Acta Scientiarum.
http://periodicos.uem.br/ojs
ISSN online: 2178-5201
Doi: 10.4025/actascieduc.v43i1.51998

Technological and pedagogical knowledge of content (tpack) in the construction of virtual teaching knowledge: a systematic review

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ABSTRACT. From the systematic review of literature, observing the Prisma recommendation, the article analyzed how the literature in the proceedings of the International Congress of Education and Technologies and Meeting of Researchers in Remote Education (Ciet:EnPED) has addressed the Tpack competences proposed by Mishra and Koehler in the construction of virtual teaching knowledge. Searches - using the descriptors (a) Tpack, (b) TPCK, (c) technological pedagogical content knowledge, (d) *technological pedagogical content knowledge*, (e) Mishra, (f) Shulman, (g) teaching knowledges and (h) knowledge basis for teaching – resulted in the selection of six articles that addressed the Tpack in the role of virtual teaching. The analyzed articles indicated that the theoretical model Tpack reveals itself as viable to understand the process of appropriation of the use of technologies in the education by teachers, also working as a source for the construction of virtual teaching. Besides, the results achieved by the analyzed articles corroborate the postulates proposed by Tardif (2012) and Shulman (1987), suggesting that the knowledge basis for virtual teaching is formed by a set of knowledge resulting from training, experiential learning and constructed knowledge in the interaction with their peers. Since this review stuck to the annals of Ciet:EnPED, it is suggested that future studies use other databases to verify whether the results described here are replicable. Moreover, it is suggested that new research examines the factors that interfere in the performance of the virtual teacher, deepening the understanding of the process of construction of virtual teacher knowledge, as well as possible differences in necessary knowledge for virtual teaching due to the different professionals who compose the team.

Keywords: teacher qualification; teaching knowledge; virtual education.

Conhecimento tecnológico e pedagógico do conteúdo (tpack) na construção do saber docente virtual: uma revisão sistemática

RESUMO. A partir da revisão sistemática da literatura, observando a recomendação Prisma, o artigo analisou como a literatura nos anais do Congresso Internacional de Educação e Tecnologias e Encontro de Pesquisadores em Educação a Distância (Ciet:EnPED) tem abordado as competências Tpack proposta por Mishra e Koehler na construção do saber docente virtual. As buscas – utilizando os descritores (a) Tpack, (b) TPCK, (c) conhecimento pedagógico tecnológico de conteúdo, (d) *technological pedagogical content knowledge*, (e) Mishra, (f) Shulman, (g) saberes docentes e (h) base de conhecimento para ensino – resultaram na seleção de seis artigos que abordavam o Tpack na atuação do docente virtual. Os artigos analisados indicaram que o modelo teórico Tpack mostra-se viável para compreender o processo de apropriação do uso de tecnologias na educação pelos docentes, servindo também de fonte para construção da docência virtual. Além disso, os resultados alcançados pelos artigos analisados corroboram os postulados propostos por Tardif (2012) e Shulman (1987), sugerindo que a base de conhecimento para docência virtual é formada por um conjunto de saberes decorrentes da formação, do aprendizado experiencial e saberes construídos na interação com seus pares. Uma vez que esta revisão se ateve aos anais do Ciet:EnPED, sugere-se que estudos futuros utilizem outras bases de dados para verificar se os resultados aqui descritos são replicáveis. Além disso, sugere-se que novas pesquisas examinem os fatores que interferem na atuação do docente virtual, aprofundando a compreensão do processo de construção do saber docente virtual, bem como possíveis diferenças nos saberes necessários para a docência virtual em função dos diferentes profissionais que compõem a equipe.

Palavras-chave: formação de professores; saberes docentes; educação virtual.

Conocimiento tecnológico y pedagógico de contenido (tpack) en la construcción del conocimiento de profesores virtuales: una revisión sistemática

