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Digital Literacy of Teachers in Training: Moving from ICTs (Information and Communication Technologies) to LKTs (Learning and Knowledge Technologies)

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Abstract: This study is based on the need to work on the digital literacy of our Infant Education degree, Primary Education degree and Master in Secondary Education students so that, as future teachers, they are able to make the necessary transition from ICTs (Information and Communication Technologies) to LKTs (Learning and Knowledge Technologies) Through a mixed methodology, knowledge and perceptions of basic technological concepts and tools of our trainee teachers are identified. The instrument used has been a Likert scale questionnaire, adapted and validated by experts from the participating universities. Its internal consistency demonstrates its worth and functionality for the proposed analysis ($\alpha = 0.958$). The first results show a clear lack of knowledge of certain technological concepts essential for their future teaching work and, in turn, show significant differences regarding the knowledge of ICTs according to the age of the participants.

Keywords: trainee teachers; ICTs (information and communication technologies); LKTs (learning and knowledge technologies); TPACK (technological pedagogical content knowledge)

1. Introduction

Within the context of the University of Alicante's (Spain) University Teaching Research Networks Project entitled 'Teacher Training in ICTs and LKTs from an Interdisciplinary Perspective: Challenges for the Twenty-First Century' (AU/3719/18-19), we began, in September 2018, a study in which we analysed the digital literacy level of trainee teachers at the universities of Alicante, Burgos, the Balearic Islands, Strasbourg, and Porto. We ran into great difficulty assessing how trainee teachers' digital literacy is evolving in these contexts. Another difficulty concerned which tool we could use to allow us to assess their technological knowledge or whether they are acquiring the appropriate methodological knowledge for the proper didactic use of information and communication technologies (ICTs) in their teaching work.

The scientific literature shows that the use of ICTs in the classroom remains limited [1]. It is not intended to promote constructivist and meaningful learning [2,3] and it is mainly applied outside the classroom for class preparation [4]. Research also shows that, despite the positive perception by teachers about the educational potential of ICTs from the early stages of education, there are important obstacles in relation to their previous experience [5], and their initial training and professional development [2,6,7].

Research has demonstrated that ICTs alone do not create knowledge [8–12]. Providing education on virtuality today supposes new forms of pedagogical implementation that facilitate the incorporation

of new technologies into teaching and learning processes in an innovative way [13]. This inclusion requires future teachers to become familiar with learning and knowledge technologies (LKT), which involves the use of these technologies as instruments to facilitate learning and disseminate knowledge. For this reason, as Cabero [14] has indicated, the use of these tools must be directed towards more training-focused applications, both for teachers and students, with the aim of facilitating more meaningful and higher-quality learning. This would mean that teachers in training within education faculties would, as future teachers, apply these tools to produce educational innovations, seeking new uses for them as they implement them rather than simply reducing them to mere technological instruments [8,9,14,15].

The current body of literature on the integration of new technologies in the educational context is unanimous in asserting that it is not enough to equip trainee teachers with ICTs, and that the process should be accompanied by the methodological knowledge required to use these technologies to generate meaningful learning [14,16,17]. From this perspective, we take the view that one of the biggest challenges posed in relation to teacher training is undoubtedly pedagogical innovation and the improvement of learning through the proper use of ICTs. The problem, as Sancho [18] has indicated, consists in how to turn the powerful and increasingly sophisticated information and communication tools into instruments for learning and knowledge, and how to teach our trainee teachers that 'the transition from ICT to LKT (. . .) is not a simple one' (pp. 20–21). However, in our opinion, such a transition is necessary in education in the twenty-first century. If we do not turn ICTs into LKTs, we will fail to take advantage of some very important resources, while also 'diminishing the quality of education rather than improving it' [19].

