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Development of the teacher's technological pedagogical content knowledge (TPACK) from the Lesson Study: A systematic review

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A systematic review is presented with the purpose of exploring the trends associated with the development of technological pedagogical content knowledge (TPACK) from Lesson Study. In the 21st century, technology established a complex and necessary relationship with different sectors of society, enabling different conceptual and practical models for the incorporation of technologies in teaching. TPACK was one of the most outstanding. In this perspective, a systematic literature review is presented taking into account 16 studies published between 2015 and 2021 with the purpose of analyzing the development of TPACK in teachers, in research that uses the Lesson Study (LS) as an intervention strategy. The review was carried out in April 2022 using the following databases: Scopus, Web of Science, Spinger Link, Proquest Central, Science Direct, Redalyc, Dialnet and Scielo. The phases of identification, screening, selection and inclusion of the flowchart of the PRISMA guide were applied. The results reveal that the LS constitutes a theoretical and practical framework that provides contextualized opportunities to work on the training needs and interests of teachers, promoting self-assessment and the construction of new conceptions about teaching with technologies. Therefore, the theoretical discussion reveals that the integrative vision of TPACK is the perspective that predominates the development of this type of research.

KEYWORDS

digital competence, TPACK, teacher training, Lesson Study, ICT, systematic review

1. Introduction

Various technologies digital and non-digital have been a key component in responding to the educational needs arising from the pandemic. This scenario marked by didactic and school management uncertainties made visible limitations and opportunities in educational models around the world, and in many cases, a moment of deep reflection to reconfigure pedagogical and investigative practices in educational establishments. This global situation allowed technologies to be positioned more vigorously, even turning them into indispensable learning resources with which families, teachers, and students managed to advance (Rivas, 2020). Thus, technology emerged as an important resource to enhance the skills of teachers and the

generation of better conditions for student learning in an unexpected context (Cabero and Valencia, 2021). However, in the field of teacher training and professional development, it remains a challenge to overcome the technocentric view of the technological component in order to mobilize it toward an understanding and implementation of situated teaching and learning experiences, where the integration of the components continues to be strengthened. Technological, pedagogical and disciplinary during classroom practices (Ortega, 2020). Similarly, the scarce digital competence of teachers for the integration of technologies in the curriculum and teaching (Cabero-Almenara, 2020) continues to constitute a complex and problematizing scenario that invites us to think and transcend the recognition of ICT as a technical tool., toward a deeper understanding of its implications in the teaching and learning of school content (Cadena, 2020). In this context, an alternative way to achieve the development of TPACK in teachers is the use of Lesson Study (LS), which is a model of teacher professional development aimed at improving the pedagogical practice of teachers based on the collaborative study of their own teaching actions (Pérez and Soto, 2015).

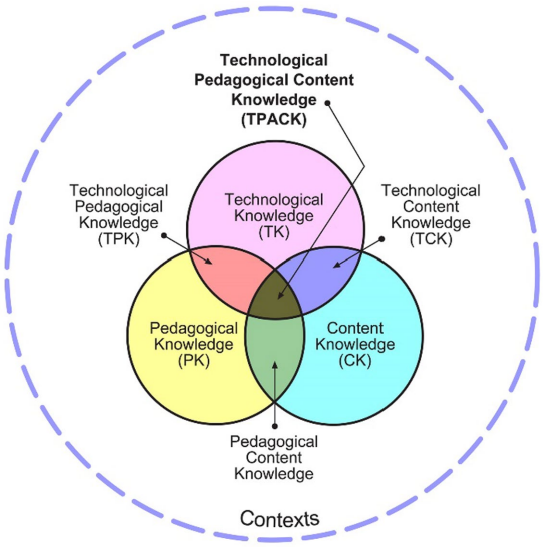

FIGURE 1
Representation of the TPACK. Source: Mishra and Koehler (2006).

1.1. TPACK

From an alternative perspective, Mishra and Koehler (2006) proposed the TPACK model as a powerful theoretical framework that seeks the curricular integration of the technological component, with special emphasis on the efficient implementation of ICT to improve the teaching and learning of school content. The studies that gave rise to this model investigated the knowledge that teachers required to adequately incorporate technology in their teaching, as well as the ways to develop it. In this model, three domains of knowledge converge in an integrated manner, namely: technological knowledge, pedagogical knowledge and content knowledge. This understanding assumes a different role for teachers, as well as the transformation of their educational experiences and training processes, emphasizing the importance of the acquisition and development of different technological skills that enable varied and effective ways for good teaching with technologies. The TPACK model has been studied in the last 20 years from various epistemological and methodological positions by different authors: Margerum-Leys and Marx (2002), Angeli (2005), Niess (2005), Cabero (2014), Pierson (2014), and Harris et al. (2017).

