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Development of the digital competence in Secondary Education Teachers' Training

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Abstract: Digital competence is one of the 8 key competences for life-long learning developed by the European Commission, and is requisite for personal fulfilment and development, active citizenship, social inclusion and employment in the knowledge society. To accompany young learners in the development of the competence, it is necessary that parents and teachers are, in turn, literate. The level of Teacher Digital Competence of 43 Secondary School teachers in initial training was evaluated using the Common Framework, a series of rubrics for 21 sub-competences in 5 areas. The overall level of competence was low (Basic). Students scored highest in Information, which refers mostly to the operations they performed while students. Secondly, in Safety and Communication, excluding Protection of Digital Data and preservation of the Digital Identity. Lowest values were achieved in Content Creation and Problem Solving, the dimensions most closely related with the inclusion of ICTs to transform teaching-learning processes. The knowledge or skills they exhibit are largely self-taught and, so, we perceive an urgent need to purposefully incorporate relational and didactic aspects of ICT integration.

Keywords: Common Framework of Teacher Digital Competence; Digital Competence; Digital Communication; Digital Content Creation; Informational literacy; Problem Solving; Safety; Teacher Training.

1. Introduction

In late 1997, the OECD launched the DeSeCo Project, with the aim of providing the conceptual basis required to identify key competences, or competences that individuals need to acquire to be prepared for life's challenges [1]. These may include individual demands - employability, personal development - as well as collective challenges – such as balancing economic growth with environmental sustainability, and prosperity with social equity. In these contexts, the competencies that individuals need to meet their goals have become more complex, requiring more than the mastery of certain narrowly defined skills.

Very shortly after, the European Commission recognised the importance of life-long learning as the response to the ongoing globalization and shift towards knowledge-based economies, and already in 2005 urged the Member States to adapt their educative systems to provide the young with the key competencies required to engage in life-long learning. Although competencies exceed by far simple knowledge or skills - competency means the ability to meet complex demands, by drawing on and mobilising knowledge, skills and attitudes in a particular context- competencies can and should be taught at school.

The Recommendation of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning [2] was intended to provide a common European reference framework on key competences for policymakers, education and training providers, the social partners and learners themselves, and support other related policies such as employment and social policies and other policies affecting youth. The recommendation identified a set of 8 competencies

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that all individuals need for personal fulfilment and development, active citizenship, social inclusion and employment.

One of these 8 competences was the Digital Competence, defined as the creative, critical and safe use of Information and Communication Technologies (ICT), to reach goals related with work, employability, learning, leisure, inclusion and social participation. Digital competence involves basic technical mastery, but also the development of abilities to (1) browse, evaluate and manage information; (2) communicate and collaborate; (3) create digital contents; (4) preserve safety; (5) solve problems, both in formal, non-formal and informal learning contexts [3]. The acquisition of this competence also requires attitudes and values that allow the user to adapt to the new needs established by the technologies, their appropriation and adaptation to their own purposes and the ability to interact socially around them. Digital competence not only allows individuals to take advantage of the wealth of new possibilities associated with digital technologies and the challenges they pose; it is also increasingly necessary to participate meaningfully in the new knowledge society and economy of the 21st century. *Media literacy* [4] enables the literate person to fully develop as an active and free member of a society surrounded by innumerable media.

With this in view, educational policies have made evident efforts to introduce ICT in schools [5,6]. Some studies have shown that integration of ICT in the primary education stage significantly improves the practical knowledge of applications and programmes, and also that this contributes to developing skills and fosters the active and autonomous role of the student [7]: digital competence implies motivation and curiosity for learning and improvement in the use of technologies. However, the increasing penetration of ICT in our classrooms, and also in quotidian contexts outside the school, does not guarantee that students develop satisfactorily their digital competence.

This highlights the need to ensure an adequate development of the digital competence of teachers. First, and taking into account the role of the teacher as an architect of the teaching-learning processes, to foster their ability to properly integrate ICTs in their teaching to transform it ; secondly, as a tool for professional development; third, but not least because of their position as an adult reference for children and adolescents.

In fact, the digital literacy training of teachers and families was recognised as part of the education objectives for the decade 2010-2020, proposed by the Ministry of Education [8], partly because many adults (parents and teachers) are unable to guide the children in the use of proper codes and responsible utilization of ICTs [9]. One of the reasons of this difficulty might be [10] the inversion of the educative system: whereas in the first half of the 20th century it was the adults who transmitted the knowledge and the necessary experience map, now young people have a better knowledge of the new codes [9]. Garrido- Lora *et al.* [10] call this phenomenon "generational digital divide", which is revealed by "the existence of evident differences between generations both in knowledge and in the use of ICT and social networks" (p.52). Teachers could often be considered *visitors* in the technological world, as they access technologies only when it is necessary, and not routinely and naturally, as young people do [11]. Adults (both the family and in the school) must acquire the proficiencies of the new literacy that will allow them to overcome the digital and inter-generational divide [8], as it is essential "that everyone (parents, tutors, teachers, institutions and governments) work together to create safe and accessible environments for children and young people, wherever they are: at home, at school or in public facilities" [12]. In consequence, both the school and the families face the challenge of contributing to promote the necessary media and digital literacy [8] and to reduce the generational digital divide [10].