Moreover, these reflections are framed by an affirmation that has become commonplace in recent studies on the issue and that, through our research, can be fully corroborated: there is a need to review the technological competence of trainee teachers. As Cabero [14] emphasises, whatever label one applies to today's students (digital natives, Generation Y, Generation Z, and so on), the reality is that teachers in training are not as technologically competent as certain works in the literature have led us to believe [20]. For this reason, it has become necessary for basic and further ICT training of future teachers to take place in contexts that are not exclusively focused on instrumental and technological aspects [10]. Instead, broader competence training of the kind proposed in the TPACK (Technological Pedagogical Content Knowledge) model is required.

This model was developed by Punya Mishra and Matthew J. Koehler of Michigan State University between 2006 and 2009. It identifies the types of knowledge that teachers must master in order to integrate ICTs effectively in their teaching. It is included in cognitive models in cooperative environments and where technology is used. Through this model, which is based on the proposals of Shulman [21], it is possible, on the one hand, to verify attainment of teachers' basic knowledge (TBK) and, on the other, to analyse proper use of ICTs in the classroom by future teachers.

According to the TPACK model, the effective use of ICTs must, in effect, incorporate three specific dimensions: technological knowledge, content knowledge and pedagogical knowledge [22] (Figure 1). The integration of these dimensions should be possible from the initial teacher training [23,24]. The relevance of this model in relation to the integration of technologies in teacher training and in teaching and learning (T-L) processes is clear, and this is apparent from the many publications related to it [25–29]. An extensive literature is devoted to analysing this model in the context of teachers' initial and ongoing training. By the same token, Anderson and Barham [30] focus on evaluating the role of ICTs in T-L processes among teachers of different subjects. Their results not only allow us to quantify teachers' ability to use technologies, but they also enable us to make predictions about the needs of practising teachers as well as those in training.

In terms of future teachers' acquisition of knowledge, Roig and Flores [31] point out that although this group possesses a high level of 'content knowledge', the same is not true when it comes to their 'technological knowledge'. On a similar note, Tsai and Chai [32] differentiate between new and experienced teachers and their perception of the mastery of TPACK components. Their research

specifies that whereas experienced teachers believe they have better credentials in relation to 'didactic' and 'conceptual' knowledge, new teachers highlight their 'technological' qualifications.

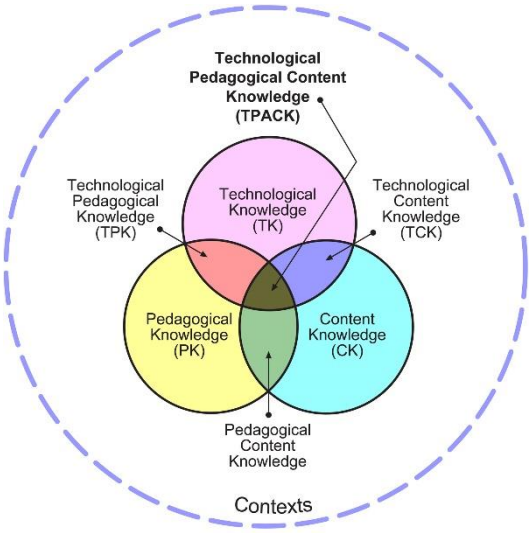

Figure 1. The TPACK model. Source: Mishra and Koehler [33].

This context that combines pedagogy, subject-specific content, and technologies is where we situate our study, in which we seek to answer two major questions in the current educational landscape: What knowledge do future teachers have of concepts such as ICTs, LKTs, MOOCs (Massive Open Online Courses), NOOCs (Nano Open Online Courses), gamification, and transmedia storytelling? What technological competences do trainee teachers in the twenty-first century have?

2. Materials and Methods

2.1. Description of the Context and the Participants

The research presented in this article is descriptive and was conducted using a mixed model that includes quantitative and qualitative elements [34] with the aim of obtaining a complete picture of the phenomenon addressed. Regarding the quantitative approach, we used a descriptive non-experimental design using a questionnaire. For our qualitative analysis, we followed a procedure of data reduction, categorization, and subsequent codification based on the open-ended responses elicited from the instrument implemented. The research was conducted in the context of the Teaching Innovation and Research Network project 'Teacher Training in ICTs and LKTs from an Interdisciplinary Perspective: Challenges for the Twenty-First Century' (UA 4351REDESICE18), to which various European and Spanish universities have contributed. Non-probabilistic convenience sampling was used, and the sample comprises 331 participants from the universities of Strasbourg, Porto, Burgos, and Alicante (Table 1).

