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Analysis of Interpersonal Competences in the Use of ICT in the Spanish University Context

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Abstract: This article analyzes Higher Education students' development of interpersonal competences when using Information and Communication Technologies. The participating sample was made up of 1490 students from three Spanish universities: Complutense University of Madrid (Spain), Pablo de Olavide University (Spain), and National Distance Education University (UNED). The data were collected through a questionnaire called "Basic digital skills 2.0 of university students" COBADI® (Registered trademark: 2970648). A factorial analysis was performed to determine possible groupings of representative factors and subsequently the trees technique was applied by running the CHAID (Chi-squared Automatic Interaction Detector) algorithm. This made it possible to develop a map of possible differences between universities, ages, and gender of students. The results showed that university students have higher competences in communicating through interactive presentations and video-images, as well as in collaborating and working with documents online through mobile devices.

Keywords: digital competence; educational innovation; interpersonal competences; university; Spain

1. Introduction

The society of information and knowledge has been studied as a social phenomenon for over five decades. It is characterized by the use of information technologies, which allows for organization into networks and gives people the ability to access, share, and process data, even remotely and in real-time [1,2]. The continuous evolution of Information and Communication Technologies (ICT) in the current Knowledge Society has led to the demand for training in new skills, called 21st-century competencies [3,4].

Children often begin to use digital technologies at a very early age. Two-year-old toddlers regularly watch films and videos, play games, and listen to music on tablet computers [5], and half of all children can use tablets autonomously by the time they enter school [6,7]. There has been an increase in the use of digital technology in European K-12 schools over the last decade [6,7]. Laptops, digital tablets, and Learning Management Systems (LMS) are all examples of commonly used technologies [8]. Thanks to them, specific methodologies and teaching strategies have been promoted, while expanding training scenarios and new forms of interaction between students and

teachers have appeared, facilitating access to content from multiple perspectives and favoring the development of multiple intelligences for students, thereby creating flexible and enriched learning environments [1,9–11]. Likewise, nowadays, independent learning is conceived mainly through interactive and participatory technologies that offer a stimulating and socially positive experience, but at the same time, become a construct that allows students to learn by doing while sharing their experiences of knowledge with others who are often on the other side of that virtual space [9,12].

Cabero and Barroso [13] suggest that ICTs have led to an essential pedagogical change in training scenarios, fostering authentic learning experiences and activities with increased depth and interactivity. They also offer an innovative and renewing approach to Higher Education, as well as promoting enhanced access to information for its ubiquity, and the possibility of controlling organizational aspects [14,15]. The pedagogical use of ICTs has also been deemed as one of the main requirements for the actual development of modern education [16,17]. Socio-educational and technological changes of the 21st century have helped to promote deep transformations oriented towards the strengthening of new trends in Higher Education Institutions, seeking to promote the mobility of students, graduates, and teaching staff to give way to a competitive society based on knowledge, where students become fundamental actors for the achievement of this purpose [9]. In this sense, competencies acquire great importance and can be interpreted as the set of knowledge, skills, and attitudes that are necessary for personal and professional development in different contexts [18]. Similarly, digital competencies are established as innovative axes in international legislative scenarios [19,20]. From the above, it can be inferred that technology has a constant presence in our current life [1,21–23] and the prevalence of synchronous conversation systems as a means of communication, social networks as relationship contexts, and content repositories provide spaces of collaboration that demonstrate the development of the creativity of its users [24].

2. Education through Competences: New Challenges for University Innovation

In the educational context, traditionally, Higher Education has been based on a teacher-centered methodological model with an emphasis on the transmission of content and its reproduction by the students, the teacher's lesson, and individual work [25]. Today, the United Nations Educational, Scientific and Cultural Organization (UNESCO) highlights the need for technological changes to be focused on teachers and students, transforming paradigms into the conception of teaching and learning, and the competences and skills related to ICT adoption in educational settings [19]. on the basis of this, the new evolving society demands ways to organize the social, political, economic, and educational life of the world's countries and, consequently, to develop new professionals with a wide range of competences, including the so-called digital competence [26].