Teachers' training programs (both initial and continuous training) have lived for a long time with their backs to this demand, but it is high time researchers or institutions assessed the real situation of this collective, for managers to introduce the measures that are required. The Master's Degree in Secondary School Teacher seems an ideal context to carry out this inquiry. According to the Organic Law of Education 2/2006 of 24th of May, this Master's Degree is a required qualification for teachers in compulsory and upper-secondary education, and in vocational training. The main objective of this Master's degree is to train students as secondary education teachers, i.e. professionals equipped to teach the subjects pertaining to their discipline, so it has a professional orientation.

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Students are themselves (at least a part of them) "digital natives" [13], and are being trained to work with 12 to 18-years old teenagers, among which autonomous learning and safety in the inter-personal interactions are of paramount importance.

Taking all this into account, the objective of this work is two-fold:

1. To identify the level of digital competence among students of the Master's Degree in Secondary School Teaching
2. To identify priority areas to be addressed in initial teacher training

2. Materials and Methods

The sample is comprised of 44 students of the Biology and Geology speciality of the Master's Degree in Secondary School Teaching of the *** *geographic range omitted* ***. The study was performed within the context of the subject "Introduction to Educational Research and Innovation", during 3 academic courses: 2015/16, 2016/17 and 2017/18. In all the 3 years the described exercise took place in the last weeks of the course, prior to the beginning of the internship period, so that it can be considered that the students had been delivered most of the contents in the training program.

As for the scope of this paper, we will use the definition of Digital Teacher Competence contained in the Common Framework of Digital Competence [14], which specifies and develops the key ideas in the DIGCOMP project [15]. This document is the result of the process of joint reflection by the Ministry of Science & Education, Autonomous Communities and experts, aimed to serve as a reference in processes of certification and training. The Common Framework is composed of 21 sub-competences in 5 areas (Table 1) and includes a rubric, which specifies performance criteria at three levels (Initial, medium, advanced) for each of the 21 items. Recently a new version (v2) was released, including a more nuanced definition with 6 levels of performance [16].

Table 1. General description of the 5 areas of Teacher Digital Competence

Area	General description	Subcompetences
Information and information literacy	Identify, locate, obtain, store, organize and analyze digital information, evaluating its purpose and relevance.	Navigation, search and filtering of information, data and digital content Evaluation of information, data and digital content Storage and retrieval of information, data and digital content
Communication and collaboration	Communicate in digital environments, share resources through network tools, connect with others and collaborate through digital tools, interact and participate in communities and networks, intercultural awareness.	Interaction through digital technologies Share information and contents. Citizen participation online. Collaboration through digital channels. Netiquette Digital identity management
Digital content creation	Create and edit new digital content, integrate and re-elaborate previous knowledge and content, make artistic productions, multimedia content and computer programming, know how to apply intellectual property rights and licenses for use.	Development of digital content Integration and reworking of digital content Copyrights and licenses. Programming
Safety	Protection of information and personal data, protection of digital identity,	Protection of devices and digital content

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	measures of safety, responsible and safe use.	Protection of personal data and digital identity. Protection of health and well-being Protection of the environment
Problem-solving	Identify needs for the use of digital resources, make informed decisions about the most appropriate digital tools according to the purpose or need, solve conceptual problems through digital media, use technologies in a creative way, solve technical problems, update their own competence and of others.	Solving technical problems Identification of needs and technological answers. Innovation and use of digital technology in a creative way. Identification of gaps in digital competence.

Following a theoretical session (45 minutes) in which the concept of (teacher) digital competence and the 5 areas were introduced, the students evaluated themselves, at home, using the rubric [14], and submitted the evaluation. The data were discussed the following day, in class, and the students were given the opportunity to correct wrong interpretations in their exercises and to resubmit them. Only the last version was considered.

All the data recorded are available as Supplementary Material (Table S1 Dataset).

3. Results

3.1. Description of the research subjects

43 students in total (13- 17 per year) completed the activity. Students had previously completed degrees in Biology, Geology or Environmental Sciences and, exceptionally, careers related to health or engineering. Most students access the Master right or shortly after having finished their degree, although a few of them have professional experience in teaching (mostly informal) or research.

In general terms, the average age was 29.65 years (range 23-50), and they had been in (limited) contact with ICTs in the role of students. The sample was fairly gender-balanced (26 female/ 17 male).

