Changes in Attitude, Knowledge, and Use of ICTs During the Progression of an Online Research Master's Program

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Article History: Received: 11 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 4 June 2021

Abstract
The objective of the research was to observe the evolution of attitude, knowledge, and use of ICT resources in students during the progression of the Research Master's degree in Teacher Training and ICTs in the Faculty of Education at the University of Extremadura. A total of 21 students from the Master's program participated. A concurrent triangulation mixed method was used, combining descriptive and inferential data analysis with content analysis, developing the quantitative and qualitative designs in parallel. Among the main conclusions obtained, it is noted that no statistically significant differences were observed in the attitude, knowledge, and use of ICT resources of the students between the beginning and the end of the Master's program. However, a positive correlation was found between knowledge and the use of ICT resources, both at the beginning and at the end of the Master's program. Moreover, it was found that not only do the students have a positive attitude and a medium knowledge with the use of ICT resources but also that the main problems in the teaching/learning process in the online Master's program are related to the teaching staff and organization.

Keywords: Attitude; ICTs; Distance education; Higher education; Learning problems.

1. Introduction.

An increasing number of higher education institutions are offering a wide range of studies on virtual platforms as such platforms have been found to make combining work and learning through Information and Communication Technologies (ICTs) possible.

The University of Extremadura offers the Research Master's degree in Teacher Training and ICTs *(*RMDTTICT*)* a Master's program that combines the teaching/learning of research content, virtual platforms, and ICT resources for education. This program changed its teaching methodology from blended learning to online learning in the academic year 2017-2018.

From the researchers' interest in this topic, the research question arose: Is there an evolution in the attitude, knowledge, and use of ICTs in the students enrolled on the RMDTTICT? As a result of the research question, the general objective, "To observe the evolution in the attitude, knowledge, and use of ICT resources in the students during the progression of the Master's program", was established.

1.1. Attitude, knowledge, and use of ICT resources.

ICTs have become a fundamental tool in higher education institutions because they can be used as didactic support, allowing for the exchange of projects and ideas, online work, the use of interactive learning applications, and the promotion of an active attitude to the search and continuous rethinking of contents and procedures (Palomo et al., 2006).

The implementation of online training models in universities is already a reality. There is an increasing number of universities whose educational programs are developed solely for online use. However, some factors, such as insufficient technical assistance in online learning models (Tallent-Runnels et al., 2006; Akbullut, 2009) cause student distrust towards these teaching/learning systems.

Previously, according to Petko et al. (2016), there were negative attitudes towards the use of ICTs in education (Papanastasiou et al., 2004). This perception has been seen to be changing in more recent studies. This is supported by the PISA 2009 report, which shows that students have a more positive assessment of the use of ICTs for academic purposes (Lee & Wu, 2012).

Student attitudes towards ICTs in higher education are usually very positive (Pino & Soto, 2010; García & Tejedor, 2011), which results in more willingness for both their use and the taking of online courses.

On the other hand, some studies have shown that students consider that it is either due to their own high level of skill when using ICTs (García & Tejedor, 2011; Herrera et al., 2015), or due to teachers showing an adequate attitude and knowledge of ICT resources, that there is higher acceptance for these resources (Rivera et al., 2017). Other studies, however, show that there are notable deficiencies in terms of digital competence (Cabero & Martín, 2014).

Regarding the existing correlations between these variables, Centeno & Cubo (2013) maintain that there is a positive relationship between the attitude towards ICTs and a person's knowledge and use of them, while Mirete (2016) asserts that the attitude towards ICTs does not correlate with the knowledge or use of ICT resources. However, it has been observed that there is a statistically significant high correlation between the knowledge that students claim to have of the different technologies and their use of them (Tejedor & García, 2006a; 2006b; Mirete, 2016), both being indispensable factors for students. Similarly, the use of ICT resources in teaching/learning is directly related to the knowledge at the user level, the attitudes towards ICTs, and the perception of the pedagogical potential of ICTs (Pino & Soto, 2010).

Cabanillas et al. (2018: 2019a) and Segovia et al. (2021) shows a positive correlation between the knowledge of ICT resources and digital competence, with the latter being one of the key skills to be achieved by students in higher education. Furthermore, Gisbert and Esteve (2011) state in their work that digital competence is a combination of knowledge, skills, and attitudes through a safe and critical use of ICTs (European Parliament and Council Recommendation, 2006), which assumes a direct correlation between these variables.

1.2. Theory of Nuclear Concepts (TNC) and the Pathfinder Associative Networks technique (PFNET).

According to Luengo (2013), TNC is based on the general theoretical framework of cognitive science. This theory presents a new vision of how knowledge is acquired and structured and how cognitive structures can be represented. TNC notes that knowledge is not constructed in a linear way, but is situated in the form of a network, where the different concepts are interrelated to each other. The content present in the student's mind forms a stable structure. When learning new content, there is a change in the previous cognitive structure.

According to Veríssimo et al. (2017), cited in Cabanillas et al. (2020), nuclear concepts are those that present a greater number of connections within a network. Every concept in the mind is equivalent to a stable structure with interrelated concepts, and any new concept acquired produces a modification in the previous cognitive structure. Nuclear concepts correspond to those that present the highest number of connections in the network and, from them, processed knowledge is built (Veríssimo et al., 2017).

To represent the structure of the concepts, the Pathfinder Associative Networks technique (PFNET) (Schvaneveldt, 1990) is used, representing the existing relationship between concepts and offering information about the cognitive structure of the students in a graphic and visual way.

2. Methodology.

2.1. Population and sample.

The population sample was composed of students from the RMDTTICT class of 2018-2019. A convenience sampling was used, where a total of 21 students participated in the research.

2.2. Research design.

For the development of the research, a concurrent triangulation design was used (Hernández et al., 2015). In this design, the quantitative (QUAN) and qualitative (QUAL) processes ran in parallel. This design has been used in other studies where descriptive and inferential analyses were combined with content analyses, as in the study by Cabanillas et al. (2019b).

The design consisted of 11 phases, which are reflected below:

1. The research problem was stated (QUAN and QUAL).
2. A review of the theoretical framework was conducted (QUAN and QUAL).
3. The objectives were set and the analysis of the document "Memoria Verifica" (a quality evaluation document for the Master's program managed by the National Agency for Quality Assessment of Spain (ANECA)), was carried out, selecting the most notable skills in relation to ICTs (QUAL).
4. The working hypotheses were developed (QUAN) and the table of categories (QUAL) was created.
5. The research designs were planned (QUAN and QUAL).
6. The research sample was selected (QUAN and QUAL).
7. The research instruments were configured and validated (QUAN and QUAL).
8. Pretest and posttest data collection was performed (QUAN and QUAL).
9. Data analysis was performed in SPSS (QUAN) and in webQDA and GOLUCA (QUAL).

