

THE REPUBLIC OF TÜRKİYE
SAKARYA UNIVERSITY
INSTITUTE OF EDUCATIONAL SCIENCES
DEPARTMENT OF FOREIGN LANGUAGES EDUCATION
ENGLISH LANGUAGE EDUCATION PROGRAM

**THE RELATIONSHIP BETWEEN AI-TPACK AND SELF-EFFICACY OF PRE-
SERVICE ENGLISH LANGUAGE TEACHERS**

A MASTER'S THESIS

MERT ACAR

SUPERVISOR
ASSIST. PROF. DR. ALİ İLYA

JUNE 2025

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DECLARATION OF ETHICS

In this study that I prepared according to Sakarya University Institute of Educational Sciences Thesis-Project Writing Guide, I declare:

- I collected and presented all the information and documents in the thesis within the framework of academic and ethical rules,
- I referred to the studies I used and cite them as a source,
- I did not make any changes in the data I used,
- I did not present the whole or any section of this thesis as another study.



Mert ACAR

SIGNATURES PAGE

This thesis entitled “The Relationship Between AI-TPACK and Self-Efficacy of Pre-Service English Language Teachers”, prepared by Mert Acar, was accepted on 27.06.2025 by the unanimous vote of the following jury as a Master’s thesis in the Department of Foreign Language Education, English Language Education Program, Institute of Educational Sciences, Sakarya University.

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ÖZET

HİZMET ÖNCESİ İNGİLİZCE ÖĞRETMENLERİNİN YZ-TPAB İLE ÖĞRETMEN ÖZ YETERLİKLERİ ARASINDAKİ İLİŞKİ

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Sakarya Üniversitesi, 2025

Eğitim alanında kullanılan teknolojik araçların hızla gelişmesi öğretmen yeterliklerini tanımlayan TPAB gibi modeller ortaya çıkarmıştır ve bu modeller de öğretmen öz yeterliği gibi temel nitelikler ile ilişkilendirilmiştir. Günümüzde yapay zekâ araçlarının geliştirilmesi ve eğitim ile bütünleştirilmesi ile öğretmenlerin sahip olması gereken temel teknolojik yeterliklerin kapsamı çeşitlenmiştir ve bu araçlara yönelik olan bilginin de öğretmen öz yeterliğini olumlu olarak etkileyeceği ortaya koyulmuştur. Bu bağlamda, yapay zekânın öncü konumu göz önünde bulundurulduğunda, YZ-TPAB (Yapay Zekâ-Teknolojik Pedagojik Alan Bilgisi) yeterliliği hizmet öncesinde İngilizce öğretmenlerinin sahip olması gereken önemli niteliklerdendir. Bu nedenle, karma araştırma yöntemlerinden sıralı açıklayıcı karma yöntem kullanılan bu çalışmanın amacı YZ-TPAB ile öz yeterlik düzeyleri arasındaki ilişkiyi incelemek, YZ-TPAB alt boyutlarının öz yeterlik düzeylerini ne ölçüde yordadığını belirlemek ve dördüncü sınıf hizmet öncesi İngilizce öğretmenlerinin YZ-TPAB ve öz yeterlik algılarını şekillendiren temel etkenleri kendi bakış açılarına göre ortaya koymaktır. Çalışmanın örneklemini İngilizce Öğretmenliği programında yer alan gerekli öğretmenlik uygulamaları ve teknoloji ile ilgili dersleri almaları sebebiyle çalışmaya daha etkili veri sağlayacaklarından dolayı dördüncü sınıf hizmet öncesi İngilizce öğretmenleri oluşturmuştur. İlişkisel araştırma yöntemi ile yürütülen nicel bölümde, uygun örneklem yöntemi kullanılarak gerekli özelliklere sahip katılımcılar belirlenmiş ve çalışmaya 303 hizmet öncesi İngilizce öğretmeni katılmıştır. Veri toplama aracı olarak Tschannen-Moran ve Woolfok Hoy (2001) tarafından geliştirilen Öğretmen Öz Yeterlik Ölçeği ve Ning vd. (2024) tarafından geliştirilen YZ-TPAB ölçeği kullanılmıştır. Bununla birlikte, betimsel istatistik, bağımsız örneklem T-testi ve çoklu regresyon analizi uygulanmıştır. Durum çalışması yöntemi ile yürütülen nitel bölümde, odak grup görüşmeleri gerçekleştirilmiş ve 13 katılımcıdan veri toplanmıştır. Nitel veriler, Creswell (2007)'in “spiral” veri analiz yöntemi kullanılarak incelenmiştir. Bulgular, YZ-TPAB ve öğretmen öz yeterliliği arasında

düşük düzeyde pozitif bir korelasyon olduğunu göstermiştir. Cinsiyet, not ortalaması ve öğretim deneyiminin öz yeterlik düzeylerinde üzerindeki etkisinde anlamlı bir farklılık bulunmamıştır. Ancak, YZ-TPAB'in üç alt boyutu olan alan bilgisi, pedagojik bilgisi ve yapay zekâ-teknolojik pedagojik bilgisi açısından not ortalamasına bağlı anlamlı bir fark tespit edilmiştir. Bunun yanı sıra, nitel verilerden elde edilen bulgulara göre dördüncü sınıf hizmet öncesi İngilizce öğretmenlerinin yabancı dil öğretiminde yapay zekâ kullanımına yönelik yeterli derecede bilgi, deneyim ve öz yeterlik sahibi olmadığı ve bununla ilgili gerekli eğitime ihtiyaç duydukları sonucuna ulaşılmıştır. Dolayısıyla bu çalışma; hizmet öncesi İngilizce öğretmenlerinin öz yeterlik düzeylerinin YZ-TPAB yeterliliklerinden etkilendiğini ve bu durumun, öğretmen yetiştirme programlarına yapay zekâ ile ilgili bilgilerin entegre edilmesinin önemini vurguladığını ortaya koymaktadır.

Anahtar Kelimeler: İngilizce öğretmen adayları, Teknolojik pedagojik alan bilgisi, TPAB, teknoloji, Öğretmen öz yeterliği, Yapay zekâ-TPAB, Yapay zekâ, Yapay zekâ-Teknolojik Pedagojik Alan Bilgisi.

ABSTRACT

THE RELATIONSHIP BETWEEN AI-TPACK AND SELF-EFFICACY OF PRE-SERVICE ENGLISH LANGUAGE TEACHERS

Mert ACAR, Master Thesis

Supervisor: Assist. Prof. Dr. Ali İLYA

Sakarya University, 2025

The rapid development of technological tools in education has led to the emergence of frameworks such as the Technological Pedagogical Content Knowledge (TPACK) model, which examines teacher competencies linked to critical qualities regarding the use of technology. In today's educational landscape, proficiency in technological tools positively influences teacher self-efficacy. As such, AI-TPACK (Artificial Intelligence -Technological Pedagogical Content Knowledge) has become a crucial competency for pre-service English language teachers upon the leading dominance of AI. The present study aims to investigate the relationship between AI-TPACK and self-efficacy perceptions, reveal to what extent AI-TPACK sub-dimensions predict self-efficacy, and explore the underlying factors of fourth-year pre-service English language teachers' perceptions of both frameworks from their own perspectives. The study applies sequential explanatory mixed-methods. The sample consisted of fourth-year pre-service English language teachers who had completed relevant teaching practice and technology-related courses. In quantitative part, correlational research design and convenience sampling was employed to recruit participants with the desired characteristics, and 303 pre-service teachers volunteered to participate in the study. Two scales, i.e., Teachers' Self-Efficacy Scale (Tschannen-Moran & Woolfolk Hoy, 2001) and AI-TPACK Scale (Ning et al., 2024) were used as data collection tools. Data were analyzed using descriptive statistics, independent T-tests, one-way ANOVA, and multiple regression analysis applied to examine differences in AI-TPACK and self-efficacy based on demographic variables and to determine the predictive power of AI-TPACK on self-efficacy. In the qualitative part, which includes case study method, focus group discussions were held, and the data were collected from 13 participants. The qualitative data were analyzed using Creswell (2007)'s data analysis spiral. The findings revealed a low positive correlation between AI-TPACK and teacher self-efficacy. No significant differences were found in AI-TPACK or self-efficacy based on gender, GPA, or teaching experience. However, a

significant difference was observed in GPA scores regarding three sub-dimensions of AI-TPACK: content knowledge, pedagogical knowledge and AI-technological pedagogical knowledge. In addition, findings obtained from qualitative data revealed that fourth-year pre-service English language teachers do not possess sufficient knowledge, experience, and self-efficacy related to the use of AI-based tools in foreign language teaching, and it is also necessary to provide domain specific training in this area. Thus, the study concludes that pre-service English language teachers' self-efficacy levels are influenced by their AI-TPACK competencies, highlighting the importance of integrating AI-related knowledge into teacher education programs.

Keywords: Pre-service teachers, Technological pedagogical content knowledge, TPACK, Technology, Teacher self-efficacy, Artificial intelligence, AI-TPACK, artificial intelligence-technological pedagogical content knowledge

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
AI-TPACK	Artificial Intelligence-Technological Pedagogical Content Knowledge
ICT	Information Communication Technology
MoNe	Ministry of Education
TPACK	Technological Pedagogical Content Knowledge
TPACK-W	Technological Pedagogical Content Knowledge -Web
TSES	Teachers' Sense of Efficacy



CHAPTER I

INTRODUCTION

The introduction section of the present study provides an in-depth explanation of the problem associated with AI-TPACK and self-efficacy frameworks and their relationship with language teaching. Subsequently, the significance and purpose of study, along with the research questions, are presented by addressing the areas in which the study can make a contribution. Finally, the definition of terms is presented.

1.1. Problem of the study

Over the past decade, remarkable development in production of technological innovations occurred globally. With rapid changes and improvements, new areas in technology have not only reached a global capacity but have also integrated into society. This expansion across different fields has influenced the essence of human life by shaping and facilitating the societal aspects (Volti & Croissant, 2024). In terms of technology, these radical changes and utilization of big data have elevated the importance of diverse technology-related fields including information and communication technology (ICT), robotics, internet of things (IoT), and artificial intelligence (AI). Consequently, technological advancements are regarded as one of the pivotal drivers for growth in various industries (Ayres & Williams, 2004). In this context, possessing technology-related knowledge such as ICT (Information Communication Technology) knowledge is regarded as one of the fundamental necessities of the twenty first century, and these skills are recognized as fundamental qualities for effectively performing tasks in the workplace (Griffin & Care, 2014). Therefore, the adoption of ICT tools has become widespread in diverse industries such as engineering, medicine, and education (Öztürk & Horzum, 2011). Among these fields, education has notably undergone profound transformation in terms of implementation of technology-related methods and techniques. Thus, schools have actively been making efforts to keep up with educational technologies such as providing in-service and pre-service training.

These set of advancements diversified teacher competencies, and introduction of new practices aimed at improving the quality of education has emerged particularly in language

teaching as English is the primary medium of international communication and academic success (Jenkins, 2007; Akiba & Liang, 2016; Crompton et al., 2024). In addition, international education policies have accentuated the demand for English teachers who have current competencies (Slapac, 2021). Among these competencies, TPACK (Technological Pedagogical Content Knowledge) has been recognized as a fundamental technology-related teacher competency for both pre- and in-service context in the last decade (Voogt et al., 2013). Koehler and Mishra (2009) defined TPACK as a model that encompasses teachers' pedagogical content knowledge with technology knowledge related to education. In this model, the domains of content, pedagogy and technology were expressed as the fundamental competencies required by teachers to effectively integrate technology into education (Koehler & Mishra, 2008). Although the TPACK framework elucidates the core domains including technological, pedagogical and content knowledge, rapid evolution of technological tools used in education has prompted improvement and updating of technological tools and frameworks.