RESUMEN. A partir de la revisión sistemática de la literatura, observando la recomendación de Prisma, este artículo analizó cómo la literatura presente en los anales del *Congresso Internacional de Educação e Tecnologias e Encontro de Pesquisadores em Educação a Distância* (Ciet:EnPED) ha abordado las habilidades Tpack propuestas por Mishra y Koehler en la construcción del conocimiento docente virtual. Búsquedas: utilizando los descriptores (a) Tpack, (b) TPCK, (c) conocimiento del contenido pedagógico tecnológico, (d) *technological pedagogical content knowledge*, (e) Mishra, (f) Shulman, (g) conocimiento de la enseñanza y (h) base de conocimiento para la enseñanza - resultó en la selección de seis artículos que abordaron el Tpack en el desempeño del maestro virtual. Los artículos analizados indicaron que el modelo teórico Tpack se muestra viable para comprender el proceso de apropiación del uso de tecnologías en la educación por parte de los docentes, y que también sirve como fuente para la construcción de la enseñanza virtual. Además, los resultados alcanzados por los artículos analizados corroboran los postulados propuestos por Tardif (2012) y Shulman (1987), lo que sugiere que la base de conocimiento para la enseñanza virtual está formada por un conjunto de conocimientos resultantes de la capacitación, el aprendizaje experimental y el conocimiento construido en la interacción con los compañeros. Dado que esta revisión estuvo de acuerdo con los anales de Ciet:EnPED, se sugiere que los estudios futuros utilicen otras bases de datos para verificar si los resultados descritos aquí son replicables. Además, se sugiere que una nueva investigación examine los factores que interfieren en el desempeño del maestro virtual, profundizando la comprensión del proceso de construcción del conocimiento del maestro virtual, así como las posibles diferencias en el conocimiento necesario para la enseñanza virtual debido a los diferentes profesionales que componen el equipo.

Palabras-clave: formación del profesorado; conocimiento de enseñanza; educación virtual.

Received on January 30, 2020.
Accepted on April 8, 2020.

Introduction

The Digital Technologies of Information and Communication (DTIC) emerged in recent decades have significantly changed social relations and their resulting paradigms - new meanings to the concepts of time-space, real versus virtual world, everything is in constant redefinition. The communicational revolution caused by the DTIC brought new configurations of spaces and power (Bauman, 2001; Santos, 2008), new territorializations (Augé, 2006; Lemos, 2007), leading to (re)signifying old concepts and (re)building new paradigms. The sociocultural scenario which rose with digital technologies has made it possible for social relationships, new forms of communication with various issuing poles, multiple languages, among others, to emerge in virtual spaces from a greater availability of information and construction of content collectively, interfering with customs, behavior patterns and the socioeconomic structure.

In this study, it is understood that man is, at the same time, a user and a product of cyber culture. Databases collect information from everyone on a daily basis, from a simple access to the internet, categorize individual tastes and customs through intelligent algorithms, allowing artificial intelligence and machine learning to interfere in the social context and strongly potentialize new human-machine relationships. In this context, different terms have been coined to describe the impact of the advance of the DTIC on various spheres of society: cyberculture (Lemos, 2003), collective intelligence (Lévy, 2003), convergence culture (Jenkins, 2008), The network society (Castells, 1999), among others. The fact is that digital devices have become almost an extension of the human body, expanding the area and time of the communicational action.

These changes also impact the educational field, strengthening the modality of Distance Education (DE), which is characterized by the space-time distance between teacher and students (Assis, Silva, Barbosa, & Menezes Junior, 2017). As highlighted by Mill, Santiago, Santos, and Pino (2018), it is possible to observe, throughout history, different generations of Distance Education (DE) due to the evolution of technologies; however, "[...] the advent of the Internet (especially Web 2.0 and later) and its tools increased pedagogical and communicational possibilities, which enriched the teaching-learning processes" (Mill et al., 2018, p. 9). This context requires from the teacher a different attitude in order to incorporate new tools and methodologies that assist the teaching-learning process (Santo, Cardoso, & Santos, 2018), especially for those who are teaching online classes - the virtual teachers.

From this scenario, the following concerns, among others, emerge: how is professional knowledge being constructed for the practice of virtual teaching in cyberculture times? Which source or sources prevail in this process? How have virtual teachers constructed their professional knowledge? Based on a literature review, this article sought to map the teaching knowledge necessary to work in Distance Education (DE).

Necessary knowledge for teaching practice

The development of professional knowledge is something that regards any and all professions. However, there is a peculiarity for teachers, since the object of their work is very influenced by the social dynamics of each time and period, demanding constant and eternal (re)evaluations from the teachers of their work practice.

Different authors discuss the necessary knowledge for teaching practice (Shulman, 1987; Freire, 2002; Mishra & Koehler, 2006; Tardif, 2012). In the view of Tardif (2012), teaching knowledge is plural - since it requires knowledge from various sources - and also temporal - being necessary throughout the years to learn to master new knowledge as a way to perfect the practice. Freire (2002) highlights that the construction of teaching knowledge involves a holistic construction process that includes, among other aspects, a political-social stance to position oneself in the world. On the other hand, Shulman (1987) points out that the knowledge basis for teaching is formed by a set of knowledge resulting from the initial education, continuing education courses and the learning acquired in practical experience, besides the knowledge constructed in the interaction with peers.