10. A methodological triangulation (QUAN and QUAL) and a credibility analysis (QUAL) were performed.
11. Discussion regarding the data and conclusions were achieved (QUAN and QUAL).

2.3. Research tools.

A closed-response questionnaire was used to collect data for the QUAN analysis. The questionnaire used was ACUTIC (Mirete et al., 2015), obtaining a Cronbach's Alpha reliability coefficient of 0.893. It was adapted to the problem and contents of the research, as well as to the context and the population participating in it.
For the data collection of the QUAL analysis, a table of categories[1] was used, carrying out a pilot study for its creation and validation as well as an open-response questionnaire (validated by the judgment of 5 experts in the field) and structured interviews, whose script was created from the table of categories.
The closed- and open-response questionnaires were provided to the students through Google Drive. Five students were interviewed by telephone in the pretest and five different students in the posttest.

2.4. Working hypothesis.

The following are the working hypotheses and the references that support them:

- **H1: There is a significant improvement in the students' attitude, knowledge, and use of ICT resources with the progression of the Master's program.**
  - H1.1: Attitudes towards ICTs improve significantly with the progression of the Master's degree (Area et al., 2008; Marín & Reche, 2012).
  - H1.2: The knowledge of ICT resources improves significantly with the progression of the Master’s program (Sosa, 2009; Hernández, 2010).
  - H1.3: There is a significant increase in the use of ICT resources with the progression of the Master’s program (Sosa, 2009).
- **H2: There are significant positive correlations between attitude, knowledge, use of ICT resources, and emotions in the pretest and posttest.**
  - H2.1: There are significant positive correlations between attitude, knowledge, and use of ICT resources in the pretest.
    - ✓ H2.1.1: There is a positive correlation between attitude towards ICTs and knowledge of ICT resources in the pretest (Tejedor & García, 2006a; 2006b; Vera et al., 2014).
    - ✓ H2.1.2: There is a positive correlation between knowledge of ICT resources and the use of ICT resources in the pretest (Tejedor & García, 2006a; 2006b; Gisbert & Esteve, 2011).
    - ✓ H2.1.3: There is a positive correlation between the attitude towards ICTs and the use of ICT resources in the pretest (Vera et al., 2014).
  - H2.2: There are significant positive correlations between attitude, knowledge, and use of ICT resources in the posttest.
    - ✓ H2.2.1: There is a positive correlation between attitude towards ICTs and knowledge of ICT resources in the posttest (Tejedor & García, 2006a; 2006b; Vera et al., 2014).
    - ✓ H2.2.2: There is a positive correlation between the knowledge of ICT resources and the use of ICT resources in the posttest (Tejedor & García, 2006a; 2006b; Gisbert & Esteve, 2011).
    - ✓ H2.2.3: There is a positive correlation between the attitude towards ICTs and the use of ICT resources in the posttest (Vera et al., 2014).

3. Results

3.1. Descriptive data analysis.

Firstly, in the descriptive analysis of the QUAN design, the results obtained for the mean values (M) and standard deviations (SD) for each of the items according to the dimensions under study are shown.
Table 1 shows how, in general, with reference to dimension 1, higher mean values were obtained for all items in the pretest than in the posttest.

Table 1

Descriptive statistics for dimension 1: Attitude towards ICTs

ITEM	Mean	SD

[1] Final version of the category table. Download at: http://bit.ly/3spfgYT

	Pretest	Posttest	Pretest	Posttest
ICTs promote engagement in the teaching and learning process	**4.43**	4.38	0.598	0.590
Teachers should use ICTs to improve the quality of learning processes.	**4.52**	4.38	0.602	0.669
It is essential to incorporate ICTs into university classrooms	**4.57**	4.43	0.598	0.676
Classes improve as ICTs are incorporated into the classroom	**3.95**	3.81	0.921	0.873
ICTs facilitate the development of classes	**4.48**	4.05	0.512	0.973
ICTs enable the achievement of skills	**3.95**	3.76	0.921	0.768
ICTs provide the flexibility of space and time for communication among members of the educational community	**4.48**	4.29	0.602	0.902

Note: Own contribution

The items with the highest mean scores in the pretest were the item: "It is essential to incorporate ICTs in university classrooms" (M = 4.57; SD = 0.598) and the item: "Teachers should use ICTs to improve the quality of learning processes" (M = 4.52; SD = 0.602).

The item with the highest mean score in the posttest was: "Teachers should use ICTs to improve the quality of learning processes" (M = 4.38; SD =0.669).

On the other hand, in table 2, it can be seen that in dimension 2, higher mean values were obtained in the posttest than in the pretest in 10 of the 12 items analyzed. In dimension 3, it can be observed that higher mean scores were obtained in the posttest than in the pretest in 8 of the 12 items analyzed.

Table 2

Descriptive statistics for dimension 2: Knowledge of ICT resources and dimension 3: Use of ICT resources

	Knowledge of ICT resources				**Use of ICT resources**			
ITEM	M		SD		M		SD	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
User tools and basic programs such as Word, PowerPoint, etc.	**4.38**	4.29	0.74	0.64	**4.67**	4.57	0.48	0.59
Web information search engines such as Google, Yahoo, Bing, Lycos, etc.	3.71	**3.86**	0.64	0.57	4.38	**4.52**	0.74	0.68
Communication systems. For example, e-mail, forum, chat, video conference, etc.	**4.19**	4.14	0.68	0.65	**4.52**	4.52	0.60	0.60
Digital libraries and databases	2.71	**2.86**	0.78	0.65	**2.71**	2.67	1.05	0.85
Web 2.0 tools. For example, Youtube, Slideshare, Picasa, Flickr, Blogger, Wikispaces, etc.	3.24	**3.67**	0.94	0.96	**3.43**	3.29	1.16	1.05
Social interaction spaces, such as Tuenti, Facebook, hi5, Pinterest, etc.	3.81	**4.14**	1.03	0.91	3.86	**4.00**	1.01	1.04
Image, audio, and video editing software, such as Photoshop, Pixelmator, Audacity, PowerSoundEditor, WindowsMovieMaker, iMovie, etc.	2.95	**3.14**	0.97	1.19	**2.81**	2.71	1.32	1.18
Virtual teaching-learning platforms, e.g. Sakai, Moodle, Suma, etc.	2.81	**3.29**	1.03	0.90	2.95	**3.05**	1.11	2.24
Data analysis software, such as SPSS, Mystat, Nud.ist, Atlas.ti, etc.	2.14	**2.52**	0.85	1.03	1.90	**2.24**	0.94	0.99
Network educational resources,	2.90	**2.95**	0.94	1.07	2.43	**3.00**	1.07	1.22

such as translators, courses, podcasts, learning object archives, etc.								
Creation of virtual materials and network resources for teaching and learning such as electronic portfolios, didactic Web, Wikis, video games, etc.	2.62	**2.90**	1.16	1.26	2.33	**2.48**	1.19	1.20
Educational programs. For example, Clic, JClic, HotPotatoes, NeoBook, etc.	2.24	**2.52**	1.09	1.32	1.71	**2.14**	1.00	1.19

Note: Own contribution

Regarding the pretest, the item with the highest mean score in dimension 2 was: "User tools and basic programs like Word and PowerPoint" (M = 4.38; SD = 0.74), coinciding with the item with the highest mean score in dimension 3 (M = 4.67; SD = 0.48). The item with the lowest mean score in dimension 2 was: "Programs for data analysis, such as SPSS, Mystat, Nud.ist, Atlas.ti, etc." (M = 2.14; SD = 0.85), being also the item with the lowest mean score in dimension 3 (M = 1.90; SD = 0.94).

