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Multivariate characterization of university students using the ICT for learning



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ABSTRACT

The new European training model has led to innovations in Higher Education as the incorporation of Information and Communication Technology (ICT) to learning processes. Each student learns in a different way and therefore the ways of studying are very relevant in the academic development. This fact has revealed the need for the use of ICT in the university environment. It has been a quantitative research using the questionnaire REATIC using a sample (N = 2117) of students from the five areas of knowledge at the University of Salamanca, to know the use and opinion they have about ICT in their learning. The results presented students management above all basic and personal interrelation programs, search engines in the network, online video portals and virtual libraries. They value the help and importance of ICT in their learning process and consider positively them as relevant tools. The results showed significant differences in the use and consideration of ICT in the five areas of knowledge. Health Sciences students present the highest preference level in use of ICT. Four well-differentiated clusters were identified by applying the factor analysis to obtain a multivariate characterization of the students: One was formed by students with a medium-low level of ICT consideration and use, another by the graduates with a high level of ICT consideration and use, to a third consisting of students with a medium-high level of ICT consideration and use and to final covering students with low level of ICT consideration and medium-low level of ICT use.

1. Introduction

In the last few years, there have been many changes in the European Universities, whose trigger was the Bologna Treaty (1999). According to the Ministry of Education, the new European training model focuses on achieving effective learning on the part of the student, encouraging self-learning.

The changes that the European Higher Education Area has introduced in the universities imply new conceptions in the teaching and learning, as well as new educational resources. One of these resources are ICT (Information and Communication Technologies), whose inclusion in the higher education classrooms is demanding a change of mentality in both teachers and students (Esteve, 2009).

According to the study by Cobo (2009), ICT are defined as: “Technological devices (hardware and software) that allow to edit, produce, store, exchange and transmit data between different information systems that have common protocols. These applications, which integrate computer media, telecommunications and networks, enable both interpersonal (person to person) and

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multidirectional (one to many or many to many) communication and collaboration. These tools play a substantive role in the generation, exchange, diffusion, management and access to knowledge”.

Information and communication technologies are becoming increasingly important and relevant in all areas of social life, but particularly in education. This has allowed students a channel of communication that has changed the way to learn. Thus, in the pedagogical field, ICT, as Cabero points out, are becoming a key element, finding us difficult formative actions that are not supported by different technological means (Cabero, 2007; Cabero-Almenara et al., 2010).

The incorporation of ICT produces the so-called educational innovation; in other words, it integrates new developments that produce changes to improve the learning process. In this way we try to reduce the time spent by students in passing a subject, acquiring knowledge, skills and new abilities (Bhuasiri, Xaymoungkhoun, Zo, Rho, & Ciganek, 2012; Bono, Arnau, & Blanca, 2006; Fidalgo, 2007).

According to Yazon, Mayer-Smith, and Redfield (2002), the interesting thing about ICT is how they should be used in university education and to what extent they transform teaching experience. Some examples of this influence are the study carried out by Prendes-Espinosa, Castañeda-Quintero, and Gutiérrez-Portlán (2010) that analyses competences for the use of ICT in future teachers, or the development of questionnaires such as that formed for teachers by Fernández, Fernández, and Cebreiro (2016). The research realized by Lareki, Martínez, and Amenabar (2010) provided results about the necessary training in ICT that the faculty requires for their teaching as well as for conducting research.

Spanish universities use 85% of ICT support services for teaching, incorporating virtual teaching, software licenses necessary for teaching, computer or multimedia classrooms, support for the elaboration of teaching material or support for the performance and correction of exams, according to the UNIVERSITIC report of 2015 (Píriz, 2015). In addition, the 64 universities participating in this dossier make available to students and teachers adequate services for a better learning as ICT support for research and management, web publications and digital content, user support, communications services or identity management.

ICT has had an impact on education by producing a series of transformations within it (Escudero, 2001). Therefore, for Maroto ICT contribute to improving student autonomy (Maroto, 2007). In addition, they allow the creation of learning environments much more flexible than those that traditional education made possible through the creation of Virtual Learning Environments (VLE). We understand as a Virtual Platform according to De Pablos (2009) “a space or environment created with the intention of a student to obtain learning experiences through resources and training materials under supervision and interaction with a teacher”.