Mishra and Koehler (2006) conceptualize the TPACK framework in terms of seven domains of knowledge (Figure 1), namely: (a) content knowledge (CK), which corresponds to knowledge of the topic that is intended to be learned or taught; (b) pedagogical knowledge (PK), which is knowledge about teaching and learning strategies; (c) technological knowledge (TK) which constitutes knowledge about operational digital technologies; (d) pedagogical content knowledge (PCK) that responds to the understanding and representation that the teacher makes of the specific teaching content for its teachability and learnability; (e) technological content knowledge (TCK) that corresponds to the understanding and representation that the teacher makes about how a technology can enhance or limit a specific teaching content; (f) technological pedagogical knowledge (TPK) that accounts for the understanding and representation that a teacher makes about how a technology influences the strategies used in his pedagogical action, and (g) technological pedagogical knowledge of the content (TPCK) that arises from the integration of PCK, TCK and TPK, this knowledge corresponds to the understanding and representation that a teacher makes for a good teaching of content with technology. Studying TPACK in this sense primarily involves understanding how good teaching with technology is developed *in situ* in teacher training and professional development.

1.2. Lesson Study

The Lesson Study, hereinafter LS, emerges as a model for teacher training characterized by its high contribution to teaching research through the collaborative participation of teachers in making curricular decisions, in interactive teaching and critical reflection of pedagogical practice (Pérez and Soto, 2015). It had its origins in Japan (Isoda, 2007) as a model that allowed the rupture of individual and traditional education that prevailed at the end of the 19th century.

The LS, according to Pérez and Soto (2015), is structured in 4 phases; The first corresponds to the analysis of the study plan to identify the topic of interest and formulate the learning objective of the students. The second accounts for class planning under the principle of anticipating student thinking, justifying the selection of the teaching model and establishing a plan for data capture. The third, related to the realization of the class, where a teacher carries out the designed plan while others observe and collect the data. And the fourth moment that allows us to reflect on the observation of the class using the data to analyze and establish the questions that arise in teaching and learning. This cyclical exercise allows consolidating and adjusting the teaching with new questions to perfect the teaching process that results in good learning. The LS is a teacher training strategy that has expanded its research and training scope to the United States with Fernández (2002) and Lewis (2002), to Europe with Pérez and Soto (2015) and Dudley

(2012). Likewise, in Colombia, the Ministry of National Education (MEN) developed the experience between 2003 and 2008 (Theran, 2018).

It is important to highlight that the TPACK requires a training scenario that allows the teacher to understand the various situations that emerge from their own teaching activity, as well as the development of the knowledge required in their professional activity. In this sense, a situated, collaborative approach is pointed out, where the teacher learns from his activity and from the reflection derived from his practice (Valanides and Angeli, 2008), elements that are associated with SL and that can also become in a coherent alternative for the strengthening of its technological competences. In this sense, it is assumed that implementing the LS to develop the TPACK is to generate a collective plan to understand the variables that arise when using ICT. That is, to design new ways of teaching where it is key to observe the curricular designs and didactics and create a harmonious climate for discussion and collective understanding of everything that is being done; In short, it is an honest exchange, a space to open thoughts, ideas, beliefs and the classroom to critically study teaching with technologies.

This systematic review sets out to explore emerging trends associated with the development of TPACK through LS, unveiling possible directions and providing answers that are currently unclear in the theoretical and practical relationship of these two models. Therefore, this work intends to build a state of the art that reveals the theoretical and methodological perspectives, the findings, the benefits and limitations arising from the studies that aimed to develop the TPACK through the LS.

2. Materials and methods

This research appeals to the use of the descriptive content analysis method, which allows examining and structuring qualitative and quantitative studies to identify trends related to each other (Ültay et al., 2021). Likewise, the contributions of Moher et al. (2009) were taken into account in accordance with the PRISMA guide following the questions:

In what continents and countries are the investigations that develop the TPACK based on the LS located?

At what educational levels and specific disciplines have the research that develops the TPACK from the LS been implemented?

Who are the participants that are part of the research that develops the TPACK from the LS?

How are the investigations on the development of the TPACK that have used the LS as a teacher training strategy designed?

How are the TPACK and LS models understood in the framework of these investigations?

What difficulties have researchers found in these investigations that develop the TPACK from the LS?

What are the conclusions derived from these works that develop the TPACK from the LS?

