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Dimensional structure of 21st century competences in university students of education

Estructura dimensional de las competencias del siglo XXI en alumnado universitario de educación

Almerich, Gonzalo; Díaz-García, Isabel; Cebrián-Cifuentes, Sara & Suárez-Rodríguez Jesús
University of Valencia

Abstract

The new Knowledge Society requires new competences, which are known as 21st Century Competences. These competences are subdivided into competencies of higher-order thinking and competences in information and communication technologies. The aim of this article is to determine the dimensional structure of 21st century competences, together with key personal factors in this regard. This is a correlational study, based on a survey design, whose sample is constituted by students of the degrees of Pedagogy and Social Education at University of Valencia, selected by a non-probabilistic and accidental sampling, collecting the information by means of two questionnaires. The results point out that the competences for the 21st century are composed of two subsets, the competences of higher-order thinking and the ICT competences, which form a whole. In addition, it has been found that personal factors have a significant impact on this structure. It is suggested that education policies should address both aspects, in order to train citizens included in the Knowledge Society.

Keywords: 21st century competences; ICT competences; high skills; university students; personal factors.

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Resumen

La nueva Sociedad del Conocimiento requiere de nuevas competencias, que se conocen como Competencias del siglo XXI. Estas competencias se subdividen en competencias de alta habilidad de pensamiento y competencias en tecnologías de la información y de la comunicación. El objetivo del presente artículo es determinar la estructura dimensional de las competencias del siglo XXI, junto con factores personales clave a este respecto. Se trata de un estudio correlacional, basado en un diseño de encuesta, cuya muestra la constituyen estudiantes de las titulaciones de grado de Pedagogía y de Educación Social de la Universidad de Valencia, seleccionados mediante un muestreo no probabilístico y accidental, recogiendo la información mediante dos cuestionarios. Los resultados señalan que las competencias del siglo XXI están compuestas por dos subconjuntos, las competencias de alta habilidad de pensamiento y las competencias TIC, que forman un conjunto. Además, se ha encontrado que los factores personales inciden de forma relevante en dicha estructura. Se sugiere que las políticas educativas atiendan a ambos aspectos, para formar ciudadanos incluidos en la Sociedad del Conocimiento.

Palabras clave: competencias del siglo XXI; competencias TIC; altas habilidades; estudiantes universitarios; factores personales

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The globalisation and economic internationalisation phenomenon, along with the appearance of information and communication technologies (ICT), are the pillars of today's Knowledge Society (Anderson, 2008¸ Voogt & Pareja-Roblin,

Corresponding author / Autor de contacto

Almerich, Gonzalo. Department of Educational Research Methods and Diagnosis, University of Valencia (Spain).
Gonzalo.Almerich@uv.es

2012). Both these phenomena entail constant change in all social domains, as well as the continuous transformation of the way we live, work and learn (Voogt & Pareja-Roblin, 2012).

The non-stop scientific-technological development that characterises today's society means that the competences required for jobs frequently and rapidly evolve. Nowadays, the labour market does not evaluate only technical competences, but also the higher order cognitive competences required for the digital context that we are immersed in today (Claro et al., 2012). Therefore, jobs require increasingly more flexible, interpersonal and ICT-related competences (van de Oudeweetering & Voogt, 2018). This entails workers having to require a high level of competences to occupy jobs in order to face complex and interactive tasks (van Laar, van Deursen, van Dijk & de Haan, 2017). This means that workers do not only require excellent technical training (van Laar et al., 2017) or specialised knowledge (van de Oudeweetering & Voogt, 2018), but they also need to master enough competences to be able to adapt to the changing requirements that jobs involve (van Laar et al., 2017).

Consequently, education has become a preferential domain in this Knowledge Society, which means that education is capable of better responding to changing needs (UNESCO, 2015). The education system has to train citizens so they can face the digital environment characterised by non-routine problem solving with complex information (Claro et al., 2012; Schleicher, 2016). For this purpose, education systems are required to train society's future citizens in a new series of competences known as twenty-first century competences (Ananiadou & Claro, 2009; Voogt & Pareja-Roblin, 2012), which must be included in national curricula (van de Oudeweetering & Voogt, 2018). Nonetheless, van de Oudeweetering and Voogt (2018) point out two problems that make the integration of twenty-first century competences difficult. One is "the absence of the educational sector in the debates and initiatives regarding curricular for twenty-first century competences (van de Oudeweetering & Voogt, 2018, p. 117). The other is that inconsistency exists in the definitions, interpretations, terminology and dimensionality of twenty-first century competences (van de Oudeweetering & Voogt, 2018).

This study intends to help clarify the dimensional structure of twenty-first century competences to better understand them and to develop education plans that improve the training of citizens now and in the future.

Twenty-first century competences

The new Knowledge Society scenario requires new competences that replace basic skills and the past knowledge expectations with others needed for today's life and work (Binkley et al., 2012; Schleicher, 2016), which have become essential for workers and citizens to be effective in the twenty-first century Knowledge Society (Ananiadou & Claro, 2009). This system of new competences has been named twenty-first century competences in accordance with the goal production scenario with respect to the framework-scenario for this century.

It cannot be stated that these competences, which include critical thinking, creative thinking or problem solving, constitute novel constructs. However, today's technological resources have changed the connotation and relevance of these competences in today's education setting (van de Oudeweetering & Voogt, 2018). This is because these new educational resources empower their development as they facilitate students' knowledge building by creating digital artefacts (Chai, Deng, Tsai, Koh & Tsai, 2015).