Whichever the level and/or modality of teaching they act, the teacher's main task consists of creating conditions that facilitate student learning, contributing for a more effective action of such on the world (Anastasiou, 2015). Over time, with the complexity that has been amalgamating social structure, especially with the advent of the DTIC, the production of knowledge has been elevated to an essential condition for the survival of humanity. We live in the information society age, in which knowledge plays a role of great prominence and becomes a commodity (Lévy, 2003). Inside of this social complexity, Tardif (2012) describes the role of a teacher as of great importance in the socioeconomic model implemented in the western hemisphere, due to this social agent's responsibility for the processes of individual and collective learning that compose the basis of the intellectual and scientific culture of modernity.

Mizukami (2004) particularly highlights Shulman's important contribution to the studies on the construction of teaching knowledge, by pointing out the role of daily classroom practice for teachers in the construction of pedagogical knowledge of the content to be taught. The daily experience of searching didactic alternatives that facilitate student learning, enables the development of a process of pedagogical reasoning by the teacher, which portrays how knowledge is set in motion, articulated and constructed aiming at better learning (Mizukami, 2004).

Mishra and Koehler (2006), based on Shulman's studies, update the categories of teaching knowledge for new technologies present in education, thus emerging the category of Tpack[1] (acronym for the term Technological Pedagogical Content Knowledge), which translated into Portuguese means *conhecimento tecnológico e pedagógico do conteúdo*. According to the authors, this new category reflects,

> [...] is an emerging form of knowledge that goes beyond all three components (content, pedagogy, and technology). [...] TPCK is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones (Mishra & Koehler, 2006, p. 1029).

In addition to mastering subject content, techniques and methods of education science, teachers also need to know how to articulate the technological tools in this context. They need to master the use of technologies, knowing how to choose the one that guarantees the best pedagogical mediation for the subject contents to be taught, taking into account the classroom context, the school and its surroundings. All this boils down to the development of the Tpack competence proposed by Mishra and Koehler (2006).

From the configuration of overlapped circles, in which each circle represents the areas of Content (c), Pedagogia (p) and Technology (t), Mishra and Koehler (2006) construct a graphical representation of the

[1] *Technological, Pedagogical And Content Knowledge* = Tpack (the letter 'A' entered the composition of the acronym later).

Tpack (Figure 1), namely: (a) Content Knowledge (*Conhecimento de Conteúdo*), which consists of the clipping of knowledge in the field of science to be addressed; (b) Pedagogical knowledge (*Conhecimento Pedagógico*), in other words, the knowledge developed by the science of education (processes, practices or methods of teaching and learning); and (c) Technological Knowledge (*Conhecimento Tecnológico*), which involves knowledge and abilities to operate specific technologies which assist the educational process. From the intersection areas between the represented circles in Image 1, result: (a) Technological Content Knowledge (*Conhecimento de Conteúdo Tecnológico*), which refers to the knowledge of the available technological resources; (b) Technological Pedagogical knowledge (*Conhecimento Pedagógico Tecnológico*), which concerns of knowing the pedagogical potentialities of the available technologies; (c) Pedagogical Content Knowledge (*Conhecimento Pedagógico do Conteúdo*), which consists of knowing the best education practice/method to be applied for that content; and (d) Technological Pedagogical and Content Knowledge (*Conhecimento Tecnológico e Pedagógicos do Conteúdo*), which relates to the knowledge that goes beyond the binary/ternary association of the variables at stake (content, pedagogy and technology), but a clarity of the understanding of concepts, representing them through the use of technologies.

The studies of Freire (2002), Tardif (2012), Shulman (1987) and Mishra and Koehler (2006), so far analyzed, stand out the necessary knowledge for teaching practice, focused on the teaching-learning process that occurs in the on-site modality. However, for teaching in the DE modality - in which there is a space-time separation between teacher and students and the use of some technology for the communication and interaction between them - will it be necessary to have the same teaching knowledge? Are there significant differences from on-site teaching? Which aspects prominently influence the construction of teaching knowledge of teachers who work in the DE modality?

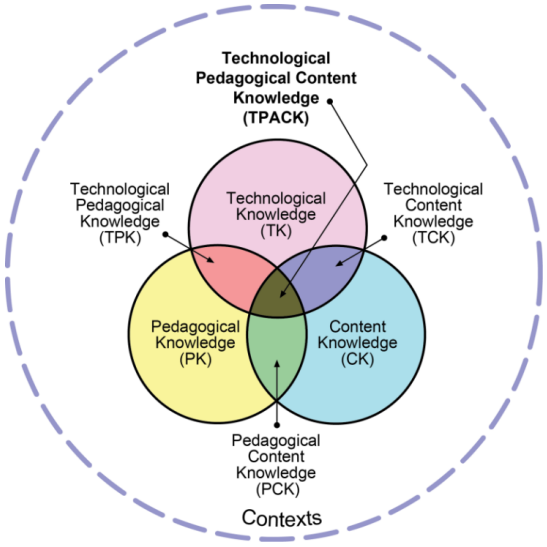

Figure 1. Overlapping circles forming the central circle `technological and pedagogical knowledge of content'[2].

