type of strategies refers to the decisions the students make to self-regulate their learning. The first category we analyzed brings us closer to the learning objectives on a social network that allows others to co-assess them and share other strategies to improve their academic formation. When asking students if they describe their objectives on a professional network (LinkedIn o Xing) or on a social network (Facebook or Twitter), only 8.3% chose the "always" option with a mean of 2.65 (*DS* = 1.32); this indicates a controversy with this variable.

The help mostly used to produce Information on the network are rough drafts on paper, 25.9%. Likewise, students rarely or never resort to help to review the information they publish, 55.9% in this option. They neither request support from their peers to review what they have done (35.8%); they almost never make digital rough drafts (39.8%), nor do they turn to professors or experts (36.9%) (See Graph 6).



Graph 6. Support to produce information on the network.
Source: Self development.

From the students' perspective, they rarely assess contributions and criticism from the users, with 19.5% in the "always" option (= 3.38, *DS* = 1.26). Regarding teamwork, they often prioritize sharing resources, with 50.5% in the "always" option (= 4.23, *DS* =.968), working jointly, 54.4%, (= 4.20, *DS* = 1.09) and interacting with others, 39.8% (= 4.03, *DS* = 1.04).

STRATEGIES TO DEVELOP METACOGNITIVE SKILLS

In this category, we analyzed the assessments made by students to develop metacognitive skills, such as examine their own learning strengths; set goals and analyze the way to meet said learning objectives; use strategies to access knowledge and how to question the information they receive. All this implies pondering on how the students learn and generate strategies to acquire metacognitive skills.

The first category questions the students evaluate their strengths and weaknesses in order to assess their effort to carry out their assignment. From the students' perspective, they analyze their strong and weak points in 53.3% in the "often" option ($\bar{X}$ = 3.82, *DS* = .910). This allows them to map their route to improve their learning strategies. The second category addresses setting objectives to take advantage of the time they dedicate to the Internet; students indicated they do so "frequently", with 43.3% ($\bar{X}$ = 3.96, *DS* =.986).

In the next category, we asked the students the way in which they decide what to learn on the Internet. We observed that they assess positively according to their capacities and skills (37.7%) between the "always" and "frequently" options; students that are in line with the objectives of the assignment (37.2%); to the topics that arise (27.3%); and to the occupational needs (20.6%). Likewise, at times, they adjust to colleagues' requests (19%).

Lastly, in this category, we analyzed the way students question the information they receive: information coming from communication networks, 40.6% with preference of the "always" option; that coming from social networks, 50.3%; from friends and family, 33.7%; and from traditional means of communication, 34.2%. Students sometimes question the information posted on Twitter, 44.4%; tutorials, 21.9%; professors, 17.6%; e-mail notices, 28.6%; forums, 24.3%; mobile applications, 24.3%; and that from experts, 15%.

DISCUSSION

The results are an X-Ray of the strategies and the ICTs students' use for their academic formation. This research shows that, in general, there are no significant differences regarding gender; this is similar to the findings of previous research, such as that of Hinojo-Lucena *et al.* (2018) on active methodologies.

We observed that while students impose challenges and objectives upon themselves to perform assignments implying self-regulating strategies and customization, they prefer to supplement said information with more traditional tools and resources linked to an in-class formation model such as the one they have always known. They are inclined toward face-to-face strategies. Our results do not differ from those obtained by Prendes *et al.* (2017), in which they make reference to Spanish students who prefer using traditional tools to digital ones.

Regarding the strategies students use to manage and plan information, the results cast that they have the relevant skills in a "connected" world, since they analyze, question, compare and respect copyrights (Chatti *et al.*, 2010; Patterson *et al.*, 2017). Moreover, we observed a certain limitation: students prefer traditional instruments and they miss out on the advantages of being connected to a network that would help them develop a learning ecology with more tools (Guodong & Xinghua, 2016).

As for the self-regulating learning tools, we observed that students do not use social networks to establish learning goals and they do not create many contents. One of the characteristics of PLEs is the possibility students have to develop personal learning networks that allow them to articulate their individual learning, or they prefer a formal context with a more open and collaborative learning which also occurs in informal spaces (Coll & Engel, 2014). As informal fields, social networks make the foregoing possible.

Chaves *et al.* (2017) found a correlation between the use of digital tools, learning self-regulation and teaching strategies, which may suggest that teachers may prefer using PLEs in their educational practice. It is worth highlighting that with the PLEs, an apprentice is expected not only to consume contents but also be a "prosumer" given the opportunities digital tools offer (Prendes *et al.*, 2017). The data in our study show that we are facing an apprentice that does not take necessarily advantage of the collaborative tools since he/she is still attached to the approaches on consumption rather than network production.

Our findings are similar to those reported by Prendes *et al.* (2017), whose study, based on the same questionnaire as ours, shows that Spanish students do not prefer using digital tools or social networks or sharing contents for their academic formation.

Lastly, in the strategies to develop metacognitive skills, we observed that the challenges students impose upon themselves on the network do not always allow them to develop complex cognitive processes such as metacognition in a connected world.

Regarding the areas of knowledge, we noticed significant differences that indicate that the students pertaining to the area of knowledge of humanities and education as well as those of social and administrative sciences prefer strategies that imply digital tools with a social component.

In contrast, engineering and technology, health and natural sciences students chose strategies that require traditional tools.

CONCLUSION

The technological component of PLEs requires the apprentices to have the knowledge-building strategies in order to use digital tools efficiently. This implies the use of PLEs with an educational purpose which in turn requires a pedagogical approach that fosters new teaching and learning methodologies. The current discourse poses that we live in an era in which ICTs are part of our daily life and of people's activities. Throughout this paper, we realized that the students do not necessarily take advantage of digital tools for their academic formation.

We do not dispute that students are ICTs users, that they feel comfortable using them, and that they use them for other activities (Gallardo-Echenique, Bullen & Marqués-Molías, 2016), however, in an era where it is expected that students be digitally literate and that they develop competences such as lifelong learning, it is urgent that universities become responsible in including in their curricula and their educational practice active pedagogies that allow the students acquire essential competences. PLEs may be an option that promotes the development of competences necessary for life.

Active pedagogies encourage open and collaborative learning and promote the development of cognitive skills. In turn, they make ubiquity, autonomous learning and self-regulation possible in students (Hinojo-Lucena *et al.*, 2018).

It is worth mentioning that our analysis shows limitations regarding the deepening of information with qualitative methodologies to understand better the way students take advantage of ICTs for their academic formation.

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