In this context, twenty-first century competences are generally understood as the set of competences and skills someone is capable of applying or using to successfully perform "critical work functions" or tasks in a defined workplace (Sang, Liang, Chai, Dong & Tsai, 2018). From the education system viewpoint, these new competences are transversal or transferrable competences

(UNESCO, 2015), and they are a set of knowledge and skills students are able to apply or use to perform academic tasks that can be transferred to the world of work.

Over the years, different public-private institutions, along with several authors, have developed distinct frameworks for twenty-first century competences (Alberta Education, 2011; Ananiadou & Claro, 2009; Binkley et al., 2012; P21, 2015; World Economic Forum, 2015). With these competence-type frameworks, we can state that proposals can be arranged into three sets. The first set groups the different basic or key dimensions for citizens (P21, 2015; European Commission, 2018; World Economic Forum, 2015), such as literacy, mathematics, scientific literacy, etc. The second set contains the competences or capacities of having higher-order thinking skills (Alberta Education, 2011). They are related with the generation, processing and ordering of complex information, the communication of information and ideas, problem solving, collaboration, teamwork and adaptability to the environment. The third set is formed by ICT or digital competences, and are related to technological resources and their suitable use.

As we see it, the last two sets (higher-order thinking competences or capacities and ICT competences) make up twenty-first century competences. According to Ananiadou and Claro (2009), these twenty-first century competences differ from those related with ICT (the domain of ICT and ICT skills for learning) and those that do not - highly skilled competences.

In the first of these two sets, we find ICT competences, also called digital competences. They form a set of the knowledge and skills that students possess to allow them to master different technological resources in order to use them to perform their academic tasks ethically, securely and responsibly. In the last two decades, several organisations (national or international) and several authors, have set up competence frameworks for citizens in general (European Computer Driving Licence –ECDL-; European Digital Competence Framework for Citizens - DIGCOMP 2.0, Vuorikari, Punie, Carretero Gómez, and Van den Brande, 2016) and for students in particular (Calvani, Fini & Ranieri, 2010; Claro et al., 2012; International Society for Technology in Education –ISTE- 2016; International Association for the Evaluation of Educational Achievement –IEA-, Frailon, Schulz & Ainley, 2013). From the university student training perspective, competence frameworks in relation to ICT can also be indicated; for example, the Digital Competence Framework for degree students (REBIUN, 2016), or the proposals put forward by several authors (Arras, Torres & García-Valcarcel, 2011; van Braak, 2004; Verhoeven, Heerwegh & De Wit, 2016). Based on them all, three competences areas for university and non-university students can be proposed: technological competences, pedagogical competences and ethical competences (Díaz-García, Cebrián-Cifuentes & Fuster-Palacios, 2016).

In the latter of the two sets, we find an area with competences related to high-order thinking skills or higher-order thinking capacities (Binkley et al., 2012). These competences distinguish the critical profile of students who are ready to enter increasingly complex areas of life and work in today's world from the profiles of those who are not ready (P21, 2015). This area also includes those competences related with ways of working (Binkley et al., 2012), which include communication and teamwork or collaborative competences. One of the main problems involved with the competences in this set is to determine and establish such competences given the diversification of the classifications put forward (Binkley et al., 2012; Chai et al., 2015; P21, 2015; Voogt & Pareja-Roblin, 2012; Voogt, Erstad, Dede & Mishra, 2013; World Economic Forum, 2015). In our case, we contemplate critical thinking, creative thinking, self-managed learning, problem solving, adaptability, communication skills, as well as interpersonal skills and groupwork.

Personal factors that impact twenty-first century competences

Education is a complex process influenced by several personal and contextual factors that are needed to understand it.

Thus for ICT competences, during the integration process of these technological resources it has been established that a series of intervening factors has influenced this process (Drent & Meelissen, 2008; Lim, Zhao, Tondeur, Chai, & Tsai, 2013; Verhoeven et al., 2016). Ertmer (1999) distinguished between the personal and contextual factors that hinder/facilitate teachers integrating ICT. This framework can be transferred to students after distinguishing among the key contextual factors in the student domain and they would be first-order factors. Some students' personal factors also exist, known as second-order factors, which are key in this situation. The personal factors studied in previous research include gender (Arras et al., 2011; Centeno Moreno & Cubo Delgado, 2013; Van Braak, 2004; Verhoeven et al., 2016; Yalman, Basaran, y Gonen, 2016), age (Cabezas-González, Casillas-Martín, Sanches-Ferreira, & Teixeira-Diogo, 2016) and frequency of using a computer or the Internet (Baturay, Gökçearslan, & Ke, 2017; Van Braak, 2004; Yalman et al., 2016).

Higher-order thinking capacities and teamwork competences have been reported to be influenced by students' personal factors. In this way, several studies refer to the influence on the higher-order thinking capacities of the gender (Azizi-Fini, Hajibagheri & Adib-Hajbaghery, 2015; Betancourth-Zambrano, Muñoz-Moran & Rosas-Lagos, 2017; Molina-Patlán, Morales-Martínez & Valenzuela-González, 2016). The same can be stated for age (Azizi-Fini et al., 2015; Betancourth-Zambrano et al., 2017) or the frequency with which a computer or the Internet is used in teamwork (Cheung & Huang, 2005).

The purpose of our study is to establish the dimensionality of twenty-first century competences in university students of Education. For this purpose, we considered the two above-mentioned sets of competences: ICT competences and competences relating to higher-order thinking and teamwork capacities. We also considered personal factors as part of the dimensional structure, such as gender, age and the frequency of using technological devices for personal and personal-academic uses.

Three specific objectives were pursued in this study:

- Determining the level of twenty-first century competences
- Determining differences in twenty-first century competences using distinct key personal factors
- Determining the dimensionality of twenty-first century competences and how personal variables related with it.

