Systematic Review of Research Conducted on the Techno-Pedagogical Content Knowledge of English Teachers[1]

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Abstract

This study is a systematic review of research on the databases of Web of Science, and Springer between the years 2012 and 2022 on the subject of the development of English teacher techno-pedagogical content knowledge. For the study group, the key concepts "the English teachers' technological pedagogical knowledge", "English teacher & technology", "EFL & technology", "ESL & technology", "TPACK (technological pedagogical content knowledge)", "English teaching & technology" were used to search on databases. The study group was formed with a total of 36 articles. In data analysis, Latent Dirichlet Allocation (LDA) was used from topic modeling methods. As a result of LDA, four topics were created: "teachers' self-efficacy in technology integration", "instructional challenges in higher education institutions", "pre-service teachers' approaches to the implementations of information and communication technologies" and "teachers' professional development in Teaching English as a Foreign Language". Accordingly, the need for TPACK for English teachers and teaching English, technology-based transformation and opportunities in English curriculums caused by TPACK, differences in teaching principles and methods of English brought out by TPACK, diversification of technology of teaching and materials, including TPACK in pre-service and in-service professional development curriculum, other qualifications of teachers such as thinking skills are some distinctive trends.

Keywords: English teacher, professional development, techno-pedagogical content knowledge

Introduction

Shulman (1987)'s viewpoint is crucial for the research on the phenomenon of teacher. In this approach, which is cited as teacher knowledge, an individual is supposed to be qualified with 7 different types of knowledge which are content knowledge, gener al pedagogical knowledge, curriculum knowledge, pedagogical content knowledge, knowledge of learners and their characteristics, knowledge of educational contexts, knowledge of educational ends and their philosophical and historical grounds to be defined as a teacher. Time brings out some developments and improvements in technology and so,

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new insights come into the light. It is advocated that technology should be integrated into curriculum is intriguing to students since technology is commonly used in daily life settings (Strommen & Lincoln, 1992). Accordingly, looking from the perspective of Education 4.0 and beyond, similar to the reflection of technological determinism, a new knowledge type named techno-pedagogical content knowledge (TPACK) arose to be acquired by teachers (Mishra & Koehler, 2006). Technological Pedagogical Content Knowledge comprises the information on how technology could be helpful in construction of new knowledge and reinforcement of previous knowledge, the situations where technology utilizes or hinders students' learning process, and the situations in which technology is effective in solving those kinds of problems. Technological improvements implicitly affect teacher role and students' expectations from teachers as in teaching knowledge. According to Kavcar (1999), effective teachers are individuals who are open to new things, refresh themselves continuously. This situation directs student teachers' expectations to the same direction, which means they seek the aforementioned qualifications in their instructors, professors (Şen & Erişen, 2002). Once technology integration is on board, teachers are also expected to be equipped with the necessary skills and to adapt (Hennessy, et al., 2022). From this, it is obvious that TPACK is multi-directional for teaching profession.

English Language Teacher Content Knowledge

Teaching English has different pivots considering teaching English as a foreign language and teaching English as a second language. Stern (1983) states that a second language and a foreign language differ from each other in terms of their functionalities, learning goals, language framework and learning methods. We can state that teaching English as a foreign language (TEFL) has a quite different structure compared to other content knowledge areas. In a communicative language class, language as a communication tool and language as content knowledge cannot be thought separately. In the process of language teaching, the teacher's use of the target language as content and a communication tool while teaching is necessary to support language acquisition (König, et al., 2016).

English Language Teacher Content Knowledge has a crucial role in instructional methodologies. English teachers and teacher candidates are expected to be responsive and ready to technological improvements. Thus, it is said that technology should be integrated into curriculum for training foreign language teachers (Luke & Britten, 2007). Since technological improvements are deterministic in the way communication and life direct to, it is impossible to consider teaching English and technology use separately. Digital natives have higher confinement to technology compared to older generations. Education technologies offer more effective teaching environments for digital natives (Puebla, et al., 2021). Accordingly, English teachers' teaching knowledge and technology knowledge are supposed to be integrated.

Effective use of technological tools and students' understanding of how effectively they will use those tools facilitate correct use of technology in language teaching. Teacher being a subject and an organizer of innovative activities takes part in the process of creation, application and dissemination of new adaptations (Kharatova & Ismailov, 2022). Thus, contribution of technology to education depends on teacher's understanding and being innovative (Prapphal, 1997). While whether technology was beneficial or harmful was being discussed at the end of 1990s, it is seen that technology has become a primary teaching tool in some specific situations and environments. Various teaching ways or methods like mobile applications for teaching, web applications, blended learning (Valiathan, 2002), and flipped learning show that education and teaching has turned into something with no limits and beyond

classroom framework. This situation is valid for other content knowledge areas from teaching English, as well. However, the fact that the current generation is growing up with the latest technology makes them digital natives and tech-savvy while in-service teachers from older generation do not have the same tendency to catch up with the latest trends.

