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Students' perceptions about their competencies in Information and Communication Technologies (ICTs)

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Abstract: In contemporary times, human life is greatly affected by the Information and Communication Technologies (ICTs), which enable the generation of virtual spaces, knowledge, and interactions that were unimaginable in the past. Within this context, it is important to analyse students' competencies in the use of ICTs. This article presents the results of a research project aimed to identify the ICT competency levels among students from the Spanish university of Salamanca and the Mexican universities of Veracruz and Chihuahua. The sample included the pupils of 60 professors (20 from each university), who significantly used ICTs in their classes. The data were obtained from questionnaires applied to the students of the selected ICT-mediated classes. Results show that students trust their competency in ICTs to interact in ICT-mediated environments.

Keywords: Competency; Information and Communication Technologies; ICTs

Translation by **Cruz Alberto Martínez-Arcos** (University of London)

1. Introduction

The technological revolution has promoted a new society marked by global changes and innovation in the information technologies, all of which influences the economy, politics, the competitive aspects, the labour market, the educational strategies, and the new learning structures (Aypay, 2010; González, 2004), as well as the new forms of recreation and immediate, permanent and real-time interaction among people worldwide (Garcia, 2010). Therefore, a new paradigm is being built by the global society through the ICTs, which cross transversally all the communication fields (Piedra, 2010), by connecting people with

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information, products and ideas, and operating both individually and in communities worldwide (Aypay, 2010). To face these changes ICT competencies have become part of the requirements demanded by many working positions.

The proposals of UNESCO involve the development of ICT competencies, which emerge as a paradigm in education. Similarly, universities, since they are open education systems, cannot be indifferent to the changes occurring around them and take into consideration the educational and accreditation needs that are contemplated in the global society and are included in the educational policies, which highlight the importance of developing ICTs in the contemporary world, including the member states of the OECD (Aypay, 2010).

The fundamental strategies of higher education institutions outline the need to form citizens able to participate responsibly in all the fields of social life, and act productively and creatively in the development of their functions. In addition, they encourage the curricular design centred in learning and based on competencies; including proficiency in ICTs, as one of the alternatives that allows achieving the objective of education and pertinence in relation to the transformations occurring in the world.

Huerta, Perez and Castellanos (2000), consider that the globalised world requires an increase in the productivity of social actors. They have also highlighted the need for mechanisms that allow changing the educational process with respect to the organisation, contents and teaching methods in order to connect education more effectively with the real work, to acquire qualified staff capable of responding to the needs of production, technological innovation, the management of ICTs and competition in global markets.

The development of competencies is proposed as an approach that is closer to the needs of the labour market (Ben Youssef and Dahmani, 2008). It can be said that competent persons, in any given profession, are those who perform well the role that is expected from them. This definition corresponds with Ibarra's (Estévez et al., 2003: 5), who defines competencies as a "set of abilities, skills, knowledge, and attitudes needed for optimal performance in a given occupation or productive role". Linking this concept to ICT competencies, it can be said that the latter are a group of skills, knowledge and attitudes that are applied to the use of information and communication systems, including the equipment involved, and specifically, according to Godoy (2006), the ability to make Web designs, manage presentations, databases, graphics software, spreadsheets, online bibliographic databases, web browsers, e-mail and chat applications, and word processors, among others.

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After having contextualised ICT competencies, it is necessary to delimit this object of study to the university context. This article addresses the perceptions of ICT competencies among public university students from Mexico and Spain. This article presents part of the results of a research project aimed to analyse the attitudes, competencies, and productive use of new technologies among university students, in order to effectively participate in the process of methodological change currently experienced by universities and their relations with the levels of quality (satisfaction and improvement in the different performance indicators).

In this sense, we present the results obtained in the case studies of three universities: the University of Salamanca (Spain), the Autonomous University of Chihuahua (Mexico), and the *Universidad Veracruzana* (Spanish for University of Veracruz) (Mexico). However, this article only presents the analysis of the ICT competency levels among students. The findings presented in this study contribute to the understanding of the complex process occurring in the public universities, although due to the features and limitations of the study we cannot make generalisations.

1.1. ICT competencies

According to Llorente and Cabero (2005), the digital or technological literacy is presented today as an essential element for the education of university students which, when articulated in relation to the ICTs, involves the need of being knowledgeable in the use of new and old codes, symbolic systems and ways of interaction.

The development of these competencies appears as a paradigm in education and, to delve into the concept of competency, they provide a definition that describes competent persons are those who do very well what is expected from them in a given field. For Fuentes (2007: 53), competency is:

> A set of knowledge, skills, attitudes, and values that are needed to effectively perform an occupation or a productive role.

This definition involves observable behaviours that contribute to the successful completion of a task (McLelland, in Martín, Hernández and Beléndez, 2009), and it implies knowing, knowing-how and knowing how to transfer that knowledge (Pérez in Cárcamo and Muñoz, 2009). Linking this concept to ICT competencies, it can be said that the latter are a group of skills, knowledge and attitudes that are applied to the use of information and communication systems, as well as the devices that the activity involves and, according to *NETS for Students* (2007), also the knowledge that people should know and be able to learn and transfer, effectively, in order to live productively in a digital world.