Method

Research design

Our research design was correlational and based on a cross-sectional survey study.

Participants

The participants in this study were selected by applying accidental non-probabilistic sampling. Our study sample comprised 485 students from the Degrees of Pedagogy (52.8%) and Social Education (47.2%) at the University of Valencia (Spain), of whom 13.2% were males and 86.8% were females. Their mean age was 21.3 years (SD: 3.91) within a range from 18 to 53 years.

All these students had a computer and mobile telephone, 98.5% had Internet connection and 89.6% possessed a tablet. They stated using their different technological devices (computer, Internet, mobile phone and tablet) for personal uses several times a week, with daily use being regular ($\bar{x}$ = 4.7). They indicated that they used these devices slightly less frequently for personal-academic use ($\bar{x}$ = 4.4). Both male and female students always or almost always used their computers and the Internet for personal and personal-academic use. They employed their mobile

phones always or almost always for personal uses, and sometimes used them for their personal-academic uses every week and less regularly than for their personal uses. Finally, they rarely used their tablets for both personal and personal-academic uses.

Instruments

We used two questionnaires to collect information: the Student Engagement Questionnaire (SEQ) by Kember and Leung (2009) and our Innovatic Protocol (2016).

- To evaluate the higher-order thinking and teamwork competences, we used the SEQ version by Kember and Leung (2009). The SEQ has been validated in a Spanish sample (Gargallo López, Suárez-Rodríguez, Almerich, Verde Peleato & Cebriá Iranzo, 2018).

  The full questionnaire comprised 35 items and evaluates fifteen areas: seven for students and eight about the teaching-learning process setting. In our case, we used the seven transversal or generic student competences that Kember and Leung (2005, 2009, 2011) grouped into two sets:

  - Intellectual capacities that are linked to the transversal competences of Knowledge Society (Kember & Leung, 2011). They deal with these five higher-order thinking capacities: critical thinking, creative thinking, self-managed learning, adaptability and problem solving. These capacities are assessed by 10 items. It has a Cronbach's alpha of .80 for reliability.
  - Teamwork competences. They evaluate communication and teamwork capacities (Kember & Leung, 2011). There are two competences, communication skills on the one hand and interpersonal skills and teamwork on the other hand. These competences are assessed by 4 items. It has a Cronbach's alpha of .74 for reliability.

  The questionnaire's response options are given on a 5-option Likert-type scale, which go from I totally disagree to I totally agree.

- Innovatic Protocol (2016). It collects information about several sections on ICT for university students. It consists in five areas: technological competences, pedagogical competences, personal and academic use and attitudes to ICT technologies. The factors in this questionnaire contemplated herein include:

  - The overall score for the technological competences dimension. This section asks students about whether they master different technological resources on a Likert-type scale with five response options. It has a Cronbach's alpha of .94 for reliability.
  - The overall score for the pedagogical competences dimension in ICT. This section asks students about how they integrate ICT into their academic tasks and/or training activities. It has a Cronbach's alpha of .90 for reliability
  - The overall score for ethical competences in the ICT dimension. This section asks students about the ethical aspects to do with legally using applications and acknowledging authorship in their academic tasks and/or training activities. It has a Cronbach's alpha of .83 for reliability
  - Personal variables. The following personal variables were used: gender; age divided into three age groups (18-19 years, 20-22 years and >= 23years); frequency with which technological devices are used for personal uses in three groups (low, medium and high); frequency with which technological devices are used for personal-academic uses in three groups (low, medium and high).

Data analysis

A data analysis was done using the SPSS 24.0 package (the licence for it is held by the University of Valencia). Descriptive statistics, Multivariate Analysis of Variance

(MANOVA) and Analysis of Variance (ANOVA) were run, along with a principal components analysis for the categorical data (CATPCA).

Procedure

The data collection procedure was carried out during academic years 2016-17 and 2017-2018 by students completing printed questionnaires.

Results

First of all, we present the descriptive statistics of the different considered dimensions. Secondly, a relationship was found between the personal factors and dimensions. Finally, the dimensionality of the considered areas was established.

Descriptive statistics of twenty-first century competences

Students' level of higher-order thinking capacities was high, as the mean ranged from 3.91 for creative thinking to 4.15 for adaptability. The variability in the five analysed dimensions was low, which meant notable homogeneity in students' responses.

Table 1. Descriptive statistics of the twenty-first century competences dimensions

	Mean	Standard deviation
Higher capacities		
Critical thinking	4.05	0.64
Creative thinking	3.91	0.75
Self-managed learning	4.12	0.67
Adaptability	4.15	0.67
Problem solving	4.06	0.60
Teamwork		
Communication skills	3.95	0.73
Interpersonal skills	4.07	0.69
ICT Competences		
Technological competences	3.02	0.50
Pedagogical competences	3.55	0.49
Ethical competences	3.62	0.73

Students' level for teamwork competences was high for both competences, with a higher mean for interpersonal skills. Variability was low in both dimensions, which indicated high homogeneity for students' responses.

Students' level for ICT competences was medium for all three competences, but was slightly lower for the technological ones. The highest level went to ethical competences. For all three competences, variability was low, with greater dispersion for the ethical competences, for which students' responses were somewhat homogeneous.

Personal factors and twenty-first century competences

This section analysed and presents the differences in twenty-first century competences using the variables gender, age, frequency of using technological devices for personal uses and frequency of using technological devices for personal-academic uses. For this purpose, both MANOVA and ANOVA analyses have been carried out.