With respect to the posttest, the item with the highest mean score in dimension 2 was the same as the pretest: "User tools and basic programs such as Word and PowerPoint" (M = 4.29; SD = 0.64), coinciding with the item with the highest mean score in dimension 3 (M = 4.57; SD = 0.59). The item with the lowest mean score in dimension 2 was: "Programs for data analysis, such as SPSS, Mystat, Nud.ist, Atlas.ti, etc." and "Educational programs, such as Clic, JClic, HotPotatoes, NeoBook, etc." (M = 2.52; SD = 0.85) and (M = 2.52; SD = 1.09), respectively, with the latter coinciding with the lowest mean score in dimension 3 (M = 2.14; SD = 1.19).

3.2. Inferential data analysis.

For the development of the inferential analysis, version 21 of the statistical software SPSS was used. A confidence level of 95% and an error of 5% were also used. However, certain correlations obtained results with a confidence level of 99% and an error of 1%.

With respect to the statistical tests used, according to Berlanga and Rubio (2012), in the field of social sciences, it is usual to use nonparametric tests since there are quite a few variables that do not achieve the conditions of parametricity, normal distribution of the sample, similar variances and sample sizes greater than 30 people, as is the case of this research.

Table 3 shows the results obtained for hypothesis 1.

Table 3

Results of hypothesis 1

Hypothesis	**Results and test**	
Hypothesis 1	**H_0 is accepted and H_1 is rejected.**	
Hypothesis 1.1	p=0.304	H_0 is accepted and H_1 is rejected. Wilcoxon test
Hypothesis 1.2	p=0.254	H_0 is accepted and H_1 is rejected. Wilcoxon test
Hypothesis 1.3	p=0.257	H_0 is accepted and H_1 is rejected. Wilcoxon test

Note: Own contribution

Therefore, the null hypothesis is accepted (rejection of hypotheses 1.1, 1.2, and 1.3) and the following working hypothesis is rejected: “There is a significant improvement in the students' attitude, knowledge, and use of ICT resources with the progression of the Master's program.”

Table 4 shows the results obtained for hypothesis 2.

Table 4

Results of hypothesis 2

Hypothesis	**Results and test**	
Hypothesis 2	**H_0 is partially rejected and H_1 is partially accepted.**	
Hypothesis 2.1	**H_0 is partially rejected and H_1 is partially accepted.**	
Hypothesis 2.2	**H_0 is partially rejected and H_1 is partially accepted.**	
Hypothesis 2.1.1	CC: 0.035 p=0.881	H_0 is accepted and H_1 is rejected. Spearman's correlation
Hypothesis 2.2.1	CC: 0.153 p=0.507	H_0 is accepted and H_1 is rejected. Spearman's correlation
Hypothesis 2.1.2	**CC: 0.545*** **p=0.011**	H_0 is rejected and H_1 is accepted. Spearman's correlation
Hypothesis 2.2.2	**CC: 0.860**** **p=0.000**	H_0 is rejected and H_1 is accepted. Spearman's correlation
Hypothesis 2.1.3	CC: -0.066 p=0.775	H_0 is accepted and H_1 is rejected. Spearman's correlation
Hypothesis 2.2.3	CC: 0.004 p=0.985	H_0 is accepted and H_1 is rejected. Spearman's correlation

Note: Own contribution
* Correlation is significant at the 0.01 level (bilateral).
** Correlation is significant at the 0.05 level (bilateral).
The null hypothesis is rejected (p=0.011) and the following working hypothesis is accepted: "There is a positive correlation between knowledge of ICT resources and the use of ICT resources in the pretest." The null hypothesis is rejected (p=0.011) and the working hypothesis is accepted: "There is a positive correlation between the knowledge of ICT resources and the use of ICT resources in the posttest." Regarding hypothesis 2, this implies that the null hypothesis is partially rejected (partial rejection of hypotheses 2.1 and 2.2) and the working hypothesis is partially accepted: "There are significant positive correlations between attitude, knowledge, and the use of ICT resources in the pretest and posttest:"

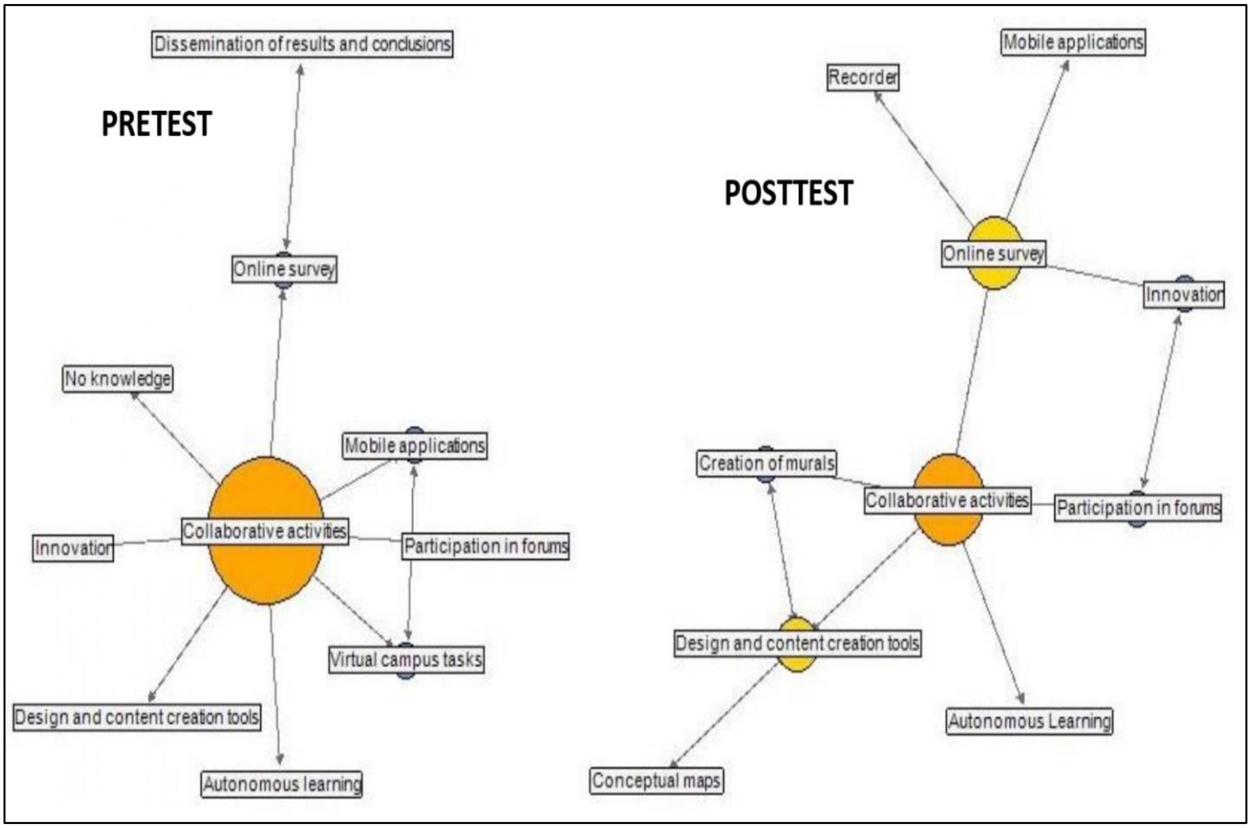
3.3. Content analysis.