In summary, TPACK, is a framework offering us a structure to understand how effectively teachers integrate technology into their teaching. The importance of TPACK comes to the forefront considering the preference levels of the alternative practices such as mobile applications for teaching, blended learning, and flipped learning and the fact that Web 2.0 - 3.0 and 4.0 populate in educational settings as much as daily life. TPACK can be utilized to facilitate to better understand the relations among technology, pedagogy and content knowledge in the concept of teaching English as a foreign language. English teachers are thought to integrate technology into their teaching more effectively, offer their students deeper learning experiences, and better get desired learning outcomes with the help of TPACK. TPACK is a research topic in terms of teaching English as a foreign language from Turkey's perspective. Thus, research of TPACK is deterministic for curriculum, model and theories toward English teachers' professional development.

Accordingly, a variety of research has been conducted in order to find out the facts related to technological and pedagogical content knowledge of in-service and pre-service teachers, to understand the encountered problems, or to discover the best practices. This study aims to bring out the research trends by examining the researches in English teachers' techno-pedagogical content knowledge. Our research questions are below:

1. What are the prominent research trends of English teachers' techno-pedagogical content knowledge?
2. What is the distribution of the studies according to the continents and countries?
3. What is the distribution of the studies according to the years they were published?

Method

Research Design

This research is systematic research aiming to analyze the articles looking into English teachers' techno-pedagogical content knowledge. In this research, topic modeling which is one of the text-mining techniques is used to analyze the data. Text mining is a work of data mining. It is a process of gleaning eligible and useful patterns for specific purposes (Hippner & Rentzman, 2006). Text mining has some fields like text classification, clustering, gaining topics, granulation, sentiment analysis, summarizing texts, entity relationship, and topic modeling.

Topic Modelling and LDA

In this research, topic modelling technique was used. Topic modelling is a process of discovering the patterns which are obvious or grounded in texts. It is a robust technique that is used in order to analyze texts like natural language processing, machine learning, and data mining (Zhao, et al., 2021). Topic modelling clusters words automatically with the help of programs and it enables to find out the relation in the texts which are included in the data set (Jelodar et al, 2019). One of the most popular topic modelling techniques is Latent Dirichlet Allocation (LDA).

LDA is cited as a probable model of a data set. LDA is based on the idea that every document in the data is a mixture of specific topics which are structured with word frequency distribution (Blei, Ng & Jordan, 2003). With the help of LDA, topics are structured by discovering the common words in the documents and which topics are found in the data set and which topic is dominant in each document can be disclosed. The main of using LDA in this study is to reveal the topic trends of the articles in the data set.

Data Collection

To create the data set, the specified keywords were used to scan the articles in the data bases of Web of Science and Springer. The keywords and phrases used to search the documents in the two data bases consist of 'English teachers' technological pedagogical knowledge', 'English teacher & technology', 'EFL & technology', 'ESL & technology', 'TPACK' (Technological pedagogical content knowledge), 'teaching English & technology'. As a result of the search process, 42 articles were listed. The parts of each article which are the publication year, the country of research, the abstract were compiled to be used in the data set.

Inclusion and Exclusion Criteria for Articles

The inclusion and exclusion criteria were applied to choose the articles for the data set. At the end of the process, the data set was structured with the abstracts of the elected 36 articles. The details of the data set can be found as Attachment 1. Inclusion criteria can be seen in the Table 1 below.

Table 1

Article inclusion and exclusion criteria

Criteria	Include	Exclude
Language	English	Other languages
Participants, sampling	Teachers, teachers and students	Students
Relation to technology	TPACK, ICT, technostress, technology integration, technology-based	No technology relation, scale development, student perspectives
Date range	2012-2022	2011 and before

Data Analysis

In this research, Python programming language and Python libraries for data analysis. The distribution of the articles according to the continents, countries and years was analyzed using some Python libraries. The abstracts in the data set were analyzed using LDA technique and Python programming language.

One of the crucial points in LDA is to have a clean data set. Pre-processing is done with the aim of cleaning the data and getting the meaningful part after removing basic prepositions, numbers, conjunctions and punctuation. At the pre-processing, the researchers made decisions on the words which should be excluded from the dictionary for the LDA model. First, white spaces, blanks, and punctuation was removed. Then, noun phrases and adjectives were chosen to construct the dictionary. Since parts of speech like verbs, adverbs, and prepositions have a misleading effect on calculating word frequency, all those stopwords were excluded. The tokens were obtained at the end of the process. The

ones seen only once were excluded. Next, it was realized that there are some tokens that have high frequency but are related to research models and techniques. Since they are not in the scope of the research, they were excluded manually. The tokens which were excluded from the dictionary are below:

Figure 1

The words excluded from the dictionary

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(['findings', 'using', 'research', 'data', 'qualitative', 'survey', 'study', 'result', 'results','finding', 'paper',
'discuss', 'maxqda', 'phase', 'sample','aim', 'need', 'factor','variable', 'factors', 'datum','report','analysis','mean',
'score','deviation','statistic', 'frequency', 'percentage','index','interview', 'questionnaire','total', 'cart', 'case',
'article', 'test','variance','validity', 'equation', 'hypotheses', 'element', 'gap', 'method','answer', 'methodology',
'validation', 'value', 'validity','reliability','purpose', 'subject', 'literature', 'area','question', 'according', 'age',
'scale','collection', 'process', 'sampling', 'correlation', 'regression','dictum','participant','researcher','chart',
'record', 'reference', 'pattern', 'claim','pilot', 'table', 'interval','reality','form', 'firewall','mixed', 'quantitative',
'various', 'related', 'field', 'standard','project','concept', 'theory','open', 'ended', 'new', 'context', 'positive',
'issue', 'current', 'system','critical', 'outcomes','descriptive','different', 'example', 'instrument', 'work', 'important',
'time', 'resources', 'resource', 'framework', 'aspect','potential', 'principle', 'theoretical', 'technical', 'model',
'suggestion', 'valid', 'implication', 'approach', 'year'])
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in the dictionary. The accepted token frequency is 3 in 1 repeating words in the documents and this filter was applied in the dictionary. After this process, the total number of tokens in the dictionary is 98. So, we had everything needed to train the LDA model.

Findings

The findings of the research were obtained at two different steps. The initial step is the analysis to discover the distribution of the articles according to the continents, countries and years. The second step is the analysis with the LDA model. To get the yearly distribution of the articles the Python library matplotlib was used. The articles included were published between the years of 2012 and 2022. According to Figure 2, one article in 2012, 2013 and 2015, 2 articles in 2014 and 2016, 3 articles in 2020, 4 articles in 2017, 5 articles in 2018, 6 articles in 2021 and 7 articles in 2022 were published. Accordingly, the percentage of the yearly distribution of the articles is given in Figure 3. The 19.4% of them in 2022, 16.7% of them in 2021, 13.9% of them in 2018, 11.1% of them in 2017, 11.1 of them in 2020, 8.3% of them in 2019, 5.6% of them in 2016, 5.6% of them in 2014, 3 different 3.8 of them in 2015, in 2013 in 2012 were published.

Figure 2

2012-2022 yearly distribution of the techno-pedagogy articles in Web of Science and Springer
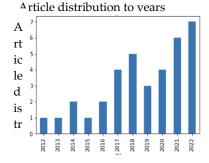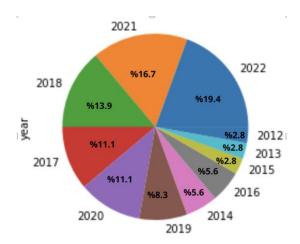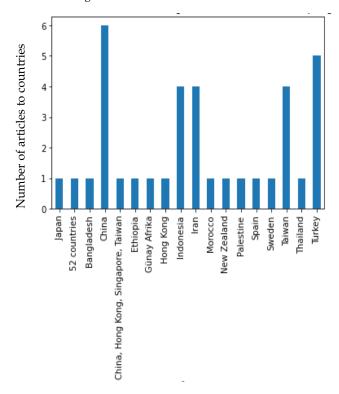
Article distribution to years

Figure 3

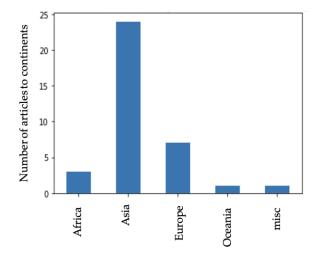*The percentage of articles to years*

According to the findings, in more than a decade, between the years 2012 and 2022, the research volume of English teachers' technological and pedagogical content knowledge increased. The trend changed between 2019 and 2020 and the decrease observed was thought to be related to the Covid-19 pandemic and giving importance to distance education in research.

The distribution of the articles according to the continents and countries can be seen in Figure 4 and Figure 5. As in Figure 4, one research was conveyed in the countries which are Japan, Bangladesh, Ethiopia, the Republic of South Africa, Hong Kong, Morocco, Palestine, Spain, Sweden and Thailand between 2012 and 2022. One share research was done in Hong Kong, Singapore, Taiwan and China, another research was also done including 52 countries. There are 4 articles done in Indonesia, Taiwan and Iran, 5 articles in Turkey and 6 in China. We can say that the research on English teachers' technological and psychological content knowledge was mostly done in Asia considering these data.

Figure 4

Distribution according to the countries

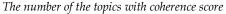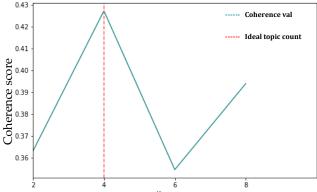**Figure 5**

Distribution according to the continents

LDA Model and Findings

LDA model was used with the dictionary constructed in pre-processing. This process creates relations between tokens with the given standards in the scope of machine learning and turns them into sample topics by scanning the data set. At the first attempt, LDA model with 5 topics was tried and coherence

and perplexity values were checked. A higher coherence score and lower perplexity score are better for the model. After this process, how many topics are built by the model is determined. The model has 32.7 perplexity estimate and the coherence score was obtained as 0.4273 after two calculations. At the end of the process, 4 topics were decided to structure for the meaningful explanation. The figure below displays that the highest coherence score complies with 4, which gives us the ideal number of the topics to be identified.