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These competencies are included in the educational standards that various countries have developed in the form of profiles, such as NETS (2007) in the United States, the Official certificate in Computing and Internet (B2i) in France, the incorporation of ICTs indicators in the National Curriculum in England, as well the transversal integration of the ICTs in schools, in Belgium (Llorente and Cabero, 2005).
It is important to note that all the previous standards describe key points of the educational development of ICT-literate students. NETS (2007) includes: the ability to make Web designs, presentations, databases, and the ability to use graphics software, spreadsheets, databases, online applications, e-mail, chat applications and word processors, among others. Moreover, UNESCO (2008) has presented the ICT competency standards for teachers, which combines the requirements for teachers and students in today's world and emphasises the current importance of ICTs for all countries, including the members of the OECD (Aypay, 2010).

Competencies in ICTs can be classified as: a) the core competencies of digital literacy, which are related to the use of ICTs in the classroom presentations and activities, and involve the use of digital tools to obtain information, and the use and development of materials obtained from various online sources; b) the implementation competencies, which are related to the use of skills and knowledge to create and manage complex projects, solve problems in real-world situations, collaborate with others, and make use of information and experts networks; c) the ethical competencies, which are related to the ethical, legal and responsible use of ICTs (UNESCO, 2008).

1.2. Justification

Our interest in this object of study is based on the fact that students' competencies to use technological tools and apply them productively and ethically in the search and organisation of information, problem-solving, collaborative work, and the improvement of communication processes, are considered of fundamental importance to properly respond to the demands arising in the teaching contexts that significantly integrate ICTs.

It can also be noted that through the use of ICTs in education, students are acquiring new in abilities such as: a) greater collaboration, b) team work, and c) project management. These competencies are increasingly closer to the needs of the labour market and productivity and, perhaps, less and less focused on the curricula (Ben Youssef and Dahmani, 2008). Therefore, this study in three universities (two from Mexico and one from Spain) can provide a better understanding in this matter.

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1.3. Approaching the problem

Universities are centres that form professionals and thus are ideal environments to analyse how people acquire ICT competencies, which are so demanded in the current labour market. Based on this fact, the question that guided our research in the three universities was: Is there any similitude among the evaluations made by the students of the universities of Salamanca, Chihuahua, and Veracruz about their competences in the use of ICTs?

1.4. Hypothesis

There is a similitude in the self-evaluation of students regarding their ICT competencies across the studied universities.

2. Research methodology

For this kind of research we considered it was appropriate to use the study of cases, which according to Yin (2003) contributes to broaden and deepen the knowledge about individuals, groups, organizations and related phenomena. Three case studies were used: the University of Salamanca (Spain), the Autonomous University of Chihuahua (Mexico), and the *Universidad Veracruzana* (Spanish for University of Veracruz) (Mexico).

This research is quantitative, applied, descriptive, exploratory, and empirical. The study employed the analytic-synthetic and theoretical-deductive methods.

2.1. Universe of study

The universe of study of this research is composed of 495 students from the University of Salamanca, 516 from the University of Veracruz, and 699 from the University of Chihuahua (see table 1). The sample selection considered the professors who used ICTs in their classes as a significant resource to support education. Being an exploratory study, it was agreed to select a sample of 20 teachers from each of the participating universities. The number of professors was established based on their availability to collaborate with the researchers, and the fact that these professors had incorporated the use of institutional technological platform to support the teaching of their subjects.

It should be noted that, given the exploratory nature of this research, we decided to extend the sample to all areas of knowledge at the three universities due to the difficulty to find teachers who were using the support of the technological platform that each University promotes and were willing to cooperate.

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The sample was finally composed of a total of 1710 students, who took classes with the selected teachers, distributed at the tree participating universities, as shown in table 1. The distribution of students by gender reflects the actual situation in the university context, with a slight predominance of women (see table 2); the predominant age range is between 20-50 years; and the modality of education is fundamentally face-to-face (table 3).

Main characteristics of the global sample:

Table 1: Sample distribution by University (sample of students)

	Frequency	Percentage
Chihuahua	699	40.9
Salamanca	495	28.9
Veracruz	516	30.2
Total	1710	100.0

Table 2: Distribution by gender

	Frequency	Percentage
Females	1015	59.4
Males	695	40.6
Total	1710	100.0

Table 3: Distribution by teaching mode

	Frequency	Percentage
On-site	1660	97.1
On-site and on-line	42	2.5
On-line	8	.5
Total	1710	100.0

Table 4: Distribution by number of students per class

	Frequency	Percentage
Less than 20	230	13.5
Between 20-50	1390	81.3
Between 50-100	90	5.3
Total	1710	100.0

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2.2. Techniques

The techniques used to collect information were: surveys and literature reviews. The survey allowed us to identify: 1) students' demographic characteristics, 2) students' ICT competencies, and other aspects that are not considered in this article, such as: teaching scenarios, conditions of teaching, students' education needs in relation to new technologies; students' assessment of the potential benefit of ICT in their learning process; as well as students' attitudes and motivations towards the use of ICTs in their university education.