- Gender

The means of the higher-order thinking capacities between male and female students were similar for all the dimensions, with

higher mean values for male students for critical thinking and self-managed learning. Female students obtained higher values for creative thinking, adaptability and problem solving. In multivariate terms, these differences were statistically significant (Wilks Lambda =.971; $F_{(5,476)}$= 2.830, p=.019) and a small effect size (partial η^2 = .029). According to the univariate analysis, and after running the ANOVA tests, statistically significant differences were found only for the adaptability competence (see Table 2), with a small effect size.

For teamwork competences, both male and female students obtained similar values, and no statistically significant differences were observed (Wilks Lambda =1.00; $F_{(2,479)}$= 0.020, p=.980) in either multivariate or univariate terms (see Table 2).

Finally, for ICT competences male students obtained higher values for technological competences, while female students obtained higher values in both pedagogical and ethical competences. In multivariate terms, differences were statistically significant (Wilks Lambda =.922; $F_{(3,481)}$= 13.515, p=.000), and the effect size was medium (partial η^2 = .078). At the univariate level, and according to the ANOVAs, statistically significant differences were found in pedagogical and ethical competences (see Table 2) with a small effect size in both cases.

Table 2. Descriptive statistics according to gender and ANOVA in the twenty-first century competences dimensions

	Group	Mean	Standard deviation	F	Sig.	Partial η^2.
Higher capacities						
Critical thinking	Male	4.17	0.50	2.912	.089	.006
	Female	4.03	0.65			
Creative thinking	Male	3.88	0.72	.110	.740	.000
	Female	3.92	0.76			
Self-managed learning	Male	4.15	0.64	.102	.750	.000
	Female	4.12	0.68			
Adaptability	Male	3.98	0.68	4.701	**.031**	**.010**
	Female	4.18	0.66			
Problem solving	Male	3.98	0.63	1.374	.242	.003
	Female	4.07	0.59			
Teamwork						
Communication skills	Male	3.95	0.65	.000	.992	.000
	Female	3.95	0.74			
Interpersonal skills	Male	4.05	0.71	.029	.865	.000
	Female	4.07	0.69			
ICT competences						
Technological competences	Male	3.04	0.56	.111	.740	.000
	Female	3.02	0.49			
Pedagogical competences	Male	3.32	0.53	17.612	**.000**	**.035**
	Female	3.59	0.47			
Ethical competences	Male	3.19	0.69	26.683	**.000**	**.052**
	Female	3.69	0.71			

- Age

The means of the higher-order thinking capacities rose with each increasing age group as follows: the oldest age group (>= 23 years) obtained the highest value for all the dimensions, while the lowest values for critical thinking, self-managed learning and

problem solving went to the youngest age group (18-19 years). In multivariate terms, these differences were statistically significant (Wilks Lambda =.950; $F_{(10,950)}$= 2.490, p=.006) with a small effect size (partial η^2 = .026). In univariate terms, in ANOVA, statistically significant differences were found for critical thinking and self-managed learning (see Table 3), along with a small effect size in both cases. For both the critical thinking and self-managed learning dimensions, multiple comparisons were made by Scheffé's method. This enabled us to verify that there were only significant differences between the oldest age group (>= 23 years) and the youngest one, while no significant differences were observed for the intermediate age group.

Table 3. Descriptive statistics according to age groups and ANOVA for the twenty-first century competences dimensions

	Group	Mean	Standard deviation	F	Sig.	Partial η^2
Higher capacities						
Critical thinking	18-19	4.00	0.67	6.156	**.002**	**.025**
	20-22	4.01	0.63			
	>23	4.28	0.53			
Creative thinking	18-19	3.90	0.76	1.774	.171	.007
	20-22	3.88	0.73			
	>23	4.06	0.80			
Self-managed learning	18-19	4.02	0.67	3.605	**.028**	**.015**
	20-22	4.16	0.68			
	>23	4.23	0.63			
Adaptability	18-19	4.19	0.66	.910	.403	.004
	20-22	4.11	0.69			
	>23	4.19	0.61			
Problem solving	18-19	4.00	0.59	1.466	.232	.006
	20-22	4.07	0.61			
	>23	4.13	0.56			
Teamwork						
Communication skills	18-19	3.95	0.68	.141	.868	.001
	20-22	3.94	0.80			
	>23	3.99	0.57			
Interpersonal skills	18-19	4.04	0.69	.350	.705	.001
	20-22	4.08	0.70			
	>23	4.11	0.68			
ICT competences						
Technological competences	18-19	2.95	0.48	4.535	**.011**	**.018**
	20-22	3.09	0.51			
	>23	2.97	0.50			
Pedagogical competences	18-19	3.52	0.49	.522	.594	.002
	20-22	3.57	0.49			
	>23	3.55	0.48			
Ethical competences	18-19	3.70	0.69	2.062	.128	.008
	20-22	3.56	0.75			
	>23	3.64	0.74			

For teamwork competences, the three groups obtained similar means in the two dimensions, but the oldest age group always obtained the highest value. No statistically significant differences (Wilks Lambda =.998; $F_{(4,956)}$= 0.221, p=.927) were found in either univariate or multivariate terms (see Table 3).

Finally, for ICT competences we found that the highest mean for technological and pedagogical competences went to the 20-22 year-old age group, and the lowest one to ethical competences. The youngest age group obtained the highest value for ethical competences. The multivariate test showed statistically significant differences (*Wilks Lambda* =.966; $F_{(6,960)}$= 2.794, p=.011) and a small effect size (partial η^2 = .017). In univariate terms, the ANOVAs revealed statistically significant differences for technological competences (see Table 3) and a small effect size. Using Scheffé's method, the multiple comparisons gave significant differences for technological competences between the 18-19-years-old and the 20-22-years old age groups.