In this context, integration of AI in education gained prominence. These updates were followed by adoption of AI-supported technologies to offer enriching learning experiences to students (Ayanwale et al., 2024). In the light of growing popularity of generative AI, many applications were developed such as Duolingo, Elsa Speak, and Google Translate (De la Vall & Araya, 2023). Moreover, there are various developed features that enhance teaching practices such as reading comprehension, giving feedback, providing personalized educational experiences (Pokrivcakova, 2019; Xu & Wang, 2019; Noviyanti, 2020). Although the integration of AI in classrooms remains a topic of discussion due to its limitations of being distinct from human characteristics and context-specific knowledge, its scope is broadening, and new AI technologies are being produced daily (Crompton et al., 2024). In the same line with TPACK, AI knowledge is also significant determinant for teachers in providing high-quality teaching experiences. Therefore, enhancing learning opportunities and providing enriched language learning environment through integration of technology is one of the fundamental skills of language teachers (Bugueno, 2013). However, many teachers feel overwhelmed in the classroom without having a good command of knowledge about AI concepts and working (Mikeladze et al., 2024). Insufficient skills can hinder the implementation of AI in language education (Bhandari, 2020). In this line, according to the recent research findings, teachers using AI-based materials mentioned that small percentage of them (%20) possess sufficient knowledge or training in integrating AI-

based tools (Edmett et al., 2023). In addition, both in-service and pre-service EFL (English as a Foreign Language) teachers have been struggling to incorporate theory and practice related to technological programs (Aydın, 2013).

What is more, insufficient sense of efficacy and training is a significant determinant of their reluctance to accept new innovations and support students' learning experiences (Tsai & Chai, 2012; Foulger et al., 2017; Katemba, 2020; Drajati et al., 2023; Biçer, 2023; Cun & Huang, 2024;). Bandura (1978) defined self-efficacy as the perceptions of teachers that affect their performance at the desired level. When teachers have insufficient self-efficacy beliefs, they may face obstacles in some work-related areas including AI utilization and selecting suitable AI-based learning materials (Emre, 2019). In this context, EFL teachers' willingness to implement AI-powered materials in educational setting is influenced by their self-efficacy beliefs (Bai et al., 2019; Wang & Chuang, 2024). In parallel to the developing appreciation of English language teachers' competencies, such as technological knowledge and self-efficacy, there has been an emphasis on studies aimed at establishing a close connection between theory and practice to assist pre-service English language teachers in developing their skills prior to entering real classroom environment (Kömür et al., 2010). However, as it is also considered that teachers are at the heart of education, professionally development courses have been provided to them; however, the presence of challenges in effectively implementation of AI-based tools especially among novice teachers is still continuing. These sequences of challenges affect each other, and teachers are struggling to feel competent towards their classroom practices which can potentially emerge several problems such as not being able to conduct advanced technological tools and providing low quality and traditional learning experiences. Therefore, when limitations and complexity of utilizing AI materials are considered, lack of self-efficacy can result in falling behind estimated goals in foreign language education. For that reason, teachers should not only be equipped with contemporary technological skills but also develop strong beliefs toward implementation of these contemporary educational processes to get positive outcomes at the end (Chou et al., 2024; Yang, et al., 2024; Tram & Tran-Thanh, 2024; Lu et al., 2024).

In this context, there have been many studies investigating teachers' TPACK levels and self-efficacy perceptions in the relevant literature (Gürol & Aktı, 2010; Akyüz, 2018; Clark & Newberry, 2019; Koyuncuoğlu, 2021; Karchmer-Klein & Konishi, 2023). Despite an extending body of research focusing on AI for in-service language teachers, there remains a lack of sufficient recent studies on pre-service English language teachers about the use of AI

(Pokrivcakova, 2024). Although research in this area generally investigates competencies about technology and self-efficacy, the limited current information on pre-service teachers' perceptions of their competencies presents challenges in providing the necessary opportunities for teachers to develop themselves (Balyer et al., 2017). At this point, it is significant to examine pre-service teachers' perceptions of their competencies regarding current educational practices such as AI-TPACK. In addition to these, there are also a limited number of studies on pre-service English language teachers' perceptions of their competencies in Türkiye (Yüksel, 2014). Consequently, literature noticeably demonstrates that there is still a significant research gap in both AI and efficacy beliefs. In this regard, Öz (2015) suggested that foreign language teachers' current competencies related to technology in Türkiye should be examined due to limited knowledge in this area. For this reason, it could be understood that there is a lack of research particularly addressing pre-service teachers in Türkiye and the current practice of AI content. Furthermore, the language teaching process is indispensable from technological tools since students need to be exposed to audial, visual, verbal, and oral materials. That being the case, implementing AI technologies without enough knowledge and confidence might end up with failure in language teaching, and EFL teacher training programs may keep falling behind of contemporary practices due to lack of knowledge in pre-service teachers' requirements related to their sense of efficacy and AI knowledge.

1.2. The purpose and significance of the study

The integration of technology into education is progressing at an unprecedented pace today (McLain et al., 2019). Technology-based teaching created relevant methods and principles including mobile-based, game-based, computer-based, massive online open courses (MOOCs), AI, flipped learning, interactive whiteboard (Shahid et al., 2019; Tahiru, 2021; Kouser & Majid, 2021). As one of the technological materials currently integrated into education, AI has both advantageous and disadvantageous aspects in terms of application in classroom (Li et al., 2023). Despite its limitations, AI offers enriching opportunities such as motivating students and providing effective learning resources (Pesek et al., 2022). In this regard, innovations such as generative AI have demonstrably improved the quality of education provided by teachers in the classroom (Allegra et al., 2023). Particularly in language learning, AI-driven applications have offered high-quality learning experiences on

different components of language such as writing, grammar, and vocabulary acquisition (Karataş et al., 2024). For these reasons, teacher competencies related to technology became a significant factor in providing successful learning outcomes (Rohaani et al., 2012). In addition, they should be redefined and rethought with the rapidly increasing involvement of AI. As Koh (2019) mentioned that competencies related to the use of technology such as TPACK are considered essential frameworks for teachers. Despite the long presence of the TPACK model in education, the emergence of new technological tools such as AI has prompted elevation of new research domains which includes incorporation of teachers' and students' perspectives on current technological tools. Therefore, along with the ability to use educational technology, being capable of using AI tools has been considered an important quality for teachers (Kim et al., 2020). As a result, the TPACK model, which has been longstanding framework and research area in education, was updated by AI extension (Ning et al., 2024). Hence, AI-TPACK is a current and significant quality since it encompasses both the AI and technology dimensions.

As Voogt and McKenney (2017) stated that the knowledge of how technology is utilized in teacher training programs affects teachers' attitudes and practices about technology. In this context, Oran (2023) also mentioned that the rapid development of AI technology is a potential determinant of teachers' self-efficacy perceptions. Therefore, it could be understood that self-efficacy is closely related with professional competencies, and being able to use technological tools in education is also related to teacher self-efficacy. Thus, examining pre-service English language teachers' perceptions of their current competencies is important for training teachers with the necessary skills in the pre-service period. Moreover, there has been an emphasis on studies aimed at establishing a close connection between theory and practice to assist pre-service English language teachers in developing their skills prior to entering real classroom environment (Kömür et al., 2010). Although research in this area generally investigates basic competencies such as TPACK, content knowledge, teaching strategies, and self-efficacy, the limited current information on pre-service teachers' perceptions toward their competencies brings some challenges in providing the necessary opportunities for teachers to develop themselves (Balyer et al., 2017). Additionally, it was noted that there is a noticeable research gap particularly in AI content for pre-service teachers. At this point, it is significant to examine pre-service teachers' perceptions about their competencies regarding current technology-related educational practices (Haseski, 2019; Eyüp & Kayhan, 2023). Therefore, focusing on pre-service English

language teachers' perceptions of their professional competencies is significant (Rizkiani, 2021), and Öz (2015) suggested that foreign language teachers' current competencies related to technology in Türkiye should be evaluated. For these reasons, the results of the present study can contribute to the relevant gap in the literature particularly in local level through developing an understanding on fourth-year pre-service English language teachers' perceptions of their sense of efficacy about using AI. Additionally, acquired implications can assist to educational policymakers in terms of revising and providing the teacher training programs for EFL pre-service teachers by means of gaining insights about the relationship between AI-TPACK and sense of efficacy levels of fourth-year English pre-service teachers. Accordingly, the purpose of the present study is to reveal the relationship between AI-TPACK and self-efficacy levels and the extent to which AI-TPACK sub-dimensions predict self-efficacy levels and investigate the underlying factors that might shape fourth-year pre-service English language teachers' AI-TPACK and self-efficacy perceptions from their own perspectives. Accordingly, the following research questions were sought to answer in the present study:

1. What are pre-service English language teachers' perceptions of AI-TPACK and teacher self-efficacy, how do these vary across demographic variables, and how do teachers interpret the role of AI-TPACK in shaping their self-efficacy beliefs?

- 1.1. What is the level of pre-service English language teachers' perceptions of the AI-TPACK model?

- 1.2. What is the level of pre-service English language teachers' perceptions of their teacher self-efficacy?

- 1.3. Do pre-service English language teachers' levels of AI-TPACK vary according to demographic variables, i.e., gender, GPA, and teaching experience?

- 1.4. Do pre-service English language teachers' perceptions of their teacher self-efficacy vary according to demographic variables, i.e., gender, GPA, and teaching experience?

- 1.5. Do any of the sub-dimensions of the AI-TPACK model (CK, PK, PCK, AI-TK, AI-TCK, AI-TPK, AI-TPACK) predict pre-service English language teachers' self-efficacy perceptions?

1.6. What do the pre-service English language teachers think about the role of AI-TPACK sub-dimensions in their self-efficacy perceptions?

1.3. Definitions

Artificial Intelligence (AI): The term AI means to a program that can pretend to human actions or complete the tasks that cannot be done in a short time (McCharty et al., 2006).

Technological Pedagogical Content Knowledge (TPACK): TPACK is an educational technology related framework. It was first designed by Shulman (1986) as PCK (Pedagogical Content Knowledge). Koehler and Mishra (2005) extended the framework by adding technological dimensions. The framework describes which educational technology knowledge teachers should have, and it is seen as a significant feature.

Artificial Intelligence-Technological Pedagogical Content Knowledge (AI-TPACK): It is an extended and updated version of TPACK. Ning et al., (2024) developed AI-TPACK, and it is used to both define what features teachers need to use AI in classroom and how these features serve pedagogical purposes.

Self-Efficacy: Bandura (1977) defined self-efficacy as people's perceptions of their knowledge and abilities to complete tasks or take an action.

Information Communication Technology (ICT): Using technological tools to do some tasks such as collect data, interact with other people, and store information (Cambridge University Press, 2020).

Technological Pedagogical Content Knowledge-Web (TPACK-W): It is updated form of TPACK framework. TPACK-W is related to the addition of Web dimension to TPACK. The framework explains teacher competencies toward combining web, technology, content, and pedagogical knowledge (Zhou et al., 2017).

CHAPTER II

LITERATURE REVIEW

In this chapter, the relevant literature is examined under the main headings of Educational Technology, Technology use in Language Education, TPACK model, AI, AI and education, AI and Language Education, AI-TPACK and Self-efficacy. The TPACK model is explained in the third main title, followed by an explanation of its sub-dimensions: technology knowledge, pedagogical knowledge, content knowledge, technological pedagogical knowledge, technological content knowledge, pedagogical content knowledge and technological pedagogical content knowledge subheadings, which are the sub-dimensions of the TPACK model, with references to the relevant literature. Subsequently, the twelfth main title scrutinizes AI and the relationship of it with education and language teaching including ethics regarding the use of AI. In addition, AI-TPACK framework is introduced in the fifteenth main title where the AI-TPACK and its sub-dimensions are explained in detail. Finally, the last section explains the concept of self-efficacy and TPACK by referring to various studies in the relevant literature.