Table 1. Sample distribution by genre and studies.

Studies	Women	%	Men	%	Total
Bachelor's Degree in Infant Education	58	17.5%	24	7.3%	82
Bachelor's Degree in Primary Education	61	18.5%	39	11.7%	100
Master's Degree in Secondary Education	96	29.0%	53	16.0%	149
Total	215	65%	116	35%	331

The courses of the sample members from each university are as follows in Table 2:

Table 2. Courses of the sample members' universities.

University	Code	Course	Subject
Alicante	17216	Bachelor's Degree in Infant Education 2nd	Teaching Social and Cultural Environment
	17541	Bachelor's Degree in Primary Education 3rd	Teaching Spanish Language and Literature for Primary Education
	17530	Bachelor's Degree in Primary Education 4th	Teaching of Reading and Writing
	17523	Bachelor's Degree in Primary Education 2nd	Teaching of Social Sciences: Geography
	17533	Bachelor's Degree in Primary Education 3rd	Teaching of Social Sciences: History
	12140	Master's Degree in Secondary Education	Practicum II
	12059	Master's Degree in Secondary Education	Research, Innovation and use of ICT in the Teaching of Language and Literature
Burgos	07240	Master's Degree in Secondary Education	Teaching Innovation and Initiation to Educational Research in Social Sciences
Strasbourg	Professeurs des écoles 2e année (1er degré)		Master Mention MEEF (Métiers de l'Éducation et de la Formation)
	Professeurs des Lycées et Collèges, 2e année (2nd degré)		Master Mention MEEF (Métiers de l'Éducation et de la Formation)
Oporto	Mestrado em Ciências da Educação (1°)		Avaliação de Programas de Intervenção Sociocomunitária

2.2. Instrument

The analysed variables were measured through a mixed questionnaire composed of 17 items and organised into two sections. The first section concerns a set of socio-economic aspects (gender, age, programme of study; items 1–3), while the second is divided into two subgroups of questions. The first subgroup comprises questions about concepts such as ICTs, LKTs, MOOCs and NOOCs, and transmedia storytelling (items 4, 8, 10, 12, 13, 15, 17), and the second features questions relating to knowledge and perceptions of these resources in relation to teacher training (items 5, 6, 7, 9, 11, 14, 16) (Table 3).

Table 3. Researcher's instrument.

Item	Question
Item 1	Sex
Item 2	Age
Item 3	Studies you are currently doing
Item 4	I know the ICT concept and I understand its meaning
Item 5	ICTs help improve teaching processes
Item 6	I consider that my training in new technologies is
Item 7	ICT helps the acquisition of skills learning
Item 8	I know the TAC concept and understand its meaning
Item 9	I believe that TACs help me in my training as a future teacher
Item 10	I know what Gamification is and I understand its meaning
Item 11	I believe that Gamification helps me in my training as a future teacher
Item 12	I know the MOOC concept and I understand its meaning
Item 13	I know the NOOC concept and I understand its meaning
Item 14	I believe that MOOCs and NOOCs help me in my training as a future teacher
Item 15	I know the concept of Transmedia Narrative and I understand its meaning
Item 16	I believe that Transmedia Narratives help me in my training as a future teacher
Item 17	Innovating in teaching is

The questionnaire deploys a Likert scale of five response options that range from 'completely agree' (CA) to 'completely disagree' (CD). We also added an open question that allowed us to collect the qualitative data of the study. To conduct quantitative analysis of the data, we calculated descriptive statistics, such as mean and standard deviation, using SPSS v. 23 for Windows. As for the instrument's reliability coefficient, we obtained a Cronbach's alpha of $\alpha = 0.958$, indicating a high level of reliability.

