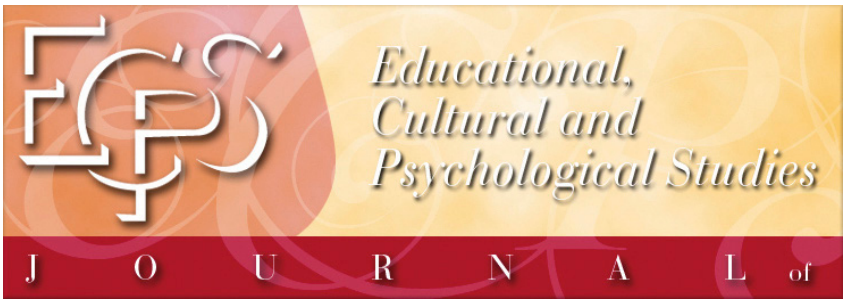

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Media and Context of Science Education in TPACK: A Systematic Review

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MEDIA E CONTESTO DELL'EDUCAZIONE SCIENTIFICA IN TPACK: UNA REVISIONE SISTEMATICA

Abstract

The development of media and context within the framework of Technological Pedagogical and Content Knowledge (TPACK) is important in science education. The purpose of the systematic review is to find out the media and context used in the TPACK framework for the development of science learning. Media is related to learning technology such as technology in communication, collaboration, assessment, visualization, and online learning. The use of science learning media in developing TPACK consists of two types, the first using a single type of media and the second using multiple types of learning technology media. The learning context includes micro in the form of classes, meso in the form of schools, and macro in the form of the wider community, as well as the context of teachers and pre-service teachers. The context of science education in TPACK relates to the type of research such as micro-level using mixed research methods, experimental,

qualitative, research and development, and macro level usually using survey research. The TPACK framework is an approach to explaining effectiveness, evaluation, and reflection in the use of learning technology.

Keywords: Context; Media; Science education; TPACK.

1. Introduction

Technological, Pedagogical, and Content Knowledge (TPACK) is an effective way to integrate learning with technology (Santos & Castro, 2021). Self-regulation challenges and challenges in using learning technology are the main challenges faced by students. The challenges for teachers are mainly in the use of technology to teach (Rasheed *et al.*, 2020). TPACK is a teaching framework to integrate technology into teaching. Integrating technology into the curriculum becomes an integral part of the best learning (Bahri *et al.*, 2021). Now contextual knowledge in TPACK needs to be considered to adopt the use of technology for individual students, specific classrooms, schools, or with the development of society in general (Rosenberg & Koehler, 2015). TPACK is also a framework that can help teachers provide learning that supports 21st-century skills (Chai *et al.*, 2020).

Learning technology media now continue to develop and vary such as online learning, these developments need to be studied for their effectiveness and reciprocal responses between teachers and students. Meepung *et al.* (2021) explained that teachers must design appropriate learning materials for learners in the form of online learning and apply educational technology to stimulate the interest of learners, including those who are committed to success in online learning. Researchers see the importance of tools for creating interactions between instructors and learners that help learners feel authentic during online learning.

Teacher professionalism training through development supports increased integration of technology in the classroom within the TPACK framework in the literature review through self-perception measurements, tests, classroom observations, and interviews (Guzmán González & Vesga Bravo, 2024). Research on TPACK component knowledge is popular research, meanwhile, research on development and integration is still limited in literature studies (Dewi *et al.*, 2021). TPACK research of pre-service teachers in the literature review was assessed using a variety of methods including self-report measures, open-ended questionnaires,

interviews, performance assessments, and observations (Wang *et al.*, 2018) The context in schools and the wider community is part of the object of study of TPACK development, however, the TPACK research situation has not been fully explained, so the TPACK situation needs to be carried out in further research (Rosenberg & Koehler, 2015). So literature research on media and context is education important for teacher and pre-service teachers.

