IEEE Access
Multidisciplinary ⋮ Rapid Review ⋮ Open Access Journal

Received November 9, 2019, accepted December 16, 2019, date of publication December 31, 2019, date of current version January 8, 2020.

Digital Object Identifier 10.1109/ACCESS.2019.2963314

MOOCs and NOOCs in the Training of Future Geography and History Teachers: A Comparative Cross-Sectional Study Based on the TPACK Model

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This research was funded by Research Group in Didactics of History and Social Sciences (DHISO/University of Burgos, Spain), and supported by the research project EDU2016-80145-P (Ministry of Economy and Business of Spain).

ABSTRACT MOOCs (*Massive Open Online Courses*) and NOOCs (*Nano Open Online Courses)*, which are part of e-learning, are being incorporated into the online teaching strategies of higher education institutions around the world. Research on the outcomes of their implementation has shown both their educational potential and their limitations. However, little is known about the instructional effectiveness of these courses and their potential contribution to the acquisition of specific competencies linked to the TPACK (*Technological Pedagogical Content Knowledge*) model for the training of future Geography and History teachers. To this end, this study examines perceptions regarding the instructional effectiveness of two MOOCs and two NOOCs on geographical and historical education, through an analysis of the performance in TPACK competency dimensions of future teachers ($n = 1993$). Based on a cross-sectional descriptive approach, central tendency statistics analyses (mean and standard deviation) and inferential analyses (Mann-Whitney U test and Wilcoxon rank-sum) were used. Participants reported optimal levels of satisfaction across all competency dimensions of the model for their teacher training. Inferential statistical analyses further revealed the existence of statistically significant differences depending on participants' university and gender. Both the instrument applied and the results obtained are of use in making educational decisions regarding the design and implementation strategies of MOOCs and NOOCs specifically aimed at the professional development of future Geography and History teachers.

INDEX TERMS MOOCs, NOOCs, educational technology, TPACK, teacher training, higher education, Geography and History teaching and learning.

I. INTRODUCTION

The explicit recognition of the use of information and communication technologies (ICTs) and the acquisition of teachers' digital competence (TDC) are reflected in the guidelines of the European Higher Education Area, in the 2006 European recommendation [1], and, more recently, as being among the priorities of the European Commission [2]. This reality implies a pedagogical shift capable of meeting the educational and technological training needs of the future teaching body. In this regard, MOOCs (Massive Open Online Courses) and NOOCs (Nano Open Online Courses), which are flexible in the setting of their content, resources, and timing [3], represent a clear step forward in terms of access to open knowledge [4]. In MOOCs and NOOCs, the user learns and internalizes skills and abilities on a continuous and permanent basis in order to achieve their qualification [5].

The Information and Knowledge Society (IKS) requires the training of independent professionals in personal, social, and professional digital competencies, with the ability to adapt to new social demands. Current demands with regard to personalised learning, connection and interaction with peers, unlimited access to learning resources and sources of information, and the availability of times and places for learning in more natural settings of coexistence [6], [7] support the

The associate editor coordinating the review of this manuscript and approving it for publication was Daniela Cristina Momete.

educational and social potential of online training, including that offered by MOOCs and NOOCs [8], [9].

MOOCs and NOOCs, which are part of e-learning, have been incorporated into the online educational strategies of higher education institutions around the world [10]–[12], at times resulting in effects that go against the true democratisation of higher education and universal learning [13]. Research on the outcomes of their implementation has shown both their educational potential and their limitations. Among these limitations are the investment of resources and time; the need for greater institutional support [14]; the need for greater social-interactive engagement among participants [15]; high dropout rates [16], [12]; and the aggravation of issues around accessibility and exclusivity in developing countries [17].