Virtual teaching

Currently, DTIC are strongly present in everyday social relations. Specifically for education, new mediations made possible by digital technologies have appeared through online courses. Thus, new competences for teaching knowledge in a virtual environment, beyond those necessary in on-site teaching, are designed. The didactic-pedagogical mediation in the processes of teaching and learning made possible through the DTIC brought specific demands to the qualification of the virtual teacher.

In this context, two characteristics of teaching practice in the DE modality are relevant for the understanding of knowledge required for virtual teaching. The first characteristic refers to the separation of planning and execution. As Brito and Mill (2018) highlight, different from the on-site courses (in which the same teacher carries out the planning and execution of the discipline), in the DE courses there is a separation between planning and execution, since the discipline offer occurs after a thorough and detailed process of planning that involves the definition of the objectives and contents to be worked on, the

[2] Image reproduced with permission from the publisher, ©2012 for tpack.org. Retrieved from http://www.tpack.org/, in the section `Tpack Images'.

elaboration of materials that will be used and the preparation of the Learning Management System (LMS) in which the discipline will occur.

The second characteristic, related to the first one, refers to the presence of politeaching, defined by Mill (2017, p. 8) as the "[...] collective of workers who, even with diverse formations and roles, is responsible for the teaching-learning process in Distance Education''. A peculiar feature of virtual teaching that distinguishes it from the on-site one is the work being fragmented among many professionals, a pedagogical teamwork, different from the on-site teacher who executes, basically all by himself, all pedagogical work from the conception up to the teaching (Belloni, 2012). From this results a collaborative and fragmented work done by a multidisciplinary team composed by professionals who work directly on the teaching (content teacher, trainer teacher, virtual tutor, on-site tutor) and professionals who work on offering conditions so that the process is carried through adequately (instructional designer, coordination, multidisciplinary support team, among others; Mill, 2017).

It is important to highlight the urgency for the virtual teacher, more than other professionals involved in politeaching, to appropriate the pedagogical technological knowledge, in order to explore all potentiality that the DTIC can offer in LMS, given its responsibility in the conduction of the teaching-learning process. The development of the Tpack competence is extremely necessary and a conditioning factor for teaching in virtual environments. In online classroom spaces, the intersection of content, pedagogical and technological bases is constantly present, requiring the virtual teacher to master these competences. Therefore, it is imperative that professionals who work in conducting virtual classrooms – teacher-trainer, virtual tutor and on-site tutor – are competent in the pedagogical use of digital technologies.

In this context, this study consists of a systematic review which examined how literature has approached the Tpack competences, proposed by Mishra and Koehler (2006), in the construction of virtual teaching knowledge. This research used, as a database, the annals of the 'International Congress on Education and Technologies and Meeting of Researchers in Distance Education' (Ciet:EnPED)[3], an event organized by the General Secretariat of Distance Education (SEaD) of the Federal University of São Carlos (UFSCar). The event takes place every two years with the objective of providing researchers, professors and students with the integration and sharing of national and international scientific production in the DE or on-site teaching-learning area, incorporating DTIC (International Congress of Education and Technologies [Ciet] & Meeting of Researchers in Distance Education [EnPED], 201 9).

Data accumulated from the event in the four editions that have already taken place (2012, 2014, 2016 and 2018) show that 3,234 participants took part (with representatives from all Brazilian states and other countries in Latin America and Europe) and the presentation of 1,409 works. The evaluation of articles for Ciet:EnPED is made through the 'double-blind' process, in which two specialists analyze the text, not previously knowing its authorship, which tends to ensure the quality of the accepted papers to make it to the annals of the event. For these reasons, the annals of Ciet:EnPED were chosen as the database for the article.

Method

The methodology adopted was a systematic literature review, observing the Prisma recommendation (Galvão, Pansani, & Harrad, 2015). The systematic review of literature is a methodology that consists of grouping results from various studies on a specific topic, on the basis of previously defined procedures in order to, from a criteria analysis, to elaborate a synthetic study of the results (Ramos, Faria, & Faria, 2014) . The Prisma recommendation – as the protocol was named, containing a checklist with 27 items and a four-step flowchart – aims to improve the reporting of systematic reviews and meta-analyses. It initially appeared for randomized clinical trials, but it is perfectly applicable for systematic reviews in other types of research, by simply adapting items in the checklist or the flowchart (Galvão et al., 2015).