The presence of technology has become a new challenge for teachers in learning, including how to develop technical knowledge and integrate it with content, teaching, and learning in certain contexts. The technology in question is the technology that can help teachers represent concepts, principles, or laws. Therefore, teachers must have competencies that include content knowledge, pedagogic knowledge, technological knowledge, or TPACK (Oliver, 2011; Joke Voogt *et al.*, 2013; Sang *et al.*, 2016). The TPACK framework helps teachers reflect on strengths and weaknesses to promote innovation in teaching and learning (Valstad & Pinto, 2018). Therefore, research on TPACK is still a trend, in supporting more effective learning.

Success in learning, teachers not only know technology and how to use it, but knowledge of pedagogy and content. The integrated technological pedagogical and content knowledge framework provides a broader analytical framework and the quality of teachers in integrating it (Koehler & Mishra, 2009). Currently, TPACK has been implemented in various settings, either for the development of technology-based teaching activities or teacher assessment on the integration of technological knowledge and experience (Agyei & Voogt, 2012; Chai *et al.*, 2012; Pamuk *et al.*, 2013; Özgün-Koca *et al.*, 2020). Systematic research aims to analyze the types of media and context used in the TPACK framework of science education, this is important because literature research on the media situation for developing TPACK is limited in studies.

2. Method

2.1. *Search strategies*

The selection process followed the preferred reporting of items for systematic reviews and meta-analyses (PRISMA) statement guidelines (Moher *et al.*, 2009). The literature search method used database search engines:

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(a) Education Resources Information Center – ERIC, (b) ScienceDirect (c) Researchgate, and (d) Google Schoolar.

2.2. *Inclusion and exclusion criteria*

A literature search using TPACK in science learning as a search keyword, then limited in the last 10 years, is intended that the research has the best up to date information. The search for articles focused on media themes and the context of TPACK and was limited to the last 10 years from 2014 to 2023, obtained 111 articles. Then the articles were selected using media criteria and the context of science education within the TPACK framework with 28 articles of the best discussion (inclusion), 78 articles being excluded from screening, and 5 articles excluded from eligibility, taking into account the selection of articles that meets the best criteria *(Fig. 1).*

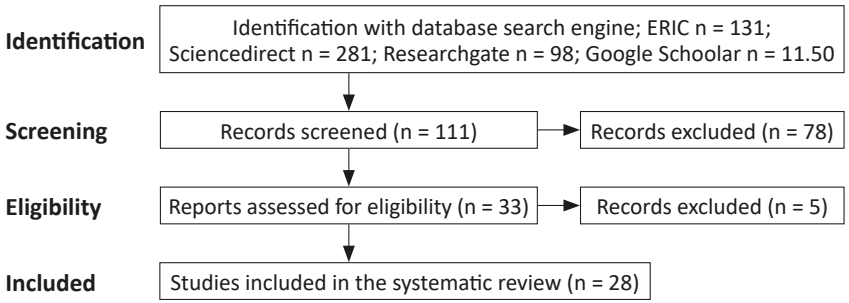

Figure 1. – Primary diagram of the screening and selection procedure.

2.3. *Data extraction and analysis*

The selected literature is then reviewed and analyzed in depth concerning the research objectives including (a) TPACK media in science education, (b) TPACK context includes learning context including micro in the form of classes, meso in the form of schools, and macro in the form of the wider community, teachers, and students and (c) types of research.

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3. Result

The presence of pedagogical knowledge is emerging as an important factor in the integration of technology and the ability to articulate how technology is used in teaching and learning. It is important that pedagogical knowledge and the ability to discuss this knowledge in the context of TPACK significantly impact the ability of teachers to use technology in learning effectively (Benson *et al.*, 2015). Pedagogical considerations are at the heart of keeping this focus on the transformative potential of TPACK (Mishra *et al.*, 2011). The media and context of TPACK are something interesting for studying literature because learning technology media has developed rapidly.

Rosenberg & Koehler, (2015) mentioned the level of context in the current review defining it as follows:

a. Micro: factors in the classroom that influence the development, implementation, or assessment of TPACK. This level of context includes teacher actions and practices, classroom norms, and technology in the classroom.
b. Meso: factors in the school and community that influence the development, implementation, or assessment of TPACK. This level of context includes the individual school or school system, school culture, technology-related infrastructure, and leadership expectations.
c. Macro: factors in state, national, and global factors that influence the development, implementation, or assessment of TPACK. This level of context includes the social, political, or economic conditions of the larger country (or countries) that shape norms and policies such as national curriculum standards and technology initiatives at the state or national level.