Again, it is important to remark that this article only describes part of all the work undertaken. The first section of the questionnaire consisted of demographic questions (e.g., gender, university or school affiliation, university identification number, number of students per class). The second segment included 12 questions about students' ICT competencies.

According to Cronbach's alpha formula, the reliability of each section of the questionnaire is high, with values of 0.86 for students' ICT competency levels. The results of the questionnaire were analysed with the statistical software SPSS.

2.3. Characteristics of universities under study

This section presents brief information about the foundation, student body, degrees offer, and academic staff of the participating universities: the Spanish University of Salamanca, and the Mexican universities of Veracruz and Chihuahua.

2.3.1. University of Salamanca

The University of Salamanca was founded in Spain almost 800 years ago. It is very prestigious, nationally and internationally. It currently has a total of 25 educational centres, of which 17 are Faculties, 3 are *Escuelas Técnicas Superiores* (Schools of Advanced Studies), and 5 are *Escuelas Universitarias* (University Schools). It also operates 22 own centres, 3 affiliated centres, 63 departments, 171 areas, 19 technology centres and 8 research institutes.

The distribution of the academic staff (according to its "Academic memoir 2007/2008") is as follows: 209 Chair Professors/Senior Lecturers; 52 professors of *Escuelas Universitarias*; 697 full professors; 321 full professors of *Escuelas Universitarias*; 732 extraordinary professors (associate, visiting and Emeritus); 162 assistant professors and teaching fellows; 162 research fellows; and 1 workshop teacher. In the academic year 2007-2008, 26.746

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students completed their undergraduate studies (60.45% were women and 39.55% were men).

The university offers various types of degrees: masters' degrees (offering academic and professional specialization, and initiation in research); doctoral degrees (based on the 1998 and 2005 official doctoral programmes plans); *titulos propios* (programmes aimed at completing university education with titles like master, expert and specialist); Continuing Education and extraordinary courses (educational activities aimed at the acquisition, perfection and updating of knowledge and skills); and International courses (oriented to the teaching of all levels of Spanish language to foreigners). The undergraduate degree studies (the first and second cycle studies) are adapted to the European Higher Education Area and are being replaced by the *título de grado* (bachelor's degree). This university also offers courses for seniors (University of experience), which involve activities that facilitate the personal and intellectual development of older people.

In this sense, the university offers 71 bachelor's degrees; 41 first cycle university programmes; 47 second cycle university programmes; 49 master's degrees; 39 Doctorate degrees; 63 National *títulos propios*; 7 International *títulos propios*; 3 formats for special courses and continuing education programmes (complementary education aimed at first and second cycle university students; continuing education designed for graduates and professionals; open education designed for children, adolescents, young people, adults, elders, or people with special needs), which are organised in different institutional programmes such as: summer courses; office automation; training programmes for professors from the University of Salamanca and non-university professors.

2.3.2. Universidad Veracruzana

The *Universidad Veracruzana* (University of Veracruz) was founded in 1944. It is currently the higher education institution with the greatest impact in the southeast of Mexico, one of the most important universities in the country, and the most prestigious in the State of Veracruz.

The University operates educational centres in 26 municipalities and is organised in 5 campuses across the State of Veracruz: Xalapa, Veracruz-Boca del Río, Orizaba-Córdoba, Poza Rica-Tuxpan, and Coatzacoalcos Minatitlan. It owns 27 Higher Education Units, which include 74 faculties and 23 research institutes; 7 research centres; 3 high technology laboratories, and 1 museum, as well as centres of languages and music, and art workshops, among others.

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The *Universidad Veracruzana* has 335 buildings which welcomed 53,634 students during the academic year 2008-2009. The student body is distributed across 219 formal educational programmes: 145 undergraduate studies; 63 postgraduate studies; 10 advanced technical studies (*Técnico Superior Universitario*); and 1 technical degree. The University serves 31.3% of the population of higher education students in the State of Veracruz. In addition, 12,994 more students are treated in non-formal education programmes like art workshops, language centres, self-access centres, children's music programmes, and continuing education, among others. Altogether, from August 2008 to February 2009 the university attended 66,628 students.

The student population is attended by 5,893 academics, of which 2,771 are full-time workers (including administrative and teaching staff), 79 part-time, and 3,043 are professors working only few hours. Of the full time professors attached to the 27 Higher Education Units, 85% have postgraduate studies: 28% doctoral degrees, 47% master's degrees, and 10% specialisation degrees (report of the *Universidad Veracruzana*, 2009).

2.3.3. Autonomous University of Chihuahua

The Autonomous University of Chihuahua was created officially on 8 December 1954 (UACH, 2008). It is present in 9 municipalities across Chihuahua, the largest Mexican State: Camargo, Chihuahua, Ciudad Juárez, Cuauhtémoc, Delicias, Guerrero, Guachochi, Ojinaga and Parral. This institution operates a total of 14 faculties: Agriculture and forestry Sciences; Agro-technologic Science; Political and Social Sciences; Chemistry; Law; Physical education and sports sciences; Nursing and Nutritional Sciences; Philosophy and Literature; Engineering; Animal Husbandry and Ecology; International economy; Dentistry and Arts. The number of students enrolled in 2009 was 25,225, which were attended by 610 full time professors, 120 part-time professors, and 1,839 provisional teachers.