1. Inclusion criteria: (a) papers of research or review results that combine the TPACK and LS models in their title, abstract or keywords; (b) papers published between 2015 and 2021 and (c) papers written in Spanish and English.
2. Exclusion criteria: (a) studies that are not within the typology of papers and (b) papers that do not allow free and complete access.
3. Search strategy: equations were defined in English and Spanish, using Boolean operators ALL, AND, OR and NOT. Several tests and iterations of the equation and of each of the selected descriptors were made until the definitive equation was found that allowed the finding of the related data in this systematic review: TPACK AND "LESSON STUDY." Next, the advanced search options of the *Scopus, Web Of Science, Spinger Link, Proquest Central, Science Direct, Redalyc, Dialnet* and *Scielo databases* were used to specifically focus the studies.

In turn, a flowchart represented in Figure 2 was configured, where the selection of studies was presented, indicating the size of the sample (number of papers) by databases, the screening and inclusion process, indicating the number of papers for each case (Moher et al., 2009).

According to the established criteria, in the identification phase, 6 duplicate papers were targeted through the Mendely application and Endnote Web. From the reading in the screening, 49 were discarded, mainly because they did not combine the TPACK and LS models in teacher training processes. According to the reading of the title, abstract and keywords, 16 papers were considered adequate, as shown in Table 1.

3. Results

Most of the studies (10/16) that combine the TPACK and LS categories are located on the Asian continent, the largest number in Indonesia (4), two in the Philippines, two in Turkey, one in China and one in Thailand. The above phenomenon can be associated with the fact that LS emerged in Asia, where its impact and visibility have been more relevant. Pérez and Soto (2007) point out that the theoretical debate that has taken place at the international level shows an approach to the multiple, plural and complementary ways of putting SL into practice, especially in the context of Southeast Asia. Likewise, there is research in Puerto Rico (2), South Africa, Ireland, Canada and the United States, the latter influenced by research that explored the viability of LS in the US (Fernández, 2002) (Table 2).

Table 3 shows the educational levels and the disciplinary domains with which the investigations were developed. Most of the studies are located at the secondary education and higher education levels, seven (7) of the sixteen (16) studies focus on the disciplines of mathematics (5) and science (3), followed by the disciplines of chemistry (2), physical sciences (2), English (1), and physical education (1). One study did not indicate the specific discipline, since it focused on the development of TPACK through the LS through courses for teachers to acquire knowledge and skills to learn to teach with technology in an interdisciplinary manner.

Table 4 shows the participants who were part of the research, of which the studies reveal that 113 were teachers in initial training and 242 teachers in service. In relation to teachers in initial training, it was observed that the experience developed with a smaller number of participants (3) was that of Paristiowati et al. (2020), while the research by Darsih et al. (2021) developed with in-service teachers was the one with the fewest participants (3). In turn, the investigations that had a