Based on the analysis of the media review literature and the context of science education in TPACK as follows *(Table 1).*

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Table 1. – Media and context of science education in TPACK.

No	Author's	Media	Context	Research Method
1	Stinken-Rösner *et al.* (2023)	E-books and Learning Apps, Explanatory videos, quiz apps, QR tip cards, modeling software and virtual and augmented reality, concept cartoons, mind maps, and concept maps	Micro, pre-service teachers	Experiment, quantitative approach
2	Valtonen *et al.* (2023)	Microscopes	Micro, pre-service teachers	Qualitative
3	Nilsson (2022)	Technological Content Representation (T-CoRe) example digital air humidity sensor and virtual reality	Micro, pre-service teachers	Qualitative
4	Chaipidech *et al.* (2022)	The module of TPACK-oriented personalized ubiquitous learning system	Micro, in-service teachers	Experiment, quantitative approach
5	Dewi *et al.* (2022)	Learning Management System such as Google Drive	Micro, pre-service teachers	Experiment, quantitative approach
6	Phattaraporn *et al.* (2021)	Module of mobile game-based inquiry learning in science (MGILS)	Micro, pre-service teachers	Experiment, quantitative approach
7	Chaipidech & Srisawasdi (2021)	Phet simulation, microcomputer-based laboratory	Macro, in-service teachers	Qualitative
8	Gustavo *et al.* (2021)	Wiki, Blogs, Facebook	Macro, school teachers	Survey
9	Arslan & Erdogan (2021)	3D (3-dimensional) printing	Micro, pre-service teachers	Mixed method
10	Lachner *et al.* (2021)	Module TPACK berbasis model SQD (Synthesis of Qualitative Data)	Micro, pre-service teachers	Quasi-experimental
11	Bahri *et al.* (2021)	Moodle-based e-learning, blended learning	Micro, pre-service teachers	Research and Development (R&D)
12	Chaipidech *et al.* (2021)	Mobile technology teaches STEM situation-related photosynthesis	Micro, in-service teachers	Experiment, quantitative approach
13	Supriyadi & Gunanto (2021)	Online learning, PPT media using videos and images	Micro, pre-service teacher	Qualitative
14	Juanda *et al.* (2021)	Online learning, Zoom Meetings, Google Classrooms, cisco Webex, Quizizz, or WhatsApp	Macro, in-service teacher	Survey
15	Irdalisa *et al.* (2020)	Visualization, graphics, and animation	Micro, pre-service teachers	Experiment, quantitative approach

No	Author's	Media	Context	Research Method
16	Nuangchalerm (2020)	YouTube, Google Applications, line, Facebook, and video	Macro, pre-service teachers	Survey
17	Oner (2020)	Virtual internships	Meso, pre-service teacher	Qualitative
18	Setiawan & Phillipson (2020)	Social media usage for Searching and Studying (SS), Download Media (DM), Sharing Media (SM), Professionalism Development (PD), and Entertainment and Motivation (EM)	Macro, pre-service teachers	Quantitative
19	Chai *et al.* (2019)	Google site, concept maps, web-based resources, PowerPoint presentations, online videos	Macro, pre-service teachers	Survey
20	Şimşek & Sarsar (2019)	Social media (Facebook, Twitter) and communication (e-mail)	Macro, scool in-service teachers	Survey
21	Dalal *et al.* (2017)	Digital citizenship, instructional software, teachers pay teachers, PhET science simulations, web-based applications, khan academy, teacher tube, or YouTube, and assessment tools such as Hot Potatoes, quizlet, and Kahoot	Micro, pre-service teachers	Mixed method
22	Papanikolaou *et al.* (2017)	Teacher training and online learning	Meso, pre-service teacher	Experiment, quantitative approach
23	Noor Davids (2017)	Module teaching practicum e-assessment	Micro, pre-service teachers	Qualitative
24	Guerra *et al.* (2017)	Portfolios such as videos, podcasts, and literature, MindMeister	Micro, in-service teachers	Mixed method
25	Baran & Uygun (2016)	Four technologies such as Diigo, infographics, simulations, and blogging	Meso, pre-service teachers	Qualitative, case study
26	Ke & Hsu (2015)	Mobile augmented reality artifact creation, mobile media artifact viewing with VoiceThread-based discussion	Micro, pre-service teachers	Mixed methods
27	Koh *et al.* (2014)	VoiceThread, podcast, web spiration, MindMeister, and social media	Macro, in-service teachers	Survey
28	Sancar-Tokmak *et al.* (2014)	Digital storytelling process	Micro, pre-service teachers	Qualitative