- Frequency of using technological devices for personal uses

The mean value of the higher-order thinking capacities rose with more frequent use, except for creative thinking where the highest mean went to the medium frequency use group. The low frequency use group obtained the lowest values for almost all the capacities, except critical thinking. These differences were not statistically significant (*Wilks Lambda* =.990; $F_{(10,948)}$= 0.479, p=.904) according to both multi- and univariate tests. After running the ANOVAs, no statistically significant differences were found for any capacity (see Table 4).

The mean for teamwork competences in both dimensions increased as the frequency use group went from low to high, and the high frequency use group always obtained the highest value, with the low frequency use group obtaining the lowest value. The multivariate test found no statistically significant differences (*Wilks Lambda* =.985; $F_{(4,954)}$= 1.853, p=.117). The univariate test revealed statistically significant differences and a small effect size (see Table 4) for communication skills. After running Scheffé's method of multiple comparisons, differences were found between the low and high frequency use groups.

The high frequency use group obtained the highest mean for mastering ICT competences for all three competences: technological, pedagogical and ethical. The low frequency use group presented the lowest value in the three competences. Differences according to the multivariate test were statistically significant (*Wilks Lambda* =.958; $F_{(6,958)}$= 3.467, p=.002) with a small effect size (partial η^2 = .021). According to the univariate test, and having run the ANOVAs, statistically significant differences were found for both technological and pedagogical competences (see Table 4) with a small effect size for both. The multiple comparisons done by Scheffé's method with technological competences resulted in differences in the low and high frequency use groups. The differences obtained for pedagogical competences appeared in the lowest competence level group compared to the other two groups.

Table 4. Descriptive statistics according to frequency use groups for technological devices for personal uses and the ANOVAs in the twenty-first century competences dimensions

	Group	Mean	Standard deviation	F	Sig.	Partial η^2
Higher capacities						
Critical thinking	Low	4.05	0.55	.018	.982	.000
	Mean	4.04	0.64			
	High	4.06	0.71			
Creative thinking	Low	3.88	0.72	.149	.862	.001
	Mean	3.93	0.71			
	High	3.90	0.87			
Self-managed learning	Low	4.07	0.67	.839	.433	.003
	Mean	4.12	0.65			
	High	4.19	0.73			
Adaptability	Low	4.11	0.66	.303	.739	.001
	Mean	4.16	0.66			
	High	4.17	0.71			
Problem solving	Low	3.98	0.59	1.436	.239	.006
	Mean	4.06	0.61			
	High	4.12	0.58			
Teamwork						
Communication skills	Low	3.81	0.79	3.695	**.026**	**.015**
	Mean	3.95	0.71			
	High	4.08	0.68			
Interpersonal skills	Low	3.99	0.67	1.067	.345	.004
	Mean	4.07	0.69			
	High	4.13	0.71			
ICT competences						
Technological competences	Bajo	2.90	0.46	6.260	**.002**	**.025**
	Mean	3.02	0.48			
	High	3.14	0.54			
Pedagogical competences	Low	3.41	0.44	7.676	**.001**	**.031**
	Mean	3.56	0.49			
	High	3.66	0.50			
Ethical competences	Low	3.50	0.72	1.920	.148	.008
	Mean	3.66	0.72			
	High	3.64	0.75			

- ***Frequency of using technological devices for personal-academic uses***

The mean value obtained for higher-thinking capacities rose as the frequency use group went from low to high, except for critical thinking, which obtained the highest mean for the medium frequency use group. The low frequency use group obtained the lowest values for all the capacities. These differences were not statistically significant (*Wilks Lambda* =.975; $F_{(10,946)}$= 1.189, p=.294) in either the multivariate or univariate test. After running the ANOVAs, no statistically significant differences were found for any capacity (see Table 5).

Table 5. Descriptive statistics according to frequency use groups of technological devices for personal-academic uses and the ANOVA on the twenty-first century competences dimensions

	Group	Mean	Standard deviation	F	Sig.	Partial η^2
Higher capacities						
Critical thinking	Low	4.03	0.63	.069	.933	.000
	Medium	4.06	0.62			
	High	4.04	0.69			
Creative thinking	Low	3.84	0.76	2.000	.136	.008
	Medium	3.91	0.71			
	High	4.02	0.80			
Self-managed learning	Low	4.05	0.65	2.820	.061	.012
	Medium	4.11	0.69			
	High	4.24	0.67			
Adaptability	Low	4.08	0.67	1.453	.235	.006
	Medium	4.19	0.65			
	High	4.19	0.71			
Problem solving	Low	4.01	0.59	1.994	.137	.008
	Medium	4.04	0.61			
	High	4.15	0.58			
Teamwork						
Communication skills	Low	3.85	0.72	4.878	**.008**	**.020**
	Medium	3.94	0.74			
	High	4.12	0.70			
Interpersonal skills	Low	3.99	0.67	2.474	.085	.010
	Medium	4.06	0.72			
	High	4.18	0.66			
ICT Competences						
Technological competences	Low	2.94	0.44	5.599	**.004**	**.023**
	Medium	3.02	0.50			
	High	3.14	0.56			
Pedagogical competences	Low	3.40	0.50	12.648	**.000**	**.050**
	Medium	3.60	0.45			
	High	3.66	0.49			
Ethical competences	Low	3.51	0.75	3.940	**.020**	**.016**
	Medium	3.62	0.73			
	High	3.76	0.69			

The mean of the teamwork competences on the two dimensions increased as the frequency use group went from low to high, and the highest value always went to the high frequency use group, while the low frequency use group always obtained the lowest value. Statistically significant differences were found with the multivariate test (*Wilks Lambda* =.979; $F_{(4,952)}$= 2.588, p=.036), along with a small effect size (partial η^2 = .011). According to the univariate test, statistically significant differences and a small effect size were observed for communication skills (see Tabla 5). After running Scheffé's method for multiple comparisons, differences were obtained between the high and low frequency use groups.