As part of the Open Educational Resources (OER) movement, MOOCs and NOOCs adopt alternative educational designs to those used in traditional online courses, which is crucial in participants' mass motivation and performance [18]. This type of course has been studied locally, both in terms of the learning outcomes produced among university and pre-university participants [19]–[22] and students' socio-digital reputation in virtual communities [23], as well as in terms of their teachers' perceptions and motivations in their design [24], [25]. However, research into teachers' professional development through MOOCs and NOOCs [26], [27] has been particularly scarce. In this vein, little is known about the acquisition of specific competencies associated with the TPACK model, the influential variables in their acquisition by future teachers, and the instructional effectiveness of these courses [28]. Moreover, practically no MOOCs or NOOCs intended for teacher training in Geography and History at different educational levels, or for the acquisition of disciplinary content in these areas [29], [30], focus on the TPACK technological/competency-based teaching and learning model.

In this context, the present study has two objectives. On the one hand, it aims to understand and assess the perception of future teachers, enrolled in two MOOCs and two NOOCs, of the proficiency obtained in Technological Pedagogical Knowledge (TPK), in Technological Content Knowledge (TCK), and in Pedagogical Content Knowledge (PCK) in the fields of Geography and History. Therefore, the measurement of learning obtained in this study corresponds to the perceived learning, since the nature of data prevents its comparison or correlation with standardized external measures of learning achievement. On the other hand, it seeks to test whether there are statistically significant differences between the TPACK dimensions (TPK, TCK, and PCK), depending on gender and university institution of origin. The following research questions are put forward:

1) To what extent do MOOCs and NOOCs contribute to the acquisition of competency-based learning under the conceptual framework of the TPACK model?

2) Does geographical/institutional origin affect the assessment of TPACK dimensions (TPK, TCK and PCK) after taking teacher-training courses in Geography and History?

3) Does the gender of future Geography and History teachers influence their self-perceptions of competency achievement in each TPACK dimension?

In keeping with these questions, the following hypotheses are made: a) H_0 (null hypothesis): There are no significant differences between the TPACK dimensional variables and the gender and institutional origin of participants, with a Type I error of 0.05; b) H_1 (alternative hypothesis): There are statistically significant differences between the TPACK dimensional variables and the gender of participants, with a Type I error of 0.05.

II. METHOD

A. PARTICIPANTS

A total of 1993 undergraduate and postgraduate students from Spanish universities (1036) and other universities around the world (957) agreed to take part in the study. Their distribution according to gender was 1390 women (69.7%) and 603 men (30.3%). The age range goes from 20 years to over 40 years, distributed in six subgroups (Table 1).

TABLE 1. Sample distribution by age and gender.

Age	Gender	U_1	U_2	Total
20 years	Women	160	101	261
	Men	65	35	100
	Total	225	136	361
21 years	Women	102	77	179
	Men	48	30	78
	Total	150	107	257
22 years	Women	53	31	84
	Men	25	11	36
	Total	78	42	120
23-29 years	Women	251	424	675
	Men	77	61	138
	Total	328	485	813
30-40 years	Women	41	49	90
	Men	50	86	136
	Total	91	135	226
+ 40 years	Women	42	59	101
	Men	48	67	115
	Total	90	126	216
Total				1993

U_1 = Spanish Universities; U_2 = Non spanish Universities. Source: own elaboration.

B. INSTRUMENT

We opted for a methodological design based on survey-type studies, together with a cross-sectional quantitative methodology of a descriptive and inferential nature. The questionnaire used was designed ad hoc, based on that used by Schmidt et al. [31] and Ortega-Sánchez and Gómez-Trigueros [9], the content of which has been validated for the present study by experts from four Spanish universities (Alicante, Murcia, Illes Balears, and Burgos). The instrument consists of 33 items measurable on a 5-point Likert scale (from 1, *Strongly disagree* to 5, *Strongly agree*) and organised into four study dimensions: 1. Socio-demographic characteristics (items 1–3); 2. Technological Pedagogical Knowledge (TPK) (items 4–15); 3. Technological Content

Knowledge (TCK) (items 16–23); and 4. Pedagogical and Content Knowledge (PCK) (items 24–33).

In order to verify the reliability of the questionnaire, we calculated Cronbach's alpha. The result obtained ($\alpha = .957$) confirms the instrument's high and adequate internal consistency for the proposed study [32], [33].