4. Discussion

Technology has spread through educational systems and environments, teachers are tasked with more than understanding the relationship between content and pedagogy. Technology brings new challenges to teaching including the development of knowledge, technology, and how it is integrated with content, teaching, and learning, in certain contexts (Rosenberg & Koehler, 2015). In the context of teacher education programs in Thailand, the TPACK Framework is used as important knowledge for the qualifications of pre-service teachers for today's education. TPACK is used for restructuring the educational courses of pre-service science teachers such as the use of mobile game technology (Phattaraporn *et al.*, 2021). Therefore, the TPACK component has become a competency in the education of pre-service teachers and in-service science teachers.

TPACK provides an explanation that can consider knowledge about technology to play a role in effective learning (Shulman, 1986; Koehler & Mishra, 2009). The TPACK framework is seven constructions with Mishra & Koehler (2006) the following explanation:

1. Knowledge of Technology (TK) includes knowledge of learning technology tools.
2. Pedagogical Knowledge (PK) includes knowledge of teaching methods and strategies.
3. Content Knowledge (CK) includes knowledge about the subject matter.
4. Technology Pedagogical Knowledge (TPK) includes knowledge of the use of technology to apply teaching methods.
5. Knowledge of Technology Content (TCK) includes knowledge of the representation of subject matter with technology.
6. Knowledge of Pedagogical Content (PCK) includes knowledge of teaching methods about subject matter content.
7. Knowledge of Technological Pedagogical Content (TPACK) includes knowledge of using technology to implement constructivist teaching methods for various types of subject matter content.

Theoretically, basic forms of knowledge (CK, PK, and TK) and secondary forms of knowledge (TPK, PCK, and TCK) should be the basis for developing the TPACK framework and as predictors of teacher TPACK (Chai *et al.*, 2013; Dong *et al.*, 2015). A transformative model that can help pre-service teachers develop technology pedagogical methods and strategies to integrate subject matter knowledge into science lessons, and further improve abilities from PCK to TPACK (Jang & Chen, 2010). The presence of pedagogical knowledge is emerging as an important factor in integrating technology and the ability to articulate how technology is used

in teaching and learning. It is important that pedagogical knowledge and the ability to discuss this knowledge in the context of TPACK significantly impact the ability of teachers to use technology in learning effectively (Benson *et al.*, 2015). Pedagogical considerations are central to keeping this focus on the transformative potential of TPACK (Mishra *et al.*, 2011). Therefore, pedagogy is a supporting factor in the use of learning technology media.

The media used in the development of TPACK has a variety, there is an interesting thing that some researchers use social media such as Facebook and Twitter as technology in learning. Koh *et al.* (2014) used a survey on the use of technology to create web pages, social media (e.g., Blog, Wiki, Facebook), collaboration tools (e.g., Google Sites, CoveritLive), communication tools (e.g., VoiceThread, Podcasts), online sticky notes (e.g., Diigo, Wallwisher), mind tools (e.g., Webspiration, MindMeister), and visualization tools (e.g., Wordle, Quizlet). Dalal *et al.* (2017) provided opportunities for participants to use (a) learning video resources such as Khan Academy, TeacherTube, or YouTube, (b) presentation software such as PhotoPeach and Prezi, (c) online formative assessment platforms such as Quizlet, and Kahoot, (d) online networking platforms such as Edmodo and Google, and (e) other online learning resources such as teachers pay teachers, PhET science simulations, and video broadcasting via Periscope.