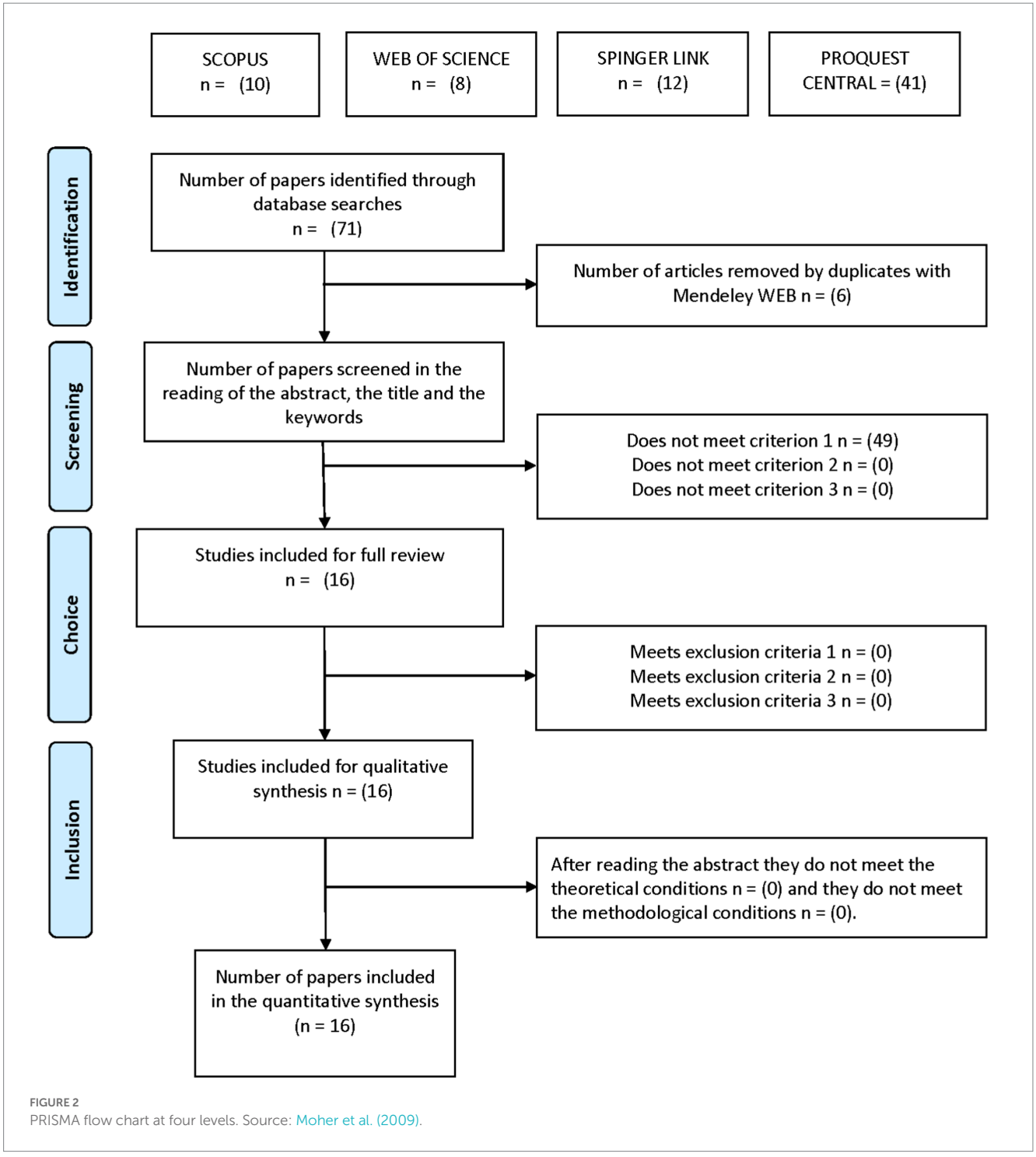

FIGURE 2
PRISMA flow chart at four levels. Source: Moher et al. (2009).

high number of participants were that of Zhou et al. (2017) with 65 teachers in initial training and that of Carpenter and Munshower (2020) with 120 teachers in service.

Now, the LS shows that the teaching and learning cycle of this strategy is implemented with a small group of teachers; between 3 to 6 (Stigler and Hiebert, 1999). In this sense, seven (7) of the investigations were carried out among this range of participants (Kurt and Çakıroğlu, 2018; Paristiowati et al., 2020; Anci et al., 2021; Darsih et al., 2021; Hernández-Rodríguez et al., 2021; Huang et al., 2021; Marron and Coulter, 2021), which indicates that the SL is undergoing adaptations in terms of the number of participants, possibly to respond to the context of the research (Table 3).

Most studies used qualitative approaches (14/16). The method that prevailed in the research reviewed was the case study (9), which was used to systematically understand and interpret what happens with the pedagogical practices of teachers when they try to integrate technologies. The most frequently used instruments were: observation (8), understanding that it is an activity that is part of the operative nature of the LS, as well as interviews (5). Likewise, other

TABLE 1 Databases.

Database	Web of science	Scopus	Spinger link	Project central
# Of articles	4/8	10/10	3/12	5/41
1		Anci et al. (2021)		
2		Darsih et al. (2021)		
3	Hernández-Rodríguez et al. (2021)	Hernández-Rodríguez et al. (2021)		
4	Huang et al. (2021)	Huang et al. (2021)		
5	Joubert et al. (2020)	Joubert et al. (2020)	Joubert et al. (2020)	
6		Chatmaneerungcharoen (2019)		Chatmaneerungcharoen (2019)
7		Rochintaniawati et al. (2019)		
8		Paristiowati et al. (2020)		Paristiowati et al. (2020)
9		Zhou et al. (2017)		
10			González et al. (2021)	
11				Yildiz and Baltaci (2017)
12				Carpenter and Munshower (2020)
13				Danday and Monterola (2019)
14		Danday (2019)		
15	Marron and Coulter (2021)			
16			González et al. (2021)	

Source: Own elaboration.

TABLE 2 Countries where the research was carried out.

Country	Authors
Indonesia	Anci et al. (2021), Darsih et al. (2021), Paristiowati et al. (2020), Rochintaniawati et al. (2019)
Thailand	Chatmaneerungcharoen (2019)
Philippines	Danday (2019) and Danday and Monterola (2019)
Turkey	Yildiz and Baltaci (2017) and Kurt and Çakıroğlu (2018)
United States and Puerto Rico	Carpenter and Munshower (2020)
South Africa and Botswana	Joubert et al. (2020)
Canada	Zhou et al. (2017)
Puerto Rico	Hernández-Rodríguez et al. (2021) and González et al. (2021)
China	Huang et al. (2021)
Ireland	Marron and Coulter (2021)

Source: Own elaboration.

techniques found in the studies were recordings (7), reflective diaries (5), discussion groups (4), surveys (2), rubric and card classification. It is important to point out that within these qualitative studies, the use of form (3) was found to evaluate the TPACK proposed by Schmid et al. (2021). The results of multiple investigations show that the TPACK questionnaire can be considered a valid and reliable instrument to assess the TPACK of teachers (Schmid et al., 2021). In turn, all qualitative studies combine various techniques and instruments to capture the information necessary for their interpretation. The mixed-type investigations (2) combined quantitative and qualitative methods, descriptive methods (2) and quasi-experimental methods (2) were distinguished, which used forms and pretest-posttest tests (Table 5).