The comparison between the PFNETs obtained in the pretest and posttest is shown below.

- ✓ **Category 1: ICT Resources**

In figure 1, it can be observed that regarding subcategory 1.1: "Research activities with ICT resources", just as in the pretest, collaborative activities are at the center of the axis for research activities. A relationship is established between virtual platform activities, participation in forums, and mobile applications. The most distant content is the use of ICT resources for the dissemination of results and conclusions. On the other hand, in the posttest, collaborative activities continue to be the fundamental content of the network, but there are also two important contents nearby: design and content creation tools and online surveys.

Figure 1
Pretest posttest networks of subcategory 1.1



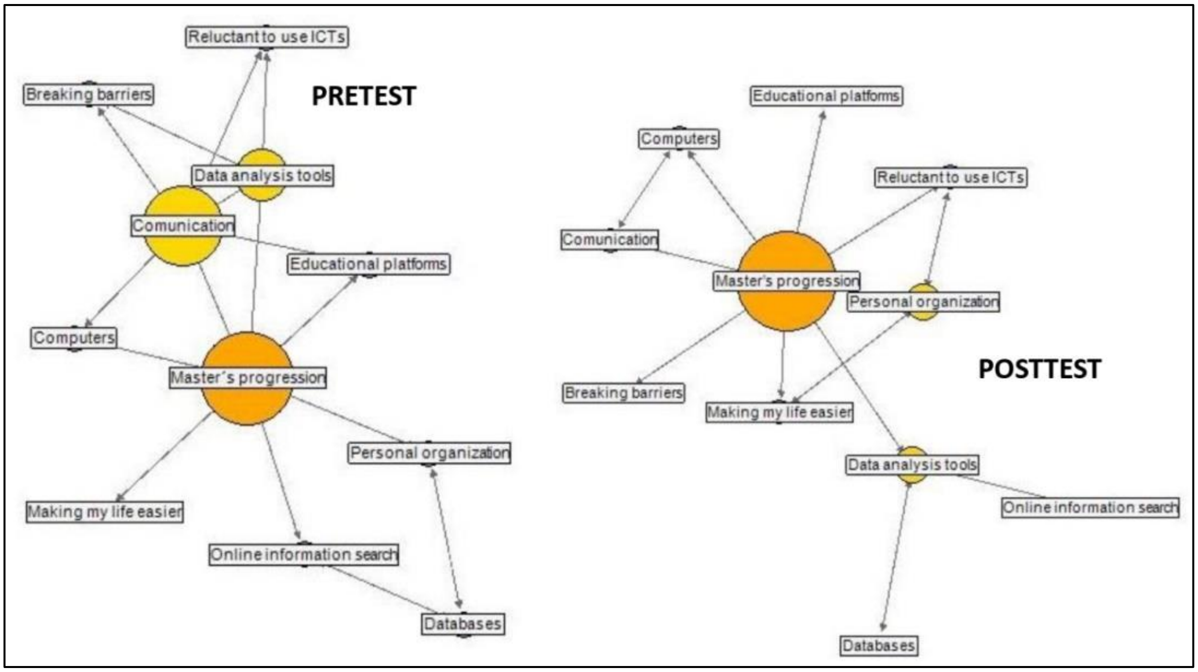
Note: Own contribution

In figure 2, it can be observed that regarding subcategories 1.2: "ICTs as tools for obtaining information" and 1.3: "Use of ICTs", the essential use of ICT resources for the progression of the Master's program is the axis of the pretest network, with the use of ICT resources as an element for communication being another very important content, linking with data analysis tools.

However, in the posttest, both communication and data analysis tools decrease in the number of links, but the consideration that ICTs are indispensable for the progression of the Master's degree is still maintained as the axis of the network.

Figure 2

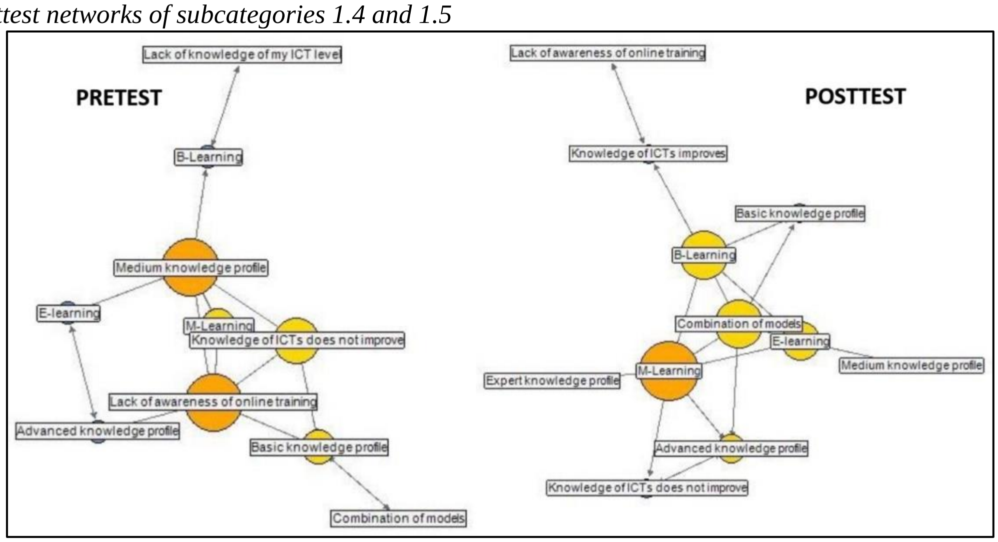
Pretest posttest networks of subcategories 1.2 and 1.3



Note: Own contribution

Figure 3 shows, in the networks of subcategories 1.4: "ICT knowledge" and 1.5: "Online training", that in the pretest, the medium ICT knowledge profile of the students and the lack of knowledge in online training are placed as nuclear contents in the network. The combination of online models is placed in a very distant node in the network, while in the posttest, this consideration takes on greater importance from the students.
However, the nuclear concept of the network in the posttest considers m-learning as a fundamental online training model. In both networks, the consideration that the students do not know their ICT level and have no training in online training models is located at a distant pole.