Finally, we saw that the means of all three competences increased for ICT competences with higher frequency use. The high frequency use group obtained the highest mean for all three competences: technological, pedagogical and ethical. However, the lowest value went to the low frequency use group for these three competences. According to the multivariate test, differences were statistically significant (*Wilks Lambda* =.939; $F_{(6,956)}$= 5.101, p=.000) and the effect size was small (partial η^2 = .031). The ANOVA showed statistically significant differences in the three competences (see Table 5), with a small effect size in all three cases. Scheffé's method of multiple comparisons revealed differences for technological competences between the low and the high frequency use groups. A significant difference was observed for the pedagogical competences between the low frequency use group and the other two groups.

The dimensional structure of the twenty-first century competences

This section presents the dimensional structure of twenty-first century competences for the purpose of obtaining a joint vision of the existing effects and relationships among higher-order thinking competences (critical thinking, creative thinking, self-managed learning, adaptability and problem solving), teamwork competences (communication skills, interpersonal and teamwork skills) and ICT competences (technological competences, pedagogical competences and ethical competences) in university students studying Education. Within this structure, the personal variables of gender, age, frequency of using technological devices for personal uses and frequency of using technological devices for personal-academic uses were contemplated.

To this end, a principal components analysis for categorical data (CATPCA) was used to reduce dimensionality, and to integrate the four above-cited variables into this structure at the same time.

With our results, we opted for a two-dimensional model according to the obtained values (see Table 6 and Fig. 1), which explains 50.33% of the model's total variance. The global Cronbach's α coefficient (.890) indicates that the model shows a good fit.

Table 6.- Summarised model

		Variance	
Dimension	**Cronbach's alpha**	**Total (Self-value)**	**Percentage**
1	.799	3.565	35.65%
2	.354	1.468	14.68%
Total	.890[a]	5.033	50.33%

a. Cronbach's alpha total was used in the total eigevalue

The first dimension contributed the most to explain the model (35.65% of the model's total variance), with a high Cronbach's alpha coefficient value (.799) and was, thus, the main dimension. The second dimension gave the lowest percentage to explain the model (14.68% of the model's total) and an acceptable Cronbach's α coefficient value (.354), which suggests that this dimension is a nuance of the first dimension.

Table 7. Saturations in components

Dimensions	Dimension	
	1	2
Critical thinking	.571	-.333
Creative thinking	.635	-.121
Self-managed learning	.676	-.101
Adaptability	.611	-.371
Problem solving	.761	-.080
Communication skills	.645	-.110
Interpersonal skills	.696	-.095
Technological competences	.323	.699
Pedagogical competences	.520	.628
Ethical competences	.388	.533

The **first dimension** contributed the most to explain the model (70.8% of the total explained variance), and all the studied variables in it are located on its positive side (see Table 7, Fig. 1). Two groups with the involved variables can be made out. The first set is made up of the higher-order thinking and teamwork capacities, while the second is represented by ICT competences, with a closer relationship between the pedagogical competences and the first set.

The **second dimension**, which is a nuance of the first dimension (29.2% of total explained variance), represents the differentiation among higher-order thinking capacities, teamwork competences and ICT competences. This showed that higher-order thinking capacities and teamwork competences form a set (see the negative side of the second dimension in Fig. 1) where we can see some differentiation of critical thinking and adaptability from other capacities and competences. The other set is formed by students' ICT competences, which are on the positive side of the dimension.

When we considered personal variables in line with gender, we saw that female students generally displayed a higher level of competences than male students for the first dimension. Nonetheless, male students displayed a stronger link to higher-order thinking capacities and teamwork competences for the second dimension.

We also found that the older students were, the higher their level of comeptences generally became, which agrees with the first dimension. However, the second dimension represents the link between the oldest students (23 year-olds or older) to higher-thinking capacities and teamwork competences, and 20-22 year-old students to ICT competences.

A similar pattern was observed for frequency of using technological devices for personal uses or for personal-academic uses. For the first dimension, we noted that the level of competences generally rose as students' personal/personal-academic uses of technological devices increased. The second factor dimension distinguished the students who frequently used these devices, and who were more clearly linked to ICT competences, from those students who infrequently used technological devices, and who were more closely related to higher-order thinking capacities and teamwork competences.

Finally, we were able to distinguish three groups with the dimensions of the twenty-first century competences and the personal variables. The first one corresponded to the 20-22-year old female students who frequently used technological devices for both personal and personal-academic uses. These students also showed a generally suitable level of competences, which were more linked to ICT competences. The second group was preferentially formed by male and female

students aged 23 or more who infrequently used technological devices. These male/female students were linked to higher-order thinking capacities and teamwork competences.Also, they master at lower level ICT competences. Finally, we found male and female students in the 18-19-year-old age group with a generally lower level of competences, who were more linked to ICT competences.

