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Exploring English Language Pre-service Teachers' Technological Pedagogical Content Knowledge

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Abstract: Based on Shulman's (1986) concept of Pedagogical Content Knowledge (PCK), Technological Pedagogical Content Knowledge (TPACK) emerged and became a helpful framework for comprehending the objectives of using technology in pre-service teacher training programs. The purpose of the present study was to evaluate Iranian pre-service EFL teachers' (PSEFLTs) perceptions towards their TPACK regarding their gender and academic year of study. To this aim, 254 Iranian PSEFLTs across various academic years of study filled out a 39-item EFL TPACK questionnaire developed by Baser et al. (2016). The questionnaire included seven categories: Content Knowledge (CK), Pedagogical Knowledge (PK), Technology Knowledge (TK), PCK, Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Technological Pedagogical Content Knowledge (TPCK). Based on the collected data, which were subjected to the Kolmogorov-Smirnov test, descriptive statistics, t-tests, one-way ANOVA, and post-hoc analysis, it was found that PSEFLTs generally held mildly favorable perceptions towards their TPACK. Notably, the lowest mean score was observed for the TK component, while the component with the highest mean score was the CK component. In terms of the gender effect, statistically significant differences were found in the TK and TPCK dimensions, where males outscored females in both TK and TPCK and females outscored males in CK. Furthermore, an examination of the relationship between participants' TPACK and their academic years of study manifested a statistically significant difference primarily between freshmen and seniors. The results are expected to encourage curriculum planners to develop PSEFLTs' training programs by integrating technology courses into the ELT curriculum.

Keywords: EFL Teaching, Pre-service EFL Teachers, Teacher Education, Technology in Education, TPACK.

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Introduction

Swift advancements in technologies result in notable changes in all areas of daily life and classroom methods as well. Education systems worldwide are striving to incorporate modern technologies into the educational process. Teachers are well-versed in technology due to its integration into our lives; however, the challenge lies in grasping the full potential of technology and utilizing it effectively to enhance the learning experience. As a result, there is a demand for certified educators who can keep up with the latest developments in educational technology and effectively incorporate them into their subject matter. For a considerable amount of time, educational academics have been debating the qualities of qualified teachers. One of the earliest comments on this matter was provided by Shulman (1986, 1987), who also established the concept of PCK. According to Shulman, competent educators should be able to plan the way that students learn the material in classroom settings. They should also possess adequate pedagogical understanding. Over time, the advancement of educational technologies has made it essential for educators to include these tools in their lesson plans; this has required a rethinking of pedagogy and teacher certification requirements. In actuality, the Covid-19 pandemic process caused emergency remote teaching scenarios to arise globally; teachers began to teach remotely, and technology use became a necessary component of teaching ability. The public became more aware of the significance of technology use in education as a consequence of this extraordinary circumstance (Seufert et al., 2021). During this process, it became increasingly clear how important it is to be able to use educational technologies to improve the effectiveness and efficiency of the learning process. As a result of the importance placed on incorporating technology into the classroom context, the concept of TPACK emerged. It was realized that providing teachers with PCK alone would not adequately prepare them to meet the ever-evolving demands of the teaching profession. Pierson (2001) carried out the first comprehensive study that combines technology and pedagogy in the field of teacher training, examining elementary teachers' technology incorporation practices. The study offered detailed information about how instructors use technology, and in her concluding statement, she used the terms "technological knowledge" and "knowledge of technological pedagogy and content." Later, as a consequence of their five-year research project, Mishra and Koehler (2006) introduced the notion of TPACK into the literature and developed its theoretical framework. They added the "technology" factor to PCK, so extending Shulman's (1986) approach. The TPACK framework proposed by Mishra and Koehler (2006) has served as a guide for numerous studies.

Over the past twenty years, the TPACK framework has been extensively used to assess the TPACK of teachers. Given the fact that the technological integration of in-service EFL teachers is believed to be predicted by their TPACK (Raygan & Moradkhani, 2020), a vast number of research has investigated in-service teachers' TPACK level (Alharbi, 2020; Ali & Hawk, 2024; Aisyah et al., 2021; Budianto et al., 2023; Elmaadaway & Abouelenein, 2023; Mansour et al., 2024). Although the TPACK level of pre-service teachers (PSTs) could also be a predictor of the degree to which technology will be integrated into their future teaching, there is scant research on their TPACK level. Additionally, analyzing pre-service teachers' TPACK could reveal its shortcomings, which could serve as the foundation for any project that EFL teacher educators organize and carry out to assist PSEFLTs in improving their TPACK. Therefore, by analyzing PSEFLTs' self-perceived TPACK, this study is expected to contribute to the corpus of research on PSEFLTs' TPACK. The results of this study could provide pre-service EFL teachers with strong motivation. This emphasizes the importance of the study by allowing educators from different contexts to decide which areas need greater attention in order to improve PSEFLTs' TPACK.