Figure 3
Pretest posttest networks of subcategories 1.4 and 1.5



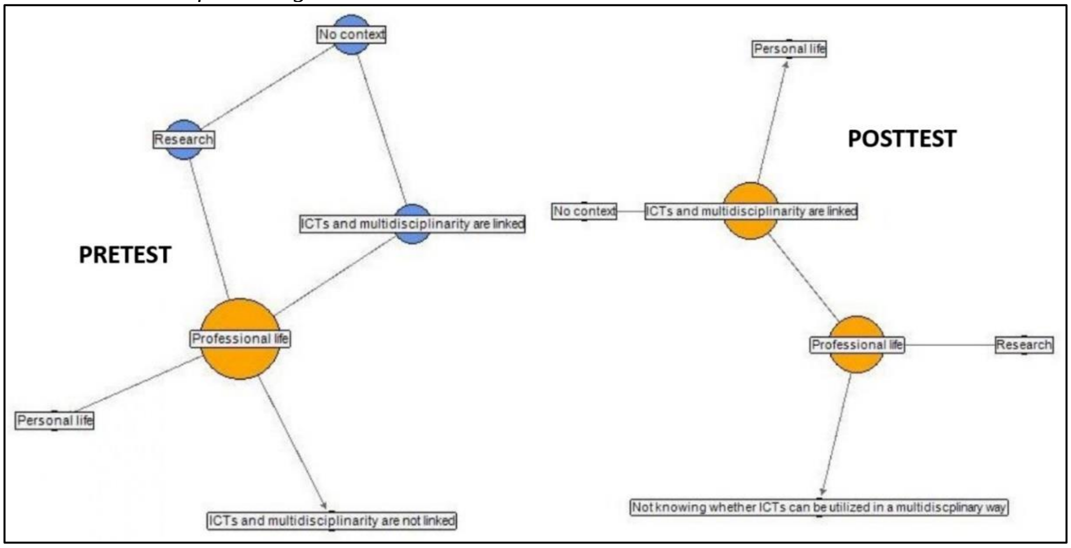
Note: Own contribution

- ✓ **Category 2: Problem resolution.**

In figure 4, the networks of the subcategories 2.1: "Multidisciplinarity" and 2.3: "Extrapolation of knowledge" show the main node of the pretest network being the students' consideration that the knowledge acquired in the Master's degree can be used in their working life. On the other hand, in the posttest, this central node is shared with the consideration that ICTs can be used in a multidisciplinary way in the different areas of the Master's program.

Figure 4

Pretest posttest networks of subcategories 2.1 and 2.3



Note: Own contribution

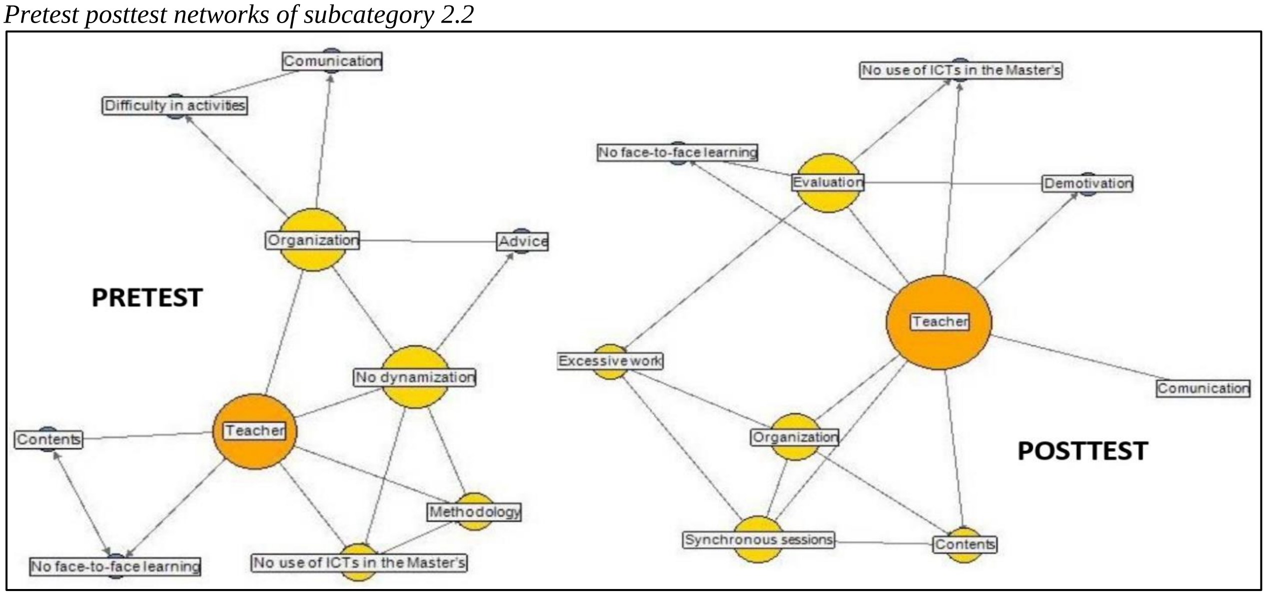
Figure 5 shows, in the networks of subcategory 2.2: "Problems of the teaching/learning process", that in both the pretest and the posttest, students consider the teacher to be the main axis of both networks for the teaching/learning problems found in the Master's degree. It can be observed that in the posttest, the number of links even increases when compared to the pretest.

Similarly, in both networks, communication problems are located in distant nodes in the pretest and the posttest. In the pretest, the organization and the lack of dynamic Master's activities are also considered important nodes of the network, while in the posttest, evaluation is another important node together with the teacher.

It can be observed that evaluation also becomes more important in the posttest, approaching the central node of the network and increasing its number of links. This is an element that did not appear in the pretest network, resulting in greater importance for the students. Evaluation is always one of the most complex elements of the curriculum in online training environments and the students' assessment in the posttest network corroborates this.

Figure 5

Pretest posttest networks of subcategory 2.2



Note: Own contribution

A credibility analysis of the results was carried out in the QUAL design. A questionnaire was provided to the students through Google Drive 8 months after the end of the Master's program. The results and conclusions obtained were outlined and participants were asked to indicate with which ones they agreed and disagreed, according to their experience in the Master's program.
A total of 69.56% of the students agreed with the contents of the conclusions, while 30.44% did not. Therefore, there is general agreement with the conclusions obtained in the analysis of the QUAN data by the students.