2.1. Educational technology

Educational technology is defined as utilizing suitable technological tools during the learning process to make it easier (Force, 1977). In addition, the definition of educational technology is follows:

“Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources” (Januszewski, 2008, p. 1).

Advancement of technology has been continuing since the starting point of human life. Technology comprises a vast number of tools being used in different fields. As shown in Figure 1, educational technology has witnessed various and quick transformation since the beginning of Industrial Revolution (Chikwaka et al., 2024).

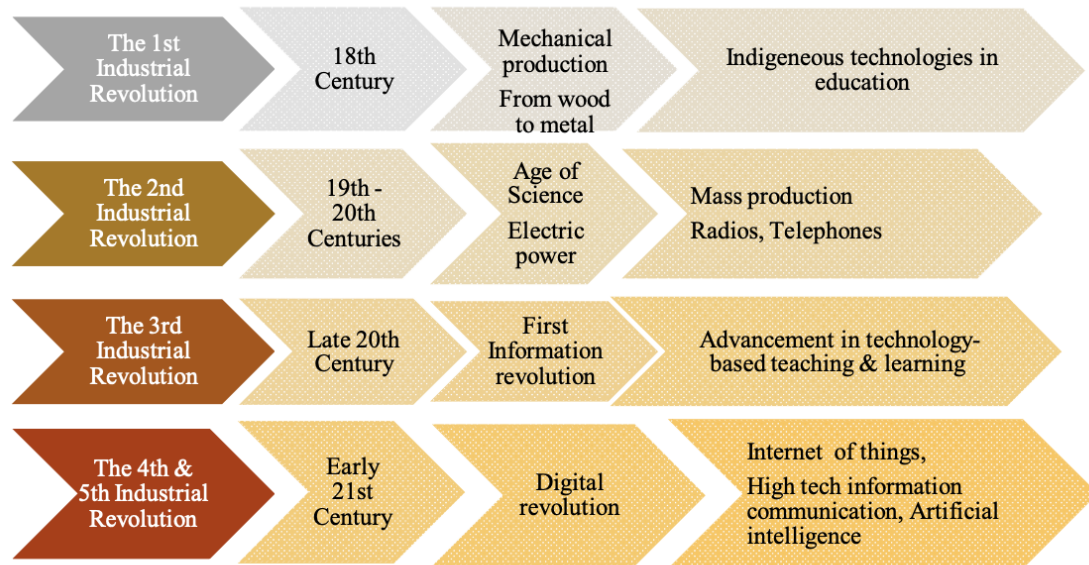


Figure 1. History of Technology-Based Teaching and Learning (Chikwaka et al., 2024, p. 44)

In the past, educational technology was solely dependent on paper and pencils; however, the turning point of educational technology was the production of steam-driven rotary press in the nineteenth century. As Molenda (2022) stated that this allowed humans to mass production of prints and contributed education by creating artwork, illustrations, and visual materials for education. By the development of technology, new skills and equipment were revealed to conduct diverse tasks. Therefore, audiovisual materials were integrated into the education process. In addition to this, using television to instruct people had a major impact in the 1950s. With the development of televisions, governments decided to create channels for instructional purposes (Reiser, 2001; Yamin, 2019). For these reasons, 1950s were accepted as the establishment of modern computing advancements in learning and teaching as some initial technological tools such as typewriters for teaching arithmetic began to be utilized. Following the gradual improvement of technological tools, the computer era began in nearly all industries in the world. In 1980, first computers were introduced by some brands such as Apple, and personal computers were becoming widespread, then the view of integrating modern technological tools in curriculum and learning gained importance (Romeo, 2008). That being the case, teachers embarked on making use of educational multidimensional learning materials such as educational videos, smartboards, smartphones (Chikwaka et al., 2024). Information Technology (IT) gradually became prominent as

obtaining and disseminating of knowledge through various techniques were constantly implemented in education. It involves transferring the information by gathering and organizing (Hamidi et al., 2011). In addition, ICT enables people to educate themselves by allowing them to learn anytime, anywhere, and accessing remote learning these days. The importance of ICT is not only observed in the learning process but also in professional career. Accordingly, one of the most common reasons of implementing ICT tools in the classroom is making teachers and students familiar with technology and computer literacy to better prepare them for future workplace experiences (Tinio, 2003). Subsequently, basic assisting materials were revealed including visuals, projectors, and presentations. Over the past decade, education has incorporated various types of technological models and theories. Some of the fundamental and theoretical approaches are Technology Acceptance Model (TAM), blended learning, augmented reality (AR). Among these models, TAM dates back to 1980s. TAM model asserts embracing discovering facilitating reliable technological tool ranging from social media to assistant robots and virtual reality (Davis, 1986; Park & Kwon, 2016; Yu, 2020). In addition, AR technology is regarded as a tool for both gamification and communication that can provide interactive environment for students. According to Molnar et al., (2018), AR technologies can create project-based learning surroundings with the help of smartphones and tables which are commonly used in education today. After these developments, accessing technology easily established several technological practice areas such as online learning, computer-assisted learning, and technology-enabled behavioral interventions in education (Escueta et al., 2017).

In this vein, educational technology is considered as a factor that increases students' performance by providing information to be used in real world (Firmin & Genesi, 2013). In today's education, AI has started to be used by many schools. As Tahiru (2021) mentioned that although there are challenges of using AI in education, it provides some opportunities such as engagement, facilitating teachers' work, and assisting evaluation process of student performance.

2.2. Technology in language education

The use of technology has long been within language education. In the first phases of technology integration into language teaching, there were basic tools such as multimedia and audio-lingual materials (Warschauer & Healey, 1998).

Until the end of the twentieth century, some basic technological tools such as radio, mimeograph, videotapes, projector, and computers were used in language education (Nawaila et al., 2020; Vistari et al., 2023). With the developments, blended learning implementations became prevalent in language education which mixed the traditional face-to-face learning with web-based learning and teaching techniques (Sharma, 2010). In these periods, most common terms were CALL (Computer-Assisted Language Learning) and ICT (Li, 2017), and CALL can be defined as utilizing applications of the computer for language instruction (Levy, 1997). In addition to these, history of the development of CALL proceeded gradually. As Warschauer (1996) mentioned that there are four phases of CALL as follows:

- Behavioristic CALL
- Communicative CALL
- Integrative CALL (Multimedia CD-ROM)
- Integrative CALL (Internet)

According to Torat (2000) practice of CALL in language learning serves certain purposes which are divided into six practices: drill and practice, computer as tutor, computer as simulation/problem solving, games on computers, computer as a tool for ELT (English Language Teaching) teachers and learners, internet applications. Moreover, its applications in education were predominantly used by universities and large industries as they were able to afford it; however, producing large amount of computer and spreading personal computers diminished the price of online applications; therefore, CALL became feasible and reachable method in language education during seventies (Higgins, 1983). In the current state of education, implementation of CALL brings both positive and negative aspects to the classroom. As Dina and Ciornei (2013) stated that computers are rich source of information that can assist students' learning, nevertheless, they are lack of considering individuals' cognitive and emotional development, that's why, the role of teacher at this point is crucial.

As for the using ICT in language instruction, integration of ICT tools into language education has a long historical trajectory, dating back to fifteenth century when Gutenberg's print press with movable type enabled distribution of text materials. Since then, there has been gradual increase in the development of technology, and technological tools and applications became sophisticated with effortless dissemination of knowledge (Chambers et al., 2004). However, increasing the importance of using technological tools in language learning occurred in twenty first century (Nawaila et al., 2020). Subsequently, integration of internet in language education allowed to access big amount of data both written and spoken, and these opportunities were benefitted by numerous educational institutions. In addition to these, these sources have gradually improved, and they have been replaced by machine-learning applications these days. For instance, AI systems have been assisting both learning and teachers by providing feedback, translation, learning activities, interactive content for the lesson (Bown, 2012; Lim et al., 2023; Creely, 2024).

2.3. The framework of Technological Pedagogical Content Knowledge (TPACK)

The advancement of technology has led to the widespread use of technological tools across diverse sectors. Notably, the incorporation of innovations in education domain has emerged the necessity for teachers to develop technology-related competencies. As a result, the TPACK model revealed and defined the technological, content and pedagogical competencies of teachers. The TPACK model traces its origin to the concept of Pedagogical Content Knowledge (PCK) developed by Shulman (1986). Shulman (1987) developed PCK model by synthesizing pedagogy and content knowledge, which emphasized that teachers should not only have pedagogical knowledge but also have the necessary qualifications for their content. However, with the development of technology, the technological repertoire became a significant core focus in education (Pierson, 2001). Upon interaction of technology and pedagogical content knowledge, the framework was expanded by highlighting the integration of technological proficiency into pedagogical knowledge (Pierson, 2001). Koehler and Mishra (2014) defined TPCK (Technology-Supported Pedagogical Knowledge) with pedagogy and content knowledge. However, Mishra and Koehler (2006) developed the TPCK model to make the integration of technology with pedagogy and content knowledge dimensions, and the model evolved to a more updated and effective version. In addition, along with the development of the TPACK model, its scale was developed by Schmidt et al.

(2009) to measure the knowledge levels of teachers for this model. With subsequent advancements in TPACK, various areas embarked on focusing on the model, and the scope of the TPACK model was diversified such as TPACK-W (Technological Pedagogical Content Knowledge-Web) and AI-TPACK developed (Zhou et al., 2017; Ning et al., 2024).

2.4. TPACK dimensions

The TPACK model consists of three main categories: Technology Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). From the interaction of these three main categories with each other, Technological Pedagogical Content Knowledge (TPACK), Technological Content Knowledge (TCK), and Pedagogical Content Knowledge (PCK) sub-dimensions emerged (Mishra & Koehler, 2006). As a result of this interaction, Technological Pedagogical Field Knowledge is revealed, as shown in Figure 2.

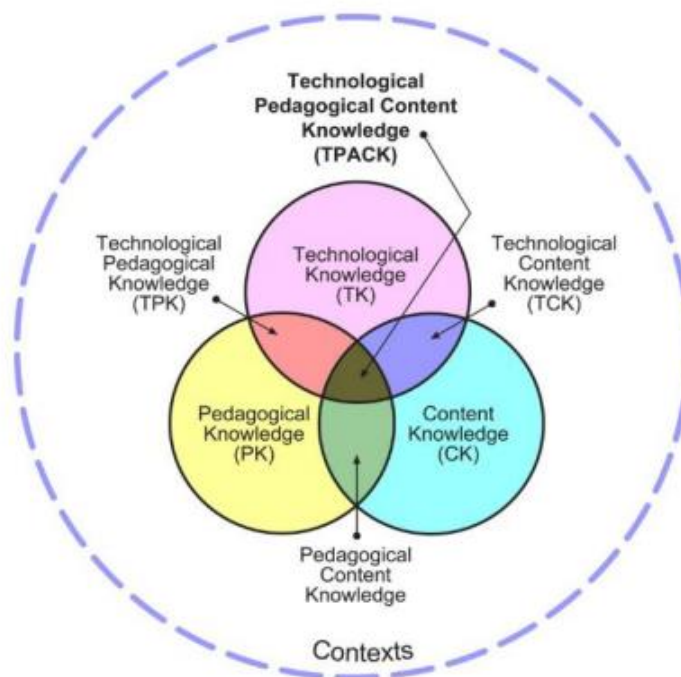


Figure 2. TPACK Framework and its dimensions (Koehler & Mishra, 2009, p.63)

2.5. Technological Knowledge (TK)

As Mishra et al. (2013) mentioned that technological knowledge, one of the dimensions of TPACK is related to Information Technology Fluency (FITness), as defined by the Information Technology Literacy Committee of the National Research Council. The concept of FITness defined by the council covers not only digital literacy but also understanding information technology at a level that will apply it in everyday life (NRC, 1999). In this context, technological knowledge emphasizes having knowledge about various technological tools such as computers, mobile devices, digital video, and software applications (Koehler & Mishra, 2008; Schmidt et al., 2009). Furthermore, technological knowledge is also defined as the capacity of individuals to achieve diverse tasks utilizing their technological knowledge and to adapt to their daily works. (Mishra et al., 2013). Compared to other dimensions, technological knowledge is more open to change and renews itself (Sarıçoban et al., 2019). Therefore, it is a requirement for teachers to know how to integrate technology with education (Martin et al., 2018). However, since the use of technology in language education is increasing more and more, it is necessary to train teachers who are adequately equipped with technology knowledge (Kessler & Hubbard, 2017).