The University of Chihuahua offers 50 bachelor's degrees, 53 master's degrees, and 5 doctoral degrees. 14 of its master's programmes are part of the National Programme of Quality Post-degrees, which is recognized by CONACYT (Mexico's National Council of Science and Technology). Currently, 100% of the academic programmes offered by this university are accredited by external agencies, as a result of the constant review and updating processes; constant teacher and staff training, and large investments –from the national and regional governments and its own resources. Thus the university enjoys a strong infrastructure and modern technology that together promote and increase the quality of education and research.

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It should be noted that the universities under study are a small sample of the universe of higher education institutions in Spain and Mexico. Therefore, the results of this case study are not applicable to the situation of the rest of universities in these countries. However, the relevance and prestige of these institutions give us a guideline to review the obtained results.

3. Results and discussion

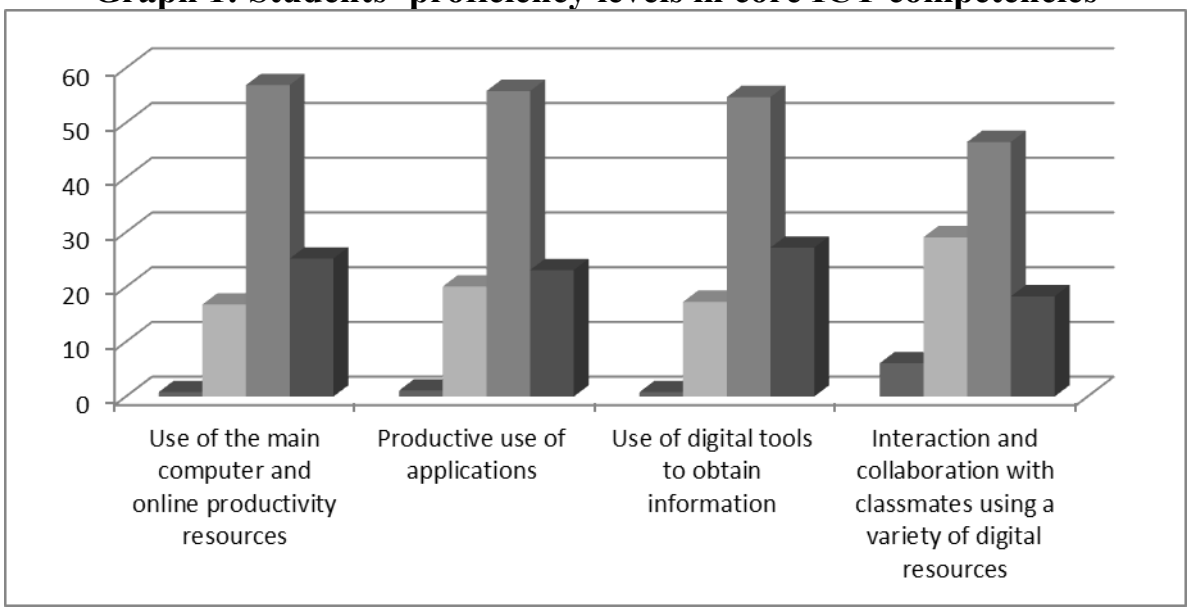
The study aims to compare the self-evaluation of ICT competencies made by the students from the universities under study, and to analyse university students' competencies in new technologies to participate effectively in the process of methodological change currently occurring in the universities.

The following section presents the data obtained about students' competencies.

3.1. Competencies

The analysis of ICT competencies among students is based on students' self-assessment in 14 competencies grouped in three dimensions: core competencies, implementation competencies, and ethical competencies, following some international guidelines, like the ones provided by UNESCO, for their classification. Students were asked to rate their level of competency using the following scale: 1 = Zero competent; 2 = Little competent; 3 = Quite competent; 4 = Very competent. The description of results shows the competencies forming each of the three specific dimensions, based on the factorial analysis performed on them.