3.4. Methodological triangulation.

A methodological triangulation of the data obtained through the two methodologies (QUAN and QUAL) was performed, following the process developed in Alzás' (2015) doctoral thesis that contrasts, in a descriptive way, the quantitative and qualitative data analyses. The results obtained from closed-responses, open-responses, and interviews were compared according to several dimensions.
For the **use of ICT resources**, the levels of use analyzed in the qualitative aspect were categorized as follows:

- Low level of use (Levels 1 and 2 on the quantitative scale).
- Medium level of use (Level 3 on the quantitative scale).
- High level of use (Levels 4 and 5 on the quantitative scale).

For the **knowledge of ICT resources**, the levels of knowledge analyzed in the qualitative aspect were categorized as follows:

- Basic level of knowledge (Levels 1 and 2 on the quantitative scale).
- Medium level of knowledge (Level 3 on the quantitative scale).
- Advanced level of knowledge (Level 4 on the quantitative scale).
- Expert level of knowledge (Level 5 on the quantitative scale).

Table 5 shows the QUAN and QUAL contrasts in the use of ICT resources. Regarding design and content creation tools, we can observe that basic design programs such as Word and PowerPoint have a very high frequency of use (QUAN = 97.6%), but image, audio, and video editing programs are not so frequently used by students (QUAN = 30%). The qualitative aspect indicates that these resources are quite frequently used (QUAL = 15.26%).
Regarding collaborative activities, a low percentage indicates that students use Web 2.0 tools very frequently (QUAN = 38.1%), which is a result similar to that obtained in the qualitative aspect (QUAL = 34.81%).
Regarding the search for online information, the use of online information search engines such as Google, Yahoo, Bing, Lycos, etc., shows a high frequency of use by students (QUAN = 90.5%; QUAL = 32.65%).
The use of libraries and digital databases, such as Scopus, JCR, and Dehesa UEX, shows a low frequency of use by students in the quantitative aspect (QUAN = 9.5%), but a much higher frequency in the qualitative aspect (QUAL = 26.97%).
A low frequency of use of programs for data analysis, such as SPSS, Mystat, Nud.ist, Atlas.ti, etc., is observed in the quantitative aspect (QUAN = 14.6%), which contrasts with the high frequency of use of programs for data analysis during the progression of the Master's program (QUAL = 39.26%).
On the other hand, ICT resources are frequently used for communication according to the quantitative design: specifically, e-mail (QUAN = 95.2%) and to a lesser extent social networks (QUAN = 66.7%), presenting a high percentage of references in the qualitative aspect (QUAL = 23.57%).
Finally, the use of virtual educational platforms shows a low volume of use in both aspects (QUAN = 38.1%; QUAL = 10.94%).

Table 5
Triangulation in the use of ICT resources

	Quantitative item	Scale		Qualitative content	Student references
I C T R	**User tools** and basic programs such as Word, PowerPoint, etc.	1 2 3 4 5	0% 2.4% 97.6%	Design and content creation tools (12 References) 15.26%	I make use of ICTs at the user level, mainly using the office package. I use ICTs for the creation of documents. I use Quick to edit videos. To finalize, I would also use Canva to improve the

ESEARCH ACTIVITIES	**Image, audio, and video editing** software, such as Photoshop, Pixelmator, Audacity, etc.	1 2 3 4 5	47.7% 21.4% 30.9%		presentation. I use ICTs to create documents or do work on Windows (Office). However, I also use ICTs to make PowerPoints to explain contents, to make infographics, or to present a topic or discussion.
	Web 2.0 tools. For example, YouTube, SlideShare, Picasa, Flickr, Blogger, Wikispaces, etc.	1 2 3 4 5	19.1% 42.9% 38.1%	Collaborative activities (27 References) 34.81%	I use Google tools for teamwork to share information with students through Google Drive Through collaborative work with classmates, multidisciplinary ICTs can be linked with subjects. Drive and Skype, to work collaboratively, have been a great help with working in the groups formed during the Master's course.
INFO SEARCH WITH ICTS	**Web information search engines** such as Google, Yahoo, Bing, Lycos, etc.	1 2 3 4 5	0% 9.5% 90.5%	Online information search (15 References) 32.65%	I use ICTs to search for information in order to develop an adequate theoretical framework. I initially use the Internet to search for information I use the Internet to search for information.
	Digital **libraries and databases**	1 2 3 4 5	28.6% 61.9% 9.5%	Database (12 References) 26.97%	We have also looked at databases such as JCR, Scopus and dissertation databases. I would use databases that are related to education, thesis papers, and so on.
	Data analysis software, such as SPSS, Mystat, Nud.ist, Atlas.ti, etc.	1 2 3 4 5	66.7% 19% 14.3%	Data analysis tools (18 References) 39.26%	Data analysis using SPSS to obtain results in the research. To analyse data, ICT tools would be used to evaluate the information collected. ICT resources related to statistical measurements and data analysis. For a research project, I would use, for example, the statistical analysis program SPSS, as it saves a lot of time in statistics and calculations.
USE OF ICT RESO	**Communication systems**. For example, e-mail, forum, chat, etc.	1 2 3 4 5	0% 4.8% 95.2%	Communication (20 References) 23.57%	To be in contact with people hundreds of kilometres away, in this case, fellow researchers. I consider them important; it is a way to communicate with both teachers and students. ICTs can be used to help clarify concepts quickly and efficiently, as they help to communicate quickly and effectively. ICT resources are indispensable for everything from communicating to seeing each other. ICTs allow you to communicate with your classmates and teachers. E-mail to get in touch with other institutions. You must use Adobe Connect, for proper communication.
	Social interaction spaces, such as Tuenti, Facebook, hi5, Pinterest, etc.	1 2 3 4 5	9.7% 23.8% 66.7%		
	Virtual teaching-	1	33.4%	Educational	Uploading of notes (books) to the eScholarium

U R C E S	**learning platforms**, e.g. Sakai, Moodle, Suma, etc.	2 3 4 5	 28.6% 38.1%	platforms (8 References) 10.94%	platform, daily use of Rayuela. Personal Miblog, which I use as an educational platform. Web pages with many songs, theater for the kids, you can also work with eScholarium in high school with the kids.

Note: Own contribution

Table 6 shows the contrast between the QUAN and QUAL aspects in the results obtained for the knowledge of ICT resources.

The results obtained for the level of basic knowledge are similar for both the quantitative and qualitative aspects (QUAN = 21.12%; QUAL = 18.33%). However, regarding the level of basic knowledge, a higher evaluation of this level by the students was observed in the quantitative aspect (QUAN = 26.95%; QUAL = 48.33%).

For the advanced level of knowledge, the same results were observed for the quantitative and qualitative aspects (QUAN = 31.45%; QUAL= 30%). Finally, for the level of expert knowledge, a higher evaluation from the students was observed for the quantitative aspect (QUAN = 15.41%; 3.33%).

