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Technopedagogical and disciplinary knowledge of primary school teachers in different socio-demographic contexts

Conocimientos tecnopedagógicos y disciplinarios de los profesores de primaria en diferentes contextos sociodemográficos

Miguel A. Paidican Soto[1], Begoña Gros Salvat[1], Pamela Arredondo Herrera[2]

[1] University of Barcelona, Spain
[2] University of Granada, Spain

mpaidiso7@alumnes.ub.edu , bgros@ub.edu , pamarredondo@correo.ugr.es

ABSTRACT. The aims to explore teachers' technological, pedagogical, and content knowledge (TPACK) and its relationship with socio-demographic factors. A quantitative, non-experimental, transactional study was conducted, consisted of 403 primary school teachers. The TPACK questionnaire Chilean version. Descriptive, correlational, and inferential techniques were used for the statistical analyses, consider normality, contrast, and post-hoc tests were considered. It is show that teachers have higher levels of pedagogical (4.27) and disciplinary (4.12) knowledge compared to technological (3.59). Likewise, there are positive correlations in all dimensions of TPACK, highlighting technological knowledge (TK) and its derivations of technological content knowledge (TCK) and technological pedagogical knowledge (TPK), with values between (.613) and (.732).

RESUMEN. El objetivo de la investigación es explorar el conocimiento tecnológico, pedagógico y de contenido (TPACK) de los docentes y su relación con los factores sociodemográficos. Se realizó un estudio cuantitativo, no experimental y transaccional, con una muestra de 403 docentes de primaria. Se utilizó el cuestionario TPACK, versión chilena. Se realizaron análisis estadísticos descriptivos, correlacionales e inferenciales, considerando pruebas de normalidad, contraste y post-hoc. Se concluye que los docentes presentan mayores niveles de conocimiento pedagógico (4,27) y disciplinar (4,12) en comparación con el tecnológico (3,59). Asimismo, existen correlaciones positivas en todas las dimensiones del TPACK, destacando el conocimiento tecnológico (TK) y sus derivaciones de conocimiento tecnológico de contenido (TCK) y conocimiento tecnológico pedagógico (TPK), con valores entre (.613) y (.732). Además, se identificó diferencias significas en algunas de las dimensiones del TPACK, conforme a las variables al género, años de servicio, dependencia administrativa, formación profesional y evaluación docente.

KEYWORDS: Knowledge of technological pedagogical content (TPACK), Primary school teachers, Integration of technology, ICT.

PALABRAS CLAVE: Conocimiento del contenido pedagógico tecnológico (TPACK), Profesores de primaria, Integración de la tecnología, TIC.

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1. Introduction

The aim of the research is to explore teachers' technological, pedagogical, and content knowledge (TPACK) and its relationship with socio-demographic factors. A quantitative, non-experimental, transactional study was conducted. The sample consisted of 403 primary school teachers. The Chilean version of the TPACK questionnaire was used as an instrument. Nowadays, societies are faced with the rapid development of science and technology, which leads to knowledge quickly becoming obsolete. Schools are part of this reality, for example, management teams face the challenge of improving student learning through the incorporation of new technologies. According to Lee (2002), the development and application of information and communication technologies must always go hand in hand.

1.1. General framework of TPACK model

In recent years, research related to teacher training in the field of Information and Communication Technologies (ICT) has focused on several pedagogical models. One of them recommended by Mishra & Koehler in 2006, called Technological Pedagogical Content Knowledge (TPACK), based on Schulman's (1986) theory of pedagogical content knowledge (PCK), aims to understand and to describe the types of knowledge teachers need for efficient ICT integration. TPACK is composed of three key knowledge domains, technological, disciplinary, and pedagogical. The interaction of these skills identifies four further dimensions, see Figure 1.

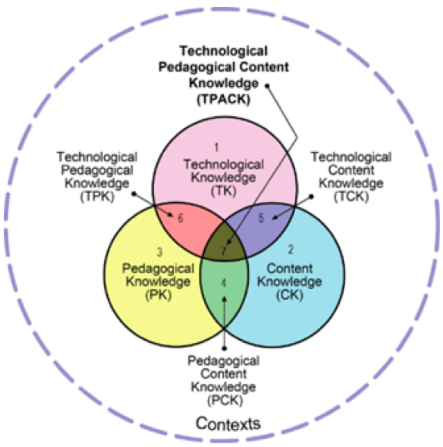

Figure 1. TPACK Model. Source: Reproduced by permission of the publisher, © 2012 by tpack.org.

1. Technological Knowledge (TK): Focuses on the use and integration of traditional and new technologies in the curriculum (Koehler and Mishra, 2005; Mishra and Koehler, 2006; Koehler et al., 2007; Koehler and Mishra, 2008; Mishra and Koehler, 2008; Harris et al., 2009; Koehler and Mishra, 2009; Schmidt et al., 2009; Zhang and Tang, 2021).

