VALIDATION OF THE TPACK-IT SCALE FOR PRE-SERVICE TEACHER TRAINEES

VALIDAZIONE DELLA SCALA TPACK-IT PER INSEGNANTI IN FORMAZIONE

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ABSTRACT
TPACK (Koehler & Mishra, 2005; Mishra & Koehler, 2006) is one of the most important approaches to describe the integration of technology in teaching and learning design. The aim of this study is to analyze the validity and reliability of the TPACK.xs questionnaire (Schmid et al, 2020) of the Italian version, through Confirmatory Factor Analysis (CFA). The results show the reliability of TPACK.xs-IT as a tool that can become a support for teacher training and professional development.

Il TPACK (Koehler & Mishra, 2005; Mishra & Koehler, 2006) è uno degli approcci più importanti per descrivere l'integrazione della tecnologia nella progettazione didattica. Lo scopo di questo studio è analizzare la validità e l'affidabilità del questionario TPACK.xs (Schmid et al, 2020) della versione italiana, attraverso l'analisi fattoriale confermativa (CFA). I risultati mostrano l'affidabilità del TPACK.xs-IT come strumento a supporto della formazione degli insegnanti e del loro sviluppo professionale.

KEYWORDS
English: TPACK, pre-service teachers, ICT, didactics.
Italiano: TPACK, insegnanti in formazione, TIC, didattica.

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Introduction

Technology has become an essential part of our daily lives even in the academic context and teachers are increasingly being asked to use technology in their educational practice.

Almost thirty years ago, the Italian Ministry of Education published the first National Information Technology Plan (1985), which added information technology to the secondary school curriculum. This set off a process of gradual but steady change that has led to increasing use of ICT, thereby improving and innovating the teaching and learning processes for all students (Calvani, 2010; de Anna, 2012; Maragliano, 2004; Pagliara, 2015), contributing to the construction of inclusive contexts and processes in a digital age (Limone, Toto, 2022).

The addition of these technologies, however, does not always proceed hand in hand with enhancement of the quality of teaching and improvement in the process of learning, above all when the teachers themselves do not have clear ideas about the goals and do not understand the educational dimension of the individual tools or are not able to connect and integrate them with appropriate content, as well as daily teaching practice. For this reason, it is essential to pay particular attention to the training of the future teachers, to ensure that they are not reduced merely to teaching their students how to use digital tools, but rather using them to engage in a broader sense, from the lesson planning to practice in the classroom (Maragliano, 2004).

In this view, the latest National Plan for a Digital School (2016), included as part of law no. 107/2015, aims to foster the application of digital curricula, the use of innovative teaching methods and the development of new learning environments thanks to the use of ICT.

The basic idea is to establish a systematic process of cultural growth in the school that starts from a renewed sense of purpose, where the school is seen as an open space for learning, a vast laboratory where students can acquire the life skills they need.

In this paradigm, technologies become routine, ordinary means to an end, one of the pillars through which students grow from being consumers to “critical consumers” and even “producers” of digital content and architecture, able to develop skills across the board in every sector and field of work, solve problems, put ideas into practice, acquire independence of judgment and awareness of their own talents, become malleable and flexible in their search for problem-solving