C. PROCEDURE

The questionnaire was delivered by email upon completion of the MOOCs and NOOCs, using the free application Google Forms. Students received the questionnaire in their university and/or personal email accounts and were informed of the objective of the study, as well as the confidentiality with which the answers given would be treated. The forms remained open from the time the courses were completed (February 2017) until December 2018.

The design of the courses was based on the systematic review of the commonly accepted conceptual and procedural curricular contents linked to the disciplines of Geography and History. In this way, the relevant structuring contents were selected for their ability to explain how Social Sciences are built for teaching and learning. However, the lack of similar digital courses in Geography and History prevented the contrast and feedback of our formative decision through valid referents.

The four courses are part of the same training unit, two MOOCs dedicated to the teaching and learning of Geography and History, and two complementary NOOCs dedicated to the treatment, deepening and acquisition of specific procedural competencies in the geographical area. The participating students were enrolled in the four courses, with the aim of achieving comprehensive training in TPACK competencies within the disciplinary field of Geography and History.

The MOOCs implemented (''Course 0: Teaching Geography using Google Earth'' [http://cort.as/-MWAj]; ''Course 1: Teaching Geography with Google Earth'' [http://cort.as/-MWAs]; and ''New educational possibilities for learning and teaching History in primary schools'' [http://cort.as/-MWAu]) were sequenced in six teaching modules, in keeping with each of the study's dimensions (TPK, TCK, and PCK). Each module includes a section on disciplinary content in Geography and History, presented in video format along with its written transcript; a set of complementary texts, links, and other secondary material to support the disciplinary content; and a theoretical-practical test on issues related to the educational and conceptual content worked on in each course.

The NOOCs (''Introduction to geographical ICT tools for the Bachelor's Degree in Primary Education and the Master's Degree in Secondary Education: Topographic sections'' [http://cort.as/-MWBG] and ''Initiation to geographical ICT tools for the Bachelor's Degree in Primary Education and the Master's Degree in Secondary Education: Choropleth maps'' [http://cort.as/-MWBP]), were structured around an initial section about pedagogical and educational content in video format and a PowerPoint presentation, a set of complementary material (links and bibliographic references), and a practical test with the purpose of confirming the knowledge acquired throughout the course.

Both the MOOCs and the NOOCs offered spaces for social interaction (forums), in which participants could raise questions, learn among peers, and propose training alternatives to the topic addressed. The creation of these spaces aimed to promote cooperative learning, understood in this training context as an important element in the technological-interactive construction of knowledge and in interactive social participation through group work [34], [15]. Recently defined predictive factors were considered in the design of the MOOCs and NOOCs, such as the courses' quality, accessibility, and usefulness [35], [36], as well as meeting current educational training requirements for the creation of digital material [18].

D. ANALYSIS OF DATA

In order to achieve the objectives of the study, both descriptive and inferential analyses were performed, using the statistical software programme SPSS v.23. To test the normality of the data, the histograms of each of the items in the questionnaire were analysed, as well as the Q–Q plots. Non-normality of values could be observed in all cases. Similarly, the Kolmogorov-Smirnov test was applied, which produced a level of significance below 0.05 ($p < 0.05$), confirming the atypical distribution of the data. Following a descriptive analysis of the items (mean and standard deviation), non-parametric Wilcoxon rank-sum and Mann–Whitney U tests were applied, equivalent to Student's t test, but of great use when dealing with independent samples with a non-normal distribution.

III. FINDINGS

A. DESCRIPTIVE ANALYSES

Table 2 shows the values obtained from the descriptive statistical analysis (Table 2). These findings show the students' positive perception of the usefulness of the MOOC and NOOC training resource for their teaching work. As such, we can observe high appraisal for these resources for their training in the TPK_{1-12} dimension, with average values close to 5 ($M \geq 4.75$) and low dispersion responses ($SD \leq 0.645$).