Literature Review

The TPACK Framework

According to Mishra and Koehler (2006), TPACK is a theoretical framework that is frequently used to describe teachers' knowledge of technology incorporation. TPACK is based on the basic theories of Shulman (1986), who proposed three aspects of knowledge for teaching professionally. According to Voss et al. (2011), the term "PK" refers to instructional practices that are generic in nature and assist students in their learning by creating an efficient learning environment, whereas CK is defined as teachers' particular expertise relevant to the material to be taught and PCK stands for content knowledge that is pertinent to the instruction of a certain subject. It assists teachers in adapting knowledge to learners' possible requirements and preparing appropriate materials. TK, or teachers' professional knowledge of technology, including digital tools and infrastructure, is another knowledge component that Mishra and Koehler (2006) included in their TPACK framework. Three more "t-intersections", i.e. TPK, TCK, and TPCK that are frequently connected to teachers' technology integration have evolved as a result of the addition of technological knowledge (Scherer et al., 2017). TPK is not restricted to any particular content; rather, it refers to teachers' overall comprehension of technology integration to promote students' learning (Scherer et al., 2017). TCK, based on Koehler and Mishra (2009), is the ability to employ

technology in a variety of content-specific contexts and TPACK explicitly deals with content-specific instructional techniques within the context of incorporating technology. According to Koehler and Mishra (2009), TPK and TPACK are essential for a successful technological integration. While TPACK should specifically help teachers integrate educational technology for content-specific teaching practices, TPK should assist teachers in applying their knowledge about teaching with technology in a general way (Koehler & Mishra, 2009). This framework currently serves as the essential knowledge foundation for teachers in the twenty-first century (Figure 1).

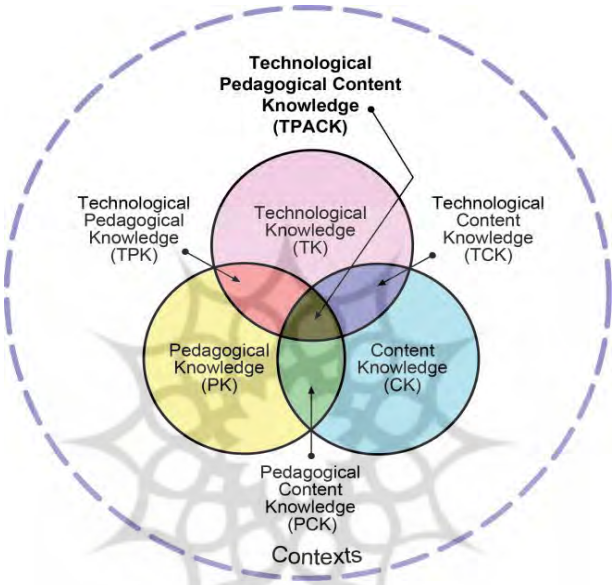

Figure 1. Graphic Representation of Technological Pedagogical Content Knowledge (From http://tpack.org)

Studies on TPACK with PSTs

A conceptual framework called TPACK helps explain how technology can be successfully incorporated into classrooms. The primary methods used in a significant amount of research on TPACK assessment were questionnaires, interviews, performance evaluations, and observations. Surveys were the most widely used research tools among these strategies (Koehler et al., 2012). The most popular one, specifically for pre-service educators, was created by Schmidt et al. (2009). 124 PSTs' TPACK in the context of America were measured using this instrument; TPK was seen to be the most important of the seven knowledge components, while the least important ones were PCK and TK. Significant links were discovered between TPACK and other components. A number of further research (Chai et al., 2010; Chai et al., 2011) altered Schmidt et al.'s TPACK survey to investigate the

TPACK levels of PSTs. Koh et al. (2010) looked at the TPACK of 1,185 Singaporean PSTs. Five unique conceptions emerged from their analyses: knowledge from critical reflection (KCR), knowledge from pedagogy (KP), knowledge of teaching with technology (KTT), and knowledge of pedagogy (TK). The items belonging to TPK, TCK, and TPACK constructs were loaded as KTT since the participants were unable to discriminate between them. In a similar vein, the TPACK development of 889 Singaporean pre-service teachers was examined by Chai et al. (2010). According to their findings, the teachers' TPACK was positively impacted by CK, PK, and TK, with PK having the biggest impact. Both prior to and after receiving ICT training, the perception of TK was the lowest among the participants. The TPACK development of 834 PSTs in Singapore was also studied by Chai et al. (2011). TCK and PCK were not among the five factors that the exploratory factor analysis results produced. In both models, it was discovered that TK and TPK positively and strongly predicted TPACK. According to the aforementioned studies, PSTs were unable to differentiate between TCK, PCK, and TPK. A 50-item test was later designed by Baser et al. (2016) to evaluate the TPACK of 378 PSEFLTs in Turkey. The findings demonstrated that pre-service instructors struggled to differentiate between TPK, TCK, and TPACK. Sarıçoban et al. (2019) used Baser et al.'s (2016) scale to measure the teaching preparation and knowledge (TPACK) of 77 PSEFLTs. The findings showed that PSEFLTs possess a sufficient degree of technical pedagogical subject knowledge; however, there are still certain areas that require improvement. In another study conducted by Koşar (2024), 158 PSEFLTs' perception towards TPACK was assessed in mixed-methods research. The results showed that although PSEFLTs had the highest level of technological knowledge, their mean value for CK was the lowest. Furthermore, in 28 items, there was a statistically significant difference between the TPACK of the PSEFLTs.