2.6. Pedagogical Knowledge (PK)

Koehler and Misra (2009) explained pedagogical knowledge as a dimension that includes lesson planning, classroom management, methods and techniques, which are general competencies of teachers for the teaching process. At this point, teachers with deep knowledge of pedagogy understand how students structure their knowledge, so pedagogical knowledge covers cognitive, social and developmental processes, theories and how to apply them in the classroom (Koehler et al., 2013). Therefore, teachers with sufficient pedagogical knowledge can evaluate the learning processes of students by selecting and applying the appropriate methods, techniques and materials to be used in the classroom. In addition, teachers possessing sufficient pedagogical knowledge can evaluate the processes before the lesson, as well as analyze the processes during the lesson which enables them to deal with

classroom management problems or use appropriate strategies against difficulties that may arise in learning (Mishra & Koehler, 2008).

2.7. Content Knowledge (CK)

Content knowledge is the field-specific domain that is relevant to the subject to be learned or taught (Koehler et al., 2013). In addition, Shulman (1986) mentioned that content knowledge includes theories, ideas, organizational frameworks, established practices and approaches. In this line, content knowledge covers teachers' knowledge about their domain. Therefore, it is an important teacher qualification since it affects the transfer and learning of the target subject (Kleickmann et al., 2013). Teachers should have knowledge about the subject they are going to teach as well as how this subject is different from other disciplines (Öz, 2015). Deficiencies in content knowledge negatively affect providing students with an effective learning experience and the effective transfer of the subject to be taught (Kehler & Mishra, 2008). Therefore, teachers should have the knowledge required by their discipline. For this reason, it is important to have a good degree of field knowledge as teachers are the first source of students (Shulman, 1987).

2.8. Technological Pedagogical Knowledge (TPK)

Teachers should improve themselves in technology, pedagogy and content components and keep them up to date. However, although these components reflect a field of information within themselves, they also have overlapping sides. One of them is technological pedagogical knowledge which reflects the teachers' ability to use certain technological tools in the teaching process (Mishra and Koehler, 2006). To improve the knowledge of technological pedagogy, it requires a deep knowledge of technology and analyzing the impact of this technology on the teaching processes (Koehler et al., 2013). For example, it is the knowledge domain of being able to evaluate how technological material to be used in the classroom can motivate learning. At this point, Koehler et al. (2013) drew attention to the different uses of technology and explained the ability to adapt technology to different situations, and they emphasized that understanding the possibilities provided by technology

and how they can be used differently according to dynamic context and objectives are important principles of TPK. In this context, since education and technology are integrated, it is an important competence to be able to evaluate the impact of technology on educational processes. In this regard, Koçoğlu (2009) emphasized the importance of developing teachers' abilities to use technology in different pedagogical purposes.

2.9. Technological Content Knowledge (TCK)

Technological content knowledge emerges from the combined application of technological knowledge and content knowledge (Cox, 2008). Mishra and Koehler (2006) defined technological content knowledge as teachers' competencies to utilize certain technological tools related to their disciplines and lesson topics. In addition, technological content knowledge is defined as the ability to choose the technological tools that best support the subject area (Harris & Hofer, 2011). Mishra et al. (2009) emphasized that content shapes the use of technology, and technology also develops understanding about current field-specific information. In this context, it is necessary for teachers to be aware of the technological tools that can best convey the subject area, and to be able to evaluate how these tools will reflect this subject area in the classroom before the lesson and to choose appropriate technological tools. Therefore, understanding the impact of technology in classroom applications is important to develop technological tools suitable for education (Koehler et al., 2013).

2.10. Pedagogical Content Knowledge (PCK)

Pedagogical content knowledge is the interaction of the techniques used in the teaching process with domain knowledge (Shulman, 1986). In this context, Koehler et al. (2013) explained that there are factors that are the basis of teaching such as curriculum, pedagogy that promote learning within the scope of PCK. As in other dimensions, attention is drawn to the decision-making evaluation competencies applied by the teacher in teaching in pedagogical field knowledge. In this regard, Mishra and Koehler (2007) explained pedagogical content knowledge in the form of which strategies are appropriate to be applied within the scope of the subject to be taught and having the ability to adapt field-related

knowledge to create a better teaching environment. Similarly, Shulman (1987) defined it as being able to present certain topics, to understand, to overcome problems that may be encountered in education, to be able to organize, to adapt the interests and abilities of different students to the specified topic.

2.11. Technological Pedagogical Content Knowledge (TPACK)

The sub-dimensions of TPACK are forms of detailed fields that arises from the interaction of content, pedagogy and technology with each other, and the TPACK model differs from its individual sub-dimensions in terms of using technology and pedagogical techniques at the same time (Koehler et al., 2013). For this reason, TPACK encompasses a different dimension from its other sub-dimensions and emphasizes the dynamic reflection of each dimension within the classroom. Therefore, content, pedagogical and technological knowledge are of equal importance in order to provide a meaningful learning experience in the context of the TPACK model (Wang et al., 2024). The use of technology in education still has an important place. Therefore, the TPACK is a model for integrating education and technology, and the focus should be on the TPACK model for effective teaching (Santos & Castro, 2021). For this reason, the TPACK model, which explains essential teacher competencies for the use of technology, draws attention to the fact that teachers who provide an effective teaching experience must also be competent in technology, pedagogy and content knowledge and be able to apply it in the current classroom environment.

2.12. TPACK and language education

The emergence of the TPACK model stems from the PCK developed by Shulman (1986). Koehler and Mishra (2005) developed upon the model by integrating technology dimension, and it was formalized as TPACK framework. Then, its assessment scale was created to measure the TPACK levels of teachers. The TPACK model has been the subject of many studies, and new structures have been integrated into the TPACK. Since language education comprises utilization of technological devices, this phenomenon resulted in elevation of research in language teaching field. Accordingly, in the study conducted by Archambault

and Crippen (2009) in the USA, it was found that teachers' PK and CK levels were high; however, their knowledge levels were low for the technology dimension. In addition, Fathi and Yousefifard (2019) observed that while students perceived their teachers as highly proficient in pedagogy and content, they mentioned that technology knowledge was relatively weaker.

According to the findings of a study conducted by Solak and Çakır (2014), male pre-service English language teachers had higher TPACK levels, and there was no significant relationship with academic achievement. Similarly, another study conducted to determine the TPACK levels of pre-service teachers showed that teachers had high levels in TPACK sub-dimensions excluding technological ones (Farhadi & Öztürk, 2023). On the other hand, several studies were conducted to enhance the competencies of teachers by addressing insufficient TPACK levels or technology knowledge. In another study, ICT training was applied to increase the TPACK levels of teachers before starting to teach in real classroom, and positive results were obtained about their TPACK level after their perceptions were received at the end of the training (Chai et al., 2010; Koh, 2019; Valtonen et al., 2015).

In addition to research on teachers' TPACK levels, new structures about the TPACK framework were also investigated. As an example, new TPACK dimensions and scales with technology content such as TPCK-W (Technological Pedagogical Domain Knowledge-Web) and ICT-TPACK were developed (Kadioğlu-Akbulut et al., 2020; Lee & Tsai, 2010). In addition, there were some field-specific frameworks that were designed. For instance, the TPACK-EFL (TPACK- English as a Foreign Language) scale developed by Başer (2015) emerged. Similarly, with the widespread use of AI applications in education, TPACK has been extended by interaction of AI and TPACK framework. The AI-TPACK scale developed by Ning et al. (2024) is used to determine both teachers' field knowledge and pedagogical knowledge, as well as their knowledge about AI applications in the classroom.

2.13. Artificial Intelligence (AI)

The term AI was first used by John MacCarthy in 1955 (McCharty et al., 2006). AI is defined as a program that performs certain tasks by imitating human intelligence (Mitchell, 2019). In addition, Wang and Sun (2020) explained the definition of AI, which has been shaped over the years, as a program that learns from experiences and has an adaptation feature. In

this line, AI has been considered as an interdisciplinary field that comprises art, science, engineering, and psychology (Whitby, 2009). On a broader account, AI can be categorized into various categories including reasoning, programming, data mining, and theory of computation (Oke, 2008). In addition, AI, which is defined as a sub-branch of machine learning, is considered among the most common technological tools today (Minh et al., 2022). Various versions of these tools have appeared, and examples of these include machine learning, natural language processing, and robotic tools (Mondal, 2021). AI tools have started to be used in different sectors and have enabled important developments today (Duan et al., 2019). In this context, AI has gained popularity and started to be used in diverse industries.

2.14. AI and education

The use of AI in education has witnessed continuous developments since its emergence about thirty years ago as shown in Figure 3 (Randhawa, 2020). The association of AI with education has gained momentum with the development of intelligent education systems (Hwang, 2003). In the last 25 years, the field of Artificial Intelligence in Education (AIED) took big steps. As Roll & Wylie (2016) mentioned that AIED made successful improvements in the last two decades, and not only technological tool but also theoretical contributions related to technological were also developed.

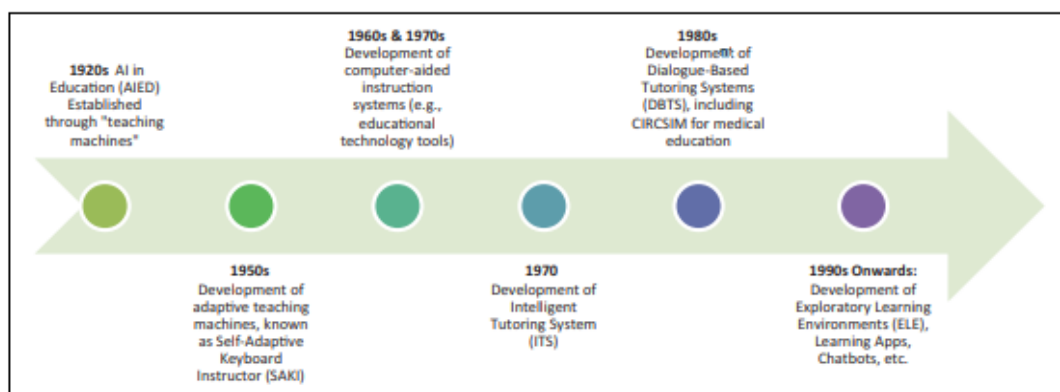


Figure 3. Timeline of AI in Education (Randhawa, 2020, p. 20)

As a current example, ChatGPT Edu was designed as an extension of ChatGPT in 2024 (OpenAI, 2024). ChatGPT was tested at different higher education institutions such as Edu Oxford and Arizona Universities, and it provided support on personalized learning, evaluation and feedback (OpenAI, 2024). In the field of education, AI introduced new opportunities in establishing a more effective form of education (Baker, 2021). Current research on how AI is used in education continues by accepting that it has positive effects on educational processes (Hwang et al., 2020). Hwang (2020) defined AI as an effective tool that reveals new models, technological developments and instructional tools in education. For this reason, various artificial intelligence tools have been used in the field of education to create technology-supported learning environments and to perform different tasks in the educational process (Chen et al., 2020).