In the current model of Competences Education, the focus lies on the institutional organization of educational systems, defining curricula and training programs where its eminently practical character prevails in parallel with theoretical training [18]. This is necessary thanks to the sustained knowledge that the traditional model is not suitable for training professionals in the currently emerging society, which is full of uncertainty and is constantly changing [27]. In line with this, different authors have explained that a form of competence is a process by which people can creatively solve problems, carry out activities, ask questions, seek relevant information, analyze, understand, and reflect when applying their knowledge and providing an answer to the demands of a real environment [28,29]. Also, it is possible to define digital competence as the training of know how to use technology effectively to improve all areas of our daily life. In this sense, the European Commission [30] describes Digital Competence as one of the nine key competences needed for citizens to be integrated into and participate in current society. In particular, the European Commission [30] says that "digital competence involves the safe, critical, and responsible use of, and commitment to digital technologies for learning, at work, and for participation in society". In line with these ideas, it can also be understood as the ability to make critical use of ICTs by exchanging information and resources [31], which requires a critical and reflective attitude, autonomy, ethics, and collaboration [32]. Therefore, Digital Competence must be

seen as a key competence necessary for lifelong learning [33] and occupation [34,35], and a modern digital society educator must continuously enrich and complement his or her digital competence by working with the growing digital generation of aboriginal children in the digital society [36], and without forgetting that the pedagogical should always be prioritized over the technological for the proper curricular integration of ICT in the classroom [1].

However, digital competence is not an isolated skill to develop, as it implies a compendium of abilities, skills, and attitudes towards different areas and dimensions of knowledge [37]. The protagonist of educational action is the student, who must face this technological society and who has transformed the different ways of communicating, learning, accessing work, etc.. In short, they must live in the present and be prepared for the future [38]. Ultimately, we believe that university student training focused on digital competence is necessary to enable students to become digital dynamizers and techno-proactive agents for the sustainable development of the Digital Global Society.

3. Methodology

The data were collected using a questionnaire called "Competencias básicas digitales 2.0 de estudiantes universitarios" (Basic Digital Skills 2.0 of University Students) completed by COBADI® (Basic Digital Competences 2.0 in University Students / Registered Mark: 2970648). This questionnaire was created and tested by researchers from the research group EDUINNOVAGOGiA® (HUM-971), a group recognized by the Andalusian Research, Development and Innovation Plan and the Office of Transfer of Research Results of the Pablo de Olavide University. The questionnaire has 31 items divided into three main blocks. The first block was called "Competences in the use of ICTs for the search and processing of information", composed of 23 items measured in a Likert scale with 1–4 points (1 = "I feel completely ineffective" up to 4 = "I feel that I completely master it") referring to individual competence in the use of various technological tools (e.g., "I know how to use programs to plan my study time."). The questionnaire was distributed digitally among students from three universities through a non-probabilistic sampling of convenience. The three universities were: Universidad Complutense de Madrid (Spain), Universidad Pablo de Olavide (Spain), and Universidad Nacional de Educación a Distancia (UNED) (Spain). High reliability was obtained [39] for the overall questionnaire (α Cronbach = 0.9, ω = 0.75). High reliability was also found for the "Competences of the use of ICTs for the search and processing of information" subscale (α Cronbach = 0.91, ω = 0.77). The procedure and the data gathering were carried out during three academic years, between 2018 and 2019. During the assembling of the sample, the anonymity of the participants was preserved during their participation answering the questionnaires. Researchers obtained electronic informed consent.

The analysis was carried out with the 12 items corresponding to Block II: "Interpersonal competences in the use of ICTs in the university context. For analysis, we employed a mixed analysis method that combines parametric statistics with data mining. First, we performed a factorial analysis to determine possible groupings of representative factors and subsequently applied the trees technique by applying the CHAID (Chi-squared Automatic Interaction Detector) algorithm [40] and, in this way, were able to determine the map of possible differences between universities, ages, and the gender of university students. This technique, when faced with numerous samples (more than 1000 participants) has the advantage of being able to simplify complex relationships between variables when creating subgroups, is relatively easy to interpret, is built with a nonparametric approach that does not require compliance with statistical assumptions, handles skewed distributions without the need to perform transformations on the data, and is robust to extreme scores. The use of this data mining technique helps to look for specific subgroups and relationships that might not meet traditional statisticians. In this way, it helps to reveal hidden information [41].