2. Content knowledge (CK): This is the amount of actual knowledge that the teacher has about a specific subject. Such knowledge involves an understanding of teaching and learning processes (Koehler et al., 2007; Koehler and Mishra, 2008; Mishra and Koehler, 2006; Mishra and Koehler, 2008; Harris et al., 2009; Schmidt et al., 2009; Shulman, 1987).

3. Pedagogical knowledge (PK): Knowledge that includes teaching and learning processes, classroom management, lesson planning, assessment of teaching and learning processes, and knowledge of students' learning styles (Koehler and Mishra, 2005; Mishra and Koehler, 2006; Koehler et al., 2007; Koehler and Mishra, 2008; Mishra & Koehler, 2008; Harris et al., 2009; Koehler and Mishra, 2009; Munyengabe et al., 2017; Schmidt et al., 2009¸ Shulman, 1987).

4. Pedagogical content knowledge (PCK): Corresponds to the intersection of CK and PK that includes knowledge of diverse teaching methods for different subjects (Koehler and Mishra, 2005; Mishra and Koehler, 2006; Koehler et al., 2007; Koehler and Mishra, 2008; Mishra & Koehler, 2008; Harris et al., 2009; Koehler and Mishra, 2009; Munyengabe et al., 2017; Schmidt et al., 2009; Shulman, 1986).

5. Technological content knowledge (TCK): Resulting from the combination of TK and CK, this knowledge provides the flexibility of using appropriate technologies for educational purposes (Koehler and Mishra, 2005; Mishra and Koehler, 2006; Koehler et al., 2007; Koelher et al., 2014; Munyengabe et al., 2017; Schmidt et al., 2008).

6. Technological pedagogical knowledge (TPK): Resulting from the combination of TK and PK, it is the knowledge of how to use technology to adopt different teaching methods (Koehler and Mishra, 2008; Harris et al., 2009; Mishra and Koehler, 2008; Munyengabe et al., 2017; Schmidt et al., 2008).

7. Technological pedagogical content knowledge (TPACK): Corresponding to the result of the intersection of CK, PK, and TK, it is the knowledge of the use of technology in varied subjects and the practice of teaching methods. This knowledge facilitates subject learning for the learner with appropriate pedagogy and technology (Koehler and Mishra, 2009; Koehler et al., 2014; Munyengabe et al., 2017; Schmidt et al., 2009).

Mishra and Koehler (2006) proposal refers that TPACK emerges as a theoretical framework that allows understanding the knowledge that a teacher must raises when integrating technologies effectively. For Angeli and Valanides (2009) the body of TPACK goes beyond the mere integration of knowledge, it constitutes a more integrative vision of the use of ICT. Authors such as Cox and Graham (2009) and García and Martin del Pozo (2016) describe that TPACK allows understanding of the contributions of technology in education, as well as its impact on teacher training, specifically on technology's contributions in education the integration of didactic strategies enriched with ICT. In addition, it is observed that the TPACK represents a valuable tool to analyze the digital competences of teachers, for example, (Borthwick et al., 2008; Cabero et al., 2015; Jang and Tsai, 2013; Paidicán, 2017; Paidicán and Arredondo, 2022a; Schmidt et al., 2009; Roig and Flores, 2014).

1.2. TPACK model in primary education

Research on the TPACK model in primary education presents a constant development, for example, there are three systematic literature reviews (SLR), two of which partially address primary education considering between 27.2% and 36.3% of the studies analyzed (Rodríguez et al., 2019; Yeh et al., 2021). The exception is Paidicán and Arredondo (2022b), whose SLRs cover primary education articles in their entirety. However, the topics addressed in teacher-centred TPACK research are related to teacher education programs, teacher experiences, technological knowledge development and relationship with TPACK, and self-reporting of teacher knowledge. The latter represents the most studied line of research (six studies), however, data analysis includes descriptive, exploratory factorial, correlational, inferential, and structural model analysis, although the number of studies is insufficient to establish any level of trends or relationship between the studies.

This highlights the need to carry out studies of the TPACK model in primary education that include descriptive, correlational, and inferential analyses to establish trends, contrasts, and relationships between socio-demographic variables such as age, gender, professional training, teacher evaluation, administrative unit, and years of service. It should be noted that the development of studies related to teacher knowledge is key to the implementation of educational improvement plans and professional training processes for in-service teachers.

It should be noted that each teacher has his or her own level of knowledge according to TPACK, which is influenced by various factors. Previous TPACK studies identify teacher-centred factors, self-motivation, digital competence, and teacher age (Absari et al., 2020; Adulyasa, 2017; Raygan and Moradkhani, 2020; Sojanah et al., 2021; Voithofer et al., 2019). Also, external factors to teachers such as socio-economic status,

infrastructure, school climate and school management are observed (Adulayasa, 2017; Harris and Hofer, 2011; Raygan and Moradkhani., 2020; Sojanah et al., 2021).