Chui et al. (2023) stated that the AI tools used in education are classified under four headings as learning, teaching, management and evaluation. As a result of AI-supported education process, especially the personalized teaching has emerged as a key advantage (Bhutoria, 2022). In accordance with this, Zhai et al. (2021) emphasized that AI can track their academic success, appropriate tasks, and constructive feedback. In addition, Chiu et al. (2023) drew attention to the use of AI in the development of activities implemented in the teaching process; however, considering the research conducted on feedback content, it was stated that AI is still weak in providing sufficient context-specific personalized feedback that students need. In addition, the advantages and disadvantageous situations of AI from the teachers' point of views were examined. At this point, it was observed that AI contributes to teaching processes in terms of lesson planning, facilitating implementation and alleviating teachers' work. On the other hand, its limitations have been detected in terms of understanding and adapting to certain teaching situations (Çelik et al., 2022). For time-management, it has been suggested that AI tools make teachers' work easier because they can create complex tasks to be implemented on paper (Chassignol et al., 2018). In addition, challenges in ethical aspects were detected which also revealed the area of ethics pedagogy (Brenstein & Howard, 2021). In this context, it can be harmful for cognitive development of the users since it can present what is wanted in a short time, and the user doesn't have to think and analyze to create an output (Bu, 2022). Similarly, mentioned that main ethical concerns regarding AI are privacy and autonomy as these two have potential damage in many aspects such as creativity, decision-making, and monitoring online activity (Adel et al., 2024). That being the case, AI assisted education can disrupt the learning and

development of student autonomy, learning approaches, classroom interactions and pedagogical roles (Han et al., 2023).

2.15. AI and language education

AI applications have gained popularity in language education by assisting teachers and students. Although AI tools have become widespread in the last years, they were used and researched a long time ago. Goda et al. (2014) conducted a study by using ELIZA, which is an old form of AI, and found that students' cognitive skills for complementing speaking tasks were improved. With the development of novel and improved tools, AI became a material which enhances the learning process not only in classroom but also in extramural learning activities. In this vein, according to Liu et al. (2022), when fifth-year students practiced reading activities by using AI chatbots as an out-of-class tool, their reading proficiency enhanced through discussion about readings provided by AI chatbots. As for the impact on writing skills, AI-assisted learning processes were analyzed and revealed that significant improvement both in writing skills and in motivation were observed (Song & Song, 2023). In this line, Zhou (2020) emphasized that AI-based self-learning platforms were useful for developing listening skills as they evaluated the performance of students and gave them suggestions at the end of activities. As Solak (2024) mentioned that AI was regarded as useful by language teachers and students. When the general impact of AI is considered, its advantages outweigh the disadvantages, and it was revealed that AI technology would be frequently utilized in language education in the future.

The studies on AI have been the focus of the educational studies in the last years. There have been many domain-specific studies. Therefore, the effects of AI in language education have been studied in both quantitative and qualitative research. Firstly, teachers' perspectives on AI tools were investigated, and when the relevant literature is analyzed, it was observed that there are some overlaps in terms of teachers, who are from different education levels. Teachers' perspectives on implementing AI tools in the classroom included diverse points of views. Considering the limitations such as ethical issues and obtaining personalized outputs, it was emphasized that it should be used by considering the profile of stakeholders or teaching context. Moreover, teachers should have competence on using AI applications. Despite the urgent implications obtained from the studies, most of the teachers mentioned

that they have lack of confidence and competence to acquire desired outcomes from AI applications (Pokrivcakova, 2019; Ulla et al., 2023; Alharbi & Khalil, 2023; Santiana et al., 2023; Moorhouse, 2024;). To this end, the lack of confidence in using AI tools promoted the studies related to providing AI education to teachers and analyzing the outputs of the AI instruction in terms of both emotional and professional aspects. In this context, in the study conducted by Moourhouse et al. (2024), with the help of in-service training related to Generative AI (GenAI) in language education, teachers gained improvement in pedagogical and technological competence in their pre- and follow up interviews after they took 11-week course aimed at developing teachers' AI competence. In this line, controversial perspectives were observed in using AI in language education. In some studies, the focused aspect was training EFL teachers and observing their improvement. However, at local level, studies or practical interventions have not been sufficient. As İçen (2022) emphasized that educational awareness in Türkiye should be raised toward using AI.

2.16. AI-TPACK (Artificial Intelligence-Technological Pedagogical Content Knowledge)

AI technology has been regarded as different from other traditional technologies in terms of affecting learning and influencing teaching methods. Additionally, it has been suggested that it should be integrated with technology-based models (Ning et al., 2024). Therefore, Ning et al. (2024) revealed the AI-TPACK framework and developed the AI-TPACK scale to measure teachers' competencies related to both AI and the TPACK domains. As shown in Figure 4, AI-TPACK model emerged from the dynamic interaction of content knowledge, pedagogical knowledge and knowledge of artificial intelligence technologies. In addition, the framework created a particular domain to the teaching of certain subjects utilizing AI technology.

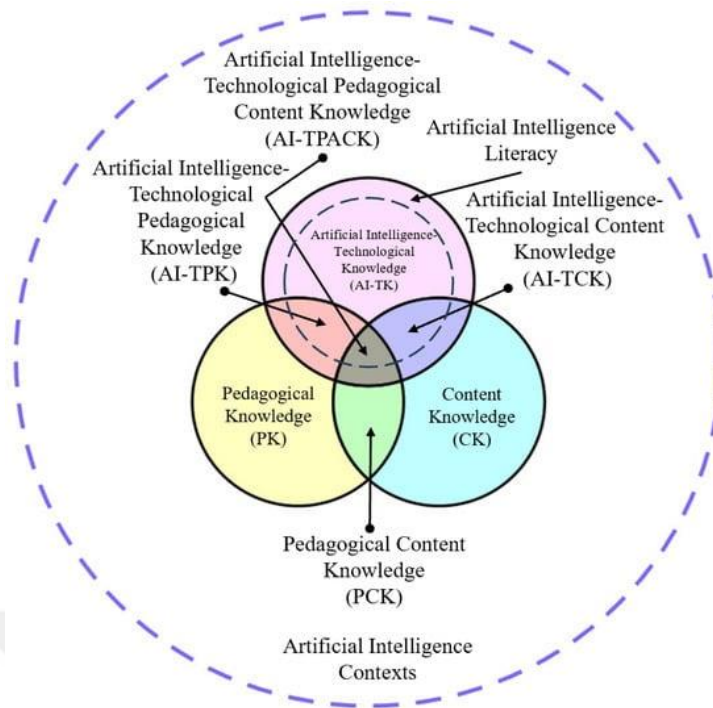


Figure 4. AI-TPACK Structural Diagram (Ning et al., 2024, p. 5)

2.17. Teacher self-efficacy

According to the definition of Bandura (1995), self-efficacy is conceptualized as the degree to which teachers believe or trust their abilities to improve students' learning. However, teacher self-efficacy is also defined as teachers' self-beliefs and judgment in achieving the desired results in diverse situations such as students' learning problems, being unmotivated, or ensuring student participation (Tschannen-Moran and Hoy, 2001). In addition, teacher self-efficacy is correlated with classroom management and students' interests in the classroom (Friedman & Kass, 2002). In this context, teachers with high self-efficacy are defined as those who can take risks, cope with difficulties in the classroom and perform complex tasks effectively (Vannatta & Fordham, 2004). Teacher self-efficacy is the subject of many studies in the field of education. In these studies, it is associated with the factors of teachers' commitment to their profession, interest in using new methods, positive behavior, and ability to use strategies for student problems (Evans & Tribble, 1986; Guskey, 1988; Woolfok et al., 1990). Accordingly, teachers with high self-efficacy can plan the lesson effectively and apply appropriate methods and techniques (Kiremit, 2006).

Ashton and Webb (1986) defined teachers with high self-efficacy as teachers who demonstrate their abilities in the field of education and can provide effective learning experience. On the other hand, teachers with low self-efficacy were defined as teachers who exhibit a traditional approach rather than a humanistic approach that takes care of student characteristics in the classroom and cannot support students to focus on the given task (Mojavezi & Tamiz, 2012; Raoofi et al., 2012). At this point, as stated by Tschannen-Moran and Hoy (2001), student motivation, behavior, and academic achievement are influenced by the teacher's self-efficacy perception. Due to all these factors, it is important for teachers to have positive perceptions of their self-efficacy to support students' learning. In addition, in recent years, teaching self-efficacy has been mentioned together with the use of AI. At this point, Yang et al. (2024) have stated that the use of AI shapes the self-efficacy of English teachers today and provides more effective teaching. In this context, teachers' self-efficacy perceptions have been associated with new teacher competencies today compared to the past. As a result, AI is considered as an important factor, and its supportive effect on self-efficacy is seen more clearly.

2.18. Teacher self-efficacy and language education

Bandura (1995) defined teacher self-efficacy by associating it with teachers' belief in themselves and their abilities to overcome difficulties encountered in the teaching process or to perform any task. Tschannen-Moran and Hoy (2001) explained teacher self-efficacy as the level of successfully coping with difficult situations faced by teachers. The self-efficacy levels of teachers are important competencies in terms of providing effective learning experiences in the teaching process. In this regard, Vannatta and Fordham (2004) explained teachers with high self-efficacy as the teachers who do not reduce students' motivation in difficult situations and believe in themselves while performing complex and challenging tasks. On the other hand, teachers with low self-efficacy are explained as incapable of attaching importance to the progress made by their students in the teaching process and making efforts to cope with difficult situations (Küçükylmaz & Duban, 2006). For these reasons, teacher self-efficacy has been considered an important competence and has been examined in many studies in the field of English teaching.