The Influence of Demographic Factors on TPACK

In certain studies (Atar et al., 2019; Ersanli, 2016; Koh et al., 2010; Mashhadi et al., 2023; Momenanzadeh et al., 2023; Sarıçoban et al., 2019), gender was another topic that emerged. Koh et al. (2010) investigated the TPACK of 1185 Singaporean PSTs; the findings revealed disparities in the perceptions of TPACK between males and females. In terms of TK, CK, and KTT, male PSTs evaluated themselves higher than female PSTs. Upon measuring effect size, they discovered that while TK remained statistically significant, CK and TKK were not as significant as they would have been to indicate a meaningful difference. The aforementioned research supports Ersanli's (2016) experimental study's results which

indicated that males had higher TK perceptions. A study by Lin et al. (2013) investigated how science instructors perceived TPACK. It dealt with how educators saw the advantages of using technology in the classroom. The findings indicated that although female teachers' TK was lower, their levels of confidence were higher in their pedagogical knowledge. Furthermore, a significant and negative correlation was found between the age of female teachers and their perceptions of TK, TPK, and TCK. Öz's (2015) findings align with gender disparities in how men and women view themselves, particularly with regard to PK and TK. According to Öz's (2015) research, there was significant variation in the PSTs TK perceptions of males and females; the males had much greater TK perceptions. Sarıçoban et al. (2019) also verified that men believed they had higher TK compared to their female counterparts. However, other research found little to no variation in the TPACK views of the two genders. For example, Koh et al. (2010) examined the TPACK perceptions of Singaporean PSTs and found no statistically significant differences between males and females. This is consistent with Horzum's (2013) findings on 239 PSTs in various subjects (such as science, computing, social studies, and instructional technology), which found no noticeable variations in the TPACK perceptions of males and females. Taking into account study variables such as age, gender, and college type, the research conducted by Shaqour and Al Saadi (2015) sought to determine the level of preparedness of university teachers towards the use of the learning management system in accordance with the TPACK framework. The study discovered that there was a very high level of TK, CK, and PK. TPACK was medium, while TPK was high. Given the covariates (experience, gender), there were not any statistically significant differences between the means of the teachers' TPACK levels of knowledge. The variables (age, specialization) caused statistically significant differences in the average TK of teachers at a given time. In a similar vein, Momenanzadeh et al. (2023) compared Iranian and Omani PSEFLTs' TPACK perceptions. In the contexts of Iran and Oman, the study found no evidence of statistically significant gender differences. Likewise, in a study conducted by Mashhadi et al. (2023), there were no noticeable variations in the TPACK scores in general or the perceptions of the various TPACK constructs between male and female Iraqi EFL teachers.

Using technology in English instruction is crucial, much as it is in all other educational subfields. Teachers must be able to smoothly incorporate technology into the educational process based on the utilization of all TPACK components. It is possible that PSTs who did not receive technology-related instruction during their undergraduate studies will not have the necessary skills when they begin teaching. Nonetheless, teachers can be deemed sufficient if

they progress professionally, stay up to date with technology, and integrate it into the classroom. Therefore, it might be advantageous to make up for these shortcomings through opportunities provided by the government or by the teachers themselves. Reviewing literature revealed that little research has addressed PSEFLTs' TPACK perception. To fill this gap, this study aimed to shed light on this issue and the following three research questions were developed with this goal in mind:

1. What are Iranian pre-service EFL teachers' perceptions of TPACK?

Is there a significant difference in participants' TPACK perceptions in accordance with gender?

Is there a significant difference in participants' TPACK perceptions in accordance with academic achievement?

Methodology

Research Design

The purpose of the current study was to examine how Iranian PSEFLTs assess their own TPACK level and determine whether gender and academic year had any discernible effects. Using a survey method, this study is quantitative in nature. By analyzing the connections between variables, quantitative research tests certain hypotheses. Typically, research instruments like tests, questionnaires, and structured interviews are used to measure these factors (Adnan & Latief, 2020). The research variables included PSEFLTs' TPACK perceptions, gender, and academic year.

Participants

Participants in the present study included 254 (86 females and 168 males) PSTs who were studying in different academic years (Freshman: 84, Sophomore: 37, Junior: 74, and Senior: 59) and their ages ranged from 18 to 29 ($\bar{x}$ = 20.8). They were majoring in Teaching English as a Foreign Language (TEFL) at two branches of Teacher Education University in Iran (Mazandaran and Markazi). Convenience sampling was adopted to select the participants.

Table 1 below displays the demographic information for the participants.

Table 1. Demographic Information of the Participants

Category	Subcategory	Frequency	Percentage
Gender	Female	86	33.86
	Male	168	66.14
Academic year	Freshman	84	33.1
	Sophomore	37	14.57
	Junior	74	29.13
	Senior	59	23.2
Location	Mazandaran	152	59.84
	Markazi	102	40.16
Age range	18-20	125	49.21
	21-23	121	47.64
	24-26	6	2.36
	27-29	2	.79

Research Instrument

The survey was presented in English and divided into two sections. The first part captured background data such as age, gender, academic year, and location. The second section contained the TPACK-EFL Questionnaire which was developed and validated by Baser et al. (2016) in order to gauge PSEFLTs' perception of their TPACK. Since the questionnaire was created specifically for pre-service language teachers, it was recommended over other TPACK questionnaires. It included 39 items on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), and consisted of seven components, namely TK, CK, PK, PCK, TCK, TPK, and TPACK. Evidence for internal consistency of the survey was maintained through Cronbach's alpha. The reliability estimate for the entire scale was α=.93, and the reliability coefficients for the TPACK factors varied from 0.78 to 0.94 (see Table 2).