Figure 6

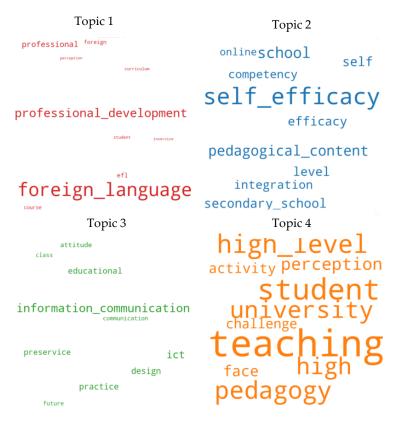*The number of the topics with coherence score*

LDA model restructured with 4 models decided at the previous stage. With the new model, the documents in the data set were classified into four different topics and the word clouds were created from the dictionary for each identified topic. After this analysis stage, we obtained our four topics and named them manually, as given below:

- Teachers' professional development in language teaching,
- Teachers' self-efficacy in technology integration,
- Pre-service teachers' approaches to information and technology implementations,
- Instructional hardships in higher education institutions.

The topics were named considering the keywords found in each topic of the LDA model. The first topic includes course, professional development, EFL, foreign language, foreign, perception, student, professional, curriculum and in-service. Thus, this topic named as *Teachers' professional development in language teaching*. The second topic consists of self-efficacy, online, competency, pedagogical content, level, integration, secondary school and school. Regarding the given words, the second topic is determined as *Teachers' self-efficacy in technology integration*. The keywords of the third topic comprise of high level, perception, activity, student, university, teaching, pedagogy, challenge and face. As the third title, *Pre-service teachers' approaches to information and technology implementations* was decided. The fourth topic includes attitude, class, educational, ICT, information communication, preservice, design, future, and practice. *Instructional hardships in higher education institutions* is defined as the fourth topic title. Figure 7 displays the identified four topics and their 10 keywords with the most frequency.

Figure 7

Word cloud display of topics

Topic 1

professional foreign
perception
curriculum
professional_development
student   inservice
efl
foreign_language
course

Topic 2

online school
competency   self
self_efficacy
efficacy
pedagogical_content
level
integration
secondary_school

Topic 3

attitude
class
educational
information_communication
communication
preservice   ict
design
practice
future

Topic 4

high_level
activity perception
student
university
challenge
teaching
face   high
pedagogy

1. Topic: Teachers' Professional Development in Language Teaching

The first topic determined is *teachers' professional development in language teaching* as a result of the LDA model. Professional development, education program, in-service, teaching English as a foreign language, experience are the dominant keywords in the articles which are included in this topic. Some research about teachers' beliefs related to techno-pedagogical content knowledge, classroom implementations and their experience was conducted.

Figure 8

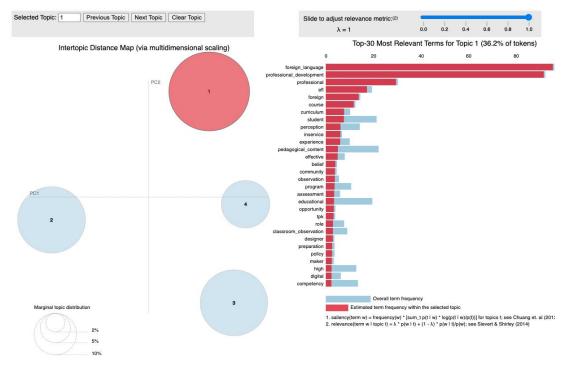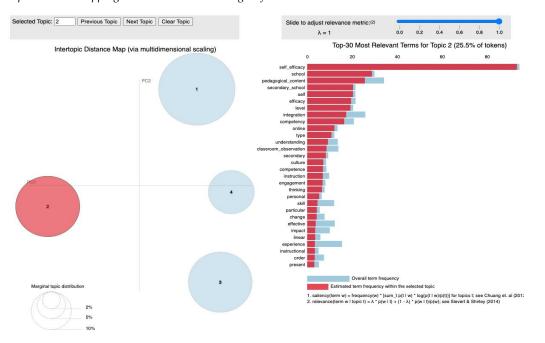*Topic 1, LDA Mapping and Relational Percentages of the Tokens*

Figure 9

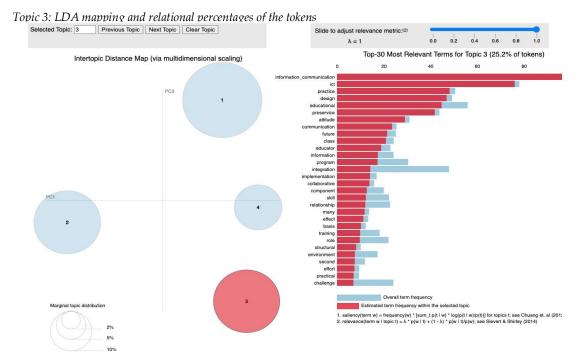*Topic 2: LDA Mapping and Relational Percentages of the Tokens*

3. Topic: Pre-service teachers' approaches to information and technology implementations

The third topic determined is pre-service teachers' approaches to information and technology implementations. Under this topic, the research papers of information technologies, implementation, design, pre-service teachers, their attitudes related to technology integration, their skills, and their training were listed.