Researchers in using media in TPACK development studies consists of two types, the first using a single type of media such as the use of the module of Mobile Game-based Inquiry Learning in Science (MGILS) (Phattaraporn *et al.*, 2021), virtual internships (Oner, 2020), microscopes (Valtonen *et al.*, 2023), and the second using multiple types of learning technology media such as Google site, concept maps, web-based resources, PowerPoint presentation, online videos (Chai *et al.*, 2019), PhET Simulation, microcomputer-based laboratory (Chaipidech & Srisawasdi, 2021) (*Fig. 2*). E-books and learning apps, explanatory videos, Quiz apps, QR tip cards, modeling software, virtual, and augmented reality, concept cartoons, and mind maps (Stinken-Rösner *et al.*, 2023). The use of various types of learning technology media is expected to encourage minds-on and hands-on activities in students.

The application of TPACK in supporting inquiry learning through introducing technology for learning science content. The teacher or student then asks a comprehensive scientific research question that can be answered through digital analysis of the image or other digital media such as animation, simulation, and video. Inquiry learning can use virtual laboratories such as the use of PhET Simulation. Teachers can also ask students to develop research questions based on their prior knowledge of the

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topic (Maeng *et al.*, 2013). The aim of TPACK is to analyze the quality of teacher knowledge required for the integration of technology into teaching through virtual internships, it is computer-based practical simulations, working collaboratively, on authentic tasks, and engaging in complex professional thinking (Oner, 2020). The TPACK framework can be used to analyze teacher competence in using learning media and technology.

(a) (b)

Figure 2. – Training workshops on the use of digital technology; (a) utilization of simulation PhET media; (b) microcomputer based laboratory (Chaipidech & Srisawasdi, 2021).

Knowledge of content appropriate technology within the TPACK framework, and its characteristics include the following actions. (a) Choose special technologies (tools) with disciplines of scientific content. A variety of technologies facilitate the achievement of learning objectives more effectively in various disciplines. (b) Reusing technology (tools) from other disciplines for content suitability. Teachers must be able to use the technology that has been used in a new pedagogical perspective. Examples of analyzing a blog can be used in learning strategies in various disciplines. This knowledge also includes an understanding of how to reuse tools from one discipline to another, such as using a calculator in geography to perform map calculations (Jaipal-Jamani & Figg, 2015).

The use of learning media as a way to encourage the improvement of TPACK knowledge and skills. Koh (2018) mentioned scaffolding design as a way to build teacher confidence in TPACK and is useful for helping teachers to articulate pedagogical changes in their lesson designs. Feedback was provided to improve the TPACK scaffolding design as well as guidelines to support pedagogical change through the TPACK professional development program. Jamaludin *et al.* (2022) explained pre-service teachers in microteaching need to improve their competencies, including

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self-confidence in learning, understanding essential material in the curriculum structure, contextual material, using various learning technologies and using learning videos effectively that encourage student participation. Therefore, TPACK is used for program development and teacher preparation in developing content, pedagogy, and technology specifically.

Based on the research context, more research at the micro level is in the form of experimental research activities in the classroom and at the macro level in the form of survey research at the regional/regional scope. Meanwhile, meso level research is rarely carried out in an institutional setting that allows cross-disciplinary research. The use of learning technology media in TPACK is related to research designs with a large number of media usually using survey techniques, while the use of technological media in single or small quantities is usually used in experimental research (*Tab. 2*). Rosenberg & Koehler (2015) expressed that although the TPACK framework is consistently context-bound, in some TPACK studies, this context has been conceptualized in very different ways. Ke & Hsu (2015) explained that TPACK research in a micro context on pre-service teachers with research in the form of mobile augmented reality media with discussions more supportive of component competencies from TPK and TPACK while viewing ordinary mobile media with peer discussions more supportive of CK.

Table 2. – Total of research in media and context.