Table 2. Variables and Reliabilities

Reliability statistics	Items	Cronbach's Alpha
Technology Knowledge (TK)	1-9	.78
Content Knowledge (CK)	10-14	.82
Pedagogical Knowledge (PK)	15-20	.83
Pedagogical Content Knowledge (PCK)	21-25	.86
Technological Content Knowledge (TCK)	26-28	.81
Technological Pedagogical Knowledge (TPK)	29-35	.94
Technological Pedagogical and Content Knowledge (TPCK)	36-39	.91
Total	39	.93

Procedures for Data Collection and Analysis

To garner data on the participants' TPACK perceptions, the survey link of the TPACK-EFL Questionnaire, prepared via Google Forms, was sent to 286 PSEFLTs across various academic years, encompassing freshmen to seniors. Out of this number, 254 PSEFLTs (86 females and 168 males) filled it out and formed the final number of participants. Since every question was required to be answered, participants had to respond to all the items prior to submitting the questionnaire. Accordingly, we collected a full dataset devoid of any missing data. Given that the participants could comprehend the English version of the questionnaire, the researchers decided not to administer the translated version. It is noteworthy to mention that the participants received assurances that the information they provided and their answers to the questionnaire would be kept confidential. To answer the previously developed research questions, first, the normality of the distribution of data was examined through skewness, kurtosis, and Kolmogorov-Smirnov tests and then the data were subjected to descriptive statistics, t-tests, one-way ANOVA, and post-hoc analysis. The mean and standard deviation of each item were calculated using descriptive statistics, and the perception of TPACK between male and female pre-service teachers was compared using Cohen's d and the independent-samples t-test. Moreover, one-way analysis of variance (ANOVA) and Bonferroni post hoc were run to find out if there were any significant differences between the individuals based on their academic year of study and where exactly the differences lied.

Results

Normality Tests

In order to examine the normality of the distribution of the whole scale along with the individual components, the data were examined through skewness, kurtosis, and Kolmogorov-Smirnov tests, using the SPSS program. As depicted in Table 3, the skewness and kurtosis values of all the components and the whole scale fall within the standard range, i.e. +1 and -1, and the Kolmogorov-Smirnov test results are higher than $p > 0.05$; therefore, it can be said that the data show a normal distribution and as a result it is possible to use parametric tests.

Table 3. Tests of Normality for Study Variables

Variables	Skewness	Kurtosis	Kolmogorov-Smirnov (sig.)
TK	.07	-.87	.13
CK	-.93	.96	.06
PK	.4	-.83	.13
PCK	.06	-.92	.08
TCK	-.98	-.43	.06
TPK	.01	.06	.17
TPCK	.33	.22	.08
Total	.28	-.16	.200

Research question 1: What are Iranian pre-service EFL teachers' perceptions of TPACK?

To answer the first research question seeking Iranian pre-service EFL teachers' perceptions of TPACK, descriptive analyses were conducted. The elements in the TPACK-EFL questionnaire assessing participants' TPACK perception are presented one by one.

Questions 1 to 9 in Table 4 deal with PSEFLTs' perceptions towards TK. As can be seen, more than half of the participants (66.6%) showed their agreement with the point that they can use technological terms such as operating system and wireless connection. The highest rate of agreement was seen for Item 2 in which 59.8% of the participants strongly agreed, 29.5% agreed, and only 8.7% and 2.0% of them expressed their neutral opinion and disagreement respectively with the idea that they can adjust computer settings. Focusing on Item 3, a great majority of the participants (86.3% with a mean value of 4.36) expressed their agreement on their ability to use computer peripherals. With regard to their ability to troubleshoot common computer problems (Item 4), using digital classroom equipment (Item 5), and using Office programs (Item 6) more than half of the participants revealed their agreement with mean values of 3.82, 3.69, and 3.48 respectively. On the other hand, almost a third of the participants (37.7%) agreed upon the issue that they can create multimedia, 22.8% neither agreed nor disagreed, and nearly two-fifths of them (39.4%) showed their disagreement. The lowest rate of agreement (15.7%), with a mean value of 2.27, was observed for Item 8, expressing their ability to use collaboration tools, the rest 21.7%, 30.7%, and 31.9% reported 'neither agree nor disagree', 'disagree', and 'strongly disagree' respectively. In contrast, a very large majority of the participants (85.8%) indicated their agreement that they can learn software that makes it easier for them to finish a range of jobs quickly. In general, by analyzing the results of items 1-9, one finds out that Iranian PSEFLTs'

responses with the mean value of 3.71 demonstrate that they have favorable technological knowledge.

Table 4. Descriptive Statistics Related to Technological Knowledge (TK)

No	Item	5 F/P	4 F/P	3 F/P	2 F/P	1 F/P	Mean
1.	I can use basic technological terms (e.g. operating system, wireless connection, virtual memory, etc.) appropriately.	98 38.6	71 28.0	55 21.7	25 9.8	5 2.0	3.91
2.	I can adjust computer settings such as installing software and establishing an Internet connection.	152 59.8	75 29.5	22 8.7	5 2.0	0 0.0	4.47
3.	I can use computer peripherals such as a printer, a headphone, and a scanner.	133 52.4	86 33.9	29 11.4	6 2.4	0 0.0	4.36
4.	I can troubleshoot common computer problems (e.g. printer problems, Internet connection problems, etc.) independently.	78 30.7	82 32.3	69 27.2	21 8.3	4 1.6	3.82
5.	I can use digital classroom equipment such as projectors and smart boards.	72 28.3	86 33.9	54 21.3	30 11.8	12 4.7	3.69
6.	I can use Office programs (i.e. Word, PowerPoint, etc.) with a high level of proficiency.	60 23.6	73 28.7	66 26.0	39 15.4	16 6.3	3.48
7.	I can create multimedia (e.g. video, web pages, etc.) using text, pictures, sound, video, and animation.	40 15.7	56 22.0	58 22.8	66 26.0	34 13.4	3.01
8.	I can use collaboration tools (wiki, Edmodo, 3D virtual environments, etc.) in accordance with my objectives.	15 5.9	25 9.8	55 21.7	78 30.7	81 31.9	2.27
9.	I can learn software that helps me complete a variety of tasks more efficiently.	151 59.4	67 26.4	26 10.2	10 3.9	0 0.0	4.41
	Total						3.71