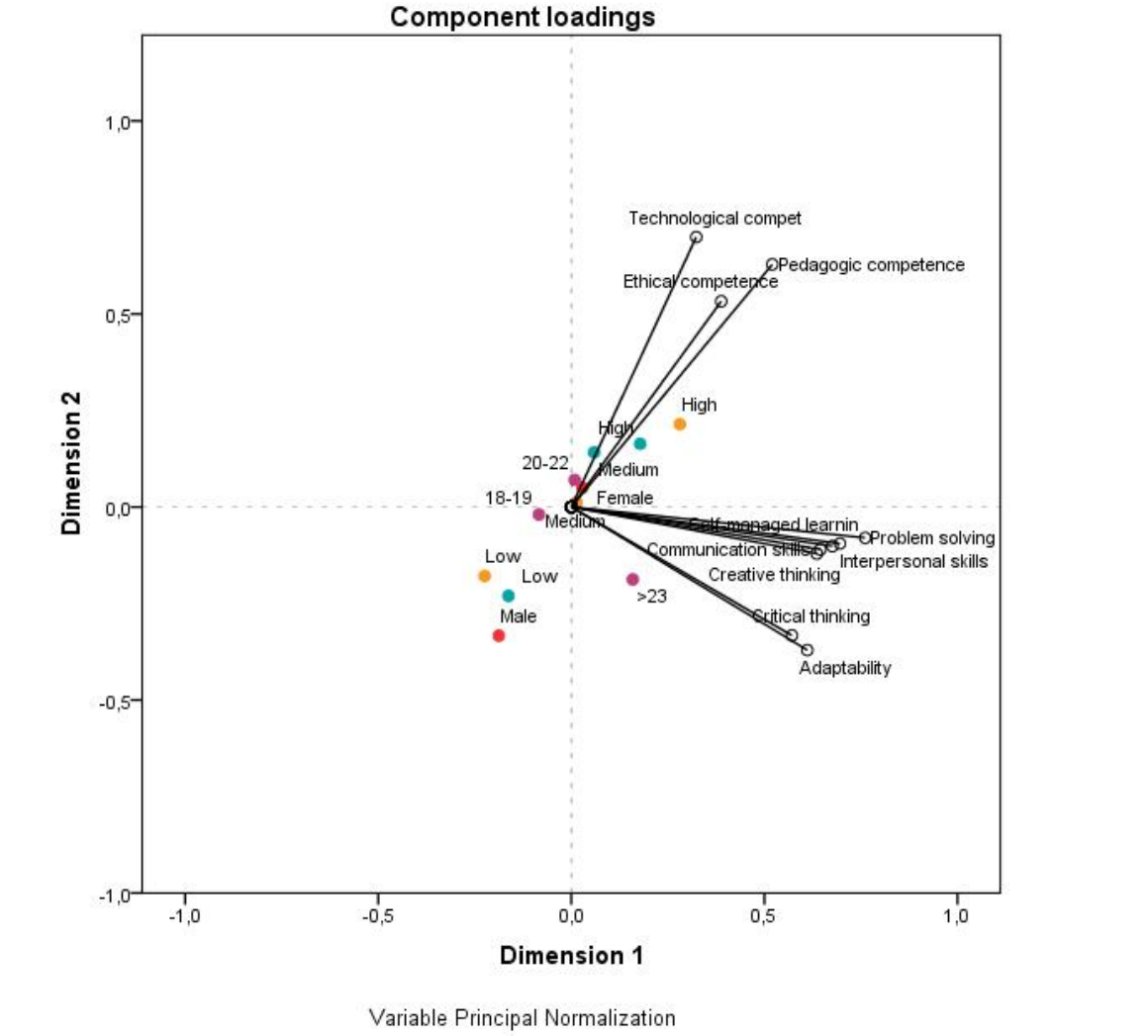

Figure 1. Dimensions and centroids in the categorical component analysis

Discussion

Our results reveal that our students' level of higher-order thinking capacities is quite high, who are characterised by presenting excellent adaptability and self-managed learning, and being well capable of problem solving and critical thinking, but for whom less emphasis is placed on creative thinking. These students are well evaluated for interpersonal skills and teamwork than for communication skills. These results partly coincide with those reported by others like Kember and Leung (2005) and by Kember,

Leung and Ma (2007). However, the sample of University of Valencia degree students obtained slightly higher mean values for all the considered dimensions.

For ICT competences, the University of Valencia students of the Degrees in the field of Education obtained a median value, with the highest value for ethical competences, followed by pedagogical competences and, finally, by technological competences. In other words, students are occasionally and regularly willing to consider the legal and ethical aspects involved in using ICT in their learning activities, and to regularly contemplate including these resources in their normal learning activities. They master technological resources as normal users, and have same limitations with the advanced functions that these resources offer. These results partly coincide with other research works (Arras et al., 2011; Díaz-García et al., 2016; Torres-Gastelú & Kiss, 2016).

We can find differences between the personal variables and the three studied constructs. For higher-order thinking capacities, female students present a slightly higher level than their male classmates, as other research works have revealed (Azizi-Fini et al., 2015; Betancourth-Zambrano et al., 2017; Molina-Patlán et al., 2016). The oldest students also present better higher-order thinking capacities, and this agrees with other studies (Azizi-Fini et al., 2015; Betancourth-Zambrano et al., 2017). We note a clear tendency for the frequency of using technological devices for both personal and personal-academic uses: the more frequently they are used, the greater students' capacity is. However, we did not obtain statistically significant differences for this tendency, unlike Cheung and Huang (2005).

When considering teamwork competences, we did not note differences in groups for both gender and age, nor in both global and univariate terms. With frequency of using technological devices for both personal and personal-academic uses, we note that the two teamwork competences (communication skills and interpersonal skills and teamwork) increase when their frequency of use increases, especially in the case of communication skills. These findings agree with those of Cheung and Huang (2005).