2.3. Procedure

As previously mentioned, our research and analysis are situated in the context of different higher education institutions, and our study took place over one academic year (2018–2019) and within the various courses listed in Table 2. In terms of our procedure, we used a non-experimental methodology that was organised into three phases. The first focused on the development and validation of the instrument of analysis (mixed questionnaire); the second focused on the online distribution of the questionnaire, which was prepared using Google Forms; and the third consisted in processing and analysing the initial results obtained from implementing the instrument.

The first step of the statistical analysis was a descriptive analysis of the data. Specifically, we obtained mean (=*M*) and standard deviation (=*SD*). To compare the effect of age and programme of study on ICT and LKT knowledge for the purposes of their proper integration according to the TPACK model, we conducted a one-way ANOVA. Furthermore, with the aim of establishing the relationship between the different variables, we used the Pearson correlation coefficient.

3. Results

3.1. Descriptive Analysis

The study is based on the structure of the questionnaire described above. This instrument is based on the proposals of Gómez-Trigueros [28], and Ortega-Sánchez and Gómez-Trigueros [35] for the analysis of perceptions about technologies in educational contexts, based on the TPACK teaching and learning model. Table 4 shows the descriptive statistics obtained:

Table 4. Descriptive analysis of the questionnaire research.

Item	*M*	*SD*
4	4.11	0.712
5	4.31	0.760
6	3.85	0.798
7	3.99	0.965
8	2.32	1.003
9	2.50	0.998
10	4.45	0.839
11	3.99	0.845
12	3.05	0.922
13	3.78	0.806
14	2.99	1.074
15	4.08	0.871
16	4.14	0.977

In general, we observe a good attitude to and knowledge of ICT as a concept ($M = 4.11$; $SD = 0.712$), and recognition of it as a resource for improving teaching processes ($M = 4.31$; $SD = 0.760$). Along the same lines, trainee teachers know what gamification (item 10: $M = 4.45$; $SD = 0.839$) and transmedia storytelling (item 15: $M = 4.08$; $SD = 0.871$) are. On the other hand, a different pattern can be observed for the questions regarding knowledge of other technology-related concepts, such as LKTs (item 8: $M = 2.32$; $SD = 1.003$) or MOOCS (item 12: $M = 3.05$; $SD = 0.922$) and NOOCs (item 13: $M = 3.78$; $SD = 0.806$).

Where questions refer to consideration of all of these tools in participants' teacher training, the results obtained are mixed. When asked about their perceptions of their own ICT training, the trainee teachers have doubts about this capacity (M = 3.85; SD = 0.798), though they do attribute significant value to it for the acquisition of competences, as shown by the responses to item 7 (M = 3.99; SD = 0.965). By contrast, they afford little importance to LKTs (item 9: M = 2.50; SD = 0.998) or to MOOCs and NOOCs (item 14: M = 2.99; SD = 1.074) in teacher training. This is not the case when they are asked about the use of gamification (item 11: M = 3.99; SD = 0.845) or transmedia storytelling (item 16: M = 4.14; SD = 0.977) in teacher training; they positively assess the use of such resources for the purposes of their professional training.

3.2. Comparison of Means According to Age and Programme of Study with Knowledge of Concepts Relating to Teaching Technologies

We then conducted a one-way ANOVA to compare the effect of age and programme of study on knowledge of key concepts such as ICTs, LKTs, MOOCs, NOOCs, gamification, and transmedia storytelling. Regarding participant age, the 331 sample members were organised into five sub-groups; their distribution is shown in Table 5.

Table 5. Age and programme of study of the sample.