For the group of items dealing with the CK component of the questionnaire (see Table 5), the results reflect that a considerable proportion of the respondents are able to convey their thoughts and emotions by speaking (Item 10, $\bar{x} = 4.31$) and writing (Item 11, $\bar{x} = 4.36$) in English. In a similar vein, a great majority of the participants (98.4%) expressed their ability to read English-language texts and pronouncing them correctly (Item 12). The highest rate of agreement belongs to Item 13 in which all the participants unanimously showed their

agreement ($\bar{x}$ = 4.90) that they can understand English texts, while the lowest rate of agreement is depicted in response to Item 14, stating that they can easily figure out a native English speaker's speech. In total, Iranian pre-service EFL teachers with an average mean value of 4.39 showed their highly favorable perception towards the CK component of TPACK.

Table 5. Descriptive Statistics Related to Content Knowledge (CK)

No	Item	5 F/P	4 F/P	3 F/P	2 F/P	1 F/P	Mean
10.	I can express my ideas and feelings by speaking in English.	131 51.6	83 32.7	30 11.8	8 3.1	2 .8	4.31
11.	I can express my ideas and feelings by writing in English.	134 52.8	84 33.1	31 12.2	3 1.2	2 .8	4.36
12.	I can read texts written in English with the correct pronunciation.	141 55.5	83 32.7	26 10.2	4 1.6	0 0.0	4.42
13.	I can understand texts written in English.	228 89.8	26 10.2	0 0.0	0 0.0	0 0.0	4.90
14.	I can understand the speech of a native English speaker easily.	63 24.8	127 50.0	58 22.8	5 2.0	1.4	3.97
	Total						4.39

The descriptive statistics results of the participants' PK are shown in Table 6 below. As shown in the following table, participants agreed with items 15 and 20 expressing their ability to employ various teaching techniques suitable for a learning context (Item 15, $\bar{x}$ = 3.48) and encourage students to work independently outside of the classroom to foster self-regulated learning (Item 20, $\bar{x}$ = 3.41). Concerning their ability to design an appropriate learning experience (Item 16, $\bar{x}$ = 3.02), just over one-third of the participants revealed their agreement, while almost the same percentage (33%) indicated their disagreement with this item. In response to Item 17, a considerable percentage of the participants (55.5%) disagreed about their ability to support learners, taking into account their individual differences in different domains. In contrast, a vast majority of the participants (76.4%) indicated their ability to collaborate with school stakeholders (Item 18, $\bar{x}$ = 4.04) and reflect on their experiences (Item 19, $\bar{x}$ = 4.09). Overall, PSEFLTs with an average mean value of 3.42 expressed their mildly favorable perceptions with regard to pedagogical knowledge.

Table 6. Descriptive Statistics Related to Pedagogical Knowledge (PK)

No	Item	5 F/P	4 F/P	3 F/P	2 F/P	1 F/P	Mean
15.	I can use teaching methods and techniques that are appropriate for a learning environment.	38 15.0	78 30.7	109 42.9	27 10.6	2 .8	3.48
16.	I can design a learning experience that is appropriate for the level of students.	25 9.8	64 25.2	81 31.9	59 23.2	25 9.8	3.02
17.	I can support students' learning in accordance with their physical, mental, emotional, social, and cultural differences	15 5.9	23 9.1	75 29.5	96 37.8	45 17.7	2.48
18.	I can collaborate with school stakeholders (students, parents, teachers, etc.) to support students' learning	77 30.3	117 46.1	53 20.9	7 2.8	0 0.0	4.04
19.	I can reflect on the experiences that I gained from professional development programs in my teaching process.	70 27.6	139 54.7	44 17.3	1 .4	0 0.0	4.09
20.	I can support students' out-of-class work to facilitate their self-regulated learning.	25 9.8	93 36.6	104 40.9	26 10.2	6 2.4	3.41
	Total						3.42

Table 7 deals with inspecting PSEFLTs' PCK. As is clear from the table, the participants had rather a favorable perception regarding this component of TPACK (Total $\bar{x}$ = 3.23). To be more specific, about two-fifths of the pre-service teachers expressed their agreement with their ability to manage a classroom (Item 21, $\bar{x}$ = 3.45), evaluate students' learning process (Item 22, $\bar{x}$ = 3.36), and prepare curricular activities (Item 24, $\bar{x}$ = 3.22). Meanwhile, almost a third of the participants agreed that they can use well-suited teaching methods to develop their language skills (Item 23, $\bar{x}$ = 3.06) and adapt an appropriate lesson plan (Item 25, $\bar{x}$ = 3.06).