In addition, there are socio-demographic factors wich have been less addressed in TPACK research focusing on primary school teachers, related to gender, years of service, professional training, administrative dependency, and teacher performance evaluation (Kumala et al., 2022; Paidicán and Arredondo, 2022a). This highlights the need to carry out studies of the TPACK model in primary education that include descriptive, correlational, and inferential analyses to establish trends, contrasts, and relationships between socio-demographic variables.

The main objective of the study mainly aims to explore the technological, pedagogical, and content knowledge (TPACK) of primary school teachers and its relationship with socio-demographic variables. To do so, it is necessary to know, describe, compare, and relate the levels of knowledge presented by teachers.

2. Methods

In relation to the method used, a quantitative, non-experimental, and transactional design is chosen, because it is intended to investigate a real context (Lozada and Ramil, 2003). The sample was selected by convenience or intentionally, which is described by Huberman and Miles (1994), Palys (2008), Ragin (1999), and Saumure and Given (2008) features can be guided by one or more purposes, according to the characteristics of research. The research questions are:

1. What are the levels of knowledge presented by primary school teachers according to the TPACK model?
2. To what extent does the TPACK core knowledge tend to affect integrated knowledge?
3. Are there differences in teacher knowledge according to gender, teacher education, teacher evaluation, administrative unit, and years of service?
4. How do socio-demographic variables affect teacher knowledge levels according to the TPACK model?

2.1. Participants

The sample consisted of 403 primary school teachers from the province of Valparaíso, in the region of the same name. It includes teachers from the municipalities of Algarrobo, Quilpué, Valparaíso, Villa Alemana, and Viña del Mar. Teachers from different administrative units were considered, including municipal schools (MS), government-funded private schools (GFPS), and private schools (PS), see Table 1.

	Frequency	Percentage
Gender		
Female	281	69.7%
Male	122	30.3%
Years of Service		
0 a 5 years	122	30.3%
6 a 11 years	72	17.9%
12 a 18 years	88	21.8%
More than 18 years	121	30.0%
Administrative Unit		
MS	182	45.2%
GFPS	170	42.2%
PS	51	12.7%
Teacher training		
Bachelor's degree	348	86.4%
Master's	55	13.6%
Teacher Evaluation		
Yes	156	38.7%
No	247	61.3%

Table 1. Characteristics of the teachers participating in the study. Source: Self-made.

Table 1 shows that most of the sample is female, 69.7%. In addition, teachers with between 0 and 5 years of experience and more than 18 years represent more than 60% of the sample. In terms of an administrative

unit, the highest number of teachers corresponds to the MS (45.2%) and the GFPS (42.2%). In terms of professional training, only 13.6% of teachers have a master's degree. Finally, 38.7% of teachers have participated in a teaching performance evaluation.

2.2. Instrument

Regarding the instrument used to collect data, the TPACK questionnaire was used, adapted to the Chilean reality by Paidicán (2017). The validation of the instrument I consider two procedures. The first is a pilot application carried out by Paidicán and Arredondo (2022d), which considered 31 teachers. A Cronbach's Alpha coefficient (.948) and positive correlations were obtained in all dimensions of TPACK, the highest being TPACK and TPK (.865), TPK and TCK (.810), and PK and CK (.780).

The second procedure considered an exploratory factor analysis with a sample of 165 teachers (Paidicán and Arredondo, 2022c). In terms of construct validity, a value (.865) was observed in the Kaiser-Meyer-Olkin (KMO) measure, being adequate for the sample, and in Harman's single factor test (48.94%) representing the non-existence of the threat of common method bias. In relation to the total variance, the regrouping into five factors explains 77.86% of the instrument's responses, with the first factor, composed of TPK and TPACK, explaining 21.13% of the constructs.

Concerning reliability, Cronbach's alpha coefficient obtained (.973), while the item-total correlation analysis of the questionnaire obtained values between (0.381) and (0.844), which allows us to affirm that it is not necessary to eliminate items. In addition, positive correlations were observed in all dimensions, the strongest ones corresponding to PK and PCK (.846), TPACK and TPK (.819), and PC and CK (.775).

The research considered $P<0.7$ as a value for reliability analysis, according to Garson (2013) and Nunnally and Bernstein (1994) it corresponds to a minimum and acceptable value. The present research obtained a Cronbach's Alpha index of (.948), like that obtained in the validation processes of the instrument. The questionnaire was composed of two parts, the first part including socio-demographic data and the second part with 40 items, divided into seven sub-sections including the following items TK-7, CK-7, PK-8, PCK-3, TCK-3, TPK-5, and TPACK-7. The scale was organised on a five-point Likert scale, strongly disagree (1), disagree (2), neither disagree nor agree (3), agree (4), and strongly agree (5).

Data were collected between the second semester of 2019 and the first semester of 2020. The distribution's protocol of the questionnaire considered a previous meeting with school principals and teachers, to coordinate the application and the completion of the informed consent form. Subsequently, the instrument is applied in printed format according to the scheduled date. In the case of the electronic questionnaire, it is carried out using Google Forms and OFFICE Forms, including the questionnaire and the informed consent form.