3.2. Levels of Teacher Digital Competence

Overall, future teachers have a low level of Digital Competence: over 50% of the respondents placed themselves at a basic level in 14 of the 21 sub-competences, and in only 3 items more than 20% considered to be at an advanced level.

There were differences among areas (Kruskal- Wallis; $F=25.18$; $df=4$; $p<0.001$): scores for Information were higher than for any of the other areas, without significant differences between them (Tukey contrasts; Figure 1). The Master students taking part in the survey scored highest in Information (search, filtering, evaluation, storage and retrieval of information, data and digital content) (Table 2 and Figure 2).

Safety was the second most valued category: nearly one fourth of the students (21.2-26.5%) placed themselves at the advanced level in three of the 4 sub-competences in the area; namely, Protection of devices and digital content (4.1), Protection of health and well-being (4.3) and Protection of the environment (4.4). It is noteworthy that 53% of the Master students declared a basic level (1) on Protection of personal data and digital identity (4.2).

As for the area of Communication, the students felt prepared (at an intermediate level) to interact and share information and content (2.1; 2.2), but it is notable their unawareness about codes in the digital communication and preservation of the digital identity (2.5; 2.6).

Likewise, Master students were able to identify needs and come up with technical solutions (or seek for specialized help) (5.1; 5.2), but fail to innovate with technologies (5.3) and to identify gaps in their own digital competence (5.4).

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Last, Content Creation was the least developed area of competence, with over 60% of the students placed at a basic level in all the 4 indicators, including not only teacher-specific tasks, such as Development of Digital Content (3.1) and Integration of Digital content (3.2), but also the existence and proper use of copyright and licenses (4.3).

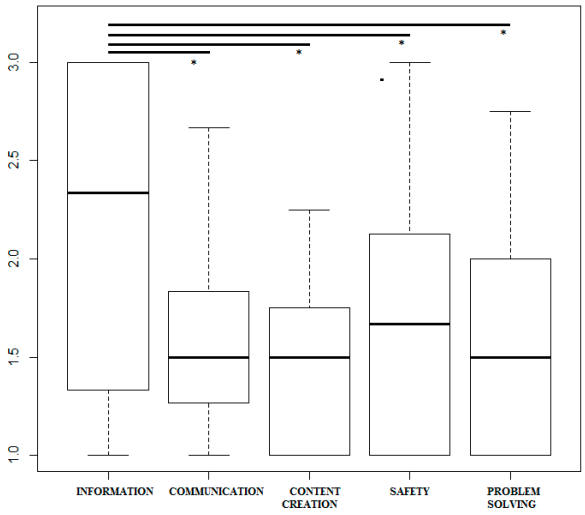

Figure 1. Mean scores per area of competence [14]. The asterisk (*) indicates significant differences ($p<0.05$).

Table 2. Percentage of students at each level of competence, for 21 sub-competences in 5 areas [14] as described in Table 1

Area	item	(1) basic	(2) intermediate	(3) advanced
Information	**I1.1**	48.6	50.0	2.9
	I1.2	40.0	44.1	17.6
	I1.3	37.1	50.0	14.7
Communication	**C2.1**	34.3	55.9	11.8
	C2.2	42.9	47.1	11.8
	C2.3	62.9	32.4	5.9
	C2.4	57.1	38.2	5.9
	C2.5	51.5	43.8	3.1
	C2.6	51.4	44.1	5.9
Content creation	**CC3.1**	57.1	41.2	2.9
	CC3.2	71.4	29.4	0.0
	CC3.3	67.6	21.2	12.1
	CC3.4	70.6	27.3	0.0
Safety	**S4.1**	40.0	38.2	23.5
	S4.2	52.9	39.4	9.1
	S4.3	47.1	33.3	21.2
	S4.4	45.7	29.4	26.5
	R5.1	42.9	55.9	2.9

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Problem-solving	**R5.2**	51.4	50.0	0.0
	R5.3	57.1	29.4	14.7
	R5.4	57.1	35.3	8.8

Most frequent category (1,2,3) is shadowed. Red for basic, Orange for Intermediate Whenever two categories differ less than 5%. both are shadowed.