The research was conducted in the annals of Ciet:EnPED, based on the four editions of the event (2012, 2014, 2016 and 2018). The search engine available on the website of the annals was used (http://cietenped.ufscar.br/). Searches in the annals of 2012, 2016 and 2018 editions were performed using the following descriptors: (a) Tpack, (b) TPCK, (c) technological pedagogical content knowledge, (d) *conhecimento pedagógico tecnológico de conteúdo*, (e) Mishra, (f) Shulman, (g) teaching knowledge and (h)

[3] Formerly titled 'International Distance Education Symposium and Meeting of Researchers in Distance Education' (Sied:EnPED).

knowledge basis for teaching. In each search, a single descriptor was used, which was examined in all fields of the article (titles, abstract and body of the text). In the 2014 edition, the website annals[4] did not provide the article search tool. Thus, for this edition, the research was carried through quick reading by the researchers, verifying in the summary and keywords of each article the existence of some of the descriptors listed above.

The selection of articles for analysis involved inclusion and exclusion criteria. Articles accepted for oral communication that addressed the Tpack in the context of virtual teaching were selected. The exclusion criteria were: (a) articles that discussed on-site teaching and (b) the ones that did not address the Tpack.

The articles selected for analysis were examined according to two sets of analysis categories. The first refers to bibliometric information of the analyzed texts and included: (a) year of publication, (b) number of authors and (c) educational level of authors. The second group of analysis categories concerns the topic of research of this study and included identifying: (a) the objective of the article, (b) the methodology applied and (c) the main results obtained/presented.

Results and discussion

Searches in the annals of each edition of Ciet:EnPED, using the descriptors listed above, resulted in the location of 30 scientific articles. The exclusion of duplicate articles reduced the total number of articles to 24. Through a quick reading (scanning) of the articles found, a new selection was made based on the exclusion criteria, resulting in the removal of 11 articles that discussed on-site teaching and seven articles that did not address Tpack. Therefore, as it can be observed in Figure 2, from the application of the inclusion and exclusion criteria, six articles were selected to compose the corpus of this systematic review, articles which were read in their entirety and integrated the analytical summary that will be presented next.

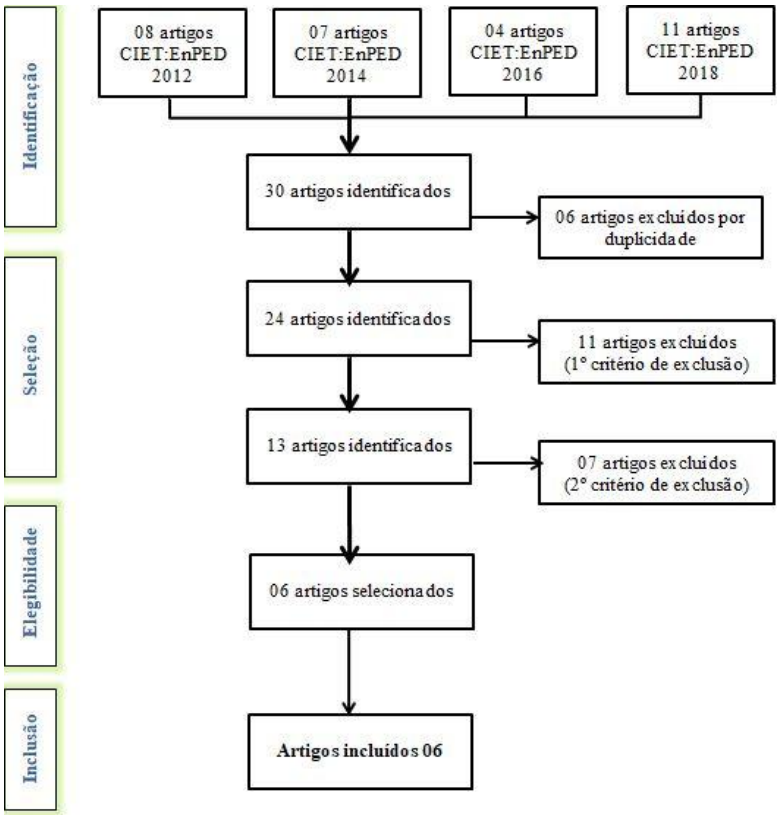

Figure 2. Result of the searches in the annals of each edition of Ciet: EnPED.

Table 1 presents a synthesis of the analyzed articles that addressed the Tpack competences in the construction of virtual teaching knowledge. Regarding bibliometric information, it was found that: (a) 50.0% of the articles analyzed were presented in the 2014 edition of Ciet:EnPED; (b) five of the six articles were written by two authors; and (c) 66.7% of the articles were product of the master's degree research projects.