Figure 10

Topic 3: LDA mapping and relational percentages of the tokens

4. Topic: Instructional hardships in higher education institutions

The fourth topic was determined to be instructional hardships in higher education institutions. Instruction, education in higher institutions, perceptions about technology integration, encountered difficulties, and innovations are in the scope of this topic. Thus, by examining the topic, it can be said that techno-pedagogical content knowledge in teaching English in high education is a strong factor determining research trends.

Figure 11

Topic 4: LDA Mapping and Relational Percentages of the Tokens

Also, the topics have distance relations among each other, which can be seen in the Cartesian coordinate system of the LDA results above. The fact that topics are not in close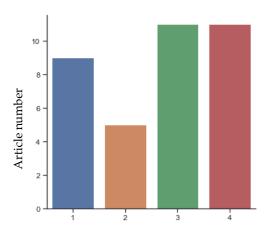 relation with each other reveals their distinction. The relation between the topics and the tokens in the dictionary is also displayed. For instance, the most frequent 30 tokens in the first topic are related to 36.2% of the dictionary. The most frequent 30 tokens in the second topic are related to 25.2% of the dictionary. The most frequent 30 tokens in the third topic are related to 25.2% of the dictionary and the most frequent 30 tokens in the fourth topic are related to 13.1% of the dictionary. With respect to this, the topic of *teachers' self-efficacy in technology integration* is related to most of the tokens in the dictionary. This shows that the articles cover this topic more frequently than the others. The least relation value belongs to the fourth topic which is *teachers' professional development in language teaching*. This can be regarded as a distinction, which means the fourth topic has a more specific content than the others.

The dominant topics for each article have been calculated. The first topic in 9 articles, the second topic in 5 articles, the third topic in 11 articles, and the fourth topic in 11 articles were calculations of topic dominance.

Figure 12

Dominant topic

The percentages of the topic range from 40% to 90%. Table 2 displays the articles, dominant topics, and the percentage of dominance. To give a specific example for detailed understanding, the first document is related to the second topic with 99%. The twelfth document is related to the third topic with 99%. The dominant topic and the percentage of the dominance of each document are as below:

Table 2

Dominant topic percentages

Doc	Dominant Topic	Percentage	Keywords
1	2	0.9979	teaching, student, high_level, pedagogy, university, high, perception, face, activity, challenge
2	1	0.9991	self_efficacy, school, pedagogical_content, secondary_school, self, efficacy, level, integration, competency, online
3	4	0.9991	foreign_language, professional_development, professional, efl, foreign, course, curriculum, student, perception, inservice
4	4	0.9718	foreign_language, professional_development, professional, efl, foreign, course, curriculum, student, perception, inservice
5	4	0.9410	foreign_language, professional_development, professional, efl, foreign, course, curriculum, student, perception, inservice
6	1	0.6884	self_efficacy, school, pedagogical_content, secondary_school, self, efficacy, level, integration, competency, online
7	3	0.8786	information_communication, ict, practice, design, educational, preservice, attitude, communication, future, class
8	2	0.6653	teaching, student, high_level, pedagogy, university, high, perception, face, activity, challenge
9	3	0.7206	information_communication, ict, practice, design, educational, preservice, attitude, communication, future, class

10	4	0.4630	foreign_language, professional_development, professional, efl, foreign, course, curriculum, student, perception, inservice
11	1	0.6033	self_efficacy, school, pedagogical_content, secondary_school, self, efficacy, level, integration, competency, online
12	3	0.9597	information_communication, ict, practice, design, educational, preservice, attitude, communication, future, class
13	4	0.4122	foreign_language, professional_development, professional, efl, foreign, course, curriculum, student, perception, inservice
14	4	0.9385	foreign_language, professional_development, professional, efl, foreign, course, curriculum, student, perception, inservice
15	4	0.5110	foreign_language, professional_development, professional, efl, foreign, course, curriculum, student, perception, inservice
16	1	0.9312	self_efficacy, school, pedagogical_content, secondary_school, self, efficacy, level, integration, competency, online
17	3	0.7458	information_communication, ict, practice, design, educational, preservice, attitude, communication, future, class
18	3	0.5450	information_communication, ict, practice, design, educational, preservice, attitude, communication, future, class
19	2	0.8494	teaching, student, high_level, pedagogy, university, high, perception, face, activity, challenge
20	1	0.4127	self_efficacy, school, pedagogical_content, secondary_school, self, efficacy, level, integration, competency, online
21	3	0.6863	information_communication, ict, practice, design, educational, preservice, attitude, communication, future, class
22	4	0.6059	foreign_language, professional_development, professional, efl, foreign, course, curriculum, student, perception, inservice
23	3	0.8563	information_communication, ict, practice, design, educational, preservice, attitude, communication, future, class
24	1	0.6384	self_efficacy, school, pedagogical_content, secondary_school, self, efficacy, level, integration, competency, online
25	4	0.6557	foreign_language, professional_development, professional, efl, foreign, course, curriculum, student, perception, inservice
26	4	0.9989	foreign_language, professional_development, professional, efl, foreign, course, curriculum, student, perception, inservice
27	1	0.6992	self_efficacy, school, pedagogical_content, secondary_school, self, efficacy, level, integration, competency, online
28	3	0.7063	information_communication, ict, practice, design, educational, preservice, attitude, communication, future, class
29	3	0.6361	information_communication, ict, practice, design, educational, preservice, attitude,