Media & research context	Media		Context research			Research subject context	
	Single	Multi	Macro	Meso	Micro	In-service teachers	Pre-service teachers
Total	7	21	8	3	17	7	21

The TPACK framework can also be used to examine the effectiveness of online learning, and even to examine teacher capabilities in the areas of content, pedagogy, and technology (Juanda *et al.*, 2021; Supriyadi & Gunanto, 2021). Koh *et al.* (2014) expressed that teachers who develop technology, content knowledge, and pedagogical contribute to self-confidence. The challenges faced by teachers need to design teacher professional technology development. Chai *et al.* (2019) explained that the ability of teachers to integrate technology into learning can predict integrative STEM learning.

Maeng *et al.* (2013) described efforts to develop TPACK as evidenced through the use of selective and appropriate technology. The use of appropriate technology for inquiry learning includes: (1) presenting an interesting introduction, (2) facilitating data collection, (3) facilitating data analy-

sis, and (4) facilitating communication and discussion of results. These results suggest that using digital images to facilitate whole-class inquiry holds great promise as a starting point for teachers new to inquiry instruction. Jr *et al.* (2021) emphasized the task of the instructor to organize and deliver content to achieve learning objectives. Moreover, developing countries must consider the socio-technical constraints of all students when designing learning content.

There are various studies on educational technology that use the TPACK framework, but there are also types of research that do not use the TPACK framework. Evens *et al.* (2017) explained research using the TPACK framework, that online learning environments have a more positive impact on PCK and PK in teacher candidates than alternative programs such as face-to-face and independent learning programs. Several studies that use technology in learning, but don't use the TPACK framework analysis, as conducted by Meepung *et al.* (2021) showed that in developing a digital learning ecosystem such as interactive tools: (1) polls, (2) quizzes, (3) gamification, (4) interactive infographics, (5) interactive videos and live streaming, and (6) Jamboard.

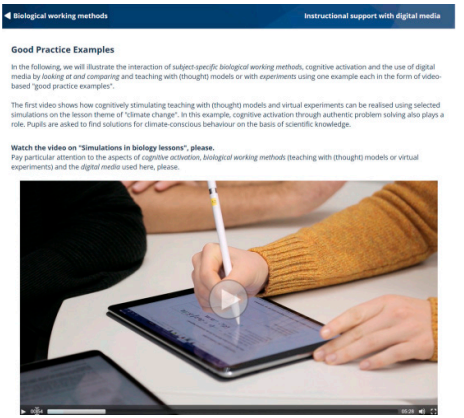

Figure 3. – Examples of good learning modeling in online modules the TPACK framework (Lachner et al., 2021).

The use of the TPACK module takes into account reflection, collaboration, and feedback as an iterative design feature of the Synthesis of Qualitative Data (SQD) model throughout the entire module. The three main sessions in the different SQD features include modeling, practice design, and authentic experiences with improved practice estimates. Pre-service

teachers are introduced to the specific principles of technology integration subjects through online learning modules during the Covid-19 pandemic. The module contains direct instructions on how technology can be integrated to improve teaching quality. For each subject, we focused on subject-specific technology integration methods and provided two content-specific videos for teacher candidates that exemplify good practice examples of technology integration in a specific discipline such as virtual experimental learning to encourage students' scientific reasoning in biology (Lachner *et al.*, 2021) (*Fig. 3*).

In developing a model for e-learning, one of the principles that emerged was the need to stimulate learning through dialogue and create a learning community. The essence of thinking about developing social interaction that unites pedagogy, technology, and content knowledge, TPACK is one model that can link these three domains as the main center of e-learning (Maor, 2016). While research on face-to-face Professional Development (PD) programs has an impact on the learning and practice of new teachers, the Covid-19 pandemic has necessitated a change in the way the program is delivered. Due to the ongoing challenges and uncertainties of the pandemic, it is important to examine how online PD approaches can leverage the advantages of technology to prepare for Computer Science (CS). The findings show that teachers benefit from virtual learning, in increasing trust when teaching, implementing lesson design, and implementation in learning practices. This shows implications for the effective design of online professional development, it has helped build teachers' understanding of content, pedagogy, and technology (Mouza *et al.*, 2014).