Graph 1: Students' proficiency levels in core ICT competencies



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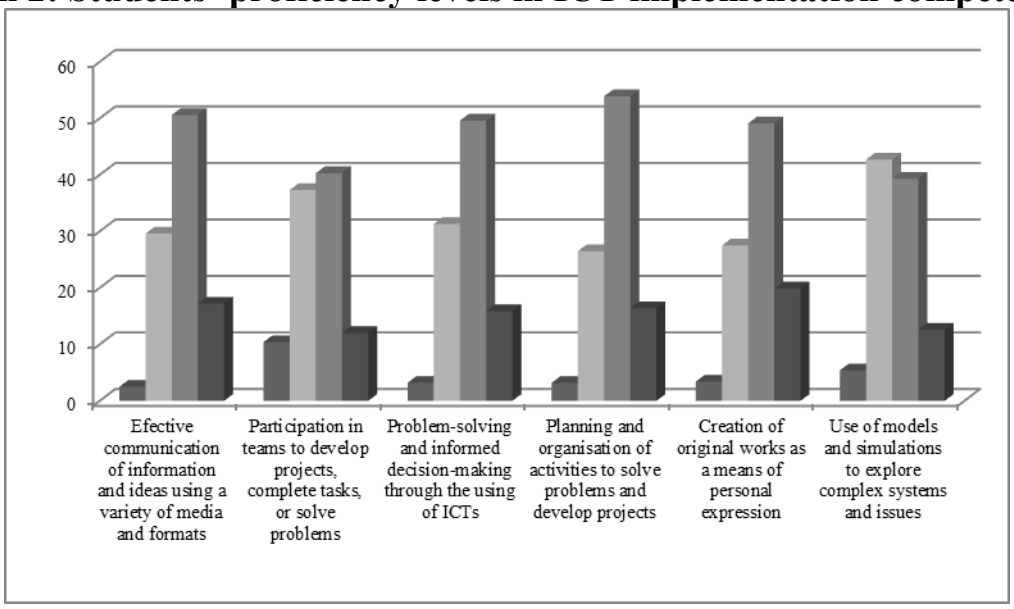
As graph 1 shows, the core competencies are related to the use of ICTs in the classroom activities and presentations, and also involve the use of digital tools to obtain information, as well as aspects related to the use and development of materials through online sources (UNESCO, 2008). Four items/competencies comprise this dimension: a) Use of the main computer and online productivity resources; b) Productive use of applications; c) Use of digital tools to obtain information from a variety of sources; d) Interaction and collaboration with classmates using a variety of digital resources.

The analysis of this dimension indicates that 76.9% of students considered themselves quite or very competent, as shown in table 1. However, 82% gave themselves a higher score in the items a) Use of the main computer and online productivity resources and c) Use of digital tools to obtain information from a variety of sources; while 78.9% gave themselves a higher score in the item b) Productive use of applications; and 64.8% in the item d) Interaction and collaboration with your classmates using a variety of digital resources.

Graph 2: Students' proficiency levels in ICT implementation competencies



Graph 2 presents the results of the dimension of implementation competencies, which includes: the use of ICT skills and knowledge to effectively communicate information; generate original works; participate in teams to develop projects, complete tasks or solve problems; and use models and simulations to explore complex systems and issues (UNESCO, 2008).

Students' responses revealed that 62.8% of them, on average, considered themselves to be competent in this dimension. The item in which students ranked themselves more competent

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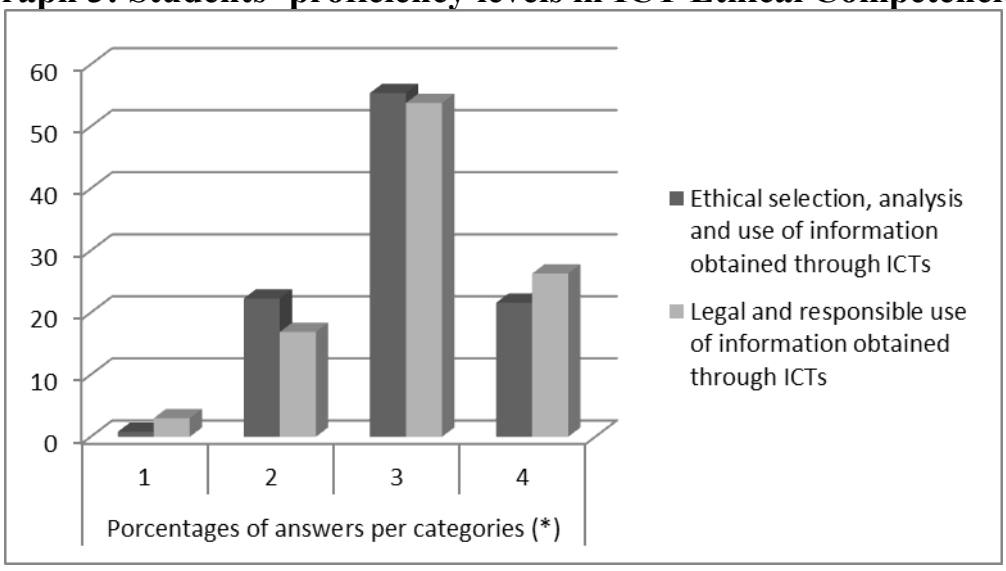
was the one about the planning and organisation of activities needed to solve a problem or a project, since 70.3% of the students evaluated themselves positively in this matter. On the other hand, the item in which students ranked themselves least competent was the one related to the use of models and simulations to explore complex systems and issues, since 42.7% of students answered "Little competent" in this regard.

At the same time, the competency in "Participation in teams to develop projects, complete tasks or solve problems" obtained a low score: 37% of students said they were "Little competent" in this regard, while 10.4% reported being "Zero competent" this regard.