3.1. Theoretical understanding of TPACK

All the investigations take as reference the conceptualization of Mishra and Koehler (2006), Koehler and Mishra (2008), and Mishra et al. (2009). The TPACK is assumed to be the knowledge that the teacher needs to facilitate student learning of certain contents through pedagogical and technological approaches. Yildiz and Baltaci (2017) mention that the TPACK is a model that explains how teachers can incorporate technology into teaching and learning processes, as well as how to use technology more effectively and closer to pedagogical and content knowledge.

For their part, Danday (2019) and Danday and Monterola (2019) define TPACK as a domain of comprehensive knowledge about

TABLE 3 Educational levels.

Disciplinary scope	Educational levels					
	Preschool	Primary	Secondary	Half	Higher	Combination of levels
Sciences			Rochintaniawati et al. (2019) and Carpenter and Munshower (2020, p. 120)			Chatmaneerungcharoen (2019)
Mathematics		Huang et al. (2021, p. 4)	Yildiz and Baltaci (2017)		Kurt and Çakıroğlu (2018, p. 5)Hernández-Rodríguez et al. (2021, p. 4)González et al. (2021)	
Chemistry			Paristiowati et al. (2020) and Anci et al. (2021)			
Physical sciences					Danday (2019) and Danday and Monterola (2019, p. 18)	
English					Darsih et al. (2021)	
Combination						Joubert et al. (2020)
Physical education		Marron and Coulter (2021)				
Does not specify					Zhou et al. (2017)	

Source: Own elaboration.

TABLE 4 Overview of the participants.

Number of participants	Teachers in training	Teachers in service	Combination of teachers in training and in service
6		Anci et al. (2021)	
40		Chatmaneerungcharoen (2019)	
18	Danday (2019)		
3		(Darsih et al., 2021)	
52		Joubert et al. (2020)	
3	Paristiowati et al. (2020)		
12		Rochintaniawati et al. (2019)	
65	Zhou et al. (2017)		
120		Carpenter and Munshower (2020)	
18	(Danday and Monterola, 2019)		
5	Kurt and Çakıroğlu (2018)		
4	Hernández-Rodríguez et al. (2021)		
4		Huang et al. (2021)	
3		Yildiz and Baltaci (2017)	
They did not indicate	González et al. (2021)		
2	Marron and Coulter (2021)		

Source: Own elaboration.

didactic competence in three educational components: educational technology, method of instruction and subject matter. Joubert et al. (2020) understands TPACK as an integration of teaching strategy and content (PCK) with the support of technology (TK). In his study he uses reverse planning design to describe the implementation of TPACK. It integrates the base components of the PCK and the TK to look at the different decisions that the teacher makes. For their part, Marron and Coulter (2021) emphasize the importance of teachers assuming a critical position of technology, in order to use it from a particular pedagogical perspective.

Unlike the other studies, Zhou et al. (2017) and Kurt and Çakıroğlu (2018) identify with the holistic view of TPACK, where this construct is assumed as a process of understanding associated with the integration of technology, with pedagogy and the content of the subject. For these authors, the use of technology implies assessing the details that emerge in the interaction of the knowledge that is part of

TABLE 5 Methodologies.

Approaches	Authors	Techniques and instruments	Methods
Quantitative			
Qualitative	Yildiz and Baltaci (2017), Zhou et al. (2017), Kurt and Çakıroğlu (2018), Chatmaneerungcharoen (2019), Carpenter and Munshower (2020), Joubert et al. (2020), Paristiowati et al. (2020), Darsih et al. (2021), González et al. (2021), Hernández-Rodríguez et al. (2021), Huang et al. (2021), Marron and Coulter (2021)	(8) Remarks (7) Recordings (5) Interviews (Harris et al., 2012) (5) Journals of reflection. (4) Discussion group (3) TPACK questionnaires (Schmidt et al., 2009) (2) Survey Rubric Card sorting	(9) Case studies Interpretive-descriptive authentic research Descriptive
Mixed	Danday (2019), Rochintaniawati et al. (2019), and Danday and Monterola (2019)	(2) Pretest-posttest (2) Form (2) Interviews Daily Core Observation	(2) Descriptive (2) Quasi-experimental

Source: Own elaboration.

the TPACK, since in this way they can appreciate in a general and integrated way the actions of the teacher when incorporating technologies into teaching.