answers (Miur, 2016, p. 70). ICT can also be used to develop creativity among the students although, as Ferrari points out (2010), the potential of ICT for creative learning resides in the effective characteristics of the technological tools, in the use that is made of them and in the interaction between individuals and the tools (Loveless, 2007). It also depends on the teacher's awareness of the limits as well as of the opportunities offered by the technologies, and on the ways in which the teacher or student use the technological tools. In this direction, for a functional and informed use of technologies, capable of taking full advantage of their potential, it will be necessary, according to Pinelli and Fiorucci, for teachers to acquire not only technological skill but also and above all methodological skills. More than the ability to use a tool with greater or lesser expertise, it is necessary for the teacher to be able to adapt the characteristics of the technological mediator to the specific intent of its application, and not the other way around (Pinelli, Fiorucci, 2020, p. 260). This means that teachers have to use ICT as means and tools to foster the transformation of knowledge and render it accessible to all, becoming privileged educational mediators (Damiano, 1993; Moliterni, 2013). This requires much more than mere technical knowledge, but rather, "*knowing how to incorporate ICT flexibly into the content of the subject matter, which is, in turn, transformed, with adequate methodological approaches, to effectively valorize the students' ability to learn ability*" (La Marca & Di Martino, 2021, p. 156). Thus, it is a matter of learning how to project knowledge. Teachers must be able to integrate ICT into their lesson planning so that the technologies can aid in the pursuit of the learning goals (access to knowledge) and would be difficult to achieve otherwise, if they remained anchored to the use of traditional teaching methods alone (Calvani, 2020; Tipton; 2020). In addition, ICT bring the students closer to the reality to which they are constantly exposed, offering them critical strategies for developing appropriate coping mechanisms.

Knowing how to plan is a complex skill that "*necessarily taps into the initial and in-service training of teachers, who are called upon to reformulate the traditional methods of teaching-learning in light of the potentials that ICT offer in terms of pedagogical accessibility*" (Sánchez Utgé et al., 2017: 134). The course of specialization for special education teachers (pursuant to the Italian Ministry decree of September 30, 2011) contemplates a workshop of 75 hours on information and communication technologies, with the dual scope of developing technological skills and also of integrating them into the inclusive didactic project, in terms of pedagogical and didactic accessibility (de Anna, 2012, 2016). In this sense, it is essential for future teachers to know "*how to choose technologies according (1) to their educational and didactic objectives, (2) to the operating*

characteristics of each one, inserting them correctly with regard to times (when), spaces (where) and ways (how) in the design of a specific class with its specific needs" (Pennazio & Bochicchio, 2022, p. 24).

In these terms, teachers in training find themselves having to acquire new skills and knowledge in this sector, and their trainers may not always have a clear conceptual reference model that can provide effective cognitive categories of reference. From studies of the literature, an interesting framework emerges: the TPACK – *Technological Pedagogical Content Knowledge* – which could provide a useful starting point on which to build a training model that is careful to combine technological, disciplinary, didactic and educational aspects in an interconnected network. "*The TPACK is a conceptual model that describes the knowledge and abilities possessed by teachers and to which they can resort in the practice of teaching when they use technological mediators*" (La Marca & Di Martino, 2021, p.156). Thus, it becomes useful to be able to dispose of a validated and reliable questionnaire in the Italian version, so as to prompt critical reflection, serving to establish serious and continuous training on ICT, in respect of the profound cognitive-planning structures of the teachers (Ala-Mutka, 2011). This type of training has to make us reflect on the integration and interconnection between pedagogical, disciplinary and technological knowledge, as can be seen from a number of research projects on the TPACK (Angeli & Valanides, 2005; Messina & De Rossi, 2015; Messina & Tabone, 2014; Mishra & Koehler, 2006, Ranieri, 2022). In this direction, we should encourage the cultural technology that, according to Rivoltella and Ferrari, enables teachers to think in depth about the relationships technology creates in training with the construction, representation and communication of knowledge, in full awareness of the fact that no technical solution would be acceptable if not supported by a careful assessment of the perspectives that open (and those that close) on the epistemological plane (Rivoltella, Ferrari, 2010, p. 22-23).

The Technological, Pedagogical and Content Knowledge Framework

After studying the subject for five years, Mishra and Koehler (2006) developed the TPACK framework to provide an answer to *"what teachers need to know in order to appropriately incorporate technology into their teaching*" (p. 1018) focusing on the study of "*how the technology is used*" (p. 1018).