When we examine ICT competences, particularly technological competences, we find that male students have a higher level than their female counterparts, as previously reported in other works (Centeno Moreno & Cubo Delgado, 2013; Van Braak, 2004; Verhoeven et al., 2016; Yalman et al., 2016). However, these differences are not statistically significant, whereas female students obtain higher means for pedagogical and ethical competences. But with statistically significant differences in general and for both these competences in univariate tests. This agrees with that reported by Arras et al. (2011). We see no clear tendency for age, although the 20-22-year-old group presents a higher mean in technological and pedagogical competences. This outcome does not coincide with the results of Cabezas-González et al., (2016), whose oldest group display better ICT knowledge. For frequency of using technological devices for both personal and personal-academic uses, as this use increases, so do the three ICT competences, a finding that coincides with other research works (Baturay et al. 2017; Van Braak, 2004; Yalman et al., 2016), but was greater for personal-academic uses and in pedagogical competences.

From our results, we can delimit the dimensional structure of the three studied constructs that form a single set, as seen with the first CATPCA dimension. Nonetheless with the second dimension, we note a differentiation among the different competences as two clearly different subsets appear. A first subset is made up of the three ICT competences, while a second subset comprises higher-order thinking capacities and teamwork competences. This dimensional structure backs the proposal put forward by Ananiadou and Claro (2009), Binkley et al. (2012) and the P21 organisation (2015), which stated that different competence dimensions form distinct subsets. This structuring also allows a direct relationship to

be shown between ICT competences and higher-order thinking competences.

Moreover, the univariate perspective of the personal factors on all the subgroups was nuanced with the multivariate perspective, which allows subgroups to be established, as the results indicate. A link is formed between the 20-22-year-old students and a high frequency use of technological devices for both personal and personal-academic uses, while students better master ICT competences. The students aged 18-19 years generally present a lower level of competences, and master ICT competences slightly better. Both male and female students aged 23 or more are characterised by having better higher-order thinking and teamwork capacities, and by displaying a higher level of critical thinking and adaptability.

Regarding the first objective, the level of competences is higher for the higher-order thinking and teamwork capacities than for ICT competences. This means that universities have to devise training plans for their students to allow them to particularly improve their ICT competences and to, thus, better manage greater student integration. According to Voogt et al. (2013), we should not take it for granted that today's male/female students have acquired the necessary ICT competences because they were born in a digitalised society.

Regarding the second objective, we found that the personal factors influenced the twenty-first century competences. The differentiation found in the studied personal factors in the set of twenty-first century competences in both uni- and multivariate terms allows training plans to be considered from a better adapted student perspective.

As for the third objective, a direct link was established among the two subsets that form the twenty-first century competences, ICT competences and higher-order thinking competences, where higher-order thinking and teamwork capacities are found. These results stress the multiple interdependent nature of the twenty-first century competences (Chai et al., 2015). Therefore, ICT competences must not be contemplated as a set of competences separated from higher-order thinking ones (Voogt et al., 2013).

This study has several limitations as it was conducted with a sample of students from the degrees of Education at the University of Valencia. Thus, it is necessary to replicate this study with other universities and degrees to be able to generalise the twenty-first century competences model.

Future research must focus on better delimiting twenty-first century competences, as suggested by Oudeweetering and Voogt (2018), to delimit competence-based frameworks that agree with twenty-first century competences and in a unequivocable manner (van de Oudeweetering & Voogt, 2018). To this end, we beleive it is necessary to develop measurement instruments that better outline twenty-first century competences. It is also necessary to consider the proposal by van Laar et al. (2017) of analysing the interaction between both subsets of competences, and ICT competences, from the high skills perspective. Finally, the magnitude of the relationship established between both subsets must be verified.

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Authors / Autores	To know more / Saber más
Almerich, Gonzalo Professor of the Area of Research Methods and Diagnosis in Education (MIDE) of the University of Valencia. Member of the Educational Technology Unit at said university. He is the corresponding author for this article. His postal address is Faculty of Philosophy and Educational Sciences. Blasco Ibáñez Av., 30. 46010-Valencia (Spain).	ORCID 0000-0002-8952-4104 ResearchGate
Díaz-García, Isabel (idiazgar@uv.es) Professor of the Area of Research Methods and Diagnosis in Education (MIDE) at University of Valencia. Member of the Educational Technology Unit at said university. Her postal address is Faculty of Philosophy and Educational Sciences. Blasco Ibáñez Av., 30. 46010-Valencia (Spain).	ORCID 0000-0002-2637-8736 Google académico ResearchGate
Cebrián-Cifuentes, Sara (saracebriancifuentes@gmail.com) Pedagogue and Master's degree in Polities, Management and Organisation of Educational Organisations, a Master's degree in Technological Innovation in Education and a Master's degree in Teacher Training in Secondary Education. Currently she is a member of the research Personnel receiving Training (FPU 2014) in the department of Research Methods and Research Diagnosis in the Faculty of Philosophy and Education Sciences at University of Valencia. Her address is Blasco Ibáñez Av., 30. 46010-Valencia (Spain).	ORCID 0000-0002-2120-8113 Google académico
Suárez-Rodríguez Jesús (Jesus.M.Rodriguez@uv.es) Chair of Research Methods in Education at the Faculty of Philosophy and Educational Sciences at University of Valencia. He is coordinator of the Educational Technology Unit at the University of Valencia. His work focuses on the methodological, analytical and measurement elements in the fields of Social Sciences and Health. His mailing address is Faculty of Philosophy and Educational Sciences. Blasco Ibáñez Av., 30. 46010-Valencia (Spain).	ORCID 0000-0002-2815-7988 Google académico ResearchGate

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