English teachers' self-efficacy perceptions related to various variables including teaching experience, age, and English language skills have been included in the studies investigating teacher self-efficacy in various language teaching contexts. In this line, Liu et al (2023) examined the self-efficacy perceptions of English teachers and found that teachers had a self-efficacy perception from intermediate to a high level. Moradkhani and Haghi (2017) observed the self-efficacy of English teachers in private and public schools in Iran and found that English teachers' self-efficacy perceptions in private schools were higher. Other studies focusing on teacher self-efficacy revealed that the perception of self-efficacy affects academic motivation, learning, and achievement (Schunk, 1995). Accordingly, English teachers' self-efficacy perceptions in Canada were observed from various demographic variables such as teaching experience and English language level, and it was revealed that English language level and teaching experience had an effect on self-efficacy (Karas & Faez, 2021). Furthermore, English teachers who were experienced and less experienced, were applied to a vocational training program to develop their self-efficacy levels, and it was found that experienced teachers showed improvement in the field of classroom management when applying innovative teaching strategies (Zonoubi et al., 2017). Similarly, Yasin et al., (2022) stated that English teachers with higher curriculum literacy knowledge have higher self-efficacy levels which was also associated with experience in the teaching profession. Furthermore, in a study aimed at improving the professional self-efficacy perceptions of English teachers, it was demonstrated that skills and competencies obtained from previous professional experiences positively affect the professional self-efficacy of teachers (Karimova et al., 2020). Additionally, Phan and Locke (2015) investigated the source of English teachers' self-efficacy and revealed their psychological and emotional states as an important source of self-efficacy. On the other hand, out-of-class readiness were regarded as the predictor of pre-service teachers' self-efficacy since readiness enables them to handle challenging classroom situations (İnceçay & Dollar, 2012). Moreover, in terms of the pre-service period, it was revealed that the behavior of mentor teacher is a significant factor that enhances the self-esteem of English language teachers as it builds a sense of professional development (Egel, 2009). Biçer (2023) also examined the self-efficacy perceptions of English teachers according to age, gender, language level being taught and professional satisfaction variables and revealed that there is a positive relationship between self-efficacy and professional satisfaction. In general, the self-efficacy construct has been commonly researched with the contents of psychological state, well-being, and professional

development of English language teachers, and it was mentioned that these variables are direct predictors of their self-efficacy perceptions (Sevimel & Subaşı, 2018; Zhang et al., 2023; Liu et al., 2023; Wang et al., 2024)

2.19. Teacher self-efficacy and TPACK in language education

Teacher self-efficacy and TPACK models have been focus of attention in the last decade. A great deal of the studies have been conducted separately in different language learning domains. However, their mutual investigation in the studies increased after the previous century when versatile technological tools emerged in education. In this line, Putry et al., (2022) stated that having self-motivation toward classroom implementations was a crucial prompt for language teachers in terms of developing themselves in different domain-specific frameworks such as TPACK. In addition, having technology knowledge has similar effects on teachers' self-efficacy and motivation. According to Dinçer et al. (2024), positive effects were observed in confidence levels of EFL educators as they integrated technological tools in their teaching, and they had positive perspectives on incorporating technology in their teaching. At this point, as language teaching includes audio, visual, and verbal elements, the close relationship between being able to utilize technology and teacher self-efficacy has been observed in language teaching process. In this line, although some teachers have difficulty in using technological content-based materials, TPACK competency has a positive relationship with teachers' self-efficacy, and it was also mentioned that technology-based interventions in teaching process have positive impact on teachers' self-efficacy.

When the relevant literature was examined, it was found that the technology dimension of TPACK was renewed, and the technological competence of teachers in the field of education was not sufficient since new complex technological tools have been developed and integrated into education. In current education, the development of AI has started to be used in education. Nevertheless, AI is new and the integration of it with the TPACK model to study the perceptions of AI-related competence in the field of education is a developing research area. Therefore, there is a considerable information gap in the relevant literature on this issue. In addition, although there are studies examining TPACK and teacher self-efficacy, there are not sufficient studies involving newly developed AI-TPACK and teacher self-efficacy. In this line, gaining knowledge about the relationship between AI-TPACK and

teacher self-efficacy can provide opportunities to improve these competencies of teachers. In addition, research examining teacher self-efficacy has mostly focused on in-service. Therefore, there is not enough information about the self-efficacy perceptions of pre-service teachers. The current study is aimed at filling the research gaps in the relevant literature and enhancing the opportunities of pre-service teachers to gain diverse professional and contemporary skills and competencies.



CHAPTER III

METHODOLOGY

This chapter presents the methodological procedures of the study. Accordingly, the approach, design of the study, setting and participants' profile, sampling strategy, data collection instruments and procedures were explained with all the details. Lastly, how the obtained data was analyzed regarding AI-TPACK, and teacher self-efficacy were expressed. In this line, the research questions in Table 1 were sought to answer. Accordingly, RQ1.1. and RQ1.2. are related to the levels of AI-TPACK sub-dimensions and self-efficacy. Additionally, RQ1.3. and RQ1.4. are about variance values based on demographic variables. Lastly, RQ1.5. is about the prediction values, and RQ1.6. is about the perceptions of pre-service English language teachers.

To this end, in research design part, design and aim of the study are explained. Setting and participants section includes information related to research area, participant selection, and demographic information about the participants. Subsequent subtitle describes the data collection instruments, and data collection procedure scrutinizes how the data collection process was conducted to reach estimated number of participants. Lastly, data analysis section gives information about how the collected data were analyzed to answer the research questions depending on the scope of study.

Table 1
The Methodology

Research Questions	Data Analysis	Relevant Items in the Data Collection Tools
1. What are pre-service English language teachers' perceptions of AI-TPACK and teacher self-efficacy, how do these vary across demographic variables, and how do teachers interpret the role of AI-TPACK in shaping their self-efficacy beliefs?		
1.1 What is the level of pre-service English teachers' perceptions of the AI-TPACK?	Descriptive Analysis	The 39 items in the Artificial Intelligence Technological Pedagogical Content Knowledge (AI-TPACK) Scale (See Appendix A) developed by Ning et al. (2024)
1.2. What is the level of pre-service English language teachers' perceptions of their teacher self-efficacy?		All 24 items in the Teachers' Sense of Efficacy Scale (See Appendix B) developed by Tschannen-Moran and Hoy (2024)
1.3. Do pre-service English language teachers' levels of AI-TPACK vary according to demographic variables, i.e., gender, GPA, and teaching experience?	Independent Samples T-test	All items in AI-TPACK Scale and demographic questions about (gender, GPA, and teaching experience)
1.4. Do pre-service English language teachers' perceptions of their teacher self-efficacy vary according to demographic variables, i.e., gender, GPA, and teaching experience?		All items in Teachers' Sense of Efficacy Scale and demographic questions about (gender, GPA, and teaching experience)
1.5. Do any of the sub-dimensions of the AI-TPACK model (CK, PK, PCK, AI-TK, AI-TCK, AI-TPK, AI-TPACK) predict pre-service English language teachers' self-efficacy perceptions?	Multiple Linear Regression	39 items in AI-TPACK Scale and 24 items in Teachers' Sense of Efficacy Scale
1.6. What do the pre-service English language teachers think about the role of AI-TPACK sub-dimensions in their self-efficacy perceptions?	Creswell's (2007) data analysis spiral	5 open-ended focus group discussion questions (See Appendix C).

3.1. Research design

As Stake (2010) emphasized that inquiring human related fields, including education, contributes to our understanding of how the societal issues work within their context-specific environment. Thus, examining current topics and developing better understanding about them is crucial to provide better educational opportunities. Therefore, comprehensive information about the general situation of new models together with grounded ones as well as particular investigation from a personal perspective can reveal the objective nature of research domain (Creswell, 2019). In this vein, this study applies sequential explanatory design as a part of mixed-method research approach to address both means of research domain. Accordingly, implementation of mixed-method approach includes combining of various ways of data collection and synthesizing them to reach clear and assembled conclusions (Dörnyei, 2007). In accordance with this, quantitative approach contains collecting information that can be converted to numeric data and asking specific questions about survey topic to make broader inferences about the group being studied (Holton & Burnett, 2005). Since this approach relies on numerical data, it provides extensive information about the obtained data that is relevant to the variables of the study (Babbie, 2010, Maheshwari, 2017, Muijs, 2004). Therefore, mixed-method research includes making use of two different means of data collection by combining their advantages (Creswell, 2015). In this line, correlational research, which includes investigating the relationship between variables, is applied in the quantitative part of the study by considering the aims of the study. This research design is utilized to make statistical descriptions about the degree of relationship between two or more constructs that are measured by collecting numeric or descriptive data (Creswell & Guetterman, 2019). In this vein, Creswell (2002) mentioned that correlational research design aims to reveal the relationship between variables. To this end, quantitative data was examined to reveal the correlation between AI-TPACK levels and self-efficacy perceptions of fourth-year pre-service English language teachers.

In addition to these, qualitative research approach goes beyond the numbers and closed-ended items in terms of providing detailed perspectives about the phenomenon with the help of contextual interpretation (Denzin & Lincoln, 2002). In this line, case study method was implemented in the qualitative part of the study since it was defined as an empirical investigation of a contemporary phenomenon in authentic context (Yin, 2003). In addition, Creswell (2007) expressed case study as a qualitative approach which enables the researcher

to conduct in-depth data collection about multiple bounded systems. Therefore, as qualitative part included revealing the perceptions of the participants, and they were specific based on their educational contexts, the qualitative data was collected in the scope of case study research design was applied.

3.2. The sample and setting

This study was conducted in foreign language education department of universities during the 2024-2025 academic year. The population of the study consists of fourth-year pre-service English language teachers. According to Higher Education Council's English Language Teaching Program, fourth-year pre-service English language teachers take the Information Technologies (IT) course in their first year and the Instructional Technology course in the second year (YÖK, n.d.). In the third year, they take both practical and theory-based courses, including Teaching English to Young Learners I and II, Teaching English Language Skills I and II, and Teaching English Language through Literature I and II. In the fall semester of their fourth-year, English teachers take internship course Teaching Practices I (YÖK, n.d.). In this context, Sevime and Subaşı (2018) emphasized that having theoretical and practical experience in the field of English education allows pre-service teachers to reflect on their professional perceptions more accurately. Therefore, fourth-year pre-service English language teachers constitute an appropriate sampling group for the present study as they have completed technology-related courses, and possess required techniques, approaches, experience in real classroom under the supervision of a mentor.

In addition to this, pre-service English language teachers were invited to participate in study on voluntary basis. Additionally, Dörneyi (2007) suggested that the sampling size typically ranges from 1% to 10% of the whole population in quantitative research, and ensuring a normal distribution by considering enough number of participants were also mentioned as essential requirements. Therefore, the estimated number was determined depending on the number of fourth-year pre-service English language teachers who enrolled in ELT department in 2019 as it was the most recent and accessible year in the database of YÖKATLAS. Additionally, GPower analysis, with %95 power at .05 significance level, indicated that the target sample size was minimum 88 participants. In this line, the estimated sample size was determined as 300 participants, which was also above the %5 of the whole

population, which is nearly 3000 pre-service teachers, and exceeds the minimum necessary sample size by ensuring sufficient statistical power.

In addition, convenience sampling method was applied since it allows accessing to sampling group readily (Creswell, 2002). Moreover, Cohen et al. (2002) mentioned that convenience sampling provides the opportunity to reach the estimated number of data acquired from a big sample size. Thus, convenience sampling is applied to reach a large number of participants. Additionally, since collecting data through a single method, such as Google Forms, would have been time-consuming in terms of reaching estimated sample size, each university that granted permission for data collection was visited. Therefore, universities that authorized data collection were selected as research sites. In this line, data were collected from 4 different regions in Türkiye. In this line, the data were collected from the following universities: 19 Mayıs University, Bolu Abant İzzet Baysal University, Sakarya University, Amasya University in Black Sea Region; Muğla Sıtkı Koçman University, Pamukkale University in Aegean Region; Başkent University in Central Anatolian Region; Uludağ University in Marmara Region. Through convenience sampling method, 303 fourth-year pre-service English language teachers participated in the research over a two-month-period. The demographic information about the participants is presented in Table 2.

Table 2
Demographics of the Participants

Variables		f	Valid Percent	Cumulative Percent
Gender	Female	189	62.4	62.4
	Male	114	37.6	100.0
GPA	Under 2.00	3	1.0	1.0
	2.00-2.49	22	7.3	8.3
	2.50-2.99	98	32.3	40.6
	3.00-3.49	126	41.6	82.2
	3.50-4.00	54	17.8	100.0
Teaching Experience	Yes	190	62.7	62.7
	No	113	37.3	100.0
Total		303	100.0	

Table 2 illustrates the distribution of gender, indicating that 62.4% ($n= 189$) of the participants were female, and 37.6% ($n= 114$) were male. This totals 303 participants. In addition to these, the distribution of the participants depending on their grade point average was 1.0% ($n= 3$) for under 2.00, 8.3% ($n= 22$) for 2.00-2.49, 32.3% ($n= 98$) for 2.50-2.99, 41.6% ($n= 126$) for 3.00-3.49, and 17.8% ($n= 54$) for 3.50-4.00. In this vein, it could be explained that most of the pre-service English language teachers' current grade point average ranges from 3.00 to 3.49 while the least of them have under 2.00 grade point average.