2.3. Data analysis procedure

The data analysis considers descriptive, correlational, and inferential statistical aspects. The management and analysis of data are carried out using the statistical package SPPS version 27 and the JASP software version 0.16.2, both for WINDOWS.

3. Results

3.1. Descriptive analysis of the TPACK model

The first part of the analysis considered the processing of dimensions and sub-dimensions of the TPACK model using the arithmetic mean, standard deviation, and ranking.

TPACK questionnaire dimensions	Media	SD	Ranking
Technological Knowledge (TK)	**3.59**	.763	7
Content Knowledge (CK)	**4.12**	.720	2
Pedagogical Knowledge (PK)	**4.27**	.726	1
Pedagogical Content Knowledge (PCK)	**4.02**	.798	3
Technological Content Knowledge (TCK)	**3.76**	.828	6
Technological Pedagogical Knowledge (TPK)	**3.91**	.754	4
Technological Pedagogical Knowledge of Content (TPACK)	**3.89**	.854	5
Average	3.94	.778	

Table 2. Description of the dimensions of the TPACK questionnaire. Source: Self-made.

Table 2 shows that the overall average of the TPACK questionnaire is (M Total=3.94, SD=.778). The highest values are obtained in PK (M total=4.27, SD= .726) followed by CK (M total=4.12, SD=.720), while TK knowledge presents the lowest values in all dimensions (M total=3.57, SD=.763).

3.2. Correlational analysis by stakeholder groups

The analysis of the central dimensions and their derivatives was carried out using Pearson correlations. Firstly, we are interested in finding out whether there is a correlation between the TK dimension and its derivatives, PK, and its derivatives, and, finally, TPACK with the key dimensions.

	TK	
	R_{XO}	p.
TCK	.613	< .001
TPK	.732	< .001
TPACK	.711	< .001
	PK	
	R_{XO}	p.
PCK	.787	< .001
TPACK	.655	< .001
	TPACK	
	RXO	p.
TK	.711	< .001
PK	.655	< .001
CK	587	< .001

Table 3. Correlations between TK, PK and TPACK vs. related dimensions. Source: Self-made.

Table 3 shows the results of the correlations. From the significance data (p≥ .05) we can confirm that there is a significant correlation between TK knowledge and related knowledge of TCK, TPK, and TPACK. Specifically, the correlations are direct, therefore, teachers with higher levels of TK knowledge affect the TCK, TPK, and TPACK dimensions. The intensities are stronger in TPACK and less intense in TCK.

According to the degree of significance (p≥ .05), the existence of significant correlations between PK knowledge and related PCK and TPACK knowledge is confirmed. Direct correlations are obtained: the higher level of teachers' PK knowledge tends to directly increase PCK and TPACK knowledge. About intensity, it is stronger in PCK, compared to TPACK.

According to the degree of significance (p≥ .05) there are significant correlations between TPACK, and the key dimensions TK, PK, and CK. Direct correlations are obtained, where the level of TPACK knowledge of teachers tends to directly increase the knowledge of the dimensions TK, PK, and CK. The highest intensity is observed in TK and the lowest is in CK.

3.3. Inferential analysis of the demographic variables

Inferential analyses were performed between the TPACK dimensions and the sociodemographic variables, gender, professional training, teacher evaluation, administrative dependancy, and years of experience. The normality test was performed, contrast tests were applied considering the effect size. Finally, post-hoc tests were used to test for differences between specific groups.

First, the assumptions of normality and homoscedasticity were verified using the Shapiro-Will test for all

socio-demographic variables, values less than (p≤ .05) were presented, the hypothesis of equal distribution was rejected, and the non-parametric statistics U Mann Whitney and Kruskal Wallis H were applied.

Dimensions TPACK	Gender	Media	S_x	R_{xo}	p.	Effect size
TK	Female	3.57	0.756	15742.000	.191	-.082
	Male	3,64	0.782			
CK	Female	4.18	0.670	20502.500	.002	.196
	Male	3.97	0.810			
PK	Female	4.29	0.725	18488.000	.208	.079
	Male	4.23	0.723			
PCK	Female	4.04	0.826	18419.000	.216	.075
	Male	3.98	0.734			
TCK	Female	3.79	0.804	18155.000	.326	.059
	Male	3.68	0.882			
TPK	Female	3.94	0.763	18178.000	.329	.060
	Male	3.88	0.736			
TPACK	Female	3.92	0.881	18994.000	.083	.108
	Male	3.81	0.787			

Nota. For the Mann-Whitney U test, the effect size is given by the biserial rank correlation.

Table 4. Contrast for Independent Samples - gender. Source: Self-made.

Regarding the distribution of teachers according to gender, see Table 1, practically three quarters of teachers are female, similar to data from the Chilean Ministry of Education (2019). For the contrast analyses, the following hypotheses are proposed:

H0: The distribution of TPACK dimensions is equal for males and females (p≥0.05).
H1: The distribution of TPACK dimensions is different for men and women (p≤0.05).