Training workshops in the context of teacher professional development are also conducted online due to the Coronavirus Disease 2019 (Covid-19) pandemic. Participants in this study included expert teachers with digital experience who attended the face-to-face teacher development program (TPD) at the two previous workshops. Studies reveal support for the professional development of science teachers regarding pedagogical technology and content knowledge in STEM education based on andragogy principles aligned with personal learning systems (Chaipidech & Srisawasdi, 2021). TPACK development can be integrated with STEM to support science learning.

Some educational development programs for pre-service teachers only mention media and learning technology in general, and don't specifically mention the media used in TPACK research such as Purwianingsih *et al.* (2022) examined on pre-service teachers' TPACK-Education for Sustainable Development (ESD) improved from early development to developed level. This means that pre-service teachers' TPACK-ESD is still at a

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low level. Açıkgöz & Akman (2023) investigated the relationship between epistemological beliefs and TPACK. Nithitakkharanon & Nuangchalerm, (2022) emphasized pre-service teachers in learning management competencies through the TPACK framework using learning media and technology. Kasi *et al.* (2022) examined the use of technology in selecting ethnoscience-based materials.

TPACK is a model for the expertise of the teaching profession to teach effectively with digital technology (Schmid *et al.*, 2021). TPACK is a way to assess the effectiveness of lesson delivery with the integration of technology, the framework becomes an ideal application in all aspects of learning, all aspects of which are important in teaching and learning processes (Santos & Castro, 2021). Technology in learning allows it to continue to grow and be varied. TPACK reminds us that learning must follow student characteristics and curriculum objectives, and learning can take place effectively and efficiently.

5. Conclusions

Skills to integrate learning on content knowledge, pedagogy, and technology within the framework of Technological Pedagogical and Content Knowledge (TPACK). The various types of technological media in TPACK development studies are used in science learning, there are two types of characteristics, the first is, the first using a single type of media such as mobile augmented reality, microscopes, and mobile game-based inquiry learning. The second is multiple media types of media used in learning by providing several alternatives such as several diverse media used in learning such as video sources, explanatory videos, presentation software, online assessment platforms, online learning platforms, and online learning resources. The context in TPACK research mostly uses the micro level, such as using mixed method research, experiments, qualitative research, and development and macro usually uses survey research, research in the meso context is the least amount. The other context also relates to the majority of pre-service teachers and some studies of science teachers, along with the development of learning that requires technology, the TPACK framework can be a way to increase success in achieving educational goals. Developing teacher professionalism can use one or various types of digital technology media which are a means of developing TPACK competencies. The use of TPACK media and context can be an option to focus on development from a small scale such as classrooms to larger ones such as between institutions.

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Riassunto

Lo sviluppo dei media e del contesto nel quadro della conoscenza tecnologica, pedagogica e dei contenuti (TPACK) è importante nell'educazione scientifica. Lo scopo della revisione sistematica è scoprire i media e il contesto utilizzati nel quadro TPACK per lo sviluppo dell'apprendimento scientifico. I media sono legati alla tecnologia dell'apprendimento come la tecnologia nella comunicazione, nella collaborazione, nella valutazione, nella visualizzazione e nell'apprendimento online. L'uso dei media per l'apprendimento scientifico nello sviluppo di TPACK consiste in due tipi, il primo che utilizza un tipo di media e il secondo che utilizza diversi tipi di media tecnologici per l'apprendimento. Il contesto di apprendimento comprende il micro sotto forma di classi, il meso sotto forma di scuole e il macro sotto forma di comunità più ampia, nonché il contesto degli insegnanti e degli insegnanti in formazione. Il contesto dell'educazione scientifica in TPACK si riferisce al tipo di ricerca come il livello micro utilizzando metodi di ricerca misti, sperimentale, qualitativo, ricerca e sviluppo e il livello macro che solitamente utilizza la ricerca tramite sondaggio. Il framework TPACK è un approccio per spiegare l'efficacia, la valutazione e la riflessione nell'uso della tecnologia di apprendimento.

Parole chiave: Contesto; Educazione scientifica; Media; TPACK.

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