Graph 3: Students' proficiency levels in ICT Ethical Competencies



As graph 3 shows, 80% of students believed they make a legal and responsible use of information through ICTs, while 77% reported being competent in the ethical use, analysis and selection of information. In addition, 73% of students rated themselves to be "quite" and "very" competent in the three dimensions of competence (core, implementation, and ethical competencies), which clearly indicates that, overall, students from the three universities, evaluated positively their own competencies in relation to the use of ICTs.

The areas of in which students recognise a higher level of competency are:

- Use of digital tools to obtain information
- Use of applications in a productive manner
- Use of the main computer and online productivity resources
- Legal and responsible use of information through ICTs

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On the other hand, the areas of competency that were rated the lowest (with average percentages under 2.7) and could be recognised as weak points are:

- Use of models and simulations to explore complex systems and issues.
- Participation in teams to develop a project, complete tasks or solve problems.

The correlation among the three dimensions is relatively high and very significant, as we can see in the matrix presented in table 5. This following data allow us to infer that we can talk of a single variable called "competencies in ICT".

Table 5: Matrix of correlations between the dimensions of ITC competencies

Dimensions	C1 Core	C2 Implementation	C3 Ethical
C1- Core Competencies	1	0.68**	0.56**
C2- Implementation Competencies		1	0.50**
C3- Ethical Competencies			1

It is important to remember that this assessment of ICT competency levels is based on the perspective of students. This study identifies the areas in which students need to be trained in ICTs to develop specific competencies such as: problem solving, teamwork, project management, the use of models and simulations to explore complex systems and issues, and ICT-mediated communication, with the objective of meeting the ICT skills required by NETS (2007) to turn students into digital citizens.

The fact that this assessment of ICT competency levels has been made by students themselves should, perhaps, encourages us to think that students' formative preoccupations should not be ignored when considering the use of ICT in the teaching-learning processes.

3.2. Gender differences in the assessment of ICTs competencies

As table 6 shows, when comparing students' average competency levels across gender groups we can see: that in nine competencies (1, 2, 3, 4, 5, 10, 12, 13 and 14) there are significant differences in favour of women; that there is a significant difference in favour of men only in a single competency (6, "use of models and simulations"); and that in the remaining four competencies (7, 8, 9 and 11) the differences are not significant. On the other

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hand, there are gender differences in the competencies constituting the three dimensions, but in the dimension of "implementation competencies" the differences are minimal; while in the dimension of "ethical competencies" the differences are greater.

Table 7 shows that while there are no significant gender differences if the comparative references are the dimensions of basic and implementation competencies, the difference is highly significant in favour of women in the dimension of ethical competencies. Graph 4 shows that the competency profile, in each of the dimensions, of the subsamples of male and female students is similar. In this graph we can see the values of each of the dimensions and the lack of differences by gender.

Table 6: Average levels in each of the "ICT Competencies": differences by gender.

	General averages	Women's averages	Men's averages	Value t
1. Use of the main computer and online productivity resources.	3.06	3.12	2.98	4.16 **
2. Productive use of applications.	3.01	3.05	2.95	2.91 **
3. Use of digital tools to obtain information.	3.08	3.12	3.03	2.65 **
4. Ethical selection, analysis and use of information.	2.98	3.03	2.90	3.86 **
5. Effective communication of information and ideas through a variety of media and formats.	2.82	2.86	2.78	2.14*
6. Use of models and simulations to explore complex systems and issues.	2.59	2.54	2.66	-3.07 **
7. Interaction and collaboration with classmates through a variety of digital resources.	2.77	2.77	2.77	0.23
8. Participation in teams to develop projects, complete tasks or solve problems.	2.54	2.52	2.58	-1.48
9. Problem solving and informed decision making through the use of digital tools.	2.78	2.79	2.77	0.38
10. Planning and organisation of	2.83	2.87	2.78	2.51*

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activities needed for solving problems or developing projects.				
11. Creation of original works as a means of personal expression.	2.86	2.87	2.83	1.07
12. Legal and responsible use of information obtained through ICTs	3.03	3.08	2.96	3.28 **
13. Consider ICTs as tools for permanent learning.	3.21	3.28	3.12	4.33 **
14. Consider ICTs as means of collaboration and social communication.	3.12	3.18	3.03	3.80 **

(*) Statistically significant for α=0.05
(**)Statistically significant for α=0.01

Table 7: Average levels of "ICT Competencies": differences by gender.

Dimensions	General averages	Women's averages	Men's averages	Value t
1. Basic competencies	2.91	2.92	2.88	1.62
2. Implementation competencies	2.77	2.78	2.75	1.19
3. Ethical competencies	3.07	3.14	3.00	5.18**

(*) Statistically significant for α=0.05
(**)Statistically significant for α=0.01

Graph 4: Average levels in the three dimensions of ICT competencies: Differences by gender