Table 7. Descriptive Statistics Related to Pedagogical Content Knowledge (PCK)

No	Item	5 F/P	4 F/P	3 F/P	2 F/P	1 F/P	Mean
21.	I can manage a classroom learning environment.	60 23.6	42 16.5	55 21.7	60 23.6	37 14.6	3.45
22.	I can evaluate students' learning processes.	59 23.2	49 19.3	77 30.3	45 17.7	24 9.4	3.36
23.	I can use appropriate teaching methods and techniques to support students in developing their language skills.	43 16.9	40 15.7	81 31.9	69 27.2	21 8.3	3.06
24.	I can prepare curricular activities that develop students' language skills.	52 20.5	51 20.1	71 28.0	61 24.0	19 7.5	3.22
25.	I can adapt a lesson plan in accordance with students' language skill levels.	43 16.9	41 16.1	71 28.0	78 30.7	21 8.3	3.06
	Total						3.23

In response to items 26-28 (see Table 8), which deal with pre-service EFL teachers' perceptions towards TCK, a great proportion of the respondents (81.9%) with a total mean value of 4.28 indicated their agreement with the statement that they can manipulate multimedia in order to express their beliefs (Item 26). Likewise, approximately three-fifths of them agreed that they could benefit from using technology (Item 27, $\bar{x}$ = 3.79). On the other hand, only a third of the participants agreed that they are able to collaborate with foreigners by employing collaboration devices. All in all, it is clearly evident (based on the total mean value of 3.68) that respondents have a mildly favorable degree of technological content knowledge.

Table 8. Descriptive Statistics Related to Technological Content Knowledge (TCK)

No	Item	5 F/P	4 F/P	3 F/P	2 F/P	1 F/P	Mean
26.	I can take advantage of multimedia (e.g. video, slideshow, etc.) to express my ideas about various topics in English.	119 46.9	89 35.0	44 17.3	2 .8	0 0.0	4.28
27.	I can beneift from using technology (e.g. web conferencing and discussion forums) to contribute at a distance to multilingual communities.	64 25.2	93 36.6	76 29.9	21 8.3	0 0.0	3.79
28.	I can use collaboration tools to work collaboratively with foreign persons (e.g. Second Life, wiki, etc.).	26 10.2	51 20.1	91 35.8	65 26.6	21 8.3	2.98
	Total						3.68

As for TPK (see Table 9), the respondents concurred that they have almost adequate knowledge in this aspect. A considerable number of participants agreed that they could teach students how to use information technologies in a safe and legal manner (Item 30, $\bar{x}$ = 4.38), control the classroom environment when utilizing technology (Item 32, $\bar{x}$ = 4.44), decide when using technology would be beneficial (Item 33, $\bar{x}$ = 4.63), and use multimedia to aid students in their learning (Item 35, $\bar{x}$ = 4.31).

Table 9. Descriptive Statistics Related to Technological Pedagogical Knowledge (TPK)

No	Item	5 F/P	4 F/P	3 F/P	2 F/P	1 F/P	Mean
29.	I can meet students' individualized needs by using information technologies.	33 13.0	59 23.2	71 28.0	72 28.3	19 7.5	3.06
30.	I can lead students to use information technologies legally, ethically, safely, and with respect to copyrights.	134 52.8	87 34.3	28 11.0	5 2.0	0 0.0	4.38
31.	I can support students as they use technology such as virtual discussion platforms to develop their higher-order thinking abilities.	26 10.2	77 30.3	76 29.9	65 25.6	10 3.9	3.17
32.	I can manage the classroom learning environment while using technology in the class.	139 54.7	94 37.0	14 5.5	7 2.8	0 0.0	4.44
33.	I can decide when technology would beneift my. teaching of speciifc English curricular standards□	173 68.1	68 26.8	12 4.7	1 .4	0 0.0	4.63
34.	I can design learning materials by using technology that supports students' language learning.	54 21.3	72 28.3	41 16.1	64 25.2	23 9.1	3.28
35.	I can use multimedia such as videos and websites to support students' language learning.	118 46.5	100 39.4	32 12.6	4 1.6	0 0.0	4.31
	Total						3.89

For the group of items dealing with participant's TPCK (Table 10), the results reflect that almost half of the respondents showed disagreement with the statement that they can use Web 2.0 tools to develop students' language skills (Item 38, $\bar{x}$ = 2.41), whereas 71.3% of the participants indicated that they could use technology-related resources and tools to support their professional growth (Item 39, $\bar{x}$ = 3.93). Meanwhile, in response to items 36 and 37, almost a third of the participants agreed that they can use collaboration tools to support students' language learning or they could support students as they use technology ($\bar{x}$ = 3.22 and $\bar{x}$ = 3.11, respectively).

Table 10. Descriptive Statistics Related to Technological Pedagogical Content Knowledge (TPCK)

No	Item	5 F/P	4 F/P	3 F/P	2 F/P	1 F/P	Mean
36.	I can use collaboration tools (e.g. wiki, 3D virtual environments, etc.) to support students' language learning.	29 11.4	68 26.8	95 37.4	53 20.9	9 3.5	3.22
37.	I can support students as they use technology to support their development of language skills in an independent manner.	41 16.1	51 20.1	79 31.1	60 23.6	23 9.1	3.11
38.	I can use Web 2.0 tools (animation tools, digital story tools, etc.) to develop students' language skills.	8 3.1	34 13.4	57 22.4	111 43.7	44 17.3	2.41
39.	I can support my professional development by using technological tools and resources to continuously improve the language teaching process.	62 24.4	126 49.6	54 21.3	9 3.5	3 1.2	3.93
	Total						3.16

Research question 2: Is there a significant difference in participants' TPACK perceptions in accordance with gender?