			communication, future, class
30	4	0.9832	foreign_language, professional_development, professional, efl, foreign, course, curriculum, student, perception, inservice
31	3	0.7121	information_communication, ict, practice, design, educational, preservice, attitude, communication, future, class
32	1	0.8155	self_efficacy, school, pedagogical_content, secondary_school, self, efficacy, level, integration, competency, online
33	1	0.8103	self_efficacy, school, pedagogical_content, secondary_school, self, efficacy, level, integration, competency, online
34	2	0.6943	teaching, student, high_level, pedagogy, university, high, perception, face, activity, challenge
35	2	0.4732	teaching, student, high_level, pedagogy, university, high, perception, face, activity, challenge
36	3	0.5084	information_communication, ict, practice, design, educational, preservice, attitude, communication, future, class

Discussion

According to the results, the number of published articles shows an increase between 2012 and 2022 although there is a partial decrease from 2019 to 2020. The fluctuation can be resulted from the instability during the Covid-19 pandemic. Çınar (2022) states that the master thesis between 2009 and 2019 showed an upward trend in their study of theme content analysis on TPACK. It is stated that there occurred an increase in the number of research on TPACK between 2010 and 2016 (Korucu, Ustan & Altun, 2017). The increase was thought to be linked to the interest rising in technology and its trendy use in educational fields. Similarly, the analysis of the articles on TPACK and TESL published in a variety of databases shows that the highest number of research was conveyed in 2018 (Greene & Jones, 2020).

Regarding this study, the research in English teachers and TPACK was conveyed in Asia mostly, the countries which published most of the research are China, Turkey, Taiwan and Iran. The analysis in the databases of Scopus and ProQuest reveal that Indonesia has the highest number of research between 2017 and 2021 (Sing, Din, Mohamed & Swanto, 2021). The descending list is as following: Turkey, Malaysia and Iran. From this perspective, we can conclude that the countries in Asia give importance to technology integration into education and they show a competitive sensitivity to technological developments.

Another fact of this study is *teachers' self-efficacy in technology integration* is a dominant trend in research between the years 2012 and 2022. *Determining TPACK competency* is the first topic in the meta-analysis of TPACK research (Kaleli Yılmaz, 2015). Similarly, the analysis the national and international articles published between 2010 and 2016 unleashed that *technology integration into education* is the utmost topic and *perceptions of technology like self-esteem, anxiety and technostress* took third place in the results (Korucu, Usta & Altun, 2017). The research (Dikmen & Demirer, 2016) supports this trend. 18% of the articles is based on *technology integration into education*, which is the second highest value. As can be regarded from

the given results, *technology integration into education and teachers' perceptions of the topic* has become a vital research topic.

According to our LDA analysis, one of the topics is *pre-service teachers' approaches to information and technology implementations*. The meta-analysis of TPACK articles shows that most of the research are conveyed with *teacher candidates (*Kaleli Yılmaz, 2015). Additionally, it is stated that the highest number of research done in Turkey between 2005 and 2013 are carried out with *pre-service teachers* (Baran & Canbazoglu Bilici, 2015). The national thesis and articles published between 2009 and 2013 revealed that 37% of the articles were about *teacher candidates*, 10% was about *in-service teachers* and 1% was about academicians (Dikmen & Demirer, 2016). The thematic analysis of the master thesis about TPACK between 2009 and 2019 showed 53.3% of the theses were about *teacher candidates* and 46.7% were about teachers (Çınar, 2022). It is uncovered that 50% of the research were conveyed with teachers and 20% of them were with teacher candidates (Sing, Din, Mohamed & Swanto, 2021). It is obvious that this study and other studies disclose that pre-service teachers are a crucial part of TPACK research.

Another topic of our study is *teachers' professional development in language teaching*. The second highest score of the topics in the analysis belongs to *teacher education* (Korucu, Usta and Altun, 2017). Ekmekci's (2018) meta-synthesis about teacher candidates and TPACK unleashed the topics which are participants' development about TPACK, qualifications, levels and teaching experience.