Participants also perceive that the MOOCs and NOOCs they participated in have facilitated the technological-disciplinary acquisition of social content (dimension TCK_{1-4}) ($M \geq 4.76$, $SD \leq 0.978$). Similarly, very positive results are obtained when participants are asked about the educational potential of MOOCs and NOOCs in the teaching and learning of Geography and History (dimension TCK_{5-8}) ($M \geq 4.83$, $SD \leq 0.572$).

Finally, participants view the training possibilities of these courses as appropriate for the acquisition of PCK_{6-10}, since they provide useful content for adapting curricular content to the available teaching materials ($M \geq 4.84$; $SD \leq 0.811$). Consistently, participants consider that the MOOCs and NOOCs they have completed (dimension PCK_{1-5}) have allowed them to acquire knowledge to

TABLE 2. Descriptive results.

D.	Var.	Item	M	SD
Dimension 1 (TPK)	TPK_1	The MOOCs and NOOCs undertaken allow me to choose the appropriate information technologies to optimise my teaching of Geography and History, such as using Google Earth to locate a place.	4.81	0.573
	TPK_2	The MOOCs and NOOCs undertaken have enabled me to use information technologies with the purpose of improving classroom interaction.	4.79	0.623
	TPK_3	The MOOCs and NOOCs I have taken part in have prepared me to use information technologies to enhance students' motivation to learn.	4.75	0.682
	TPK_4	The MOOCs and NOOCs undertaken have taught me to use information technologies to ensure students actively participate in classroom activities.	4.78	0.619
	TPK_5	The MOOCs and NOOCs I have taken part in have allowed me to evaluate the use of information technologies in the classroom from a critical perspective.	4.82	0.645
	TPK_6	The MOOCs and NOOCs undertaken have prepared me to use information technologies adaptively in various activities for teaching Geography and History.	4.80	0.624
	TPK_7	The MOOCs and NOOCs I have taken part in have trained me to be able to select appropriate information technologies to optimise the teaching of Geography and History.	4.83	0.627
	TPK_8	MOOCs and NOOCs train you to use information technologies to enhance students' motivation to learn Geography and History.	4.85	0.643
	TPK_9	MOOCs and NOOCs help you to use information technologies to promote students' active participation in classroom activities.	4.87	0.618
	TPK_{10}	MOOCs and NOOCs equip you to evaluate the use of information technologies in the classroom from a critical perspective.	4.89	0.628
	TPK_{11}	MOOCs and NOOCs train you to use information technologies adaptively in various teaching activities.	4.88	0.631
	TPK_{12}	MOOCs and NOOCs enable you to select appropriate information technologies to optimise the teaching of curricular content.	4.91	0.624
Dimension 2 (TCK)	TCK_1	The MOOCs and NOOCs undertaken have enabled me to use specific software relating to geographical and historical content, such as Google Earth.	4.76	0.978
	TCK_2	The MOOCs and NOOCs I have taken part in have taught me which information technologies may be applied in order to teach Geography and History.	4.84	0.601
	TCK_3	The MOOCs and NOOCs undertaken have trained me in the use of information technologies suitable for teaching geographical and historical content, such as multimedia resources, simulation software, etc.	4.91	0.603
	TCK_4	The MOOCs and NOOCs I have taken part in have enabled me to use specific Geography and History software to design research activities related to both disciplines.	4.89	0.621
	TCK_5	MOOCs and NOOCs train you to use specific software relating to geographical and historical content, such as Google Earth.	4.92	0.544
	TCK_6	MOOCs and NOOCs help you to acquire skills for selecting information technologies applicable to the teaching and learning of Geography and History.	4.83	0.542
	TCK_7	MOOCs and NOOCs train you to use information technologies suitable for teaching geographical and historical content, such as multimedia resources, simulation software, etc.	4.85	0.541
	TCK_8	MOOCs and NOOCs prepare you to use specific Geography and History software to carry out research activities related to both disciplines.	4.86	0.572
Dimension 3 (PCK)	PCK_1	The MOOCs and NOOCs I have taken part in have taught me to help students solve social problems related to geographical and historical content.	4.85	0.598
	PCK_2	The MOOCs and NOOCs undertaken have enabled me to develop specific teaching objectives in the Geography and History curriculum.	4.83	0.577
	PCK_3	The MOOCs and NOOCs I have taken part in have trained me to provide guidance to students in carrying out geographical and historical research activities.	4.93	0.818
	PCK_4	The MOOCs and NOOCs undertaken have enabled me to select appropriate tools for assessing students' performance in Geography and History.	4.81	0.582
	PCK_5	The MOOCs and NOOCs I have taken part in have prepared me to determine which geographical and historical concepts should be worked on in the school curriculum.	4.82	0.584
	PCK_6	MOOCs and NOOCs teach you to help students solve social problems related to geographical and historical content.	4.85	0.571
	PCK_7	MOOCs and NOOCs train you to develop specific teaching objectives in the Geography and History curriculum.	4.87	0.571
	PCK_8	MOOCs and NOOCs train you to guide students in carrying out geographical and historical research activities.	4.89	0.811
	PCK_9	MOOCs and NOOCs enable you to select appropriate tools for assessing students' performance in Geography and History.	4.88	0.567
	PCK_{10}	MOOCs and NOOCs prepare you to determine which geographical and historical concepts should be worked on in the school curriculum.	4.84	0.537