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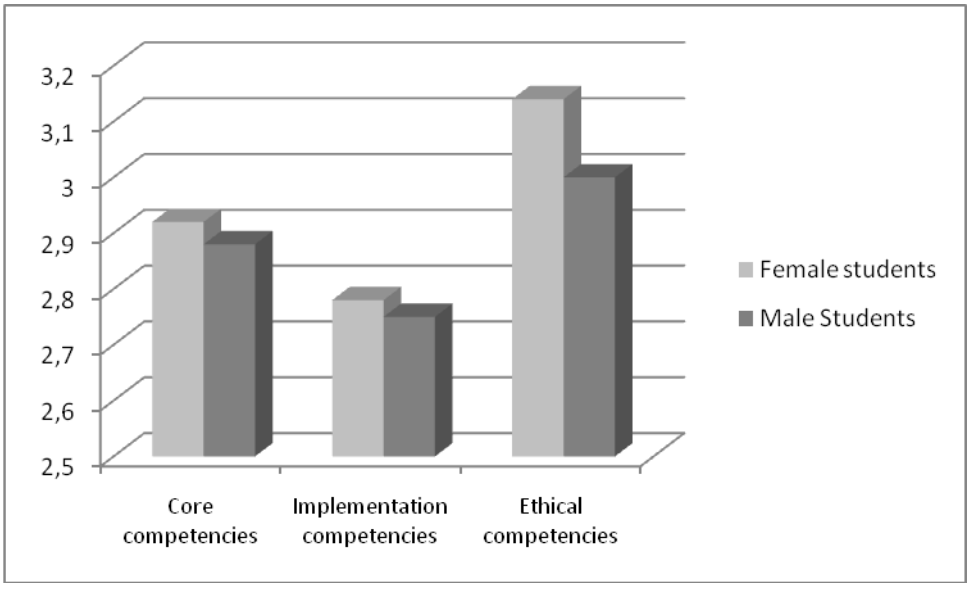

To deepen into the analysis of the possible differences and relations between the "competency levels" and "gender" variables we developed a contingency table for each of the competency types (core, implementation and ethical) and the gender variable, by calculating in each case the statistical value of X^2, its significance and the value of the correlation coefficient γ (gamma), which is considered as the most appropriate because we are dealing with an ordinal variable (the competency levels) and a nominal variable (gender). The summary of the data is presented in table 8.

Table 8: Differences and relations between the dimensions of ICT competency and gender

Types of ICT competencies	X^2	Significance	Gamma coefficient (ordinal x nominal)
Core competencies x gender	13.97	0.45	-0.05
Implementation competencies x gender	22.14	0.10	-0.03
Ethical competence x gender	43.93	0.000**	-0.16

Of the comparisons made to observe the differences in ICT competencies across gender groups, only the value X^2 corresponding to the comparison in ethical competencies is clearly

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significant, which can be understood as the replication of the conclusion obtained when assessing as equally significant the difference in averages, considering in this case the level of competence as the level of interval measurement (table 8).

3.3. Differences in ICT competencies across the three universities

Table 9 presents the average competency levels across universities from higher to lower: Chihuahua, Salamanca, Veracruz. As we can see, only in the ethical dimension of ICT competencies, Salamanca and Chihuahua have the same average level.

Moreover, the average values in each of the dimensions (table 9) are relatively high and can be initially considered satisfactory, particularly in the Autonomous University of Chihuahua. Bearing in mind that this is a subjective evaluation of competencies, we cannot ignore the benefits of planning the improvement of students' ICT training; which is a task that is permanently required given the continuous evolution of the technical and methodological proposals for the academic use of ICTs.

The last column of table 9 presents the differences in the average level of ICT competencies between the three universities.

Table 9: Average levels in the three dimensions of "ICT Competencies": differences across universities.

Dimensions	General Average	Chihuahua's average (C)	Salamanca's average (S)	Veracruz's average (V)	F	Differences occur between
1. Basic competencies	2.91	3.06	2.90	2.71	77.73**	C-S, C-V, S-V
2. Implementation competencies	2.77	2.92	2.75	2.59	58.11**	C-S, C-V, S-V
3 Ethical competencies	3.09	3.21	3.21	2.81	96.60**	C-V, S-V

(*) Statistically significant for α=0.05
(**)Statistically significant for α=0.01