Most studies reveal the imperative relationship of the three basic bodies of knowledge of the TPACK (Mishra and Koehler, 2006): technological knowledge (TK), pedagogical knowledge (PK) and content knowledge (CK). These components allow a better understanding to organize and represent the contents to the students, the successful design of the classes with technologies and to understand the efficient way to integrate ICTs into the curriculum and teaching. The integrative vision is a consolidated theoretical perspective that has been used for the initial and continuous training of teachers, as well as from the pedagogical practice of different disciplines and educational levels. Similarly, most studies recognize the theoretical value provided by Shulman (1986, 1987) to the TPACK construct, from his conceptualization of PCK referring to the integration of pedagogical knowledge (how to teach) and content knowledge (what to teach).

On the other hand, the use of some theoretical notions of Niess (2005) located in the teaching of mathematics and focused on the development of courses for teachers oriented to the learning of different technologies, but also, in the analysis of the potentialities and limitations that derive from the use of technologies when teachers in training design classes or projects for a specific topic. Authors who have studies associated with research for the design of classes with technologies are also identified (Hsu et al., 2013; Mouza, 2016), conceptual analysis of technological pedagogical content knowledge (Archambault and Crippen, 2009; Cox and Graham, 2009; Ramos, 2016), evaluation of the TPACK in pre-service teachers of English (Öz, 2015), research on communication and educational technology (Spector et al., 2014), integration of educational technology in teaching (An and Reigeluth, 2011; Roblyer and Doering, 2014), the role of TPACK in case studies of preservice physics teachers (Srisawasdi, 2012), use of technology for critical thinking (Jonassen, 1996) Y students' rejection of the use of technology in teaching (Charbonneau, 2012), among others.

3.2. Lesson Study compression

Among the most representative authors in the theoretical development of the LS we find Fernández (2002), who describes the LS as a teacher training model that provides a variety of experiences that can improve the knowledge, skills and teaching habits of a student, collaborative, critical and reflective way. In addition, this author has studied the evolution of said model in the Japanese educational system, which has allowed him to promote a guiding protocol for researchers and academics to adequately work on the development of SL in the North American context and in other countries. We also find Lewis et al. (2009), which have been contributing reflections focused on refining the theoretical and methodological model of LS, so that it can respond to the cultural and social characteristics of the United States. Lewis et al. (2009) they define the category of LS as a collaborative learning system based on live guidance that uses four characteristics; research, planning, lesson research and reflection, essential to create changes in the knowledge and beliefs of teachers, the professional community and teaching.

3.3. Development of the TPACK

The literature reveals that the strategies commonly used for the development of the TPACK in teachers are associated with the use of learning approaches through class design, which consists of a collaborative work of teachers to build solutions to teaching and learning problems. a particular context (Koehler and Mishra, 2005). Under this perspective, LS can be located, which implies a series of cycles where teachers plan, observe, develop classes and reflect on their experiences (Fernández, 2002). Likewise, microteaching (MLS),

which is a strategy that is part of teacher training programs, generally implies that a teacher in training develops a class, which is normally recorded so that he and his classmates can see it and thus be able to reflect on it. her (Fernández, 2002). Finally, the study of microteaching, which is a combination of LS and microteaching (Zhang and Tang, 2021). These types of TPACK developments are part of studies that are supported by empirical evidence revealed, for example, by Harris (2016) in teachers in service and by Mouza (2016) in teachers in training, allowing the analysis of the training process. and professional development of teachers. Then, development of the TPACK is understood as all those actions that provide a learning context for teachers to transform their knowledge about teaching, content and technology into good pedagogical practices and improvement of professional skills.

Thus, research shows some particular adaptations and their effects. In this sense, Huang et al. (2021) called for a development of the TPACK through an online intercultural LS between China and Australia. It was based on the expansive learning theory to examine the progress of teachers through various activities. From this perspective, teachers showed improvement in their TPACK and TMK (mathematical technological knowledge) for the development of skills in the design of instructional tasks and the development of capacity in the use of various teaching materials and tools (physical devices and electronic, online resources). Likewise, Hernández-Rodríguez et al. (2021) formed online planning meetings with the purpose of determining the nature of the teachers' knowledge, and also, to examine the discussions associated with defining the didactic, technological and mathematical components of a class during the LS.

For their part, Kurt and Çakıroğlu (2018) organized a group of 5 participants to implement an experience based on MLS, the study consisted of the execution of a class to collect concrete evidence and thus verify the development of the TPACK of future mathematics teachers with Regarding the teaching of statistics through virtual manipulatives. In this same line, Zhou et al. (2017) point out that the MLS in the context of the development of the LS through courses, constitutes a promising way to develop the knowledge and skills of the TPACK in teachers in training. The importance of the MLS lies in the opportunity for practice, collaborative and instant reflection and mutual learning.