As Muñoz-Miralles et al. (2016) indicate the development of ICT has generated numerous benefits as new ways of communication, work and learning. Specifically, for universities, they are very useful tools to offer a complete and effective training to students who in the near future will become professional experts. In addition, the application of ICT motivates students and captures their attention, thus becoming one of the learning engines according to experts as Ferro, Martínez, and Otero (2009).

Each student learns differently and therefore the ways of studying are very important in the academic development. Students are surrounded of technology so they use a great variety of it in their learning. For this reason, the interest in how students learn together with their use of ICT has grown in the educational community and is reflected in research such as those of Orellana, Bo, Belloch, and Aliaga (2010) or Echeverría (2014).

García-Valcárcel, Hernández, and Recamán (2012) explain the possession of technological competences for professional performance it is a social demand that must be attended to in the initial training process of the graduates and because of that, the technologies must be used as a resource that allows a better adaptation to different types of students.

There are numerous virtual tools that students use to carry out the educational process, for example, university students usually communicate via email, form work teams online or receive information through video conferencing. But all ICT tools present great advantages and provide many qualities like promote relationships among students, increase motivation and self-esteem, develop interpersonal skills and strategies to resolve conflicts, promote values such as respect, tolerance or flexibility, sharing responsibilities, etc. (García-Valcárcel et al., 2012).

The students' opinion on ICT is important because it influences their use, which affects their academic and professional success. Although a positive assessment of ICT elements does not always imply the use of them in their learning process.

According to the current Bologna process, all studies are grouped by five areas of knowledge, which are great fields of knowledge whose identity is a set of matters that are the essence of each branch. It is necessary to appreciate the particular ways of learning in each area that students have and their experiences in the use of ICT, given the influence in academic life.

The present study had three main objectives: (1) to determine the students' use and opinion of ICT by areas of knowledge, (2) to identify preferences regarding the use and consider of ICT by areas of knowledge, and (3) to characterize university students according to the consideration of ICT they use.

2. Material and methods

2.1. Research design

This study developed at the University of Salamanca, collecting information from students enrolled in the 2013–2014 academic year. A multistage sampling was carried out, making a probabilistic sampling stratified according to the proportion of university students in the different branches of knowledge in the first stage of this process, and in the second stage, simple random sampling within each stratum. For the data collection, it was used the survey methodology, through the USAL platform called Studium and through personal surveys.

The Studium Virtual Campus consists of a support service for teaching at the University of Salamanca for the use of all members of the same. It ensured confidentiality of participants' data in addition to anonymity.

2.2. Participants

This research was carried out with the answers collected to 2117 students belonging to the University of Salamanca. The sample consists mainly of women (63.1%). The five branches of knowledge defined by this university were considered, 10.4% of the participating university correspond to the branch of Arts and Humanities, 11.9% to Science, 17.1% to Engineering and Architecture, 25.6% to Health Sciences and 35.0% to the branch of Social and Legal Sciences. Most of the university students were enrolled in the first two courses of their degrees (34.9% of first, 35.2% of second, 18.6% of third and 11.3% of rest). 48.9% are between 18 and 19 years old, 26.1% between 20 and 21 years old, 14.6% between 22 and 23 years old, and 10.4% are older than 24 years old.

2.3. Instruments

The REATIC questionnaire (De Moya Martínez, Hernández Bravo, Hernández Bravo, & Cózar Gutiérrez, 2011) was used to measure the relationship between learning styles and ICT in university student education. It is a test with 60 items that the subjects must value by a Likert scale of 1 (Nothing) to 4 (Much). The items are distributed in four blocks: The first refers to the knowledge about ICT (called "Know") formed by items 1 to 14, the second group of items have to do with the use of ICTs (Referred to as "Use") comprises from items 15 to 28, the third block refers to students' considerations about ICT (called "I consider ICT") consisting of items from 29 to 44, and the fourth is the one that studies the relation between the learning styles and the ICT in the formation of the student (denominated "Use of the ICT according to the style of learning") composed by the items of 45–60 and grouped in 4 subgroups depending on the style (active, reflective, theoretical and pragmatic).

The items following the classification of Alonso, Gallego, and Honey (1994) are grouped as follows: items 47, 53, 55 and 58 are related to the active style; 48, 52, 56 and 59 linked to the reflexive style; Items 46, 49, 57, and 60 belong to the theoretical style and 45, 50, 51 and 54 with the pragmatic style.