[4] http://www.sied-enped2014.ead.ufscar.br/ojs/index.php/2014/issue/view/3

Table 1. Synthesis of bibliometric information, objectives and methodology of analyzed articles.

Author (year)	Title	Authors' level of education	Objective	Methodology
Correa and Mill (2012)	Knowledge basis of teachers in distance education: a study on music education	Master's student; Doctor.	Analyze the particularities of teaching knowledge and specific knowledge of teachers in the distance education (DE) modality in Music Education.	Application of questionnaire and carrying out of semi-structured interview
Chaquime and Mill (2014)	A study on knowledge in virtual teaching	Master's student; Doctor.	Map the knowledge constructed by the teacher throughout his experience as a virtual tutor in Distance Education (DE), identifying its nature.	Questionnaire Application
Nazario and Oliveira (2014)	Distance learning (DL) teacher training course: partial analysis of data from an online questionnaire	Master's student; Doctor.	Understand the contributions of the Teacher Training Course in DE to the knowledge basis aiming at professional teaching development.	Questionnaire Application
Rossit and Oliveira (2014)	Teaching knowledge basis for keyboard distance teaching	Master's student; Doctor.	Research the Teaching Knowledge Basis of teachers who work in the Distance Musical Education field, specifically in a musical instrument discipline (keyboard) from the License degree in Musical Education at UAB-UFSCar.	Conducting semi-structured interviews
Rose (2016)	Teaching knowledge and planning in Distance Education (DE)	Unspecified	Analyze teacher perception on the work of planning a distance discipline and what knowledge is needed for such action.	Documental analysis, questionnaire application and semi-structured interview
Mill and Silva (2018)	Teaching knowledge in distance education: a brief literature review on virtual teaching	Doctor; Specialist	Characterize teaching practice and knowledge in the distance education modality.	Literature review

The research objectives of the analyzed articles, in general, converge to the same issue: understanding the construction process of teaching knowledge for virtual teaching. However, some variations stand out. First, it is possible to notice that two refer to the construction of virtual teaching knowledge in the context of musical education (Corrêa & Mill, 2012; Rossit & Oliveira, 2014). Second, two other articles seek, by listening to virtual tutors from two higher education institutions, to understand how they build their knowledge for virtual teaching (Chaquime & Mill, 2014; Rosa, 2016). Third, Nazario and Oliveira (2014) analyze the contribution of a training course in the construction of virtual teaching knowledge. Finally, the article by Mill and Silva (2018) aimed at characterizing virtual teaching practice from bibliographic studies.

The theoretical framework present in the selected articles essentially rests on the postulates of Tardif, Shulman, Mizukami, and Mishra and Koehler. The sources of construction of teaching knowledge present in the proposals of Tardif and Shulman are used; the categories of the teaching knowledge basis proposed by Mizukami and, finally, the categories that compose the acronym Tpack are addressed, as proposed by Mishra and Koehler (2006).

As it can be seen in Table 1, the vast majority of articles analyzed refer to descriptive research (Gil, 2002), involving the collection of information mainly through the application of questionnaires and conducting interviews. Except by the article by Mill and Silva (2018), which was elaborated from a literature review. Half of the research used a qualitative approach methodology, with delineation by semi-structured interview (Corrêa & Mill, 2012; Nazario & Oliveira, 2014; Rossit & Oliveira, 2014). There was still a case study (Rosa, 2016) and a study that used methodological triangulation, contemplating bibliographical study and data collection (Chaquime & Mill, 2014).

The selected articles present results converging to the finding that virtual teaching knowledge is the amalgamation of various sources, especially initial and continuing education and experiential living. In the

article by Corrêa and Mill (2012), which aimed to understand teaching knowledge of musical education teachers in DE, it was pointed out as a result that the experiential knowledge coming from the on-site modality, added to the knowledge derived from initial education, compose a significant portion of the knowledge basis of virtual teaching. The study showed that, as a strategy, teachers worry more about communication with their students, either synchronous or asynchronous, as well as knowing each one's profile better, aiming at planning specific activities directed to them.

Chaquime and Mill (2014), based on an interview made with tutors of the courses offered by the Federal Institute of Education, Science and Technology of São Paulo, analyze aspects of the categorization elaborated by Mizukami (2004) for the construction of teaching knowledge. The conclusions they have come to are indications that pedagogical practice in DE can contribute to the construction of new knowledge for virtual teaching, as well as for the expansion of the knowledge basis necessary for teaching. They also reaffirm that the process of construction of virtual teaching knowledge is essentially experiential. The study pointed out that, in the perception of the participants of the research, knowledge of digital technologies, the virtual environment of learning and the language and written communication excel in significance for virtual teaching.