Rochintaniawati et al. (2019), Paristiowati et al. (2020), and Anci et al. (2021) implemented the LS to develop in TPACK in three stages that they named; plan, do and see. "Plan" is the stage in which teachers collaboratively build the lesson plan to be implemented. "Doing" in this stage is when a teacher develops teaching as a reference model and other teachers become observers of student learning. The "see" stage is the activity of reflection on the learning process, at this time the observers discuss and comment on the situations surrounding the student's learning process.

For their part, Yildiz and Baltaci (2017) set up an experience initially based on the informative phase and discussion in groups about a problem. Then three teachers carried out the planning and implementation phases of the class. Finally, the reflection on the learning was carried out within the framework of voice notes and observations. It is specifically pointed out how techno-pedagogical competences can be evidenced in a classroom environment both in the teacher's own practice and in that of his classmates during the development of the LS. On the other hand, Carpenter and Munshower (2020) show how the LS strategy impacts the methodological change of teachers through reflections on their teaching with technology, but they also refer to how teachers collaborate with their peers to generate new possibilities teaching.

Marron and Coulter (2021) intended to develop the TPACK using iPads to acquire and deepen new knowledge associated with the area of physical education through self-directed learning. They were based on the practice of the LS through four steps; (1) Analyze the curriculum and formulate goals, (2) Plan the lesson, (3) Conduct the lesson, (4) Reflect on the lesson and the planning process. These actors point out two imperative variables that influence the effectiveness of teachers for the integration of technology in teaching, therefore, they are part of self-directed learning; confidence (self-efficacy) and motivation (result expectations) (Niederhauser and Perkmen, 2010).

When comparing the results of the investigations, it can be concluded that all qualitative and mixed studies reported a positive effect on the development of the TPACK through the implementation of the LS. The sustenance of these experiences is based on collaborative and reflective spaces that allow an analytical and systematic view of the pedagogical practices of teachers when trying to incorporate technologies when planning, teaching and reflecting.

3.4. Difficulties

Rochintaniawati et al. (2019) point out that the course presented difficulties during the development of the first cycle of the LS since some schools in Indonesia managed a different school calendar, that is, while some schools had exams, others had vacations. Likewise, Zhou et al. (2017) recommends exploring the evaluation of the TPACK by means of a written test, since there is no research experience that examines the TPACK of teachers in training in this way. In addition, it was identified that there is a gap in the literature on studies that analyze the differential effects of a collaborative instructional planning approach that uses active and passive microteaching. Also, some assessments of the participating teachers are collected, the first mentioned: "The only negative thing I see with this approach is the time of the lesson, it is difficult to have an idea of how long these activities would take in a real class" (p. 99). The second indicated: "It is difficult to microteach as if you were in a room full of adolescents when in reality there is a room full of adults because we normally communicate with adolescents in a different way than we communicate with adults" (p. 99). The above evidences some concerns of some teachers, about their discomfort when teaching their peers as if they were school students, an aspect that Cabero and Martínez (2019) had already pointed out when considering how important the application of real problems should be for teachers in training processes.

4. Discussion

The exploration of the studies that develop the TPACK through the LS show the different ways of thinking about innovative training processes and focused on strengthening teachers' learning to teach with technologies from a critical and reflective perspective. Within this understanding, Fernandez's approach (2002) is distinguished, where he points out that a real pedagogical practice must be developed from the classroom, since it is a very powerful context to promote the

learning of teachers through the study of their praxis, and understand how students learn.

Now, making a specific analysis of the TPACK model, it is noted that the reviewed studies are mainly based on a TPACK associated with the integrative perspective (Mishra and Koehler, 2006), which is understood as an integrating body of PK-based knowledge, TK and CK that make up subcomponents; PCK, TCK, TPK, since these are formed as a consequence of the intersections between pedagogy and content (PCK), technology and content (TCK), and technology and pedagogy (TPK). According to the integrative view, these subcomponents are developed separately, but are integrated into the classroom during teaching. The preference found in the integrative TPACK can be attributed to the fact that most of the investigations tried to establish relationships between the different components that are immersed in the TPACK, since they can be perceived or contrasted in the different actions and moments of the LS; diagnosis, design, observation and reflection. This is how, it is identified that the PK component is developed more from the discussion and reflection scenarios, since they are intrinsic elements of pedagogy and *a priori* of the teacher's work.