2.4. Process

It was made a descriptive analysis of the items to know the use and opinion of ICT of university students. Students were classified according to the level of use and consider of ICT taking into account each of the areas of knowledge through the methodology of Alonso, Gallego, and Honey, (1995). The distribution of use and opinion according to branches of knowledge was analysed, and an analysis of the variance was performed to search for statistically significant differences. Finally, a Factor Analysis (FA) with principal components analysis and varimax rotation was carried out, from whose coordinates the conglomerates were calculated by means of an analysis of K-mean conglomerates. To perform the analyses was used the statistical package IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

3. Results

3.1. To determine the students' use and opinion of ICT by areas of knowledge

In terms of use of ICT, the predominant answers of the students were in the items "Basic programs such as word processor, spreadsheet, slide presentation", "Programs of personal interrelation", "Search engines in the network", "Online video portals", "Virtual libraries and encyclopedias" and "Some web browsers", obtaining scores high, over 50% (*Enough* and *Much*), in the five branches of knowledge. In the rest of the areas, some or all answers were negative (*Nothing* and *Something*).

Arts and Humanities students highlighted in utilize basic programs (Word, Excel, etc.), programs of personal interrelation (e.g. messenger, email or Facebook), search engines in the network (like Google or Yahoo), online translators (e.g. elmundo.es), online video portals (like YouTube) and virtual libraries and encyclopedias (e.g. Wikipedia or Encarta). The use of educational portals was highlighted in Science students, the employment of search engines in the network (e.g. Google) and some web browsers (e.g. WebQuest or Hunt treasure) were highlighted in Health Sciences students, and the application of image, video, audio editing programs (like Paint, Photoshop, Windows Media Maker, etc.) and multimedia devices (e.g. Pc, projector, Scanner or Webcam) in Engineering and Architecture students.

Regarding the opinion that students have of ICT, the positive scores were obtained in the items "They are an important element in my academic training", "They help me in my learning process", "They are important for their educational application", "They help me improve my academic results", "They are a means to foster personal relationships between my classmates", "They are a support to complete my academic and formative knowledge", "They are essential in today's society", "They are an aid to look for information, "They are a useful tool for preparing work" and "They serve me to occupy my leisure and free time" in the five areas of knowledge, surpassing in all cases 59% (*Enough* and *Much*). In the rest of the branches, the answers were negative (*Nothing* and *Something*).

Arts and Humanities students think that ICT help them in the learning process, they are important for their educational application, they are a means to foster personal relationships between my classmates, they are a support to complete my academic and formative knowledge, and they serve me to occupy my leisure and free time. ICT are considered an important element in the

Table 1
Items with high percentages (*Enough* and *Much*) greater than 50%.

Item	Arts and Humanities	Science	Health Sciences	Social and Legal Sciences	Engineering and Architecture
Use					
- Basic programs such as word processor, spreadsheet, slide presentation.	88.2	71.3	72.7	80.9	87.0
- Programs of personal interrelation.	89.1	84.5	82.8	84.0	77.9
- Educational portals.	62.7	67.7	62.5		63.8
- Image, video, audio editing programs.					53.3
- Search engines in the network.	95.9	94.4	95.9	93.1	88.7
- Online translators.	61.4	51.0		53.8	51.4
- Online video portals.	86.4	82.5	80.3	79.9	74.0
- Virtual libraries and encyclopedias.	86.8	80.9	72.7	70.6	71.8
- Some web browsers.	83.2	80.9	83.6	80.6	76.8
- Multimedia devices.	60.9	57.0		50.9	64.6
Consider					
- They are an important element in my academic training.	82.3	80.5	84.9	82.6	79.3
- They help me in my learning process.	81.8	77.7	78.8	80.2	79.6
- They are important for their educational application.	80.5	73.3	78.8	77.1	80.1
- They help me improve my academic results.	70.5	61.4	60.0	68.5	73.8
- They are a means to foster personal relationships between my classmates.	64.5	59.4	59.8	62.7	63.0
- They are a support to complete my academic and formative knowledge.	82.7	74.1	79.9	78.4	77.9
- They are essential in today's society.	73.6	83.3	85.4	82.6	68.8
- They are an aid to look for information.	92.3	92.0	94.5	89.9	81.2
- They are a useful tool for preparing work.	90.0	90.0	93.4	89.2	78.7
- They serve me to occupy my leisure and free time.	72.7	69.3	59.4	70.5	68.0

Bold indicates the highest or most prominent percentages.

academic training, essential in today's society, an aid to look for information and a useful tool for preparing work in Health Sciences students. The item "They help me improve my academic results" was high score in Engineering and Architecture students. (Table 1).