The authors base the framework on the works of Shulman (1986, 1987) concerning the basic knowledge of teachers: disciplinary (Content knowledge) and pedagogical (Pedagogical Knowledge). Shulman claims that the success of a teacher depends on the ability to integrate these two spheres of competence in a continuous synergy, in order to render the learning comprehensible. His theorization forms the underlying structure of Pedagogical-Content Knowledge (PCK) where, in the intersection where the integration of the skills takes place, there is a transformation that takes account of "*the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations and demonstrations – that is, the ways of representing and formulating the subject that make it comprehensible to others.*" (Shulman, 1986, p.9).

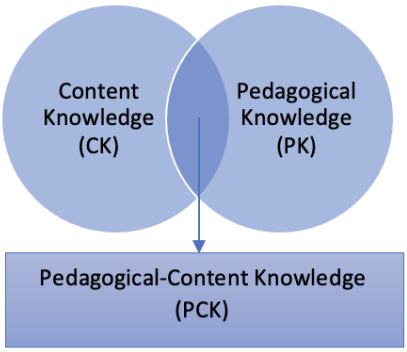

Figure 1: Pedagogical-Content Knowledge (PCK)

Mishra and Koehler introduce a third domain, relative to technological knowledge, claiming that it is essential to include this new area of expertise so that the technologies can contribute to represent the knowledge, facilitating its comprehension, and making it possible to use the more powerful representation of disciplinary content, as envisaged by Shulman's model.

That is how TPACK (Technological Pedagogical Content Knowledge) develops: by positioning the three dimensions in such a way that they appear equally important and interconnected. In fact, TPACK is the center, the heart of the framework where all the areas, including the intersections, combine to generate new knowledge. Assuming a transformative vision that "*describes the intersections of knowledge components to give rise to unique bodies of knowledge which are more than the fusion of the core component, […] TPACK cannot simply be accounted for by*

summing all other TPACK components but, rather, is a distinct form of knowledge which transforms beyond the components at its base." (Schmid et al, 2020, p.2)

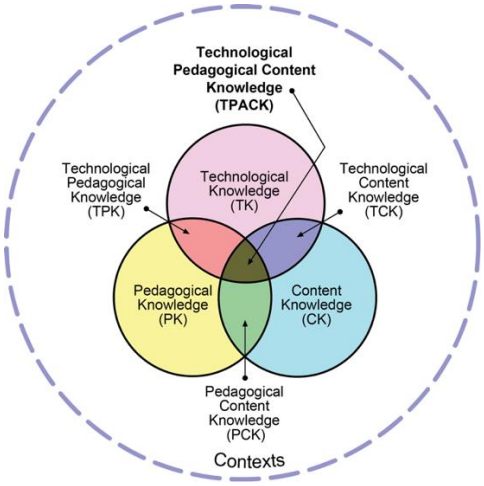

Figure 2: Technological Pedagogical Content Knowledge framework (TPACK). Source: http://tpack.org

Mishra and Koehler (2006) define the different areas and intersections that configure the seven factors of the framework as follows:

- Content Knowledge: "*the actual subject matter that is to be learned or taught*" (p. 1026), with the awareness of the different approaches and lines of research typical of every field.
- Pedagogical Knowledge: *"processes and practices or methods of teaching and learning*" (p. 1026), which include the didactic strategies, the pedagogical theories, the planning of activities and the assessment to be made relative to the context, and to the educational and training goals and values.
- Technological knowledge: knowledge of both analogical and digital technologies, taking account that the latter are in continuous evolution and any knowledge of them must be continually updated and nourished and requires "*The ability to learn and adapt to new technologies*" (p. 1028)
- Pedagogical Content Knowledge: "k*nowing that teaching approaches fit the concept, and likewise, knowing how elements of the content can be arranged for better teaching*" (p. 1027)

- Technological Content Knowledge: “the manner in which technology and content are reciprocally related” (p. 1028). The new technologies offer new ways of representing and approaching the specific contents of a discipline, for example, using certain software is it possible to let the students “play” with the content in ways that would not have been possible before the advent of these technologies.
- Technological Pedagogical Knowledge: how technology can be used for teaching and how it influences the didactic action.
- Technological Pedagogical Content Knowledge: “*is knowledge of the existence, components, and capabilities of various technologies as they are used in teaching and learning settings, and conversely, knowing how teaching might change as the result of using particular technologies*” (p. 1028)

TPACK is configured as a framework that contains the complexity of the didactic action and understands the need to contextualize it through the use of the technological elements not as an adjunct but in an eco-systemic way (Koehler and Mishra, 2009) integrating it directly into the lesson plan.