4. Results and Discussion

The following table shows the descriptive statistics of the participating sample.

Table 1 shows that the sample percentage of men and women between each university is similar, highlighting the category of women in each case. This procedure is repeated in numerous studies in the humanities and social sciences, because the number of female students is much higher than male students in these areas. The average ages of the interviewees was very similar between Universidad Pablo de Olavide and UNED, being slightly higher than the average age of the interviewees of the UNED. Table 2 shows the results of the factor analysis, applying the primary component analysis extraction method and the Varimax standardization rotation method with the Kaiser method.

Table 1. Descriptive statistics of the sample.

University	Sample	Gender		Average Age (Typical Dev.)
		Woman	Man	
Universidad Complutense de Madrid	408	374 (91.6%)	34 (8.3%)	19 (4)
Universidad Pablo de Olavide	759	730 (96.1%)	29 (3.9%)	20 (4)
UNED	323	265 (82.8%)	58 (17.9%)	22 (4)

Table 2. Total explained variance of interpersonal competences involving the use of ICT in the university context.

Comp.	Initial Self-Values			Sums of the Squared Saturations of the Extraction			Sums of Squared Saturations of Rotation		
	Total	% Variance	% Accumulated	Total	% Variance	% Accumulated	Total	% Variance	% Accumulated
1	4472	37,263	37,263	4472	37,263	37,263	3024	25,198	25,198
2	1522	12,685	49,948	1522	12,685	49,948	2274	18,949	44,147
3	1067	8888	58,836	1067	8888	58,836	1763	14,688	58,836
4	1796	6632	65,468						
5	1682	5683	71,151						
6	1636	5296	76,447						
7	1607	5059	81,506						
8	1513	4275	85,780						
9	1496	4135	89,915						
10	1456	3796	93,712						
11	1420	3504	97,215						
12	1334	2785	100,000						

As we can see in the sedimentation graph (Figure 1), there are three factors that explain 58.8% of the variance.

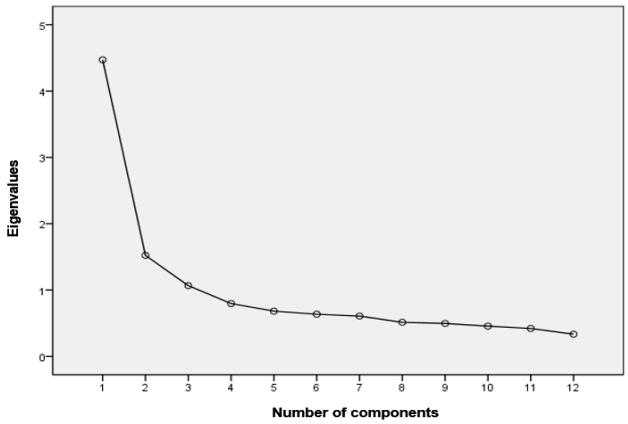

Figure 1. Sedimentation graph.

In Table 3, we present a matrix of rotated components where we can observe the grouping of variables in the three factors.

Table 3. Array of rotated components.

Items	Components		
	1	**2**	**3**
X39. I am able to use educational platforms, (WebCt, campus online, intranet, Moodle, Dokeos, etc).	1350	1135	1575
X40. I can browse the Internet using different browsers (Mozilla, Opera, Explorer, etc.).	1023	1022	1856
X41. I am able to use different search engines (Google, ixquick, mashpedia, etc.).	1042	1311	1744
X42. I feel able to work with some digital mapping programs to search for places (Google Maps, Google Earth, vpike, tagzania, etc.).	1074	1675	1230
X43. I know how to use programs to plan my study time (Google calendar …).	1296	1740	1071
X44. I work with documents on internet (Google Drive, Zoho, OneDrive …).	1133	1726	1174
X45. I am able to organize, analyze, and synthesize information using conceptual maps using some social software tools (cmaptool, mindomo, text2mindmap, bubbl …).	1503	1532	1005
X46. I can use programs to broadcast interactive presentations on internet (Issuu, Prezi, SlideShare, Scribd, etc.).	1599	1467	1020
X47. I feel competent to work with social software tools that help me analyze and/or browse content included in blogs (Tagul, Tagxedo, …)	1783	1241	1055
X48. I work with images by using tools and/or social software applications (Gloster, Picmonkey, Canva, Animoto …).	1796	1171	1116
X49. I feel able to use podcasting and videocasts (Youtube, Vimeo, etc.)	1632	1201	1187
X50. I use QR codes to disseminate information.	1728	1010	1077

As can be seen, three factors have been grouped. A first factor was represented by the items from X46 to X50 and this groups the items under a conceptual classification that we could call: "Audiovisual Creation Competence".