This study was conveyed on the topics of teaching English and TPACK. However, there is some research done about multiple content knowledge areas. In those articles, the number of articles about English teachers and TPACK seemed to be left behind. The research done in Turkey are mostly focused on teachers of science and technology and teacher candidates of mathematics and primary school (Baran & Canbazoglu Bilici, 2015). The descending list of content areas in the research published between 2009 and 2013 is as follows: mathematic teachers, science and technology teachers, primary school teachers and English teachers (Dikmen & Demirer, 2016). The research conveyed with pre-service teachers shows the articles are in the fields of science and technology, mathematic, primary school and English respectively (Çınar, 2022). The research conducted with in-service teachers are listed as mathematics, science and technology, English and primary school.

This study and other studies show that TPACK is a remarkable research topic in the professional development of English teachers and the training of pre-service English teachers. Guzmán (2019)'s teacher professional development program of TPACK in learning environments is a distinctive example. Our review reveals that TPACK is effective in the integration of technologies supporting instructional and pedagogical aims, and determining how teachers can become models of their own technology use for their students. Also, TPACK is a promoter of deep thinking of and evaluating teachers' pedagogical, technological and content knowledge which are regarded as the basics of developing students' learning experiences. Another issue can be implied from the results that the integration of technological equipment and tools do not mean only the supply, but attitudes of teachers and teacher candidates. Thus, it can be suggested that some work to be done for motivating teachers and improving their competence.

It is clear that a broad range of research trends have been brought out, which can be listed as follows: the importance and need of TPACK in terms of teaching English, technological transformations and opportunities caused by TPACK in the programs of teaching English, differences caused by TPACK in

the principles and methods of teaching English, diversification of educational technologies and materials, TPACK as a content area in the programs of pre-service and in-service teachers' professional development, TPACK's relation to the other competence areas such as thinking skills. In addition, some other trends are competency in TPACK, how TPACK can be assesed as well as cognitive and affective levels of teachers. The cases above can be regarded to be some of the causes of *the challenges encountered at higher educational institutions*.

Technological and pedagogical content knowledge is the knowledge of qualifications of teachers while they use technological tools and methods to support and improve learning. English teachers' professional development is a process of development of their qualifications to teach English and their knowledge. Research in TPACK enables to enlighten how English teachers can be more effective and support their professional development. Some supportive curriculums can be designed to help teachers improve and develop their own learning and use their own potential to develop their skills. Therefore, it can be said that improving in-service and pre-service teachers' competencies and developing materials and tools for their professional development deserve attention.

This analysis could shed light on how the pandemic influenced research trends in educational technology and informatics. Additionally, to explore the factors influencing TPACK research in specific countries like China, Turkey, Taiwan, and Iran, a deeper investigation into their educational policy and culture is recommended. Such insights could provide valuable understanding of their competitive sensitivity to technological developments in education. Furthermore, to support the integration of TPACK in teacher education, it is recommended to investigate the effectiveness of existing professional development programs and curricula for pre-service and in-service English teachers. This exploration could serve as a starting point for a compact guiding resource in designing tailored and effective professional development initiatives.

The language of the articles elected is English. Most of the research were conveyed in the countries where English is a foreign language. This resulted in some typos in most of the articles. Before the data processes, the abstracts were checked using the online grammar checker tools, proofread by the researchers, and sterilized for the program to understand the words correctly. In conclusion, the findings from the analysis of TPACK research in the context of teaching English reveal various emerging trends and areas of focus. The dominance of research on teachers' self-efficacy in technology integration indicates its crucial role in the education field. Moreover, the emphasis on pre-service teachers as a significant cohort for TPACK research underscores the significance of investing in their professional development. The study highlights TPACK's significance in teacher education and its transformative potential for teaching practices. Integrating technology in language teaching extends beyond tool provision, requiring fostering positive attitudes and motivations among educators and candidates. As the challenges faced by higher educational institutions in implementing TPACK become apparent, future research can focus on finding innovative solutions to address these challenges effectively. Embracing the dynamic nature of TPACK research and leveraging its potential can lead to more effective and transformative language education practices.

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Appendix 1. The details of the articles included in the study

Name of article: Alphabetical order	Database	Year	Authors
Applying a Technological Pedagogical Content Knowledge Framework in Ethiopian English Language Teacher Education	Springer	2014	Abera, B.
A Study of TPACK Structure of Outstanding English Teacher	Springer	2017	Na, R., Zhang, H., Wang, Y., Wang, Y., Yoneda, T., & Li, Z.
Applying a conceptual design framework to study teachers' use of educational technology	Web of Science	2017	Holmberg, J.
Developing a technological pedagogical content knowledge (TPACK) assessment for preservice teachers learning to teach English as a foreign language	Springer	2016	Baser, D., Kopcha, T. J., & Ozden, M. Y.
Developing EFL Teachers' Technological Pedagogical Knowledge Through Practices in Virtual Platform	Springer	2022	Zhang, Y.
Developing Technological Pedagogical Content Knowledge (TPACK) through Technology-Enhanced Content and Language-Integrated Learning (T-CLIL) Instruction	Web of Science	2021	Adipat, S.
Domains of Technological Pedagogical and Content Knowledge: Factor Analysis of Indonesian In-Service EFL Teachers	Springer	2020	Prasojo, L. D., Habibi, A., Mukminin, A., & Yaakob, M. F. M.
EFL Teachers' Conceptions of Professional Development during the Practicum: Retrospective Perceptions and Prospective Insights	Web of Science	2020	Aghabarari, M., & Rahimi, M.
Evaluating novice and experienced EFL teachers' perceived TPACK for their professional development	Springer	2019	Nazari, N., Nafissi, Z., Estaji, M., & Marandi, S. S.
Evaluating the potential of teacher-designed technology-based tasks for meaningful learning: Identifying needs for professional development	Web of Science	2017	George, A., & Sanders, M.
Examining EFL teachers' technological pedagogical content knowledge and the adoption of mobileassisted language learning: a partial least square approach	Springer	2016	Hsu, L.
Examining the Relationships Between English Teachers' Lifelong Learning Tendencies with Professional Competencies and Technology Integrating Self-Efficacy	Web of Science	2022	Şen, N., & Yildiz Durak, H.
Factors Influencing Teacher's Technostress Experienced in Using Emerging Technology: A Qualitative Study	Web of Science	2022	Khlaif, Z. N., Sanmugam, M., Joma, A. I., Odeh, A.,