One of the challenges of every field of research is the need to develop tools for the assessment of progress. As regards the TPACK framework, it provides reliable, validated tools that are essential to be able to continue the research and verify the effectiveness of the epistemological plan in its concrete application (Koehler, Shin & Mishra, 2012; Niess, 2012). Moreover, as suggested by Mishra and Koehler (2020) “*it is essential to provide the field of TPACK with assessment tools which are not only valid and reliable, but that are also easy and practical to administer.”* (p. 2). Currently, scales of self-evaluation are the most widely developed tools for rating the TPACK (Willermark, 2018) because they make it possible to collect the most data in the shortest amount of time. After examining the tools available in the literature, our choice fell on the work done by Schmid et al (2020) because, as pointed out by the authors of TPACK.xs, it meets the following requisites:

- Reliability of the questionnaire in measuring the seven factors of the framework through four items for each of them, which makes it a practical and economical tool.

- It is a tool which facilitates the collection of data on a range of disciplines and levels of school, a fundamental aspect for the purpose of the future development of this research.

Method

1. Sample

The validation study was carried out on a sample of 284 pre-service support teachers from different state universities in the Lazio region. Almost all the participants were women (F=82.4%, M=18%) with an average age of M=40.15; SD=7.9, range=22-60. The educational levels of the participants varied: 10.2% were high school graduates, 6% held 3-year university degrees, 60.6% held 5-year university degrees with single cycle degrees=20.4% and Doctorates=2.8%, but almost half had majored in either socio-psychological and pedagogical disciplines (28.2%) or economic-legal (20.1%) fields. At the time of the study, 75% of the participants had experience in schools at various levels (pre-school = 0.4%, primary school = 18.3%, middle school = 19.0%, high school = 37.3%. 25% of the participants are not currently teaching. As was predictable, almost half of the participants did not have official teaching qualification (48.6%), but had taught on average for 2.37 years, SD=3.8, range=0-30. The majority of the sample did not have qualification as support teachers (55.3%) but had experience working in Support with an average of M=2.08 anni, SD=2.96, range=0-30.

Sex		N	%
	F	234	82.4%
	M	50	17.6%
Age			
	Mean	40.15	
	SD	7.9	
	Range	38	
Education		N	%
	Diploma	29	10.2%
	Bachelor's degree	17	6.0%
	Master's degree	172	60.6%
	Single-cycle degree	58	20.4%

	PhD	8	2.8%
Education Field		N	%
	STEM	45	15.8%
	Legal-economic	57	20.1%
	Linguistics	33	11.6%
	Choreutic-musical	11	3.9%
	Socio-psycho-pedagogical	80	28.2%
	Sports Sciences	32	11.3%
	Geographical-historical-philosophical	26	9.2%
Current employment		N	%
	Pre-school	1	0.4%
	Primary school	52	18.3%
	Middle school	54	19.0%
	High School	106	37.3%
	No teaching	71	25.0%
Teaching Qualification		N	%
	Ordinary competitive exam	25	8.8%
	Special competitive exam	12	4.2%
	TFA	79	27.8%
	SSIS	4	1.4%
	LM85 bis	4	1.4%
	No Qualification	138	48.6%
	Other	22	7.7%
Work Experience			
	Mean	2.37	
	SD	3.80	
	Range	30	
Support Qualification			
		N	%
	Primary school	38	13.4%
	Middle school	30	10.6%
	High School	59	20.8%
	No experience	157	55.3%