D. = dimension; Var. = variable; SD = standard deviation; M = mean.
Source: the author.

adequately implement social science content in their teaching work ($M \geq 4.81$; $SD \leq 0.818$). Consequently, the descriptive results show in all its dimensions ($M \geq 4.75$, $SD \leq 0.978$) an optimal development and acquisition of TPACK competencies within the specific area of Didactics of Geography and History, main objective of the four digital courses design.

TABLE 3. *U* of Mann-Whitney and *W* of Wilcoxon in TPACK dimensions depending on the institution of origin.

D.	Var.	*U* of Mann-Whitney	*W* of Wilcoxon	Z	*p*
Dimension 1 (TPK)	TPK_1	42786.000	195659.000	-1.594	.111
	TPK_2	45013.500	201533.500	-0.540	.590
	TPK_3	44581.500	201101.500	-0.720	.471
	TPK_4	46080.500	59775.500	-0.018	.986
	TPK_5	45517.500	202037.500	-0.289	.773
	TPK_6	43287.500	199807.500	-1.372	.170
	TPK_7	44683.000	58378.000	-0.691	.489
	TPK_8	39139.000	199306.000	-3.519	.000**
	TPK_9	45587.500	59282.500	-0.259	.796
	TPK_{10}	43009.000	199529.000	-1.526	.127
	TPK_{11}	45694.500	202214.500	-0.204	.838
	TPK_{12}	45112.000	58807.000	-0.488	.625
Dimension 2 (TCK)	TCK_1	43395.000	199915.000	-1.345	.179
	TCK_2	42892.500	199412.500	-1.597	.110
	TCK_3	44122.000	200642.000	-0.973	.331
	TCK_4	45745.500	202265.500	-0.182	.855
	TCK_5	39531.000	196051.000	-3.421	.001**
	TCK_6	37656.500	194176.500	-4.378	.000**
	TCK_7	37585.000	194105.000	-4.398	.000**
	TCK_8	43203.000	199723.000	-1.462	.144
Dimension 3 (PCK)	PCK_1	40685.500	197205.500	-2.652	.008**
	PCK_2	44484.500	201004.500	-0.821	.412
	PCK_3	42972.000	199492.000	-1.565	.118
	PCK_4	44493.500	197329.500	-0.818	.413
	PCK_5	45087.500	201607.500	-0.511	.609
	PCK_6	39764.000	196284.000	-3.158	.002**
	PCK_7	40809.500	201013.500	-2.651	.008**
	PCK_8	40857.000	197377.000	-2.662	.008**
	PCK_9	42787.500	199307.500	-1.680	.093
	PCK_{10}	32772.000	189292.000	-6.779	.000**

**$p<0.01$. D. = TPACK study dimension; Var. = variable. Source: own elaboration.

TABLE 4. *U* of Mann-Whitney and *W* of Wilcoxon in TPACK dimensions depending on the gender.