3.2. Identify preferences regarding the use and consider of ICT by areas of knowledge

The descriptive statistics were calculated for the total scores of the use and consider of the ICT in the learning of university students. The average score corresponding to use was $M = 36.37$, $SE = .12$, and in consider of ICT was $M = 43.39$, $SE = .12$.

Table 2 shows the averages obtained in each of the use and consider per branch of knowledge. It highlights the fact that in all areas the opinion or consider is greater than use of ICT. Arts and Humanities students have the highest scores in use and consider of ICT. The results obtained show significant differences (p -value $< .001$).

To perform the frequency preference analysis of students' use and opinion of ICT in their learning process (Table 3), a scale has been constructed to interpret the results obtained through the REATIC questionnaire items. Students were divided into groups according to the tertiles of the sum of the scores of the fourteen items corresponding to use and of the sixteen items to consider ICT. We emphasize that the ICT use percentage of low preference is greater in Art and Humanities and the ICT consideration percentage of low preference is greater in Art and Humanities and Engineering and Architecture. The moderate level consideration of ICT shows the highest percentages in Science, Health Sciences and Social and Legal Sciences areas. The highest percentage with a high preference level in use of ICT corresponds to the Health Sciences (39.9%).

Table 2
Profile of use and consider differentiated by branches of knowledge.

	Use	Consider
	Mean \pm SE	Mean \pm SE
Arts and Humanities	38.18 \pm .36	44.26 \pm .42
Science	35.99 \pm .32	43.16 \pm .35
Health Sciences	35.12 \pm .22	42.37 \pm .22
Social and Legal Sciences	36.28 \pm .23	43.70 \pm .22
Engineering and Architecture	37.61 \pm .30	43.93 \pm .29
p -value	$< .001$	$< .001$

Note. SE = Standard error.

Table 3
Frequency of use and consider of ICT by areas of knowledge.

	Levels	Use		Consider	
		n	%	n	%
Arts and Humanities	Low	1106	52.2	897	42.4
	Moderate	538	25.4	740	35.0
	High	473	22.3	480	22.7
Science	Low	793	37.5	751	35.5
	Moderate	624	29.5	764	36.1
	High	700	33.1	602	28.4
Health Sciences	Low	635	30.0	615	29.1
	Moderate	637	30.1	752	35.5
	High	845	39.9	750	35.4
Social and Legal Sciences	Low	793	37.5	751	35.5
	Moderate	624	29.5	764	36.1
	High	700	33.1	602	28.4
Engineering and Architecture	Low	950	44.9	897	42.4
	Moderate	588	27.8	618	29.2
	High	579	27.4	602	28.4

Bold indicates the highest or most prominent percentages.

3.3. Multivariate profile of Salamanca university students to the use of ICT according to consideration

In the analysis of Principal Components, it was obtained that the first three components explained 49.14% (CP1 = 27.75%, CP2 = 12.93% and CP3 = 8.46). The rotated component matrix presents the estimates of correlations between each of the variables and the estimated components with the items ordered according to these scores and loads greater than .300.

The first component refers to the items that value the help and importance of ICT, the second component groups the items related to the consideration of ICT as tools for an end, and the third component refers to the items of negative valuation of the ICT (see Table 4).

From the coordinates obtained from the analysis of principal components with three factors, it was performed a cluster analysis. For the selection of the conglomerate type, has been applied a hierarchical cluster and the solution has been refined by the non-hierarchical K-means method and as a measure of the Euclidean distance. The means obtained from the first component in each conglomerate generated are -0.90 , 0.79 , 0.39 , -0.50 , of the second component respective to 0.83 , 0.48 , -0.79 , -0.93 and of the third component correspond to 0.26 , -0.44 , 1.35 , -0.57 respectively from the first to the fourth.