Studies	Age Groups					
	21	**22**	**23–29**	**30–40**	**+40**	**Total**
Bachelor's Degree in Infant Education	53	8	31	6	5	103
Bachelor's Degree in Primary Education	52	15	19	6	1	93
Master's Degree in Secondary Education	0	49	63	18	5	135
Total	105	72	113	30	11	331

The ANOVA results (Table 6) emphasise that age has a significant effect on technological knowledge at the level of $p < 0.05$ for the conceptual factors studied. In the case of the concept of ICTs [F = 4.379; p = 0.006], there is a major difference between, on the one hand, participants aged 21 years (M = 4.12), between 30 and 40 years (M = 4.28), and over 40 years (M = 4.21) and, on the other hand, participants aged 22 years (M = 3.67) and between 23 and 29 years (M = 3.80); the mean values for these two groupings are distinctly different. Similarly, the results on the concepts of gamification [F = 4.123; p = 0.011] and transmedia storytelling [F = 4.773; p = 0.001] show important differences between the age groups analysed. This is also the case for the concept of LKTs [F = 4.065; p = 0.015]; the means for the intermediate age groups (22, 23–29, and 30–40) are around 2 ($M \leq 2.2$), while the means for the age groups at the extremes (21 and over 40) are over 3 ($M \geq 3.06$). In the case of the concept of MOOCs [F = 4.549; p = 0.008], the disparities between means are similar (21 and over 40: M ≥ 3.40; 22, 23–29, and 30–40: $M \leq 2.26$). However, no significant differences appear between the age groups (M ≥ 2.28) in relation to the concept of NOOCs [F = 1.098; p = 0.351].

Table 6. Mean and analysis of ANOVA variance according to sample age.

Factors	Mean of Each Age Group					ANOVA	
	21	**22**	**23–29**	**30–40**	**+40**	**F**	***p***
Item 4	4.12	3.67	3.80	4.28	4.21	4.379	0.006
Item 8	3.20	2.03	2.15	2.02	3.07	4.065	0.015
Item 10	4.51	3.98	3.95	3.58	4.49	4.123	0.011
Item 12	3.54	2.06	2.09	2.26	3.44	4.549	0.008
Item 13	2.28	1.98	2.09	1.72	2.23	1.098	0.351
Item 15	4.03	3.79	3.56	3.75	4.07	4.773	0.001

In general, it can be said that there are differences between the age groups located at the extremes of the age range (21 and over 40) and the intermediate age groups (22, 23–29, and 30–40) regarding the recognition of ICTs, LKTs, MOOCs, NOOCs, gamification, and transmedia storytelling as conceptual factors.

3.3. Comparison of Means According to Age and Programme of Study with Perception of the Importance of Teaching Technologies

In a similar manner, we conducted a one-way ANOVA to compare the effect of age on perception of the importance of the technological tools referred to in the questionnaire items. The results are shown in Table 7.

Table 7. Mean and analysis of ANOVA variance according to sample age.

Factors	Mean of Each Age Group					ANOVA	
	21	22	23–29	30–40	+40	F	*p*
Item 5	4.22	4.42	4.22	4.63	4.27	2.002	0.129
Item 6	4.30	3.50	3.43	3.45	4.38	4.964	0.005
Item 7	4.09	2.49	2.67	2.82	4.19	5.132	0.000
Item 9	3.66	3.89	3.56	3.92	4.00	2.061	0.235
Item 11	3.54	3.13	3.55	3.71	3.55	1.309	0.265
Item 14	2.87	2.51	2.56	2.83	2.45	1.345	0.211
Item 16	3.16	3.07	3.11	2.75	2.64	1.187	0.307

It can be observed that there are no significant differences between the factors analysed [$F \leq 2.061$; $p \leq 0.307$] and the questions about the importance of LKTs (item 9), gamification (item 11), MOOCs and NOOCs (item 14), and transmedia storytelling (item 16). However, we detected significant differences in the items related to ICTs as a concept (items 6 and 7), with a result of $F \geq 5.132$ and a p value of $p \leq 0.005$, indicating differentiation by age group. These data are corroborated by the mean results according to age (21 and over 40: $M \geq 4.09$; 22, 23–29, and 30–40: $M \geq 3.43$).