			& Barham, K.
Flipped learning wheel (FLW): a framework and process design for flipped L2 writing classes	Web of Science	2020	Luo, Z., O'Steen, B., & Brown, C.
Hierarchical Linear Modeling to Explore Contextual Effects on EFL Teachers' Technology, Pedagogy, and Content Knowledge (TPACK): The Taiwanese Case	Web of Science	2021	Hsu, L., & Chen, Y. J.
Integrating augmented reality in language learning: pre-service teachers' digital competence and attitudes through the TPACK framework	Web of Science	2022	Belda-Medina, J., & Calvo-Ferrer, J. R.
Introducing an innovative technology integration model: Echoes from EFL pre-service teachers	Web of Science	2018	Harmandaoğlu Baz, E., Balçıkanlı, C., & Cephe, P. T.
Investigating pedagogical challenges of mobile technology to English teaching	Springer	2021	Jie, Z., & Sunze, Y.
Modeling dichotomous technology use among university EFL teachers in China: The roles of TPACK, affective and evaluative attitudes towards technology	Springer	2022	Zhang, M., & Chen, S.
Narrative inquiry for CALL teacher preparation programs amidst the COVID-19 pandemic: language teachers' technological needs and suggestions	Springer	2022	Tafazoli, D., & Meihami, H.
On Hong Kong Primary School English Teachers' Acceptance of Technology-enhanced Language Learning and Teaching	Springer	2019	Wang, F. L., Zhang, R., Zou, D., Au, O., & Xie, H.
Perceptions of Turkish Pre-Service EFL Teachers on Their Technological Pedagogical Content Knowledge	Springer	2018	İşler, C., & YILDIRIM, Ö.
Preparing in-service language teachers to design and implement technology-rich curriculum	Web of Science	2013	Keengwe, J., & Kang, J. J.
Secondary School English Language Teachers' Technological Skills in Bangladesh: A Case Study	Springer	2016	Rouf, M., & Mohamed, A. R.
Teacher immunity, technological pedagogical content knowledge, and teacher engagement: contributing factors and relations	Web of Science	2021	Beyranvand, S., & Mohamadi Zenouzagh, Z.
Teachers' ICT Practices: A Case Study of a Moroccan EFL Teacher	Springer	2014	Lamtara, S.
Technological Pedagogical and Content Knowledge of ESP Teachers in Blended Learning Format	Springer	2020	Mulyadi, D., Wijayatingsih, T., Budiastuti, R., Ifadah,

M., & Aimah, S.

Technological, Pedagogical, and Content Knowledge in Teaching English as a Foreign Language: Representation of Primary Teachers of English in Taiwan	Springer	2015	Wu, Y. T., & Wang, A. Y.
Technology Integration into the Language Classroom: Developmental Trajectory of Beginning Teachers	Web of Science	2018	Gong, Y., & Lai, C.
The role of TPACK in affecting pre-service language teachers' ICT integration during teaching practices: Indonesian context	Web of Science	2020	Habibi, A., Yusop, F. D., & Razak, R. A.
The Technology Cart and the Pedagogy Horse in Online Teaching	Web of Science	2021	Tsui, A., & Tavares, N. J.
Tracing preservice English language teachers' perceived TPACK in sophomore, junior, and senior levels	Springer	2017	Turgut, Y.
Understanding levels of technology integration: A TPACK scale for EFL teachers to promote 21st-century learning	Springer	2022	Wang, A. Y.
University teachers' technology integration in teaching English as a foreign language: evidence from a case study in mainland China	Web of Science	2021	Liang, W.
Using Activity Theory to Analyse Contradictions in English Teachers' Technology Integration	Web of Science	2019	Marwan, A., & Sweeney, T.
Validating and modelling technological pedagogical content knowledge framework among Asian preservice teachers	Springer	2013	Chai, C. S., Ng, E. M., Li, W., Hong, H. Y., & Koh, J. H.