Understanding the contributions of a Teacher Training course in DE for the teacher professional knowledge basis was the study objective of Nazario and Oliveira (2014). In it, the authors conclude that contact with DTIC in the initial training course facilitates its use in pedagogical mediation, favoring the integration of the Tpack model in teaching practice.

The study by Rossit and Oliveira (2014), regarding the teaching knowledge basis for distance musical education teachers, concludes on the need for teachers to appropriate digital technological resources and their pedagogical possibilities, being required of them constant learning and reflective practice throughout their lives. It concludes, still, the importance of the actions of continuing education and sharing of experiences among peers, as a form of construction of virtual teaching knowledge.

The study elaborated by Rosa (2016) analyzed teachers' perception on class planning in DE and what knowledge is required. Based on interviews, documental and bibliographical analysis, the author concludes that the lack of technological knowledge (TK) and also the lack of knowledge of the pedagogical use of new technologies (TPK) make it difficult for teachers to work in the virtual environment. The study points out that teachers have sought to overcome these limitations through continuing education and sharing of experiences among their peers.

Finally, Mill and Silva (2018) present a bibliographical research on teaching knowledge in DE. The research resulted in a theoretical synthesis of the thoughts of the main authors who deal with the subject, prominently Tardif, Shulman, Mishra and Koehler. In addition to a categorization of important elements to understand virtual teaching: training, knowledge, difficulties and work strategies in DE.

As for the question that worked as a guide for this review - How has present literature in the annals of Ciet: EnPED approached the Tpack competences proposed by Mishra and Koehler in the construction of virtual teaching knowledge? - it can be determined through the results extracted from the research by Nazario and Oliveira (2014) that teacher's contact with DTIC in their initial education facilitates the process of appropriation and articulation of technological resources, inside the pedagogical proposal to improve content teaching. In this way, contributing to the construction of teaching knowledge based on Tpack. These authors concluded that

> [...] the TPCK model favors the relationship of pedagogical content knowledge and technological knowledge which, when integrated, result in knowledge of pedagogical and technological content. Thus, teachers can integrate the pedagogical use of digital technologies in the teaching-learning process in their teaching practice (Nazario & Oliveira, 2014, p. 12).

Rossit and Oliveira (2014) discussed in the conclusions that the theoretical model Tpack is viable to understand the process of appropriation of the use of technologies in education by teachers. Rosa (2016) found that the lack of technological knowledge (TK) and knowledge of the pedagogical use of new technologies (TPK) make it difficult for teachers to work in the virtual environment. The data of the research disclose, according to the author, that the majority of teachers listed "technology" as the element they have the hardest time with, reflecting the lack of DTIC approach in initial education.

The analyzed articles also discuss the conditions that affect the construction of teaching knowledge for virtual teaching. They are: teaching practice (Corrêa & Mill, 2012; Chaquime & Mill, 2014; Nazario & Oliveira, 2014),

initial and continuing education (Corrêa & Mill, 2012; Nazario & Oliveira, 2014; Rossit & Oliveira, 2014; Rosa, 2016) and the sharing of experiences among peers (Rossit & Oliveira, 2014; Rose, 2016).

Three of the six articles analyzed highlight in their conclusions the knowledge acquired through experience as fundamental for the construction of teaching knowledge (Corrêa & Mill, 2012; Chaquime & Mill, 2014; Nazario & Oliveira, 2014). However, the conclusions presented by Corrêa and Mill (2012) and Chaquime and Mill (2014) differ in regard to the type of practice experienced. Corrêa and Mill (2012) highlight the experiential knowledge coming from the on-site modality, while Chaquime and Mill (2014) highlight the experience in virtual spaces as a source of knowledge construction for online teaching. Experiential practice as an important source in the process of construction of teaching knowledge was presented by Tardif (2012) and Shulman (1987). In the studies of Corrêa and Mill (2012) and Chaquime and Mill (2014) daily teaching in classroom excels as an element that stimulates the teacher to develop didactic alternatives which facilitate student learning, either on-site or online, imposing the construction of pedagogical knowledge that will facilitate the teaching of contents (Mizukami, 2004).

The analyzed articles also emphasize the role that training has as a source of construction of virtual teaching knowledge. Nazario and Oliveira (2014) affirm that the construction of virtual teaching knowledge takes place through experience, however such experience will be potentialized through courses of continuing education, highlighting besides experiential knowledge, continuing education as an important source in the construction of teaching knowledge construction. These authors affirm that continuing education can offer the teachers spaces to articulate professional development aligned with the teaching practice. On the other hand, Rosa (2016, p. 5) concludes that the lack of technological knowledge (TK) and knowledge of the pedagogical use of new technologies (TPK) make it difficult for teachers' to perform well in the virtual environment, "[...] becoming noticeable the pursuit of overcoming obstacles by the means of continuing education".