Table 6

Triangulation in the knowledge of ICT resources

Quantitative	Scale		Qualitative	Scale		Student references
Mean in dimension 2: Knowledge of ICT resources	1	21.1%	Mean in subcategory 1.4: Knowledge of ICTs	Basic	18.3%	I consider my level of ICT knowledge to be basic.
	2					
	3	26.9%		Medium	48.3%	Medium level, I do not know how to create a website but I am at ease with my website's blog.
	4	31.4%		Advanced	30%	My level is medium-advanced, except in SPSS.
	5	15.4%		Expert	3.33%	I consider my level of knowledge to be high, and those aspects, resources, or tools that I do not know I learn quickly.

Note: Own contribution

4. Discussion And Conclusions

In response to the general research objective: "To observe the evolution in the attitude, knowledge, and use of ICT resources in students during the progression of the Master's program", it has been observed that there is no significant improvement in the attitude towards ICTs, knowledge of ICT resources, and use of ICT resources. Therefore, the results are different from those obtained by Area et al. (2008) that indicated that there is an improvement in the attitude towards ICTs with the completion of a virtual course, as well as the studies by Hernandez (2010) and Sosa (2019) that showed that there is a significant improvement in the knowledge of ICT resources. However, they coincide with Marín & Reche (2012) who observed a small evolution in certain items but show that, in general, attitudes towards ICTs remain constant with the completion of the course.

This may be due to the fact that students have a very positive attitude towards ICTs at the beginning of the Master's course since graduate students like to use them, showing, in general, a very positive attitude towards them.

On the other hand, the results have shown no significant relationship between attitudes towards ICTs with knowledge and use of ICT resources. This is not in line with the study conducted by Centeno & Cubo (2013) that did establish that relationship. However, results did have similarities with those from the study conducted by Mirete (2016) that found that the dimension of attitude towards ICTs does not correlate with use or knowledge.

It has been observed that in the research activities with ICT resources, at the beginning of the Master's program, the fundamental content was the collaborative activities, which were essential for meaningful learning. However, at the end of the course, these activities lost part of their importance for the students in favor of design and content creation tools, as well as online surveys.

Regarding the use of ICTs, at the beginning of the Master's program, the students considered that ICTs were fundamental as they were used to search for information on the Internet, both in the academic and work environment. Therefore, the lack of development of this skill in distance learning environments is a serious problem. Communication is another key use of ICTs, as stated by the students. However, the students' perception, in the posttest, was that ICTs are essential for the Master's degree and that data analysis tools are preferable, highlighting that they are one of the fundamental contents of the Master's degree.
Regarding the self-perception of the students' level of knowledge of ICT resources, a coincidence was observed both at the beginning and at the end of the Master's program, that is, that students had a medium level of knowledge at both stages.
In the beginning, the main sources of problems in the teaching and learning process were related to the teachers, mainly due to the consideration by the students that there was a lack of training and a lack of adaptation to the online methodology. Another problem highlighted was the lack of organization of the Master's program, which hindered the students' ability to take advantage of the time available, demanding greater coordination among the teaching staff.
However, the credibility analysis showed that some students indicated that the teachers did their best to solve the problems that arose from the teaching and learning process.

5. Bibliography

1. Akbulut, Y. (2009). Investigating underlying components of the ICT indicators measurement scale: the extended version. *Journal of Educational Computing Research*, *40*(4), 405-427.
2. Alzás, T. (2015). *Causas de abandono temprano y de retorno a la Educación. Análisis sociológico desde una perspectiva de género* (Doctoral Thesis). Departamento de Ciencias de la Educación, Universidad de Extremadura, Badajoz. http://hdl.handle.net/10662/3656
3. Area, M., Sanabria, A. L, & González, M. (2008). Análisis de una experiencia de docencia universitaria semipresencial desde la perspectiva del alumnado. *RIED, 11*(1), 231-54. http://revistas.uned.es/index.php/ried/article/viewFile/963/882
4. Berlanga, V., & Rubio, M. J. (2012). Clasificación de pruebas no paramétricas. Cómo aplicarlas en SPSS. *REIRE. Revista d'Innovació i Recerca en Educació, 5*(2), 101-113. http://diposit.ub.edu/dspace/bitstream/2445/45283/1/612531.pdf
5. Cabanillas, J. L., Luengo, R., & Carvalho, J. L. (2018). Correlación entre el conocimiento, actitud hacia las TIC y las emociones en el máster universitario de formación del profesorado y TIC. *Revista Internacional de Tecnologías en la Educación*, *5*(2), 69-79. https://doi.org/10.37467/gka-revedutech.v5.1820
6. Cabanillas, J. L., Luengo, R., & Carvalho, J. L. (2019a). Diferencias de actitud hacia las TIC en la formación profesional en entornos presenciales y virtuales (Plan@ vanza). *Píxel-Bit. Revista de Medios y Educación*, (55), 37-55. https://doi.org/10.12795/pixelbit.2019.i55.03
7. Cabanillas, J. L., Luengo, R., & Carvalho, J. L. (2019b). Análisis de los objetos de aprendizaje y de la percepción docente del campus virtual de la Universidad de Extremadura. *International Journal of Information Systems and Software Engineering for Big Companies (IJISEBC)*, *6*(2), 41-61. http://uajournals.com/ojs/index.php/ijisebc/article/download/593/377
8. Cabanillas, J. L., Veríssimo, S., & Luengo, R. (2020). Diferencias entre alumnado y profesorado en la valoración del uso de una plataforma virtual para la enseñanza y aprendizaje de las matemáticas. In S. Oliveira, F. Freitas, P. Castro, M. González & A. P. Costa (Eds.), *Investigación Cualitativa en Educación. Avances y Desafíos* (pp. 378-389). Editorial Ludomedia. https://doi.org/10.36367/ntqr.2.2020.378-389
9. Cabero, J., & Marín, V. (2014). Posibilidades educativas de las redes sociales y el trabajo en grupo. Percepciones de los alumnos universitarios. *Comunicar, Revista científica de comunicación y educación,* (42), 166.172. http://dx.doi.org/10.3916/C42-2014-16
10. Centeno, G., & Cubo, S. (2013). Evaluación de la competencia digital y las actitudes hacia las TIC del alumnado universitario. *Revista de Investigación Educativa*, *31*(2), 517-536. http://revistas.um.es/rie/article/download/169271/158221
11. García, A., & Tejedor, F. J. (2011). Variables TIC vinculadas a la generación de nuevos escenarios de aprendizaje en la enseñanza universitaria: aportes de las curvas roc para el análisis de diferencias. *Educación XXI*, *14*(2), 43-78. http://e-spacio.uned.es/fez/eserv/bibliuned:EducacionXXI-2011-14-2-5020/Documento.pdf