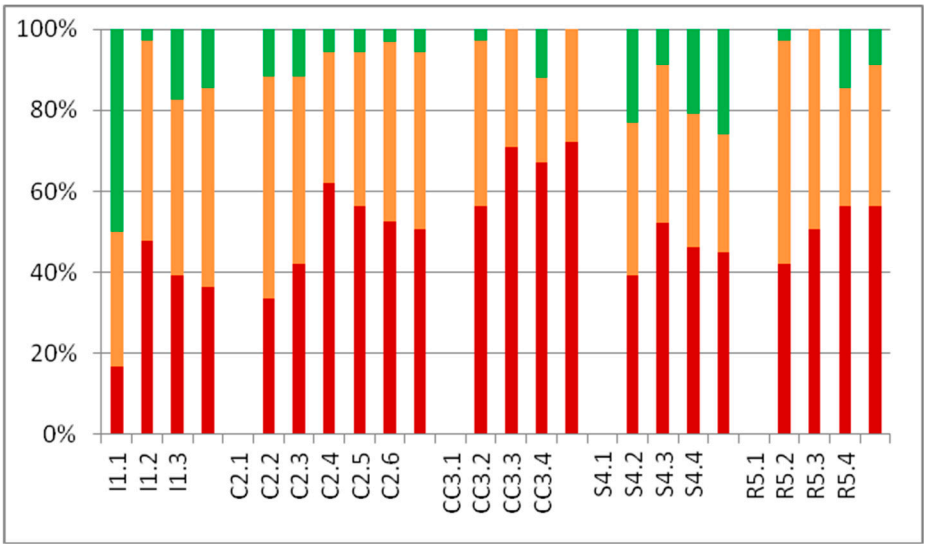

Figure 2. Cumulative percentage of students at basic (red), intermediate (orange) and advanced (green) levels

3.3. Among groups comparison

There was no difference in the level of competence with sex, neither globally (Wilcoxon's W=5322; p=0.498) nor when considering separately each area.

However, there was a negative correlation in the level of digital competence with age (rho=-0.140; p=0.012), which was mostly due to differences in Content Creation.

4. Discussion

Teachers in their initial training reach, in general, a low level of Digital Competence, as defined by the INTEF (2013) in the Common Framework of Teacher Digital Competence, which defines and develops the key ideas included in the DIGICOMP project [15]. Although high school students have incorporated the ICTs into their daily lives, they are by no means the experts we could imagine, and they are not aware of the risks of using them badly [17]. This raises concern about their ability to incorporate technologies into their routine classes, in an adequate and standardized way [18]. These data reveal they are far from acquiring the new competences that are necessary for digital ecosystems: learn throughout life (life-long learning), make maximum profit from ICTs to adapt and evolve thinking and learn to learn [19]

In general, they are most competent in the dimensions in which they were trained as students (or, at least, exposed to): interacting and sharing information (*Communication)*, and browsing, storing and retrieving digital data and contents (*Information*). These could be considered instrumental and intellectual- cognitive skills [20] are mainly technical, instrumental skills, though: for example, even if they know how to use the technologies to mediate interaction, they are unaware of the codes used in digital media (n-etiquette), the concept of digital identity or unable to generate true cooperation on-line.

Problem Solving and *Content Creation,* which partly participate of the *sociocultural* competences described by [20] are the least developed areas, in spite of being the most closely related with the work of teachers they will eventually carry out. We must we aware that the implementation of new

ICT- mediated technologies relies on both the students and teacher having acquired information, media and communication literacy (i.e. digital competence) [21]. Not until students learn to innovate using digital technology in a creative way will the ICTs become LCT (Learning and Communication Technologies); i.e. realize their potential to impact learning and, lastly, transform education.

Although it must be acknowledged that the students taking part in the exercise had not yet finished their initial training, our results suggest they had not received enough training, or it had not been very effective in promoting their Digital Competence. Anecdotic data retrieved from informal conversations with students suggest that their actual level of competence has been acquired through informal experiences and self-teaching, but not as a result of a purposeful training in the context of e.g. Teachers' Training Programmes. Although there is a weak association with age, being young (i.e. supposedly "*digital native*" (*sensu* [13]) does not guarantee an adequate level of professional skills development. Becoming literate implies knowing and using technologies, and not only using them [4]. From our perspective, there is a real need of wisely designed training programs (whether initial training for novice teachers or continuous training) which help to close this divide between the demands posed by the Knowledge Society and the end-of-course profile of newly formed teachers. In this sense, we found very useful the aforementioned Common Framework for Teacher Digital Competence [16], which aids in identifying these gaps and designing corrective or compensatory measures.

Although Safety is the second best area, there are still notable difficulties. Worrying enough, students most often consider they are at a basic level in Protection of personal data and Digital identity; and, likewise, in citizen participation, n-etiquette and management of their digital profile (Area of Communication). This both belong to the *axiologic* and *emotional* competences [20]. The individuals being able to interact socially around new technologies to participate actively in the new knowledge society requires using responsibly and respectfully the ICTs, and adults (teachers and families) must be accountable for this objective. If they are to serve as a reference for students, it is essential that the teachers are acquainted with these concepts, and able to apply them to their own interactions, whatever their speciality is. Thus, notwithstanding the importance of the didactic aspects of ICTs (or their contribution to learning and acquisition of skills), the relational components of the Digital Competence should also be given priority in training initiatives.

Supplementary Materials: The following are available online, Table S1: Dataset.

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