Dim.	Var.	*U* of Mann-Whitney	*W* of Wilcoxon	Z	*p*
Dimension 1 (TPK)	TPK_1	29138.000	40016.000	-6.978	.231
	TPK_2	32726.500	43604.500	-4.935	.454
	TPK_3	33537.000	44415.000	-4.339	.490
	TPK_4	32731.500	43609.500	-4.945	.763
	TPK_5	30103.500	40981.500	-6.181	.998
	TPK_6	31412.000	42290.000	-5.559	.211
	TPK_7	32078.500	42956.500	-5.191	.479
	TPK_8	29063.500	39941.500	-6.659	.565
	TPK_9	34629.000	43980.000	-4.739	.613
	TPK_{10}	30840.500	41718.500	-5.921	.165
	TPK_{11}	31332.500	42210.500	-5.579	.219
	TPK_{12}	29994.500	40872.500	-6.287	.428
Dimension 2 (TCK)	TCK_1	28611.000	39489.000	-7.108	.000**
	TCK_2	32937.000	43815.000	-4.893	.001**
	TCK_3	29271.000	40149.000	-6.678	.000**
	TCK_4	31386.000	42264.000	-5.633	.002**
	TCK_5	30025.000	40903.000	-6.709	.001**
	TCK_6	30148.000	41026.000	-6.617	.000**
	TCK_7	29623.500	40501.500	-6.873	.000**
	TCK_8	35098.500	45976.500	-3.825	.000**
Dimension 3 (PCK)	PCK_1	36715.000	47593.000	-2.899	.124
	PCK_2	33155.000	44033.000	-4.853	.238
	PCK_3	32652.000	43530.000	-5.063	.098
	PCK_4	33556.500	44434.500	-4.611	.320
	PCK_5	35103.500	45981.500	-3.782	.571
	PCK_6	34629.000	45507.000	-4.033	.099
	PCK_7	35001.500	45879.500	-3.893	.009**
	PCK_8	34217.000	45095.000	-4.323	.010**
	PCK_9	34664.500	45542.500	-4.073	.025*
	PCK_{10}	30383.500	41261.500	-6.370	.009**

*$p<0.05$; **$p<0.01$. D. = TPACK study dimension; Var. = variable. Source: own elaboration.

B. COMPARATIVE ANALYSIS ACCORDING TO THE UNIVERSITY INSTITUTION OF ORIGIN

According to the results obtained in the TPK dimension, and in particular item TPK_8, the scores given by participants of other universities around the world are significantly higher than those given by students of Spanish universities ($U = 39139$, $W = 195659$, $z = -3.519$, $p = .000$; $M_{ex} = 4.91$, $SD_{ex} = 0.344$; $M_{es} = 4.62$, $SD_{es} = 0.621$) (Table 3).

Something similar occurs for the variables associated with the TCK dimension, the results of which allow for the rejection of H_0, confirming the presence of differences between the various groups of students. Participants from non-Spanish universities scored higher than Spanish students (TCK_5: $U = 39531$, $W = 196051$, $z = -3.421$, $p = .001$; TCK_6: $U = 37656.500$, $W = 194176.500$, $z = -4.378$, $p = .000$; TCK_7: $U = 37585$, $W = 194105$, $z = -4.398$, $p = .000$) ($M_{ex} \geq 4.89$, $SD_{ex} \leq 4.01$; $M_{es} \geq 4.11$, $SD_{es} \leq 0.677$).