12. Gisbert, M., & Esteve, F. (2011). Digital Learners: La competencia digital de los estudiantes universitarios. *La Cuestión Universitaria*, *1*(7), 48-59. http://polired.upm.es/index.php/lacuestionuniversitaria/article/view/3359/3423
13. Hernández, C. J. (2010). Un plan de formación en competencias de informacin a travs de aulas virtuales: análisis de una experiencia con alumnado universitario. *RUSC. Universities and Knowledge Society Journal*, *7*(2), 50-62. https://www.learntechlib.org/p/149477/article_149477.pdf
14. Hernández, R., Fernández, C., & Baptista, P. (2015). *Metodología de la investigación* (6th ed.). Madrid: Mc Graw Hill. https://www.uca.ac.cr/wp-content/uploads/2017/10/Investigacion.pdf
15. Herrera, M. R., Calderón, I., & Valenzuela, J. R. (2015). La competencia transversal uso de las TIC en estudiantes de Archivística. *Revista Electrónica Educare*, *19*(3), 300-323. http://dx.doi.org/10.15359/ree.21-3.6
16. Lee, Y. H., & Wu, J. Y. (2012). The effect of individual differences in the inner and outer states of ICT on engagement in online reading activities and PISA 2009 reading literacy: exploring the relationship between the old and new Reading literacy. *Learning and Individual Differences*, *22*(3), 336-342. https://doi.org/10.1016/j.lindif.2012.01.007
17. Luengo, R. (2013). La Teoría de los Conceptos Nucleares y su aplicación en la investigación en Didáctica de las Matemáticas. *UNIÓN-Revista Iberoamericana de Educación Matemática*, (34), 9-36. http://www.fisem.org/www/union/revistas/2013/34/archivo5.pdf
18. Marín, V., & Reche, E. (2012). Universidad 2.0: actitudes y aptitudes ante las TIC del alumnado de nuevo ingreso de la escuela universitaria de magisterio de la UCO. *PixelBit. Revista de medios y Educación,* (40), 191-211. https://helvia.uco.es/bitstream/handle/10396/15041/marin3.pdf?sequence=1&isAllowed=y
19. Mirete, A. B. (2016). El profesorado universitario y las TIC. Análisis de su competencia digital *ENSAYOS. Revista de la Facultad de Educación de Albacete*, *31*(1), 133-147. https://revista.uclm.es/index.php/ensayos/article/viewFile/1033/pdf
20. Mirete, A. B., García, F. A., & Hernández, F. (2015). Cuestionario para el estudio de la actitud, el conocimiento y el uso de TIC (ACUTIC) en educación superior. Estudio de fiabilidad y validez. *Revista interuniversitaria de formación del profesorado*, (83), 75-89. https://dialnet.unirioja.es/descarga/articulo/5249496.pdf
21. Palomo, R., Ruíz, J., & Sánchez, J. (2006). *Las TIC como agentes de innovación educativa*. Dirección General de Innovación y Formación del Profesorado.
22. Papanastasiou, E., Zembylas, M., & Vrasidas, C. (2003). Can computer use hurt science archievement? The USA results from PISA. *Journal of Science Education and Technology*, *12*, 325–332. https://doi.org/10.1023/A:1025093225753
23. Petko, D., Cantieni, A., & Prasse, D. (2016). Perceived quality of educational technology matters: A secondary analysis of students' ICT use, ICT-related attitudes, and PISA 2012 test scores. *Journal of Educational Computing Research*, *54*(8), 1070-1091. https://doi.org/10.1177%2F0735633116649373
24. Pino, M., & Soto, J. (2010). Identificación del dominio de competencias digitales en el alumnado del grado de magisterio. *Teoría de la Educación. Educación y Cultura en la Sociedad de la Información*, *11*(3), 336-362. http://www.redalyc.org/html/2010/201021093015/
25. Recomendación del parlamento Europeo y del Consejo 2006/962/CE, de 18 de diciembre, sobre las competencias clave para el aprendizaje permanente. *Diario de la Unión Europea L 394* de 30 de diciembre de 2006, 10-18. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:394:0010:0018:ES:PDF
26. Rivera, L. I., Fernández, K., Guzmán, F. J., & Eduardo, J. (2017). La aceptación de las TIC por profesorado universitario: Conocimiento, actitud y practicidad. *Revista Electrónica Educare*, *21*(3), 99-116. http://dx.doi.org/10.15359/ree.21-3.6
27. Schvaneveldt, R. (1990). *Pathfinder Associative Networks. Studies en Knowledge Organization*. Ablex Publishing Corporation.
28. Segovia, M. A., Cabanillas, J. L., Lameiras, C. P., & Luengo, R. (2021). Use, Knowledge, and Perception of Education in Technological Resources of Teachers in Extremadura Prior to the Impact of COVID-19. *Turkish Journal of Computer and Mathematics Education,* *12*(12), 2508-2519. https://turcomat.org/index.php/turkbilmat/article/view/7847/6198
29. Sosa, R. (2019). El aprendizaje de alumnos de maestría con el uso de entornos personales de aprendizaje (PLE). *Revista Atlante: Cuadernos de Educación y Desarrollo* (marzo 2019). https://www.eumed.net/rev/atlante/2019/03/aprendizaje-entornos-personales.html

30. Tallent-Runnels, M. K., Thomas, J. A., Lan, W. Y., Cooper, S., Ahern, T. C., Shaw, S. M., & Liu, X. (2006). Teaching courses online: A review of the research. *Review of Educational Research*, *76*(1), 93-135. https://doi.org/10.3102%2F00346543076001093
31. Tejedor, F. J., & García, A. (2006a). Competencias de los profesores para el uso de las TIC en la enseñanza. Análisis de sus conocimientos y actitudes. *Revista española de pedagogía*, (233), 21-43. https://reunir.unir.net/bitstream/handle/123456789/4064/CompetenciasDeLosProfesoresParaElUsoDeLasTIC.pdf?sequence=1
32. Tejedor, F. J., & García, A., (2006b). Condicionantes (actitudes, conocimientos, usos, intereses, necesidades formativas) a tener en cuenta en la formación del profesorado no universitario en TIC. *Enseñanza. Anuario Interuniversitario de Didáctica*, *23*, 1-25. https://gredos.usal.es/jspui/bitstream/10366/18421/1/DDOMI_Condicionantesactitudes.pdf
33. Vera, J. A., Torres, L. E., & Martínez, E. E. (2014). Evaluación de competencias básicas en tic en docentes de educación superior en México. *Píxel-Bit. Revista de Medios y Educación*, (44), 143-155. http://dx.doi.org/10.12795/pixelbit.2014.i44.10
34. Veríssimo, S., Godinho, V., Casas, L., & Luengo, R. (2017). Evaluation of Changes in Cognitive Structures after the Learning Process in Mathematics. *International Journal of Innovation in Science and Mathematics Education*, *25*(2), 17-33. https://openjournals.library.sydney.edu.au/index.php/CAL/article/download/11295/11122