It observed significant differences among conglomerates or cluster:

The conglomerate 1 consists of 506 students who have scores below the total averages in the ICT uses and considerations.

Table 4
Rotated factor matrix of the ICT consideration.

	Component 1	Component 2	Component 3
- They help me improve my academic results.	.805		
- They help me in my learning process.	.785		
- They are important for their educational application.	.761		
- They are an important element in my academic education.	.727		
- They are a support to complete my academic and formative knowledge.	.711		
- They are a means to foster personal relationships among my classmates.	.443		
- They are an aid to look for information.	.310	.735	
- They are a useful tool for the preparation of works.		.730	
- They are essential in today's society.		.667	
- They serve me to occupy my leisure and free time.		.566	
- They hurt me more than they help me in my academic training.			.668
- They do not offer me enough security in my privacy.			.662
- They are not fully reliable in the information they provide.			.569
- They make me lose a lot of time.			.568
- They are difficult to understand and use.		-.368	.520
- They do not substitute traditional educational resources.			.430

Considering the global preference levels of ICT consideration, students in this group present a medium and low preference level (44.7% and 37.0%). According to the levels of global preference for the use of ICT, these students have a low level for use of ICT (52.0%).

This cluster mainly uses the search engines in the network such as Google or Yahoo. Arts and Humanities students usually use virtual libraries and encyclopedias (e.g. Wikipedia or Encarta) ($M = 3.37$, $SE = .10$). The use of personal interrelation programs (messenger, email, Facebook, etc.) ($M = 3.54$, $SE = .09$ and $M = 3.43$, $SE = .05$) makes the students who constitute the branch of Arts and Humanities and Social and Legal Sciences, but Arts and Humanities students and future engineers or architects like to apply online video portals as YouTube ($M = 3.39$, $SE = .11$ and $M = 3.35$, $SE = .12$).

Cluster 2 has the highest percentage of students ($n = 731$). They present values above the average of the total scores referring to the use and consideration of ICT, so they think ICT are really important and they usually apply different tools in their learning process. Students' global preference levels of ICT consideration and use are high with distribution percentages of 49.9% and 44.9%. University students from the five knowledge areas belonging to this group use personal interrelation programs, search engines in the network, online video portals and some web browsers such as Explorer, Mozilla or Firefox. Arts and Humanities, Social and Legal Sciences and Engineering and Architecture students especially use the basic programs (word processors, spreadsheets, slide shows, etc.) ($M = 3.74$, $SE = .05$, $M = 3.55$, $SE = .04$ and $M = 3.50$, $SE = .06$), but Arts and Humanities students use virtual libraries ($M = 3.57$, $SE = .07$).

Cluster 3 corresponds to university students ($n = 358$) who exceed the average of the total scores in each of the ICT uses and considerations. Observing the overall preference levels of ICT consideration, students in this cluster have medium and high levels (46.9% and 40.2%) and for use of ICT have high level (47.5%). Students of this group essentially manage globally search engines in the network (Google, Yahoo, etc.). University students of Arts and Humanities, Science, Health Sciences and Social and Legal Sciences usually use search engines in the network ($M = 3.63$, $SE = .12$, $M = 3.31$, $SE = .14$, $M = 3.70$, $SE = .10$ and $M = 3.45$, $SE = .07$) and online video portals like YouTube ($M = 3.40$, $SE = .11$, $M = 3.31$, $SE = .14$, $M = 3.33$, $SE = .13$ and $M = 3.33$, $SE = .07$). In Arts and Humanities, Health Sciences and Engineering and Architecture areas the students put to use basic programs such as word processor, spreadsheet or slide presentation ($M = 3.35$, $SE = .11$, $M = 3.30$, $SE = .15$ and $M = 3.31$, $SE = .06$), but in Arts and Humanities and Social and Legal Sciences areas the pupils manage the personal interrelation programs (Messenger, e-mail, Tuenti, Facebook, etc.) ($M = 3.35$, $SE = .14$ and $M = 3.31$, $SE = .07$). Students of Arts and Humanities are distinguished by using quite some web browsers such as Explorer, Mozilla, Fire Fox or Netscape ($M = 3.60$, $SE = .10$).