In order to address the second research question, an independent sample t-test was run. From the results presented in Table 11, it can be construed that there is a significant difference among the PSEFLTs' perception towards seven components in the TPACK-EFL questionnaire, t (2.42), $p = .027 < .05$.

Table 11. Independent Sample T-test for the Relationship between Gender and TPACK

Groups	N	Mean	SD	df	t	Sig.
Male	168	3.70	.43	252	2.42	.027
Female	86	3.57	.34			

To find out where exactly the differences lied, an independent sample t-test was run for each component separately whose results are presented in Table 12.

Table 12. Descriptives and T-test for the Relationship between Gender and TPACK

Factors	Gender	N	Mean	SD	t	df	Sig.	Cohen's d
TK	Male	168	3.94	.63	8.41	252	.005	1.11
	Female	86	3.27	.50				
CK	Male	168	4.34	.55	-2.07	252	.001	-.27
	Female	86	4.48	.34				
PK	Male	168	3.41	.58	-.14	252	.238	-
	Female	86	3.42	.52				
PCK	Male	168	3.12	.87	-.46	252	.061	-
	Female	86	3.18	.95				
TCK	Male	168	3.73	.66	1.63	252	.071	-
	Female	86	3.59	.55				
TPK	Male	168	3.92	.47	1.52	252	.073	-
	Female	86	3.83	.38				
TPCK	Male	168	3.47	.70	2.60	252	.010	.65
	Female	86	3.24	.53				

As can be seen, the differences between Iranian PSEFLTs are significant in terms of TK, t = 8.41, p = .005 < .05, CK, t = -2.07, p = .001 < .05, and TPCK, t = 2.60, p = .010 components with males outscoring females in TK and TPCK and females outscoring males in CK; furthermore, Cohen's d was used to compute 'Effect Size' statistics. According to Cohen (1988), values of 0.2 to 0.5 are considered small, 0.5 to 0.8 are considered medium, and greater than 0.8 are considered large. As a result, the analysis revealed a small effect size between groups concerning the CK component, Cohen's d = -.27, a medium effect size for TPCK, Cohen's d = .65, and a large effect size for the TK component, Cohen's d = 1.11. Despite the fact that no significant differences were found between the groups with regard to other components, females received higher scores in PK and PCK, while males overtook females with respect to TCK and TPK dimensions.

Research question 3: Is there a significant difference in participants' TPACK perceptions in accordance with academic achievement?

In order to answer the third research question of the study, a one-way ANOVA was run. As can be seen in Table 13, the results yielded showed that except for TCK, F (3. 25٠) = 2.079, p = .104, perceptions in other domains were significantly different among Iranian pre-service EFL teachers: TK = (F (3, 250) = 4.847, p = .003), CK = (F (3, 250) = 2.914,

p = .036), PK = (F (3, 250) = 3.194, p = .025), PCK = (F (3, 250) = 4.860, p = .003), TPK = (F (3, 250) = 5.390, p = .001), TPACK = (F (3, 250) = 4.010, p = .008).

Table 13. One-way ANOVA: Comparing Participants' TPACK Domain Bases on Academic Year

		Sum of Squares	df	Mean Square	F	Sig.
TK	Between Groups	7.827	3	2.609	4.847	.003
	Within Groups	102.799	250	.538		
	Total	110.626	253			
CK	Between Groups	3.778	3	1.259	2.914	.036
	Within Groups	82.560	250	.432		
	Total	86.338	253			
PK	Between Groups	5.160	3	1.720	3.194	.025
	Within Groups	102.848	250	.538		
	Total	108.008	253			
PCK	Between Groups	8.084	3	2.695	4.860	.003
	Within Groups	105.890	250	.554		
	Total	113.974	253			
TCK	Between Groups	3.760	3	1.253	2.079	.104
	Within Groups	115.161	250	.603		
	Total	118.921	253			
TPK	Between Groups	8.436	3	2.812	5.390	.001
	Within Groups	99.649	250	.522		
	Total	108.085	253			
TPCK	Between Groups	7.365	3	2.455	4.010	.008
	Within Groups	116.923	250	.612		
	Total	124.287	253			

To find out where the difference lied, a Bonferroni post hoc test was performed whose results are presented in Table 14. As it is noticeable, the statistically significant difference was between freshmen and seniors in TK, CK, PK, PCK, and TPCK components: TK (p = .001 < .05), CK (p = .033 < .05), PK (p = .019 < .05), PCK (p = .001 < .05), TPK (p = .001 < .05), TPACK (p = .005 < .05); moreover, for TPCK component, significant differences were observed between both freshmen and seniors (p = .001 < .05) and juniors and seniors (p = .031).