Factor 1. "Competence in the creation of audiovisual content."

X46. I can use programs to broadcast interactive presentations on the internet (Issuu, Prezi, SlideShare, Scribd, etc.).

X47. I feel competent to work with social software tools that help me analyze and/or browse content included in blogs (Tagul, Tagxedo, etc.)

X48. I work with images by using tools and/or social software applications (Gloster, Picmonkey, Canva, Animoto, etc.).

X49. I feel able to use podcasting and videocasts (Youtube, Vimeo, etc.)

X50. I use QR codes to disseminate information.

Under these items, we grouped actions that can be used to organize and create audiovisual content, which is one of the fundamental competence areas in area 3 of DigComp 2.1 ("Digital content creation") and, in particular, in sub-competence areas 3.1 ("3.1 Development of content") and 3.2 ("Integration and re-elaboration of digital content"), of the document mentioned above for digital content development and re-elaboration digital content skills. For a second factor, four items (from X42 to X45) are integrated and we used the tag: "Competence in digital communication and social collaboration."

Factor 2. "Competence in digital organization and planning".

X42. I feel able to use some digital mapping programs to search for places (Google Maps, Google Earth, vpike, tagzania, etc.).

X43. I know how to use programs to plan my study time (Google Calendar, etc.).

X44. I work with documents on the internet (Google Drive, Zoho, OneDrive, etc.).

X45. I am able to organize, analyze and synthesize information involving conceptual maps using some social software tools (cmaptool, mindomo, text2mindmap, bubbl, etc.).

These four items address competences in the organization, planning, and synthesis of digital content. These skills also correlate with Area 1 of DigComp 2.1 ("Competence Area 1: Information and Digital Literacy"), specifically with sub-competences: 1.1 "Browse, search, and filter data, information, and digital content" and 1.3 "Management of data, information, and digital content". Finally, we can see a third factor that is represented by the items X39, X40, and X41. These items refer to the ability of students to use different ways to locate information in different formats, writings, and audiovisuals, as well as the ability to organize information and time using digital resources. The name of this factor is: "Competence in localization, filtering, and management of digital information".

Factor 3. "Competence in localization, filtering, and management of digital information".

X39. I am able to use educational platforms (WebCt, campus online, intranet, Moodle, Dokeos, etc).

X40. I can browse the Internet with different browsers (Mozilla, Opera, Explorer, etc.).

X41. I am able to use different search engines (Google, ixquick, mashpedia, etc.).

This factor is also associated with the competence area 2 "Online Communication and Collaboration" of DigComp, and especially with sub-competence 2.1 ("Interact through digital technologies"). Students who have these competencies are able to employ different platforms, use search engines, and perform efficient navigation on a network. We then analyzed the different factors associated with interpersonal competencies in the use of ICT of university students. We achieved this by analyzing mining texts for possible differences between universities, and kept the age and gender of the students in mind. We did this to determine the nodes that are most decisive in the adoption of the different competencies and factors analyzed previously. A model was proposed that included all items related to interpersonal competencies plus age and gender. The representation of subsidiary nodes was limited to 100 and the parent nodes were limited to 50. The model obtained included the variable age as a key variable along with the following variables:

X39. I am able to use educational platforms (WebCt, campus online, intranet, Moodle, Dokeos, etc.).

X41. I am able to use different search engines (Google, ixquick, mashpedia, etc.).

X44. I work with documents on the internet (Google Drive, Zoho, OneDrive . . .).

X46. I can use programs to broadcast interactive presentations on the internet (Issuu, Prezi, SlideShare, Scribd, etc.).

X48. I work with images by using tools and/or social software applications (Gloster, Picmonkey, Canva, Animoto, etc.).

X50. I use QR codes to disseminate information.