Support Work Experience			
	Mean	2.08	
	SD	2.96	
	Range	30	

Table 1. Demographic, educational and experiential background of the participants

2. Methods

The questionnaire validated in this study is a translation of the abridged version of the TPACK.xs questionnaire by Schmid et. al. (2020), as we explained in the preceding paragraphs. This tool explores 7 factors (PK, CK, TK, PCK, TCK, TPACK) described by 4 items each, for a total of 28 indicators. Although the participants were enrolled in a course to become support teachers, the questionnaire was drafted in a generic format, without reference to any specific didactic discipline, to enable those who took it to cite even previous experiences in terms of both training and teaching experience. The questionnaire was translated twice, by an English language expert and by the special didactic and pedagogical research group involved in this study. The authors chose to use the back-translation (Brislin, 1970, 1986), through which the texts were first translated into the language of the context and then again into English by another specialist. The two translations were then sent to a translator and any differences were sorted out in the last stage. The final format of the questionnaire was validated by a focus group consisting of 2 researchers in the inclusive education field, two middle and high school teachers and two researchers in the technical field.

The demographic variables were analyzed using SPSS software, version 28, while the process of confirmative factorial analysis (CFA) was done with Mplus software, version 7. The threshold values were set as follows: minimum Chi-squared, CFI and LTI >0.95, SRMR <0.08, RMSEA <0.06, range of confidence not passing through 0 (Hu & Bentler, 2009), Cronbach's Alpha coefficient>0.85 and MacDonald's Omega>0.80 (Kalkbrenner, 2023). Cronbach's Alpha and MacDonald's Omega were used to test the reliability of the subscales. Initial analyses revealed an abnormal distribution of the data, so the analysis was made using Mplus softwear with MRL (Maximum Robust Likelihood) analysis. When data were lacking, we opted for a listwise deletion, with the entire string being deleted in case of missing data.

Results

The validation process gave excellent results: X2 (328) = 544.8, p < .001; TLI = 0,946; CFI = 0,953; RMSEA = 0,048, 90% CI [0,041; 0,055]; SRMR = 0,054. Cronbach's Alpha and MacDonald's Omega for the subscales were respectively as follows: PK (0.857 - 0.857), CK (0.841 - 0.841), TK (0.871 - 0.874), PCK (0.897 - 0.898), TPK (0.901 - 0.902), TCK (0.906 - 0.906) e TPACK (0.898 - 0.899). The number of questionnaires collected satisfied the minimum requirement of 5-10 participants per item (Bentler, 1987). The following table shows the average scores and standard deviation of each item with the results of applying Cronbach's Alpha and MacDonald's Omega to each subscale. The last column lists the standardized estimates of the CFA for each item relative to its reference factor.

Item	Mean	SD	α / ω	Estimate
PK1	4,11	0,62		0.786
PK2	4,05	0,646		0.808
PK3	3,95	0,704		0.787
PK4	3,84	0,677	0.857 / 0.857	0.732
CK1	4,03	0,777		0.727
CK2	4,05	0,679		0.774
CK3	4,17	0,647		0.818
CK4	3,99	0,678	0.841 / 0.841	0.725
TK1	4,03	0,708		0.704
TK2	3,96	0,81		0.760
TK3	3,76	0,822		0.888
TK4	3,82	0,818	0.871 / 0.874	0.822
PCK1	3,94	0,675		0.837
PCK2	3,86	0,704		0.876
PCK3	3,92	0,691		0.839
PCK4	3,93	0,677	0.897 / 0.898	0.763
TPK1	3,77	0,73		0.930
TPK2	3,79	0,712		0.939
TPK3	3,76	0,706		0.844
TPK4	3,89	0,799	0.901 / 0.902	0.643
TCK1	3,61	0,831		0.801

TCK2	3,48	0,842		0.860
TCK3	3,44	0,797		0.868
TCK4	3,4	0,832	0.906 / 0.906	0.840
TPACK1	3,71	0,72		0.751
TPACK2	4,01	0,789		0.775
TPACK3	3,95	0,734		0.889
TPACK4	3,91	0,707	0.898 / 0.899	0.918

Table 2. Average, Standard Deviation, Cronbach's Alpha / MacDonald's Omega and Estimates for every item of the questionnaire.