The knowledge acquired in training is inside the "disciplinary training" for Tardif (2012) and "initial and continuing education" for Shulman (1987). The data presented in this review seem to highlight the importance of planning conditions so that teachers who work in the DE modality develop the Tpack competences, both in courses of initial and continuing education. When developing such competences the teacher is better able to plan the teaching-learning process, as well as handling various demands involved in this process, resulting, in the last instance, in a better performance in class.

Finally, the articles also point out that the interaction of teachers with their peers, through the sharing of experiences, is a condition that favors the construction of a knowledge basis for virtual teaching (Mizukami, 2004). Rossit and Oliveira (2014) conclude that the learning exchange with their peers expands the teaching knowledge basis and stimulates knowledge construction.

Final considerations

This study examined how literature has approached the Tpack competences, proposed by Mishra and Koehler (2006), in the construction of virtual teaching knowledge. For this purpose, a systematic review of the literature in the International Congress of Education and Technologies and Meeting of Researchers in Distance Education (Ciet: EnPED) annals was done, observing the Prisma recommendation (Galvão et al., 2015). Scientific knowledge is, in essence, cumulative (Lakatos & Marconi, 1991), thus the systematic review proves to be an important initial procedure to verify how a specific subject is being addressed in the literature and to identify aspects that still lack new scientific investigations.

The articles that composed the corpus of this review were analyzed according to bibliometric information and categories of analysis that allowed answering the research question that guided this review. Regarding bibliometric information, it can be seen that most of the studies analyzed are a product of Master's program research projects. This along with the fact that studies, in their majority, can be classified as descriptive research (in other words, research that has as main objective "[...] the description of the characteristics of a particular population or phenomenon or, the establishment of relations between variables [...]" (Gil, 2002, P. 42), seems to indicate that there is still a long way to go in the understanding of how Tpack competences, proposed by Mishra and Koehler (2006), contribute to the construction of virtual teaching knowledge. In this direction, future research of explanatory character (Gil, 2002), which seek to examine the factors that interfere with the performance of the virtual teacher, will be able to deepen the understanding of the process of virtual teaching knowledge and consequently offer forms of improving the processes of initial and continuing education to work in the DE modality.

The analysis of the main results of the articles that composed the corpus of this review seem to favor the conclusion that the theoretical model Tpack is viable to understand the process of appropriation of the use of technologies in education by the teachers, also working as a source for the construction of necessary knowledge for virtual teaching. Besides that, the articles analyzed corroborate the postulates proposed by Tardif (2012) and Shulman (1987), suggesting that the knowledge basis for virtual teaching is formed by a set of knowledge resulting from training, experiential learning and knowledge constructed in the interaction with peers. In this direction, it was verified that: (a) continuing education offers virtual teachers spaces to articulate professional development aligned with the teaching practice; (b) the experience in virtual classrooms develops in the teacher didactic alternatives that facilitate student learning, producing experiential knowledge that will serve as a source of construction of teaching knowledge; and (c) the learning exchange among peers, through the interaction with other professors who work in the DE modality, stimulates the construction of knowledge, being an important source for virtual teaching.

In spite of the understanding that the teaching-learning process, in the DE modality, involves the presence of politeaching, the studies analyzed have not made distinction in relation to the necessary teaching knowledge for the different professionals who play a role in this process. Since there is a separation between the planning and execution of DE courses (Brito & Mill, 2018) and the involvement of different professionals for the course offer (Mill, 2017), it is possible that there might be differences in the knowledge necessary for teaching practice, even among professionals who work directly in teaching (content-teacher, teacher-trainer, virtual tutor, on-site tutor). Therefore, new studies can examine the demands related to the different professionals that compose the politeaching team and how each of the competences of the Tpack theoretical model relate to the different roles played. Such studies can offer specific training programs which meet the demands of the different professionals who work in the teaching-learning process in DE.

Finally, the fact that this study abides in the revision of the annals of the International Congress of Education and Technologies and Meeting of Researchers in Education (Ciet: EnPED), previously entitled International Symposium of Distance Education and Meeting of Researchers in Distance Education (Sied: EnPED), signals a limitation of the research, since it does not contemplate all scientific events of the DE area occurred in Brazil. However, due to the prominent position of this event in the scientific-academic community, above all for receiving a great amount of articles submitted from various parts of Brazil and even from overseas, it helps the corpus of this review present significant indications of how the topic has been approached in scientific research. A more extensive review of the literature on this topic, contemplating other databases, may be an unfolding for future research.

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NOTE:
The authors were responsible for the conception, analysis and data interpretation; writing and critical review of the manuscript content and the approval of the final version to be published.