For its part, the use of the LS to develop the TPACK in teachers in initial and continuing training were approached from courses and strategies to strengthen teaching, operationally 4 intrinsic transcendental moments of the LS are identified, among them are the delimitation of the situation to solve or the selection of a learning goal and exploration of concrete strategies to develop the class, then, the teachers begin to plan the class meticulously in group, obtaining planning as a product. Next, one of the group's teachers teaches the class while the other teachers observe the development and take notes on the different situations and, finally, the reflection on the process of planning and developing the class. These aspects are part of the actions of a LS cycle that converge with the theoretical narratives found in the literature (Pérez and Soto, 2015) and (Fernández, 2002).

Another aspect identified in the development of the LS in the studies, and which can be classified as a key variable that methodologically and pedagogically enriches the experience, is to have an expert who fulfills the functions of advisor, who closely follows the implementation to observe and guide the success of the experience with key recommendations. Rochintaniawati et al. (2019) point out the added value in terms of pedagogical experience provided by having an expert in the process as a participant.

On the other hand, in the methodological context of the studies that are part of this systematic review, a high preference was found for the qualitative approach, from which it can be inferred that this choice responds to the operative nature of the LS, since it requires a component of understanding and interpretation of the actions and attitudes of teachers based on the situations planned from this perspective. Although self-perception instruments are used (Schmidt et al., 2009), the look of the research goes beyond the concept that the teacher has of his training and his technological knowledge, it is more an exercise in interpreting the pedagogical task, understanding the decisions assumed by the teacher at different moments of teaching (Clark and Peterson, 1986).

The research methods were associated with the development of case studies that promoted training and professional development scenarios for teachers. Stake (2007) highlights its importance in the detailed study of the particular situations of a context, it is likely that the above was done with the assumption of achieving greater understanding and clarity of the planned situations, as well as facilitating the methodological operation of the LS. The description constituted an influential way for the analysis and systematization of the captured data, because it guided the understanding and interpretation of the realities of teachers when integrating technologies in teaching.

Under this scenario, the techniques and instruments identified in the study designs were; the TPACK questionnaire (Schmidt et al., 2009), observations, interviews (Harris et al., 2012), reflection diaries, recordings, discussion group, card classification, pretest-posttest and CoRe. The researchers took some that enjoy prestige and recognition within the TPACK theoretical corpus; TPACK questionnaires (Schmidt et al., 2009), observations and interviews (Harris et al., 2012). However, in all specific adaptations are denoted that respond to the particularities of the study, including the specific topic or subject.

On the other hand, the review of the literature reveals that there are specific subjects where studies combining the TPACK and LS categories have been focused; math, science, chemistry, physics and English. In fact, some combine different subjects within the same study according to the profiles of the teachers. There is evidence of a preference for the development of research in disciplines called "hard sciences," with a certain affinity with the "scientific method," which incorporate verification processes, rigorous and exact methods, which, in general, are part of the procedures or activities taught by teachers.

5. Conclusion

This systematic review has tried to make an approximation of the theoretical and methodological assumptions that have arisen in the studies that combine the TPACK and the LS worldwide. The results suggest insisting on the integrative perspective, as a set of knowledge that make up the TPACK (Mishra and Koehler, 2006). However, a distinction is made to focus the studies on specific knowledge about technology; TK, TPK, TCK and TPCK. On the other hand, scientific evidence shows that the qualitative approach has particularities that allow studying the various activities of teachers to understand and interpret knowledge (TPACK). Indeed, understanding and interpreting such activities implies the implementation of instruments such as observation and interview to capture data, discover connections and relate to other data sources in order to draw conclusions based on triangulations that validate the configured information.

In relation to the LS, the results show that there is no number of participants and specific space that limits the development of the cycles. Yildiz and Baltaci (2017) research revealed that the LS has been greatly modified compared to its initial structure. For these cases, technology becomes a great ally to develop the moments of the LS remotely, even granting greater capacity and flexibility for the analysis and study of the activities, as well as the evidence, since they are digitized and They can be seen as many times as necessary.

Within the limitations, it can be stated that studies in the Spanish language that combine the TPACK and LS models were not located, possibly because the highest percentage of this type of research is in English, although these two models are separately in the Spanish language show important steps in its development. Likewise, according to the nature of the investigation, a specific temporality associated with a cross-sectional investigation was established that limited a critical look at different periods assumed in this investigation.

It is important to point out that there are particularities that must continue to be explored in this type of research, for example; the role

of expert professionals and their true influence on the dynamics of the LS and the development of the TPACK, the researcher-teacher relationship, the prior awareness of teachers about the operation of the LS, to investigate how the changes they manifest are being systematized teachers in their pedagogical practice, and last but not least, the study of the divergent cultural and pedagogical implications of the Japanese context for the implementation of SL, which have been alerted by authors such as: Stigler and Hiebert (1999), Fernández (2002), Perry and Lewis (2008), and Rappleye and Komatsu (2017).

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

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