Table 4 shows that women have higher levels of knowledge in the dimensions CK, PK, PCK, TCK, TPK and TPACK. Furthermore, no significant differences are observed in most of the TPACK dimensions, except for PK knowledge (p. 002), which means that women have higher levels of pedagogical knowledge than men, with a low or medium-low effect size.

Dimensions TPACK	Professional training	Media	S_x	R_{xo}	p.	Effect size
TK	Bachelor's degree	3.55	0.75	6809.500	< .001	-.288
	Master's	3.87	0.73			
CK	Bachelor's degree	4.09	0.75	8580.000	.215	-.103
	Master's	4.27	0.47			
PK	Bachelor's degree	4.24	0.76	8380.000	.114	-.132
	Master's	4.46	0.37			
PCK	Bachelor's degree	4.00	0.82	8166.500	.069	-.147
	Master's	4.19	0.63			
TCK	Bachelor's degree	3.73	0.83	8478.500	.157	-.114
	Master's	3.94	0.76			
TPK	Bachelor's degree	3.88	0.75	8605.000	.224	-.101
	Master's	4.06	0.71			
TPACK	Bachelor's degree	3.87	0.86	8675.500	.263	-.093
	Master's	4.03	0.77			

Nota. For the Mann-Whitney U test, the magnitude of the effect is given by the biserial rank correlation.

Table 5. Contrast for Independent Samples - professional training. Source: Self-made.

The distribution of teachers according to their professional background shows that most of teachers have a bachelor's degree as their last qualification (86.4%), see Table 1.

For the contrast analyses, the following hypotheses are stated:

H0: The distribution of TPACK dimensions is equal among teachers according to academic degree (p≥0.05).
H1: The distribution of TPACK dimensions is different among teachers according to academic degree (p≤0.05).

Table 5 shows that teachers with a master's degree obtain better results in all the dimensions that make up

the TPACK. The knowledge dimensions with the highest means are PK, CK, and PCK. In addition, the TK dimension obtained a value ($p < .001$), which means that teachers with master's degrees have higher technological knowledge than their peers with bachelor's degrees, has a medium-low effect size.

Dimensions TPACK	Teacher Evaluation	Media	S_x	R_{xo}	p.	Effect size
TK	Yes	3.61	0.720	19135.000	.908	-.007
	No	3.59	0.791			
CK	Yes	4.28	0.598	23799.000	< .001	.235
	No	4.01	0.772			
PK	Yes	4.34	0.672	21119.500	.102	.096
	No	4.23	0.757			
PCK	Yes	4.09	0.745	20308.000	.341	.054
	No	3.98	0.830			
TCK	Yes	3.80	0.631	18302.500	.379	.050
	No	3.74	0.933			
TPK	Yes	3.98	0.733	21309.500	.070	.106
	No	3.86	0.765			
TPACK	Yes	3.96	0.803	21027.500	.120	.091
	No	3.85	0.884			

Table 6. T-contrast for Independent Samples - teacher evaluation. Source: Self-made.

Most teachers (61.3%) have not participated in performance evaluation processes, see Table 1. For the contrast analyses, the following hypotheses are used:

H0: The distribution of TPACK dimensions is equal among teachers who have or have not participated in teacher evaluation processes ($p \geq 0.05$).
H1: The distribution of TPACK dimensions is equal among teachers who have or have not participated in teacher evaluation processes ($p \leq 0.05$).

Table 6 shows that teachers who have participated in teacher evaluation processes have higher levels of knowledge in all the dimensions that make up TPACK. The knowledge with the highest means corresponds to PK, CK, and PCK. On the other hand, the CK dimension obtains (p. <.001) indicating that teachers participating in performance evaluation processes have greater disciplinary or content knowledge than their non-evaluated peers, with a medium effect size.

Dimensions TPACK	Administrative dependency	Media	S_x	H	p.	Effect size (n^2)
TK	MS	3.49	0.740	12.233	.002	0.018
	GFPS	3.65	0.847			
	PS	3.77	0.443			
CK	MS	4.13	0.735	4.164	.594	0.003
	GFPS	4.08	0.698			
	PS	4.18	0.752			
PK	MS	4.22	0.791	2.506	.245	0.007
	GFPS	4.34	0.643			
	PS	4.22	0.744			
PCK	MS	3.88	0.873	10.323	.003	0.029
	GFPS	4.17	0.671			
	PS	4.02	0.839			
TCK	MS	3.65	0.793	12.345	.045	0.015
	GFPS	3.82	0.875			
	PS	3.92	0.758			
TPK	MS	3.89	0.820	0.165	.720	0.002
	GFPS	3.91	0.706			
	PS	3.98	0.669			
TPACK	MS	3.82	0.909	0.919	.312	0.006
	GFPS	3.92	0.844			
	PS	4.01	0.656			

Table 7. Kruskal Wallis H-contrast - administrative dependency. Source: Self-made.