The table below indicates the correlations between the various factors of the model, the standardized coefficients of the items and their residual values.

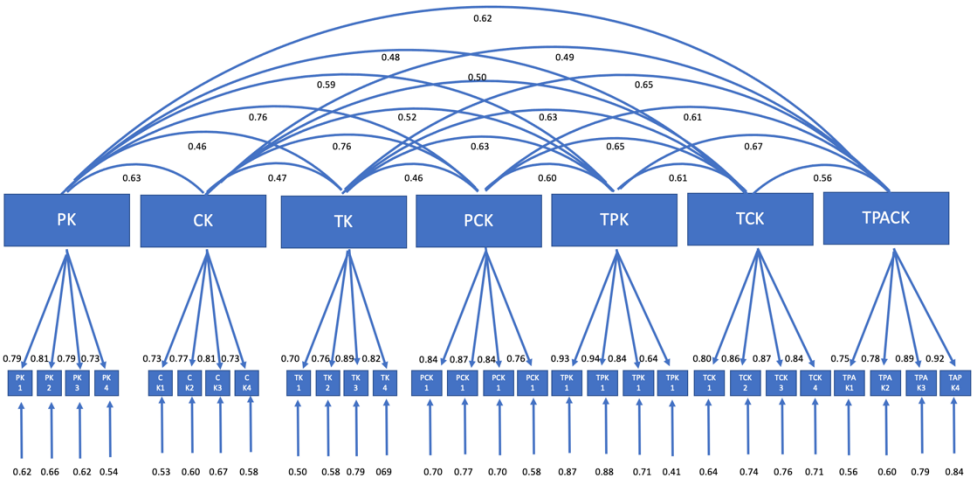

Figure 3. Confirmative Factorial Analysis of TPACK.xs-IT with standardized coefficients

Conclusion

The TPACK.xs-IT questionnaire can be administered on a broad scale and used to study specific aspects useful for our continuous improvement of teaching methods.

TPACK is an acknowledged framework at the international level and its questionnaires have been validated in a range of contexts (Herring, 2008; Baran, 2011; Rosenberg, 2015; Wang, 2019; Tseng, 2022). Although there have been many attempts to implement TPACK on a theoretical and practical level, this study is the

first to validate an Italian version of the questionnaire. The structure of the original study is entirely confirmed by this validation, which improves on some aspects, like the sample number and the absence of correlation between the variables observable in the questionnaire. In its formulation limited to 28 items, it appears highly functional and could be applied in future studies to much larger samples. Despite the excellent results, there are a few limitations to be borne in mind. The first concerns the sample size. Although the minimum number was reached, validation studies should include the largest possible number to ensure a correct procedure, taking into consideration a variety of different contexts. Moreover, the sample is heavily unbalanced toward the female component, and this obviously reflects the occupational situation in Italian schools. In the study considered, women account for 82.4%, very similar to the Italian sample in which they are 81.7% (source: https://dati.istruzione.it/espscu/index.html?area=anagStu) as compared with the OECD average of 68%. The second limitation concerns the self-evaluation of pre-service teachers, in the case of limited experience in the classroom. On this aspect, steps could be taken through a qualitative survey, based on in-depth interviews, to learn more about the considerations and opinions of the teachers.

For this reason it is to be hoped that as the studies continue, a qualitative and quantitative method can be used to compare the results of the TPACK with the effective use of technology in classroom instructional activities.

The TPACK Questionnaire is a useful initial tool which we need to continue to study through research projects in the scholastic environment, refining it in the didactic field, where there is increasing need, considering the advent of a steady stream of new technologies with ever greater sophistication, to understand how to train informed teachers able to give their pupils the critical discernment to deal with the complexity of the real world.

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