Table 14. Bonferroni Test: Comparing Participants' TPACK Domain Bases on Academic Year

Dependent Variable	(I)Academic Year	(J) Academic Year	Mean Difference (I-J)	Sig.
TK	freshman	senior	-.51269*	.001
CK	freshman	senior	-.34267*	.033
PK	freshman	senior	-.40734*	.019
PCK	freshman	senior	-.52725*	.001
TPK	freshman	senior	-.52915*	.001
	junior	senior	-.38903*	.031
TPCK	freshman	senior	-.49022*	.005

Discussion

The current research was conducted to investigate Iranian PSEFLTs' self-perceived TPACK and to ascertain whether there were any significant differences in terms of gender and academic year. Given the fact that using technology effectively ameliorates learners' performance, having appropriate knowledge of TPACK is considered an important issue for language teachers (Cheng & Xie, 2018; Donnelly et al., 2011). The results of the TPACK-EFL questionnaire revealed that the participants had generally positive perceptions towards all of the TPACK subfactors, so it is clear that they can take pedagogical and content features into account while integrating technology. In addition, the component of TPACK with the lowest mean value indicated that the participants believed they lacked sufficient technological pedagogical content knowledge, while the component of CK with the highest mean value indicated that the PSEFLTs had a significant amount of content knowledge. By contrast, in a study conducted by Koşar (2024) on 171 PSEFLTs in Turkey, it was revealed that their CK was the lowest as opposed to their TK which was the highest. The findings regarding the TPCK dimension may be seen as unexpected, considering how people especially the young generation make use of technological tools in today's digital era.

Turning to the second research question of whether there was a significant difference in participants' TPACK perceptions in accordance with their gender, males' TK and TPCK were reported significantly higher than those for females. However, females had significantly higher perceptions compared to males in the CK component. Put differently, male participants indicated feeling more confident about themselves and their ability to apply their technology expertise, while females reported much more knowledge of content knowledge. The findings of this study are in line with Karadeniz and Vatanartiran (2015), Öz (2015), Altun and Akyildiz (2018), Sarıçoban et al. (2019), Ergen et al. (2019), and Alharbi (2020)

where there was a significant gender difference in at least one TPACK dimensions. On the other hand, the findings differ from those of Mashhadi et al. (2023) and Momenanzadeh et al. (2023) where gender was not a dominant independent variable in terms of TPACK dimensions. The results of the present research underscore the challenging task of pre-service teacher education programs to prepare qualified teachers, given that language learners require qualified teachers to achieve high-quality learning outcomes and that an education system's quality can never surpass the competence of its teachers (Barber & Mourshed, 2007). Consequently, emphasizing the application of advanced technology knowledge would be beneficial for pre-service teachers as well as instructors in teacher training courses. With the right technological knowledge and abilities, pre-service teachers can successfully combine technology with their subjects and move between these related sections with ease (Baran et al., 2011). Therefore, curriculum designers, particularly those who are in charge of designing teacher education programs, need to provide pre-service teachers with technologically rich environments and involve them in tasks that will enable them to create techno-pedagogical teaching resources and will eventually boost the quality of learning.

As for the relationship between Iranian pre-service teachers' TPACK perception and their year of study, significant differences were observed between freshmen and seniors in terms of TK, CK, PK, PCK, and TPCK components with seniors having highly favorable perceptions compared to freshmen; in addition, seniors indicated better perception than juniors in TPCK dimension. In other words, it was the fourth-year students who expressed greater agreement with the items. The findings align with the findings reported in Hofer and Grandgenett's (2012), Gill and Dalgarno's (2017), and Koşar's (2024) studies. It is not surprising that seniors had higher perceptions than those in earlier university years given that they had taken some courses which required them to do some microteaching as their class activity, or had actual teaching experience in classrooms.

Conclusion

In a rapidly evolving digital world, incorporating TPACK into teacher training programs is indispensable. The developing need for technology-enhanced instruction has provoked a demand for training teachers and equipped them with appropriate skills and knowledge to apply technology effectively in the classroom. By integrating TPACK into teacher training programs, we can make sure that teachers are well-prepared to meet the demands of 21st-century students and provide them with the needed tools and information to achieve success in an increasingly technology-driven society. This need has led to numerous studies

examining PSTs' TPACK. The present study was an attempt to investigate Iranian PSEFLs' self-perceived TPACK and the variations in their TPACK with regard to their gender and their academic year. In general, the findings showed that teachers have mildly favorable to favorable perceptions towards different components of TPACK; moreover, the level of participant's CK level was the highest, while that of their TPACK was the lowest. As for the second question, male participants manifested higher self-perception in possessing TK and TPCK, while females expressed much more CK. In terms of the relationship between the participants' TPACK and their year of study, it was revealed that the statistically significant difference was mainly between freshmen and seniors. In light of this study, the study's findings might add to the ongoing discussion about how to improve the English language teacher training program. Alongside new technology advancements, the ELT program curriculum should be updated. For instance, curriculum designers can enhance the quality of teacher training programs by integrating technology into their instruction. Moreover, teacher educators are expected to modify their own instructional practices to demonstrate the future teachers how a teacher can implement TPACK in the classroom environment. It is noteworthy to mention that although this study was carried out in Iran, the findings may encourage researchers in many contexts to investigate PSTs' self-perceptions of their TPACK in their own settings and launch programs to assist aspiring teachers with getting ready for real classrooms that are unimaginable without the integration of technology.

As for the limitations, the current study was based on quantitative data. Further studies may approach the issue by combining quantitative and qualitative research methods. Additionally, the focus of the present research was on unfolding pre-service teachers' self-perception of TPACK, but to what extent they can put their TPACK into practice was not explored. In a similar vein, in-service teachers' technological pedagogical content knowledge can be investigated to determine the degree to which they require additional training.

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