In terms of distribution. more than 85% of teachers work in MS or GFPS see Table 1. The following hypotheses are put forward for the contrastive analyses:

H0: The distribution of TPACK dimensions is the same among teachers in different administrative dependency.
H1: The distribution of TPACK dimensions is different among teachers from different administrative

dependency.

Table 7 shows that PS teachers have higher levels of knowledge in the dimensions TK, CK, TCK, TPK, and TPACK, while GFPS teachers have better results in the dimensions PK and PCK. In addition, significant differences are observed in TK (p .002) PCK (p .003). and TCK (p .045) all with low effect sizes. Given that significant differences are obtained we will apply Post-Hoc tests to check between which groups the differences occur.

Dimensions TPACK	Comparisons	Z	P (Holm)	Effect size (d)
TK	MS – GFPS	-3.070	.003	-0.216
	MS – PS	-2.583	.010	-0.378
	GFPS – PS	-0.512	.304	-0.161
PCK	MS – GFPS	-3.213	.002	-0.368
	MS – PS	-1.008	.252	-0.166
	GFPS – PS	1.146	.252	0.201
TCK	MS – GFPS	-3.268	.002	-0.211
	MS – PS	2.283	.022	-0.330
	GFPS – PS	-0.082	.467	-0.120

Table 8. Dunn's post-hoc comparisons - administrative dependency. Source: Self-made.

In Table 8, we observe the existence of significant differences in the TK dimension between MS and GFPS teachers with a value (p .003) and low effect size. Also, there are differences between teachers from MS and PS with a value (p .010) and an effect size between low and medium-low. It is interpreted that GFPS, and PS teachers have higher levels of TK knowledge than MS teachers.

In the PCK dimension, significant differences are observed between MS and GFPS teachers, with a value (p .002) and medium-low effect size. It can be noted that GFPS teachers have higher levels of PCK knowledge than MS teachers.

In the TCK dimension, there are significant differences between MS and GFPS teachers with a value (p .002) with a small effect size. Also, differences are observed between MS and GFPS teachers. with a value (p .022) and a low to medium-low effect size. It is interpreted that GFPS, and PS teachers have higher levels of TCK knowledge compared to MS teachers.

Dimensions TPACK	Years of experience	Media	S_x	H	p.	Effect size (n^2)
TK	0 a 5 years	3.45	0.769	13.293	.007	.030
	6 a 11 years	3.65	0.680			
	12 a 18 years	3.80	0.729			
	More than 18 years	3.56	0.800			
CK	0 a 5 years	3.84	0.795	39.084	< .001	.082
	6 a 11 years	4.22	0.742			
	12 a 18 years	4.08	0.724			
	More than 18 years	4.36	0.506			
PK	0 a 5 years	4.09	0.805	17.216	.001	.039
	6 a 11 years	4.23	0.885			
	12 a 18 years	4.36	0.704			
	More than 18 years	4.44	0.473			
PCK	0 a 5 years	3.79	0.870	16.515	< .001	.046
	6 a 11 years	4.07	0.859			
	12 a 18 years	4.03	0.850			
	More than 18 years	4.22	0.561			
TCK	0 a 5 years	3.50	0.970	22.912	< .001	.061
	6 a 11 years	3.66	0.747			
	12 a 18 years	3.86	0.761			
	More than 18 years	4.00	0.680			
TPK	0 a 5 years	3.50	0.970	15.136	.005	.032
	6 a 11 years	3.75	0.850			
	12 a 18 years	3.80	0.667			
	More than 18 years	4.00	0.889			
TPACK	0 a 5 years	3.66	0.944	22.851	< .001	.042
	6 a 11 years	3.83	0.846			
	12 a 18 years	4.10	0.766			
	More than 18 years	4.00	0.849			

Table 9. Kruskal Wallis H-contrast - years of experience. Source: Self-made.

As for the distribution by years of service, most of the sample corresponds to teachers with 0 to 5 years and more than 18 years 87.4% see Table 1. For the contrastive analyses, the following hypotheses are used:

H0: The distribution of TPACK dimensions is the same for teachers regardless of years of experience.
H1: The distribution of TPACK dimensions is different for teachers regardless of years of experience.

Table 9 shows that teachers with more than 18 years of experience have higher levels of knowledge in the dimensions CK. PK. PCK. TCK and TPK. Furthermore. we can confirm the existence of significant differences in the TPACK dimensions and the teachers' years of service. All dimensions present values lower than ($p \leq 0.05$) ranging between (< .001 and .007). Moreover, the effect size for all TPACK dimensions is small. Therefore, we will apply Post-Hoc tests to check in which groups the differences are found.