The model was generated with 20 nodes using the CHAID growth method, of which 14 nodes were terminal. The risk estimate of the model was 0.274 and the typical error was 0.012. This model allows us to more clearly identify the differences between universities and the age of the participants. In Table 4, we present the predicted percentage of personal competences, where we can observe that the total is 72.6%. It is noted that the UPO and UNED show higher correct percentage results than the UCM.

Table 4. Classification of the model.

Universities	Predicted			
	UPO	**UNED**	**UCM**	**Correct Percentage**
UPO	604	93	62	79.6%
UNED	40	283	0	87.6%
UCM	159	55	194	47.5%
Overall percentage	539	289	172	72.6%

Below, in Table 5 and Figure 2, we present the results of the generated tree.

Table 5. Tree results.

Tree Table															
Node	UPO		UNED		UCM		Total		Cat. Pron.	Parent Node	Primary Independent Variable				
	N	%	N	%	N	%	N	%			V.	Sig. [a]	Chi-Square	Gl	Seg. Values
0	759	509	323	217	408	274	1490	1000%	UPO						
1	427	587	0	0%	300	413	727	488%	UPO	0	Age	.000	804.899	8	< = 19.0
2	91	664	1	7%	45	328	137	92%	UPO	0	Age	.000	804.899	8	(19.0. 20.0]
3	72	190	251	664	55	146	378	254%	UNED	0	Age	.000	804.899	8	(20.0. 21.0]
4	85	810	12	114	8	76%	105	70%	UPO	0	Age	.000	804.899	8	(21.0. 23.0]
5	84	587	59	413	0	0	143	96%	UPO	0	Age	.000	804.899	8	>23.0
6	6	100	0	0	54	900	60	40%	UCM	1	X50	.000	200.763	2	4.0
7	56	286	0	0	140	714	196	132%	UCM	1	X50	.000	200.763	2	2.0; 3.0
8	365	775	0	0	106	225	471	316%	UPO	1	X50	.000	200.763	2	5.0; 1.0
9	3	55	51	927	1	18	55	37%	UNED	3	X46	.000	59.524	4	5.0
10	45	212	113	533	54	255	212	142%	UNED	3	X46	.000	59.524	4	4.0; 3.0; 2.0
11	24	216	87	784	0	0%	111	74%	UNED	3	X46	.000	59.524	4	1.0
12	21	396	32	604	0	0%	53	36%	UNED	5	X39	.005	12.701	1	4.0
13	63	700	27	300	0	0%	90	60%	UPO	5	X39	.005	12.701	1	3.0; 2.0; 5.0; 1.0
14	7	96	0	0%	66	904	73	49%	UCM	7	X48	.000	20.539	1	3.0
15	49	398	0	0%	74	602	123	83%	UCM	7	X48	.000	20.539	1	4.0; 2.0; 1.0; 5.0
16	112	552	0	0%	91	448	203	136%	UPO	8	X44	.000	103.260	2	4.0
17	195	929	0	0%	15	71%	210	141%	UPO	8	X44	.000	103.260	2	2.0; 3.0
18	58	1000	0	0%	0	0%	58	39%	UPO	8	X44	.000	103.260	2	5.0; 1.0
19	18	134	63	470	53	396	134	90%	UNED	10	X41	.000	41.471	2	3.0; 2.0
20	27	346	50	641	1	13%	78	52%	UNED	10	X41	.000	41.471	2	4.0; 1.0

Growth methods: CHAID. Dependent variable: interpersonal competences in the use of ICT in the university context

[a]. With a Bonferroni correction.