Cluster 4 consists of 522 students who have scores below the total averages ICT uses and considerations. Through the global preference levels of ICT consideration and use, students present low levels (89.8% and 55.6%). Universities belonging to all areas of knowledge stand out for applying the search engines in the network such as Google especially in Arts and Humanities, Science and Health Sciences ($M = 3.44$, $SE = .10$, $M = 3.37$, $SE = .08$ and $M = 3.41$, $SE = .05$).

4. Discussion and conclusions

The results of this study show that students of the University of Salamanca mainly use basic and personal interrelation programs, management search engines in the network, online video portals, virtual libraries and some web browsers. They consider ICT are a very important help tool in their learning process and they value positively it. Nevertheless, there are significant differences in the areas of knowledge. Science students distinguished by use educational portals, Health Science university students by search engines in the network, manipulate some web browsers and consider ICT such as an important element in their academic training, essential in today's society, useful tool for preparing work and looking for information, Engineering and Architecture students are characterized by using online video portals, multimedia devices and thinking ICT help them improve their academic results, and Art and Humanities students are denoted by employment basic and personal interrelation programs, blogs or chats, online translators and video portals, virtual libraries and considering ICT help and are important in their education, a means to foster personal relationships in class and a useful tool for preparing work. Students belonging Health Science area present high preference level in use of ICT while the rest of pupils linked Art and Humanities, Science, Social and Legal Sciences and Engineering and Architecture areas show low preference level in use of ICT. Science, Health Science and Social and Legal Sciences students indicate medium preference level in consideration of ICT whereas Art and Humanities and Engineering and Architecture present low preference level in consideration of them.

In addition, our study identifies four well-differentiated clusters of university students by using FA to obtain a multivariate characterization of these students:

- The first cluster was comprised students who have a medium-low level of ICT consideration and use.
- The second cluster encompassed university students who have a high level of ICT consideration and use.
- The third cluster was composed students who have a medium-high level of ICT consideration and use.
- And the fourth cluster contained students with low level of ICT consideration and medium-low level of ICT use.

These results agree with previous studies suggesting that the use of basic programs, personal interrelationship programs and search engines in the network by students are the main uses of ICT (De Moya Martínez et al., 2011). The results obtained by Berrío-Zapata and Rojas-Hernández (2014) in their research on the university digital divide in Bogotá (Colombia) concluded that university students used ICT but, given their training and education, did not appropriate their productive possibilities beyond basic or recreational uses, and were similar to those found in our study in which we have found a conglomerate globally characterized by students using basic computer programs such as Word, Excel and PowerPoint, personal interrelation programs, search engines in the

network, online video portals and some web browsers (cluster 2).

The study performed by García-Valcárcel et al. (2012) identified the opinions of professors and students in Faculty of Education of Salamanca's University in relation to collaborative learning through ICT and to know their practices on learning with ICT. They concluded that 50% of students have used ICT in the proposed tasks and students fundamentally use search for resources on the Internet consistent with these results are similar to those found in our study.

These results are in line studies carried out by Morales, Trujillo, and Raso (2015) who investigated the assessment of Faculty of Educational Sciences students of Granada's University on the importance of ICT in teaching-learning processes, concluding the students show a positive opinion towards ICT and their agreement to the need to use ICT in the learning process like in our study.

In summary, the results found in this study are novel, few researches have focused on the students' use and opinion about ICT by different areas of knowledge with many degrees, although being part of groups with their own traits is a very relevant aspect. Further, this research analyses on the one hand the use of ICT in students and on the other the opinion they have of them, which brings much more information about university students. Besides, another strength of our study is the large number of students with whom the research is carried out (N = 2117), which is a great sample.

Our study has some limitations. One of these limitations is that this is a transversal study, which does not allow us to establish any causal relationships. Future research should focus on analysing this relationship with longitudinal studies. Finally, in our study, the sample only consists of Spanish students at University of Salamanca. It therefore might be worth extending the sample to other universities within Europe.

In conclusion, students of the University of Salamanca management above all basic and personal interrelation programs, search engines in the network, online video portals and virtual libraries and some web browsers. They value the help and importance of ICT in their learning process and consider positively the ICT as relevant tools. Depending on the areas of knowledge there are differences in the use of ICT, Health Sciences students present the highest preference level in use of ICT. And there are four well-differentiated clusters of university students according to ICT's consideration.

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