Likewise, the findings for variables PCK_1, PCK_6, PCK_7, PCK_8, and PCK_{10} ($p<0.05$) on Pedagogical Content Knowledge also confirm the existence of statistically significant differences between groups of students (PCK_1: $U = 40685$, $W = 197205.500$, $z = -2.652$, $p = .008$; PCK_6: $U = 39764$, $W = 196284$, $z = -3.158$, $p = .002$; PCK_7: $U = 40809.500$, $W = 201013.500$, $z = -2.651$, $p = .008$; PCK_8: $U = 40857$, $W = 197377$, $z = -2.662$, $p = .008$; PCK_{10}: $U = 32772$, $W = 189292$, $z = -6.779$, $p = .000$), with higher values obtained by non-Spanish universities ($M_{ex} \geq 4.75$, $SD_{ex} \leq 0.503$; $M_{es} \geq 4.09$, $SD_{es} \leq 0.710$).

This data therefore allows us to confirm the existence of differences in the scores given by participants to their teacher training experience after taking MOOCs and NOOCs based on the TPACK model. As a result, the findings allow for acceptance of H_1, which states that participants' institution of origin influences the scores achieved.

C. COMPARATIVE ANALYSIS ACCORDING TO GENDER

A statistically differential appraisal, according to gender, of the educational potential of MOOCs and NOOCs in the acquisition of the competencies of the TPACK model can be observed (table 4).

The values obtained allow for the rejection of H_0 in the case of variables related to Technological Content Knowledge, with a Type I error of 0.01 (TCK_1: $U = 28611$, $W = 39489$, $z = -7.108$, $p = .000$; TCK_2: $U = 32937$, $W = 43815$, $z = -4.893$, $p = .001$; TCK_3: $U = 29271$, $W = 40149$, $z = -6.678$, $p = .000$; TCK_4: $U = 31386$, $W = 42264$, $z = -5.633$, $p = .002$; TCK_5: $U = 30025$, $W = 40903$, $z = -6.709$, $p = .001$; TCK_6: $U = 30148$, $W = 41026$, $z = -6.617$, $p = .000$; TCK_7: $U = 29623$, $W = 40501.500$, $z = -6.873$, $p = .000$; TCK_8: $U = 35098.500$, $W = 45976.500$, $z = -3.825$, $p = .000$). In this dimension, women have higher scores than men ($M_{♀} \geq 4.86$; $SD_{♀} \leq 0.598$; $M_{♂} \geq 4.08$; $SD_{♂} \leq 0.898$).

Finally, the variables related to Pedagogical Content Knowledge conclude with the rejection of H_0, since there are significant differences between the genders regarding the practicality attributed to the MOOCs and NOOCs taken for acquiring this type of TPACK knowledge (PCK_7: $U = 35001.500$, $W = 45879.500$, $z = -3.893$, $p = .009$; PCK_8: $U = 34217$, $W = 45095$, $z = -4.323$, $p = .010$; PCK_9: $U = 34664.500$, $W = 45542.500$, $z = -4.073$, $p = .025$; PCK_{10}: $U = 30383.500$, $W = 41261.500$, $z = -6.370$, $p = .009$). In the case of these variables, women have higher scores than men ($M_{♀} \geq 4.71$; $SD_{♀} \leq 0.497$; $M_{♂} \geq 3.98$; $SD_{♂} \leq 0.851$).

IV. DISCUSION AND CONCLUSION

The importance of training future teachers in TPACK model competencies as part of their professional development [8], [37], [38] must be based on the knowledge of their perceptions of the educational potential of the most widely available online courses. In view of the findings obtained, we can observe that participants in the MOOCs and NOOCs implemented—Geography and History teachers in training—positively value the usefulness of these digital media for their professional training. These findings are consistent with previous studies [39]–[41] that confirm the educational benefits of technology in the acquisition of technological, disciplinary, and pedagogical competencies. However, the absence of a control group and, therefore, an intergroup comparative analysis, motivates the acceptance of these results with caution.

The specific training provided by MOOCs and NOOCs in TPK, TCK, and PCK for teacher training is clear from the positive appraisal of each of the TPACK model's dimensions. These findings are in line with those obtained in recent studies [9], [42] that show that MOOCs and NOOCs help in disciplinary content training [8], [43] and in the development and acquisition of teachers' digital competence [44], [45]. It was found that all participants highly value the technological, disciplinary, and pedagogical knowledge provided by these online courses, with equivalent levels across all three types of knowledge.