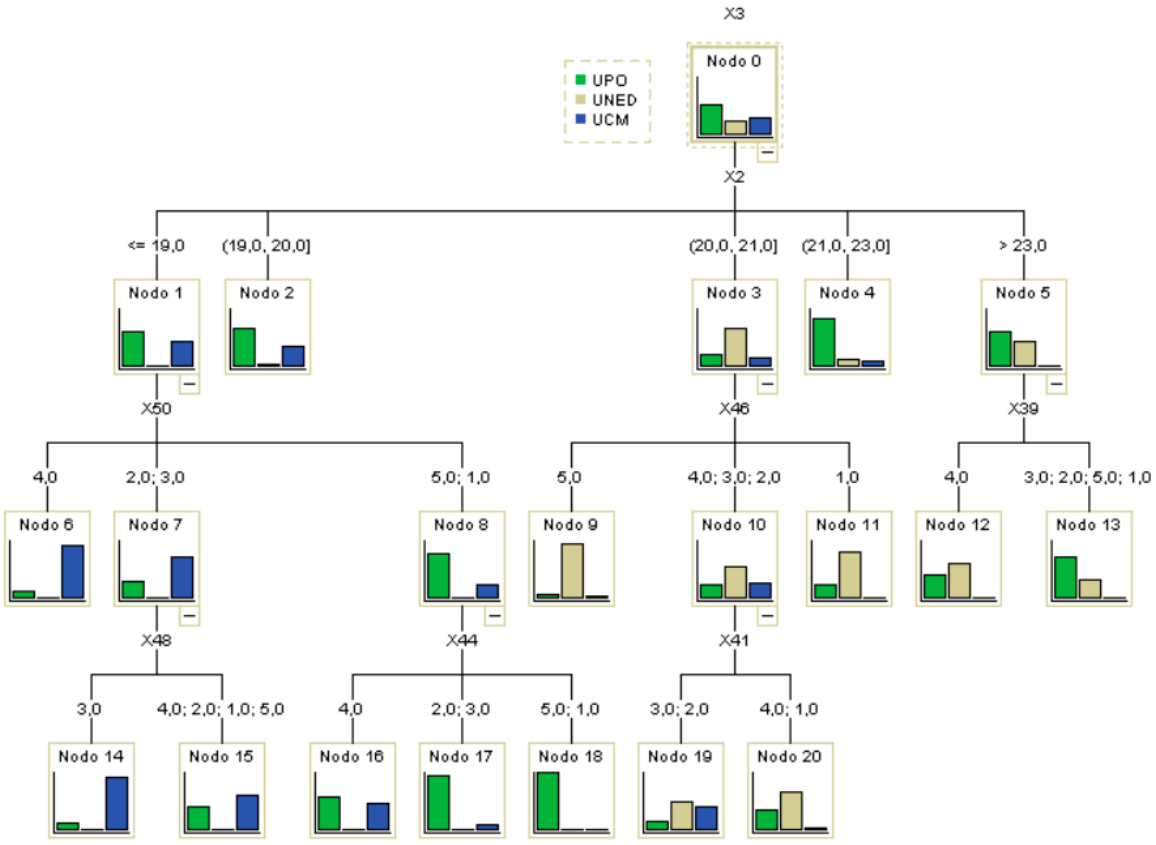

Figure 2. College Student Interpersonal Skills Tree (UPO, UCM, UNED).

As we can see in Table 5, 20 nodes were generated, 14 of them were terminal and 10 were parental. The six variables that have entered the model were all significant. Age ranges are a variable that is meaningful for all universities and generated the parent node 0 from which the remaining inferences occur. Meanwhile, the variable "X50. I use QR codes to disseminate information" was significant in UPO and UCM and not in UNED. The variable "X46. I can use programs to broadcast interactive presentations on the internet (Issuu, Prezi, SlideShare, Scribd, etc.)", it was significant exclusively in UNED. The variable "X39. I am able to use educational platforms, (WebCt, campus online, intranet, Moodle, Dokeos, etc.), was not significant in UCM. The variable "X48. I work with images by using tools and/or social software applications (Gloster, Picmonkey, Canva, Animoto . . . ") was only significant in the UCM. Finally, The variables: "X44. I work with documents on the network (Google Drive, Zoho, OneDrive, etc.)" and "X41. I am able to use different search engines (Google, ixquick, mashpedia, etc.) were only significant in the UPO and UNED, respectively. The interpretation of this data and its meaning depending on the age range of the students and the participating universities are displayed more graphically in Figure 2.

We can see how the central node is age, a determining variable in the adoption and assessment of interpersonal competences in the use of ICTs in the university context. In this context, students over 23 years old and belonging to UNED achieved better results in the use of educational platforms, ("X39 WebCt, campus online, intranet, Moodle, Dokeos, etc."), with 60.4% being comfortable using them, while in the UPO the result was 60.4% and in the UCM it was 0% (Node 12). We also note that students between 20 and 21 years old in UNED were the most competent based on variable 46 (53.3% at their maximum value 4): "X46 I can use programs to broadcast interactive presentations on internet (Issuu, Prezi, SlideShare, Scribd, etc.)", while the results for UPO and UCM did not exceed 25% (Node 10).