As for the distribution of participants regarding teaching experience, the results were as follows: 62.7% ($n= 190$) for answer "Yes", and 37.3% ($n= 113$) for "No". Accordingly, the number of fourth-year pre-service English language teachers who have teaching experience excluding internship was larger than the ones who have teaching experience solely during internship.

When it comes to focus group discussions, the participants were selected based on their voluntary participation and accessibility since reaching willing participants for the focus group discussions was challenging due to limited availability. In addition, the distribution of the gender of the participants was 76.9% ($n=10$) for females and 23.1% ($n=3$) for males.

3.3. Data collection tool and procedures

Data was collected through two different scales and focus group discussions including four sections in total. The first section of data collection is composed of four items including demographic information about gender, GPA, teaching experience, and university being studied. Second section includes “Artificial Intelligence-Technological Pedagogical Content Knowledge (AI-TPACK) scale developed by Ning et al., 2024. The scale involves 5-point Likert type items from *Strongly Non-Conformant* to *Strongly Conformant*. In the third section, “Teachers’ Sense of Efficacy Scale” developed by Tschannen-Moran and Woolfolk Hoy (2001) was implemented. The instrument includes 9-point Likert type items from *Nothing* to *A Great Deal*. Lastly, focus group discussion was applied in the fourth part of data collection. The necessary permissions for using the AI-TPACK and TSES scales were acquired from the developers (See Appendix D & E).

AI-TPACK scale, which was implemented in the second section of data collection, involves forty items and seven sub-dimensions: Content Knowledge (CK), Pedagogical Knowledge (PK), Artificial Intelligence-Technological Knowledge, Pedagogical Content Knowledge (PCK), Artificial Intelligence-Technological Content Knowledge (AI-TCK), Artificial Intelligence- Technological Pedagogical Knowledge (AI-TPK), and Artificial Intelligence-Technological Pedagogical Content Knowledge (AI-TPACK). AI-TPACK scale, which was derived from TPACK scale developed by Mishra and Koehler (2006), was extended by AI dimension.

Based on the reliability measurements of the scale, the internal consistency of the instrument was analyzed, and it was found .95, which means that it is above .70 that is satisfactory level for Social Sciences (Drost, 2011). In addition, as illustrated in Table 3, the reliability score for the factors of the scale was found as .80 for CK, .83 for PK, .91 for AI-TK, .80 for PCK, .94 for AI-TCK, .94 for AI-TPK. Furthermore, confirmatory factor analysis was assessed, and it was found that factor loadings are above the 0.5 level, which indicated high

correspondence between variables (Ning et al., 2024). In addition, according to Ning et al. (2024), exploratory factor analysis (EFA) values were investigated, and three items (CK-6, AI-TK-6, and AI-TPACK-6) were removed from the analysis since these items were with factor loadings below the 0.50 threshold level. After item removal, EFA values revealed a seven-factor structure explaining the 75.916% of the total variance, which indicated strong explanatory power (Ning et al., 2024). In the structural equation model, factor loading ranged from 0.519 to 0.913, which are all above the accepted threshold level of 0.40 (Ning et al., 2024). Overall, the model also demonstrated satisfactory internal validity in the representation of teachers’ AI-TPACK (Ning et al., 2024).

Table 3
Reliability Statistics for AI-TPACK

	Cronbach’s Alpha	Number of Items
CK	.80	5
PK	.83	6
AI-TK	.91	5
PCK	.80	6
AI-TCK	.94	6
AI-TPK	.94	6
AI-TPACK	.93	5
AI-TPACK Total	.95	39

In the third section, “Teachers’ Sense of Self Efficacy Scale” developed by Tschannen-Moran and Woolfok Hoy (2006) was implemented. The scale has two forms, which are short and long. Tschannen-Moran and Woolfok Hoy (2006) emphasized that there is not distinct difference between long and short form, and it was also recommended that both long and short form can be used with pre-service teachers. However, in data collection process, long

form of the scale was implemented as it is more detailed and suggested for pre-service teachers by the developers of the scale. The scale has three correlated factors which are Efficacy in Student Engagement, Efficacy in Instructional Strategies, Efficacy in Classroom Management, and Teachers' Sense of Efficacy Scale (TSES). The scale involves 9-point Likert type items from *Nothing* to *A Great Deal*.

In addition to these, internal consistency of the instrument was measured, and it was found that Cronbach's Alpha level for overall Teachers' Self Efficacy (TSES) is .94. This level indicated that reliability levels are above .70 which is satisfactory level for Social Sciences (Drost, 2011).

Table 4
Reliability Statistics for TSES

	Mean	SD	Cronbach's Alpha
TSES	7.1	.94	.94

The last part of the data collection includes focus group discussions consisting of five open-ended questions developed by the researcher under the guidance of supervisor. During the development of data collection tool, the researcher reviewed the relevant literature to determine principles, procedures and creation of first draft consisting of five questions related to participants' perceptions of implementation of AI in classroom and its relationship with their sense of efficacy. After the creation of 5 open-ended questions, expert revisions were acquired from 3 experts to evaluate the qualitative data collection instrument. Based on the evaluations, expert agreement ratio was calculated to indicate the level of consensus regarding appropriateness of each item. In this line, Q1, Q2, and Q4 had 1.00 value, which showed that no further revision was necessary. However, Q3 (0.33) and Q5 (0.67) was revised according to recommendations.

In data collection process, the quantitative data were collected through both Google Forms and face-to-face mode to reach the estimated number of participants. In order to reach participants, the researcher contacted English Language Teaching (ELT) Departments of fourteen universities via e-mail, telephone, and acquaintances of academics by giving information about the purpose and approval of research ethics committee. Among these

universities, On Dokuz Mayıs University, Bolu Abant İzzet Baysal University, Sakarya University, Amasya University in the Black Sea Region, Muğla Sıtkı Koçman University, Pamukkale University in Aegean Region, Başkent University in Central Anatolia Region, Uludağ University in Marmara Region provided permission to collect data. After obtaining the required permission, the scheduling process was determined via online correspondence depending on the availability of lesson hours when majority of the participants were accessible. The data were collected during scheduled lesson hours. Prior to data collection, necessary information about ethical issues, confidentiality, overall data collection tools, key terms in items, and the definition of terms in the items were informed. However, some of the participants were not reached due to absenteeism. Therefore, Google Form document of the data collection tool was shared with the responsible person or academic who could distribute the data collection tool as Google Form document to the absent participants.

In the last phase of the data collection process, focus group discussions were implemented with fourth-year pre-service English language teachers in Sakarya University. In particular, due to challenges in finding participants who voluntarily had willingness to participate in field-specific discussion, organizing mini-focus group discussions were more appropriate for qualitative data collection (Krueger, 1994; Morgan, 1977; Wilkinson; 2004). Additionally, as there was a minor group size for qualitative part, and the participants hesitated to attend a discussion with other participants, mini-focus group discussion sessions were designed (Kamberelis & Dimitriadis, 2005). For these reasons, qualitative data were collected through online meeting sessions. Participants were contacted via telephone and acquaintances. Before implementing focus group discussions, the protocol was arranged to conduct the flow of discussion efficiently (See Appendix F). According to the information and guidelines in discussion protocol, each necessary information about guidelines, ethical issues, and confidentiality were shared with participants.

3.4. Data analysis

In accordance with data collection procedure, the data analysis was carried out through several steps to address the research questions in detail. The Statistical Package for Social Sciences (SPSS) 24.0 was used for data analysis. The results obtained from instruments indicated that none of the items negatively affected reliability statistics; therefore, no items

were excluded from the data collection tools. Accordingly, in the first phase of data analysis, descriptive statistics of the responses of fourth-year pre-service English language teachers were examined to investigate participants' demographic information (gender, GPA, and teaching experience).

In addition, data collection tools were examined to reveal whether the data obtained from both scales had normal distribution. In this regard, the Kolmogorov-Smirnov test was conducted, and the result indicated that the normality test was verified since significance value was higher than 0.05 threshold level, and D value indicated very small deviation from the theoretical normal distribution ($D = 0.046$; $p > 0.20$). Thus, both AI-TPACK and TSES scales demonstrated appropriate normality values. In addition, the Skewness and Kurtosis values were examined, and the Skewness results were found to be $-.25$ for AI-TPACK scale and $-.15$ for Teachers' Sense of Efficacy scale. Regarding Kurtosis results, the values were $-.37$ for AI-TPACK scale and $-.32$ for Teachers' Sense of Efficacy (TSES) scale. While the results for both scales indicated that the distribution is slightly deviated from normal distribution, the results of Skewness and Kurtosis are considered within acceptable range of -1 and $+1$ (George, 2010; Field, 2013). Furthermore, the results included several outliers affecting the normal distribution of the data. To ensure normality, the outliers were removed from the dataset. Consequently, the results confirmed the normal distribution.

In addition, demographic information (gender, GPA, teaching experience) was analyzed by using descriptive statistics. To address the RQ1.1. and RQ1.2., the descriptive statistics of answers were examined. In this context, minimum and maximum scores, standard deviation, and means scores were calculated.

As the data obtained from two data collection tools were found to be normally distributed, parametric tests were conducted. Accordingly, Independent Samples T-Test and One-Way ANOVA tests were performed to determine the extent to which demographic variables vary across sub-dimensions of AI-TPACK and TSES scales. Additionally, Tukey's HSD was also applied as a post-hoc analysis to investigate pairwise comparisons, as it is a commonly implemented and accurate post-hoc test (Nanda et al., 2021). Moreover, Pearson Correlation test was conducted to examine the relationship between the AI-TPACK and TSES frameworks. In this regard, each sub-dimension and total score of AI-TPACK framework's relationship with TSES was detected. Herein, determination was revealed to examine the variable impact on the other ones. In the last part of quantitative data analysis, multiple linear data analysis was performed. Correlation coefficients between each sub-dimension of AI-

TPACK and TSES were found at the first phase, then multicollinearity coefficients, which were Variance Inflation Factor (VIF), Tolerance Value, and Condition Index (CI) were revealed. Lastly, predictor values (R^2 and ΔR^2) were calculated.

As for the qualitative part, Creswell's (2007) data analysis spiral was implemented. This analysis method follows a cyclical process in which the analysis was enabled to move through multiple steps rather than linear process. The process is conducted with describing, classifying, interpreting and reflecting based on the themes. Then, checking the representation of insights and interpretations to deepen understanding by revisiting earlier steps with an iterative approach were implemented (Cresswell, 2007). The spiral is presented in Figure 5 (Creswell, 2007, p. 151).