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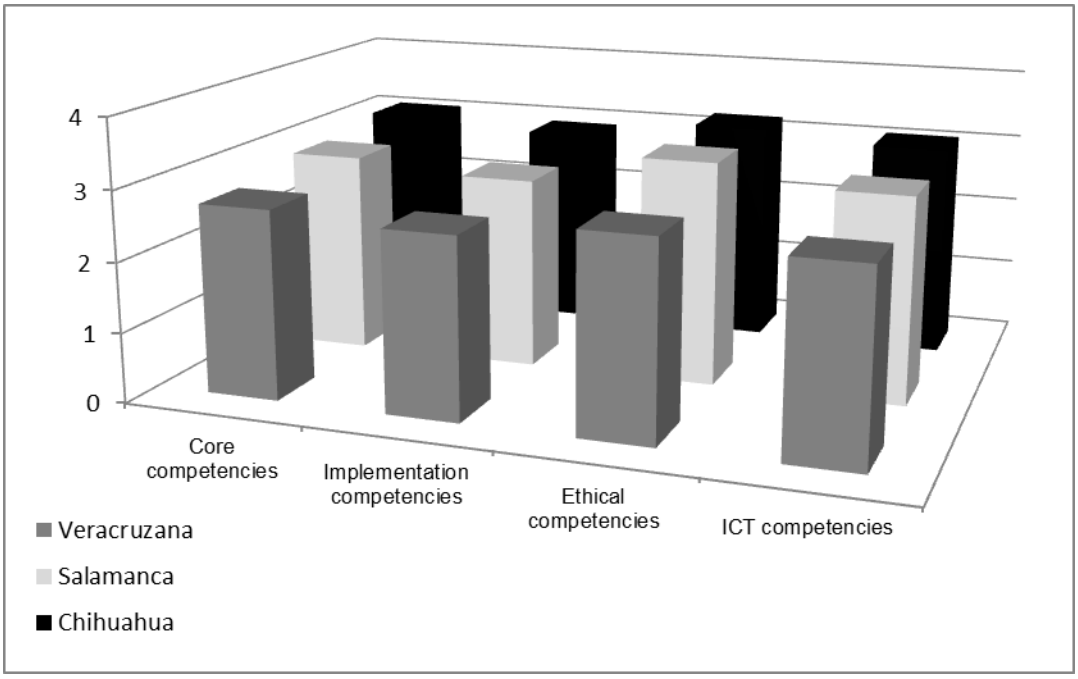
Table 10 shows that there are highly significant differences in the inter-university comparison if the comparative references are the dimensions related to the competencies or the "general ICT competency" variable. Scheffé's test indicates that these differences occur among all universities and in all dimensions and the general variable, except in the ethical dimension when comparing the universities of Chihuahua and Salamanca (the average values in this case are the same).

These differences clearly suggest the existence of three sub-groups (coincident with each of the universities) that are clearly different regarding the possession of ICT competencies. The differences could be, perhaps, explained by the fact that the samples from each university are formed by pupils studying different degrees (in the case of Chihuahua more related to scientific studies) or by the fact that students' ICT management training is enhanced and attended with greater interest than at other universities. Finding the precise explanation to this obvious fact would require deepening into the analysis strategy developed so far and collecting additional data.

Graph 5 shows that the profile of the competencies levels, in each of the dimensions, for each of the universities is clearly different. This graph shows the values of each of the dimensions and the differences between them.

Graph 5: Average levels in the three dimensions of ICT competencies: differences across universities



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To deepen into the analysis of the differences and relations established between the "competency levels" and "university" variables we developed a contingency table for each of the types of competency (core, implementation and ethical) and the "university" variable, by calculating in each case the statistical value of X^2, its significance and the value of the correlation coefficient γ (gamma). Table 10 presents the summary of the data.

Table 10: Differences and relations between the types of competencies and the "university" variable

Types of competencies	X^2	Significance	Gamma coefficient
Core competencies x university	213.29**	0.000	0.18
Implementation competencies x University	157.22**	0.000	0.16
Ethical competencies x University	260.95**	0.000	0.04
Competencies x university	585.64**	0.000	0.13

In the comparisons made to observe the differences in competencies across the different universities all X^2 values are highly significant, which can be understood as a replication of the conclusion obtained when assessing as equally significant the difference in averages (in this case considering the levels of competence as the level of interval measurement) between the various competency dimensions (table 10). Similarly, the values of the gamma correlation, although they are not very high, are also very significant due to the large size of the sample.

4. Conclusions

The study of undergraduate students' ICT competencies, according to their own perception, indicates that students rate themselves as rather highly competent to deal with the integration of technological tools in the learning processes, although this fact connot be considered as definitive as to ignore the concern of higher education institutions for starting undergraduates students' training in this type of competencies from the first courses.

Most students have expressed much appreciation towards ICTs as tools for permanent learning and as a means of social communication and collaboration, in line with the results of other investigations. Digital tools are primarily used by students for obtaining information

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and working online. Students claim to make a legal and responsible use of information obtained through ICT.

When classifying the ICT competencies into the core, implementation and ethical dimensions, we noted that students evaluated themselves more competent in the latter dimension, and then, on decreasing order, on the core competencies. Thus, the competencies that need to be strengthened the most are those that are part of the second dimension, such as participation in teams to develop projects, complete tasks or solve problems using digital tools; the effective communication of information using a variety of media; and the creation of original works as a means of personal expression. The development of these competencies largely depends on the approach made in the subjects related to these creative scenarios because it is hard for students to develop these competencies if their professors do not request them academic tasks that demand the use of these competencies.

Regarding gender differences, although they are scarce, at a statistical level some of them are significant: the female subsample considers itself more competent in some core competencies, such as the use of the main computer and online productivity resources, and above all in the ethical competencies, where they show a higher valuation of ICT as learning and collaboration tools. Overall, when considering a single score in ICT competencies, women obtain a significantly higher score.

The comparative study between universities also highlighted some statistically significant differences in the three dimensions: the students from the Autonomous University of Chihuahua rated themselves as the most competent in ICT competencies, while the students from the University of Veracruz rated themselves the least competent, and the students from the University of Salamanca generally placed themselves in the middle of the scale.

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7. Notes

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