With regard to the variable X50 "I use QR codes to disseminate information", we note that students under the age of 19 and belonging to the UCM were the most competent (Node 6). In this sense, UCM students also have greater perceived ability in the variable X48 "Working with images by using tools and/or social software applications (Gloster, Picmonkey, Canva, Animoto . . .) (Nodes 14 and 15). The variable X44 "I work with documents on the internet (Google Drive, Zoho, OneDrive . . .)" showed higher results in UPO (55.2%) and at UCM (44.8%) than at UNED. In this context, Gutiérrez-Porlán et al. [42] indicate that Google Drive is the most important tool for students to carry out group projects, followed by social network tools. And finally, in the variable X41 "I am able to use different search engines (Google, ixquick, mashpedia, etc.)" the most competent students are those of the UPO and UCM (Nodes 19 and 20).

These results show that the most significant university students' digital competences involve communicating with other people, following their activities, and using social networks through mobile devices, aspects that were already considered in previous research [43–45] as indicators of a good level of digital competence. In this sense, the frequency of use of technological devices on a personal and academic level is positively linked to technological competences [46]. Also, according to other studies [42,47], the results show that students use social networks regularly. Likewise, students have good adaptability to new situations and ideas. They are also able to achieve acceptable self-regulated learning quotas, together with valuable interpersonal and group work competences. These results substantially coincide with other investigations [3,37,48,49]. In addition, by teaching UNED students to use educational platforms for interpersonal competence through ICT, teachers can allow them to exercise social skills, which are essential for their professional future [50] and skills such as management of information and content creation, which have an impact on training for future employment [51].

On the other hand, regarding the work of documents on the network, students showed high skills with the use of different web search engines related to access, understanding, and creation of digital content [52]. The three factors of this study, including competence in the creation of audiovisual content, competence in digital organization, and planning and competence in localization, filtering, and management of digital information, are necessary competencies for university students in their future employment, as has been discussed separately in different research on digital competence [51–53].

Additionally, it can be seen that the digital competence of future teachers and students is acquiring added value in education due to the technological nature of society [54–57].

5. Conclusions

Digital competence is one of the basic competences of citizenship in the 21st century and is also one of the general competences of all Spanish universities [47]. In recent decades, the daily use of ICT has changed literacy practices in our society and education [58,59], in general, and in undergraduate students in particular [60,61]. The results of this study show that university students have higher competences in communicating with other people through interactive presentations and video-images, in collaborating, and in working with documents on the network through mobile devices. Furthermore, training, research, and technological innovation are the main axes for the improvement of the quality and competitiveness of a country, in addition to the sustainable development of citizenship. In this context, universities must adopt their training processes, taking into account, among other aspects, the characteristics and current needs of the students, facilitating the incorporation of flexible scenarios for training awareness of their training process in the acquisition of competencies and capacities, as well as the informational and digital strategies that allow them to develop processes of search and treatment of relevant and updated information related to their field of study. In this sense, there is a need for current university institutions to establish appropriate conditions to foster more student-centered learning, using innovative teaching methods, critical training, and active citizens, who are willing to provide their knowledge for social service. Finally, we believe that universities must play a new role as promoters of competences that the future graduates must handle in their academic, personal, and professional development [62,63]. Universities should redesign their training matrices to incorporate professional competences in a way that fosters the development of didactic proposals that involve collaborative work for the promotion of meaningful socio-digital learning. In this sense, as Linda Daniela establishes [64], the technological brings about a transformation of the educational environment which happens faster that the literature can offer solutions, and the focus therefore should be in the role of pedagogy. Finally, for fostering competencies, as Spector [65] proposes, we require the smartness in the design of learning environments: effectiveness, efficiency, engagement, flexibility, and reflectiveness.

6. Limitations

This study uses a non-probabilistic sample linked to the field of Spanish University students in three universities. This aspect should be taken into account as a limitation for future inferences of the teaching instrument with other larger samples and with degrees from other international fields.

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