In terms of the TCK dimension of MOOCs and NOOCs, the appraisals given by participants from non-Spanish universities are found to be higher than those given by participants from Spanish universities, and the results in the PCK training dimension are also higher among participants from non-Spanish universities. It does not seem, therefore, that the language of instruction (Spanish language) influenced the differential results obtained. This circumstance could be explained by the lack of tradition of using this type of digital courses in Spain and by some distrust of its evaluation procedures. However, more research in this area would be necessary.

This data shows the positive international appraisal enjoyed by these courses, their acceptance as technological tools related to pedagogy and content, their importance in the constant updating of teachers' professional development, the relevance to teaching of the exchanging of experiences and knowledge [46], and their power as a training tool for teachers' digital competence [8], [9].

When the three dimensions of the TPACK model are analysed according to gender, differential appraisals are also obtained based on this variable. As in other studies [47]–[50], significant differences are identified according to gender: women being the ones who attach greater importance to their teacher training in digital skills, in this case, for the teaching of historical and geographical contents. Specifically, the findings related to TCK show that the responses given by women are more positive, as they confer greater importance to MOOCs and NOOCs as technological means to acquire technological-disciplinary knowledge in the teaching of specific content. This data may be related to the different self-perceptions that men and women have of their abilities regarding the manipulative use of ICTs [51]–[53].

These differences have recently been confirmed by studies such as that of Flores-Lueg and Roig-Vila [54], which shows, in a sample of 175 future teachers, that men obtained higher results in their self-perceived level of digital competence and, in particularly, in the technical, didactic, social, ethical and legal dimensions; or that of Cabezas *et al.* [51], which demonstrates significant differences in digital competence perceptions in favor of men. A reality that is corroborated in Primary School teachers [53]. However, there are a few studies that begin to show the existence of a reduction of the digital gender gap in the use of social networks [55], [56], and in other digital competencies [57]– [62].

Similar findings can be seen in the case of variables related to the perception of PCK, as women express a more positive appraisal than do men in this dimension. These findings relate to the organisational importance given to MOOCs and NOOCs in the ordered presentation of teaching resources and material [43] and to the different self-effectiveness that the genders express with regard to their use of teaching technologies [37], [63].

In future research, we consider it interesting to delve into these possible differences in order to evaluate the educational implications that might arise. Likewise, it should be completed, also from qualitative approaches, assessing the potential incidence of age, teaching experience, knowledge of ICT and the attitude towards them of the future teachers, factors set forth in other works [61], [64]. In this line, although statistically there is a lower probability of generating solid results due to a greater number of categories, in future studies it would be interesting to address a specific comparative analysis of TPACK dimensions based on the participating age groups. The perceptions of the participants—future teachers—are positive regarding the educational potential of MOOCs and NOOCs for their training in technological, pedagogical, and disciplinary competencies. These results are consistent with previous studies, which have identified the significant contribution of these courses in the acquisition of knowledge, attitudes, skills, and aspirations among student participants [22]. However, despite the initiative of educational authorities to make progress in terms of technological

enhancement, training, and curricular inclusion, there are practically no open and online courses in Geography and History that encourage flexibility in terms of time and that free students from location dependency [65], [66].

This study reveals an intimate link between the acquisition of digital competencies and pedagogical-technological competencies and the proper digital training of trainee teachers. There is no doubt that a shift in education will be possible by first transforming the mentality of university teaching staff regarding the educational potential of ICTs and their operational inclusion in various training contexts.

In future research, it would be of interest to delve further into the differences observed according to gender among MOOC and NOOC participants, in order to assess their educational implications in the classroom and in the acquisition of teachers' digital competence. In the spirit of recent qualitative studies that have focused on the voices and emotions of MOOC participants [21], [67], applying qualitative research techniques, such as interviews or participant or non-participant observation, may lead to important findings in terms of the interpretation of these differences.

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