With regard to the qualitative analysis of the results, the data obtained from the open question (item 17), in which participants had to define what they understand by 'innovation', were translated into categories in order to make comparisons and detect contrasts. We established three categories: first, innovation as technological change; second, innovation as both methodological and technological change; and third, innovation as general transformation. In the case of the first category, our analysis produced the following dimensions, by order of frequency: incorporation of new technological tools (95%); and application of digital resources in specific teaching and learning processes (5%). As for the second category, only 19% of responses mention the inclusion of specific active and participatory methodologies. The rest (81%) refer to the closely related term 'methodological and technological change'. Within the third category, we identified a number of significant responses that indicated trainee teachers' conception of innovation. Responses included 'necessary', 'useful', 'paramount', 'the future', 'evolving', 'fun', 'creative'. These account for 18% of the total responses to the qualitative item.

These responses align with the findings of other studies that have analysed teachers' perceptions of innovation in education [31,35,36], which describe a clear interrelationship between technologies and methodologies.

4. Discussion and Conclusions

In recent years, a large body of scientific literature has addressed trainee teachers' study and perceptions of as well as training and competence in ICTs [5,10,11,16,17,35]. All these studies note the need for change within teaching qualifications so that they are suited to today's information and communication society (ICS). Technology must be integrated appropriately in the educational context by following teaching and learning models that propose the correct inclusion of technology [33]. We

believe that it is essential to understand the use of ICTs and LKTs in the university faculties and schools where teachers are trained, as well as to assess their technological competence in order to analyse their adaptation to changes in the ICS of the twenty-first century.

On the basis of this study conducted with 331 students—future teachers—we sought to meet the objectives set. The results highlight a lack of awareness among teachers in training regarding specific terms, such as LKTs, gamification, and NOOCs. Our data corroborate studies that indicate the enormous gap between the perceptions held by so-called 'digital natives' and their true level of technological knowledge [37–39]. Similarly, the results obtained in this study show teachers' lack of consideration of the possibilities that LKTs, gamification, MOOCs, NOOCs, and transmedia storytelling can bring to their training.

Considering digital competence as one of the key competences recognized by the European Commission in the educational field, research continues to show, however, low ratings in this competence (mainly in content creation and problem solving) by future teachers [40]. These results are consistent with those obtained in the study by Cabero and Barroso [22], in which the competences associated with the TPACK model were evaluated in a sample of 1368 university students, and whose results revealed training lacks in the dimensions of pedagogical knowledge and of content. Along these lines, Uzun's [24] study, aimed at analyzing the perception of 74 teachers in training from nine Turkish universities, also shows the dissatisfaction of future teachers with their technological skills for teaching.

Therefore, it is essential to enhance training in technologies and digital competence for trainee teachers. We propose the inclusion of the TPACK model to correctly integrate technology into university classrooms in order to meet the demands of the ICS and to adapt teacher training to the new requirements. More studies are needed to evaluate the influential factors in the optimal integration of ICTs and TACs in the teaching and learning processes [41–45], and the results of specific teacher training programs [46]. In this sense, a study conducted with 356 Norwegian teachers demonstrates that the digital self-efficacy of teachers seems to be related to the quality of their initial training, revealing training lacks in the acquisition of digital teaching skills [47].

With respect to the limitations of this work, it can be said that the data are partial because this is a study in progress that has a broad focus and that will continue over time—for at least two academic years. It should also be noted that it would be interesting, in future analyses, to assess perception and knowledge of ICT and LKT resources according to gender in order to evaluate possible variations arising from this factor. This line of study will begin in the 2019–2020 academic year as part of the proposed University of Alicante Research Project entitled 'The Gender Digital Divide in Initial Teacher Training: Analysis of Teachers' Digital Training' (UA/EMERG/3722/19-20). Similarly, it would be interesting to investigate the relationship between the beliefs and practices of trainee teachers, extending the study to practising teachers.

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