Dimensions TPACK	Comparisons	Z	P (Holm)	Effect size (d)
TK	0 a 5 years – 6 a 11 years	-1.491	.139	-0.272
	0 a 5 years – 12 a 18 years	-3.645	< .001	-0.473
	0 a 5 years – more than 18	-1.699	.139	-0.147
	6 a 11 years - 12 a 18 years	-1.814	.139	-0.201
	6 a 11 years – más 18 years	0.025	.490	0.124
	12 a 18 years – more than 18	2.083	.093	0.326
CK	0 a 5 years – 6 a 11 years	-3.944	< .001	-0.537
	0 a 5 years – 12 a 18 years	-1.866	.062	-0.334
	0 a 5 years – more than 18	-5.900	< .001	-0.746
	6 a 11 years - 12 a 18 years	2.046	.061	0.203
	6 a 11 years – más 18 years	-1.148	.126	-0.209
	12 a 18 years – more than 18	-3.540	< .001	-0.411
PK	0 a 5 years – 6 a 11 years	-1.732	.166	-0.149
	0 a 5 years – 12 a 18 years	-3.193	.004	-0.382
	0 a 5 years – more than 18	-3.800	< .001	-0.481
	6 a 11 years - 12 a 18 years	-1.190	.234	-0.232
	6 a 11 years – más 18 years	-1.546	.183	-0.331
	12 a 18 years – more than 18	-0.293	.385	-0.099
PCK	0 a 5 years – 6 a 11 years	-2.912	.009	-0.366
	0 a 5 years – 12 a 18 years	-2.350	.038	-0.309
	0 a 5 years – more than 18	-3.791	< .001	-0.557
	6 a 11 years - 12 a 18 years	0.655	.512	0.057
	6 a 11 years – más 18 years	-0.361	.512	-0.191
	12 a 18 years – more than 18	-1.126	.390	-0.248
TCK	0 a 5 years – 6 a 11 years	-0.203	.679	-0.191
	0 a 5 years – 12 a 18 years	-3.237	.003	-0.446
	0 a 5 years – more than 18	-3.980	< .001	-0.617
	6 a 11 years - 12 a 18 years	-2.659	.012	-0.255
	6 a 11 years – más 18 years	-3.227	.003	-0.426
	12 a 18 years – more than 18	-0.413	.679	-0.171
TPK	0 a 5 years – 6 a 11 years	0.857	.277	-0.065
	0 a 5 years – 12 a 18 years	-2.884	.010	-0.436
	0 a 5 years – more than 18	-1.957	.075	-0.335
	6 a 11 years - 12 a 18 years	-3.340	.003	-0.371
	6 a 11 years – más 18 years	-2.543	.022	-0.270
	12 a 18 years – more than 18	1.087	.277	0.101
TPACK	0 a 5 years – 6 a 11 years	-0.853	.197	-0.208
	0 a 5 years – 12 a 18 years	-4.308	< .001	-0.528
	0 a 5 years – more than 18	-3.289	.003	-0.410
	6 a 11 years - 12 a 18 years	-2.994	.006	-0.320
	6 a 11 years – más 18 years	-1.984	.071	-0.202
	12 a 18 years – more than 18	1.289	.197	0.117

Table 10. Dunn's Post-hoc Comparisons - years of experience. Source: Self-made.

In table 10, we observe in the TK dimension the existence of significant differences between teachers who have worked between 12 and 18 years value ($p < .001$) compared to teachers from 0 to 5 years, the effect size is medium-low.

In CK knowledge, it is observed that teachers with more than 18 years of work have higher levels of knowledge compared to teachers of 0 to 5 years and 12 to 18 years, whose value for both is (p. < .001), and their effect size is medium-high and medium-low respectively. Furthermore, it is observed that teachers aged 6 to 11 years have a higher knowledge of CK, in contrast to teachers aged 0 to 5 years, their effect size is medium. It is interpreted that teachers with 0-5 years of experience have lower levels of CK knowledge.

In the PK dimension, teachers aged 12 to 18 years and over 18 years have higher levels of knowledge compared to teachers aged 0 to 5 years, with a medium-low effect size.

In the PCK dimension, teachers aged 6-11, 12-18, and 18+ have higher levels of knowledge of PCK compared to teachers aged 0-5. The effect sizes are in the medium and medium-low levels.

In the TCK dimension, it is observed that teachers aged 12 to 18 have higher levels of knowledge than

their peers aged 0 to 5 and 6 to 11, the effect size of these differences is medium-low. On the other hand, teachers with more than 18 years of experience have larger differences compared to teachers aged 0-5 and 6-11 years, the effect size is medium and medium-high.

In the TPK dimension, it is observed that teachers aged 12 to 18 years and over 18 years have higher knowledge than teachers aged 0 to 5 years and 6 to 11 years, the effect size varies between low and medium-low.

In the TPACK dimension, it is observed that teachers aged 12 to 18 and over 18 have higher levels of knowledge compared to teachers aged 0 to 5 and 6 to 11, the effect size varies between medium and medium-low.

4. Conclusions and discussion

According to Mishra and Kohler (2006), technology should be integrated according to curricular and pedagogical needs. Therefore, teachers need to acquire knowledge related to configuration TPACK.

The core knowledge of the TPACK model can be concluded that primary school teachers have higher levels of pedagogical knowledge (PK) 4.27 and disciplinary knowledge (CK) 4.12 compared to technological knowledge (TK) 3.59, as argued by Beltrán et al. (2019), Bingimlas (2018), Roussinos and Jimoyiannis (2019), and Usta (2021).

When comparing basic knowledge with TPACK interactions, it is concluded that teachers present higher CK and PK knowledge, in contrast to all PCK, TPK, TPACK, and TCK knowledge interactions, with values between 4.02 and 3.76, as well argued by Doering et al. (2014), Koh and Chai (2014) and Paidicán and Arredondo (2022a).

The correlation analyses allow us to conclude that greater knowledge of TK tends to increase knowledge of TCK (.613), TPK (.732), and TPACK (.711), with the latter having the strongest correlation with. In turn, higher PK knowledge tends to increase PCK (.787) and TPACK (.655). Finally, when correlating key knowledge TK (.711), CK (.655), and PK (.587) with TPACK, it is concluded that higher TK knowledge tends to increase TPACK knowledge.

The inferential analyses provide the following conclusions: women have higher levels of knowledge in CK, PK, PCK, TCK, TPK, and TPACK, with values between 3.79 and 4.29, as pointed out by Akturk & Ozturk (2019), Paidicán and Arredondo (2022a), and Usta (2021). However, only CK (p. 002) knowledge shows significant differences with effect sizes between medium-low and low (.196). On the other hand, males have higher levels of technological knowledge (TK) whose mean is 3.64, as argued by Ekrem and Recep (2014), Luik et al. (2018), and Vatanartiran (2015).

Regarding professional training, teachers with master's degrees have higher levels of knowledge in all dimensions of TPACK, with average values between TK (3.87) and PK (4.46), as claimed by Liang et al. (2013) and Paidicán and Arredondo (2022a). However, only TK knowledge shows significant differences with a medium-low effect size (-.288).

In terms of teacher evaluation, teachers who have participated in evaluation processes obtain better results in all dimensions of the TPACK, with mean values between TK (3.61) and PK (4.34). However, only the knowledge of CK of the evaluated teachers shows significant differences, with a mean effect size (.235). It is necessary to clarify that primary education teachers in Chile, mostly in the 1st to 4th grade levels, teach several subjects, which implies the mastery of several contents rather than a specific one.

As for the administrative dependency, PS teachers have higher levels of knowledge in TK (3.77), CK

(4.18), TCK (3.92), TPK (3.98), and TPACK (4.01). Post-hoc tests allow us to conclude that MS teachers have the lowest levels of knowledge in TK value (p .003) and TCK value (p .002) compared to PS and GFPS teachers, with a low effect size. In addition, MS teachers have a lower knowledge of PCK value (p .002) in contrast to GFPS teachers, with a medium-low effect size. It is worth noting that, according to the literature reviewed, there are few studies that consider both administrative dependency and teacher evaluation as variables in primary school teachers, which represents an important contribution to the development of the TPACK model.

In terms of years of experience, teachers with more than 18 years of experience have the highest levels of knowledge in CK (4.36), PK (4.44), PCK (4.22), TCK 4.00), and TPK (4.00). Previous studies by Agyei y Voogt (2015), Janssen et al. (2019), Ladrón de Guevara et al. (2019) and Saudelli and Ciampa (2016) argue that teachers with more experience have higher scores on the knowledge related to TPACK.

Contrast and post-hoc tests confirm the existence of significant differences in all the dimensions that make up the TPACK. Regarding basic knowledge, it can be concluded that teachers between 12 and 18 years of service have greater knowledge in TK value (p. <.001), CK value (p. <.001) and PK value (p.004), compared to teachers between 0 and 5 years. While teachers with more than 18 years of service have higher levels of CK value (p. <.001) and PK value (p. <.001), compared to teachers 12 to 18 years old and 0 to 5 years old respectively.

In terms of integrated knowledge, it can be concluded teachers between 12 and 18 years of experience present higher levels of knowledge PCK value (p.004), TCK value (p.003), TPK value (p.010) and TPACK value (p. <.001), in contrast to teachers between 0 to 5 years. This trend also occurs with teachers between 6 and 11 years old, with levels of knowledge in CK value (p.012), TPK value (p.003) and TPACK value (p.006). Also, it is observed that teachers with more than 18 years of experience, have higher levels of knowledge in PCK value (p. <.001), TCK value (p. <.001) and TPACK value (p.003), in comparison with teachers between 0 and 5 years. Also, this trend is repeated with teachers between 6 and 11 years old in the TCK value (p.003) and TPK value (p.022) levels.

In terms of limitations and prospective, future studies require larger probability samples in rural contexts in order to generalise the results obtained. In addition, longitudinal and experimental studies could be developed to complement the results obtained.

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