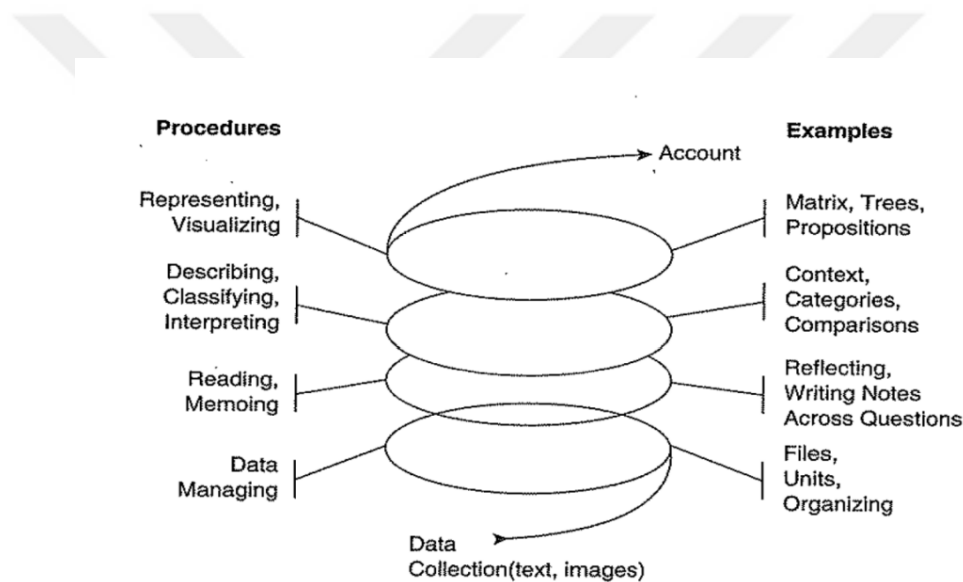


Figure 5. Data analysis spiral (Creswell, 2007, p. 151)

CHAPTER IV

FINDINGS

The present study aimed to reveal fourth-year pre-service English language teachers' AI-TPACK and teacher self-efficacy levels. Additionally, the study also examines the influence of demographic variables (gender, GPA, and teaching experience). Accordingly, by analyzing the correlation between AI-TPACK and TSES frameworks, to what extent AI-TPACK and its sub-dimensions (content knowledge, pedagogical knowledge, Pedagogical content knowledge, artificial intelligence-technological knowledge, artificial intelligence-technological pedagogical content knowledge, artificial intelligence-technological content knowledge, and artificial intelligence-technological pedagogical content knowledge) predict teacher self-efficacy was sought to answer.

4.1. Descriptive statistics based upon the AI-TPACK and teachers' sense of efficacy levels of fourth-year pre-service English language teachers

As a result of implementing descriptive analysis, results acquired from AI-TPACK and TSES scales to answer RQ1.1. and RQ1.2. were obtained. In this vein, relevant findings are demonstrated in this section which scrutinizes the descriptive statistics of AI-TPACK sub-dimensions and TSES levels.

4.1.1. Analysis based upon the AI-TPACK levels of fourth-year pre-service English language teachers

In this section, the findings on RQ1.1., which investigates the level of pre-service English language teachers' perceptions of AI-TPACK, were presented. Table 5 shows fourth-year pre-service teachers' average score for AI-TPACK levels ($M=153.25$, $SD=17.25$). In addition, the sub-dimension with the highest mean score was pedagogical knowledge (PK) ($M=25.06$, $SD=3.02$) whereas content knowledge (CK) had lowest score ($M=20.29$,

SD=2.39). According to the findings, it could be deduced that fourth-year pre-service English language teachers believed that they have medium level of knowledge in integrating AI-related technologies in their classroom practices. Additionally, results showed that they had sufficient knowledge in pedagogical knowledge such as implementing teaching methods and strategies: however, participants' perceptions indicated that they have not good command of knowledge in content knowledge related to their fields.

Table 5
Descriptive Statistics for AI-TPACK and Sub-dimensions

	N	Minimum	Maximum	SD	Mean
CK	303	12.00	25.00	2.39402	20.2937
PK	303	17.00	30.00	3.05251	25.0066
AI-TK	303	7.00	25.00	3.29830	20.5347
PCK	303	13.00	30.00	2.88396	24.7294
AI-TCK	303	10.00	30.00	4.07432	22.8746
AI-TPK	303	6.00	30.00	4.28217	23.5809
AI-TPACK	303	5.00	25.00	3.49041	20.4092
AI-TPACK TOTAL	303	105.00	190.00	17.25931	153.2508

4.1.2. Analysis based upon the self-efficacy levels of fourth-year pre-service English language teachers

Table 6 demonstrates the results of RQ1.2. which is the fourth-year English language pre-service teachers' sense of efficacy levels. In this line, it is presented that English pre-service language teachers had high level of self-efficacy (M=161.92, SD=22.812). From the findings demonstrated in Table 6, it could be concluded that fourth-year pre-service English language

teachers' sense of efficacy levels demonstrated sufficient level of confidence in their teaching. In addition, it was also indicated that they generally feel confident about their overall teaching tasks such as engaging students, managing classrooms, and implementing effective teaching strategies.

Table 6
Descriptive Statistics for Teachers' Sense of Efficacy (TSES)

	N	Minimum	Maximum	SD	Mean
Teachers' Sense of Efficacy	303	99.00	211.00	22.81283	161.9274

4.2. Analysis of fourth-year pre-service English language teachers' AI-TPACK, its sub-dimensions, and teacher sense of efficacy levels based on demographic variables

This part of the findings presents answers for RQ1.3. and RQ1.4. related to two frameworks. Therefore, the extent of variance between frameworks, which are AI-TPACK and Teacher Sense of Efficacy, and demographic variables (gender, GPA, teaching experience).

4.2.1. The variance of fourth-year pre-service English language teachers' AI-TPACK and its sub-dimensions levels regarding gender

In Table 7, AI-TPACK levels of pre-service English language teachers based on gender variable, which is the sub-section of RQ1.3., was analyzed to answer. In this line, it presents the Independent Samples T-Test values. According to the table, no significant variance was observed for females (M=153.69, SD= 17.23) and males (M=152.51, SD=17.34) at the $p < .05$ level in terms of AI-TPACK total. Furthermore, similar results were obtained from the sub-dimensions of AI-TPACK framework. In this line, there was no significant variance between two genders at the $p < .05$ significance level in terms of Content Knowledge (CK), Pedagogical Knowledge (PK), Artificial Intelligence-Technological Knowledge (AI-TK),

Pedagogical Content Knowledge (PCK), Artificial Intelligence-Technological Content Knowledge (AI-TCK), Artificial Intelligence-Technological Pedagogical Knowledge (AI-TPK), and Artificial Intelligence-Technological Pedagogical Content Knowledge (AI-TPACK).

Table 7
Independent Samples T-Test Results of AI-TPACK Regarding Gender

		N	M	SD	t	df	Sig.
CK	Female	189	20.4974	2.37591	1.1911	301	.647
	Male	114	19.9561	2.39613			
PK	Female	189	25.3333	3.02999	2.419	301	.318
	Male	114	24.4649	3.02550			
AI-TK	Female	189	20.2275	3.27565	-2.097	301	.951
	Male	189	21.0439	3.28685			
PCK	Female	189	25.0529	2.79676	2.502	301	.844
	Male	114	24.1930	2.95655			
AI-TCK	Female	189	22.7619	3.93855	-.606	301	.286
	Male	114	23.0614	4.30123			
AI-TPK	Female	189	23.5132	4.08631	-.343	301	.317
	Male	114	23.6930	4.60497			
AI-TPACK	Female	189	20.5556	3.32677	.912	301	.496
	Male	114	20.1667	3.74855			
AI-TPACK TOTAL	Female	189	153.6931	17.23650	.573	301	.995
	Male	114	152.5175	17.34819			

4.2.2. The variance of fourth-year pre-service English language teachers' AI-TPACK and its sub-dimensions levels regarding GPA

Table 8 demonstrates to what extent fourth-year pre-service English teachers' AI-TPACK and its sub-dimensions' levels vary according to their GPA scores. Namely, the answer of RQ1.3. was presented in this section.

According to Table 8, the results of One-Way ANOVA analysis test values showed that there was no significant variance at the $p < .05$ level in the AI-TPACK total levels of participants regarding GPA scores [$F_{(4, 298)} = 1.686, p = .153$]. In addition, there was no significant variance observed at the $p < .05$ level in sub-dimensions AI-TK, PCK, AI-TCK, and AI-TPACK. On the other hand, the AI-TPK sub-dimension is at the edge significance level; therefore, Games Howell test detected no significant variance among the GPA score of participants.

Upon the analysis of other sub-dimensions, there was statistically significant variance at the $p < .05$ level in Content Knowledge (CK) in terms of GPA scores of participants [$F_{(4, 298)} = 4.018, p < .05$], in Pedagogical Knowledge (PK) [$F_{(4, 298)} = 2.952, p = 0.20$]. In addition, Tukey's HSD test was conducted to identify group differences. Following ANOVA analysis, the group difference values were significant in between groups 3.50-4.00 ($M=20.66, SD=2.37$) and under 2.00 ($M=16.33, SD=5.85$) for Content Knowledge (CK) factor. In addition, variance was detected among groups 3.50-4.00 ($M=26.09, SD=2.74$), Under 2.00 ($M=24.00, SD=4.35$) and 2.00-2.49 ($M=24.00, SD=3.02$) for Pedagogical Knowledge (PK) factor. Namely, the participants having GPA between 3.50-4.00 scores had higher CK and PK levels than ones having Under 2.00 and 2.00-2.49 scores.

Table 8

One-Way ANOVA Test Results regarding AI-TPACK (Grade Point Average)

		N	M	SD	df	F	Sig.
CK	Under 2.00	3	16,3333	5,85947	4-298	4.018	.003
	2.00-2.49	22	19,1364	2,51274			
	2.50-2.99	98	20,2347	2,39329			
	3.00-3.49	126	20,4762	2,16042			
	3.50-4.00	54	20,6667	2,38707			
PK	Under 2.00	3	24,0000	4,35890	4-298	2.952	.020
	2.00-2.49	22	24,0000	3,02372			
	2.50-2.99	98	24,5816	3,10279			
	3.00-3.49	126	25,0714	3,02570			
	3.50-4.00	54	26,0926	2,74218			
AI-TK	Under 2.00	3	21,0000	3,60555	4-298	1.507	.378
	2.00-2.49	22	21,3636	3,10982			
	2.50-2.99	98	20,1735	3,43129			
	3.00-3.49	126	20,8175	3,41151			
	3.50-4.00	54	20,1667	2,79319			
PCK	Under 2.00	3	23,3333	2,88675	4-298	1.358	.249
	2.00-2.49	22	24,1364	2,98082			
	2.50-2.99	98	24,3673	3,05748			
	3.00-3.49	126	24,9365	2,88928			
	3.50-4.00	54	25,2222	2,43145			
AI-TCK	Under 2.00	3	19,6667	7,50555	4-298	1.313	.265
	2.00-2.49	22	23,9091	5,04182			
	2.50-2.99	98	22,4082	4,43937			
	3.00-3.49	126	23,1667	3,84240			
	3.50-4.00	54	22,7963	3,14060			

AI-TPK	Under 2.00	3	17,3333	10,26320	4-298	2.398	.050
	2.00-2.49	22	24,1818	4,56317			
	2.50-2.99	98	23,0408	4,81818			
	3.00-3.49	126	23,9206	3,88763			
	3.50-4.00	54	23,8704	3,29692			
AI-TPACK	Under 2.00	3	21,3333	3,21455	4-298	1.991	.096
	2.00-2.49	22	19,8182	4,50012			
	2.50-2.99	98	19,7347	4,50012			
	3.00-3.49	126	20,6905	3,12785			
	3.50-4.00	54	21,1667	2,11687			
AI-TPACK TOTAL	Under 2.00	3	139.00	32,18695	4-298	1.686	.153
	2.00-2.49	22	152.50	20,14649			
	2.50-2.99	98	150.50	18,75521			
	3.00-3.49	126	154.82	16,57230			
	3.50-4.00	54	155.66	12,97603			
Total		303	36,96664	5,68902	4-298		

4.2.3. The variance of fourth-year pre-service English language teachers' AI-TPACK and its sub-dimensions levels regarding teaching experience

Table 9 shows the findings of pre-service English language teachers' AI-TPACK levels based on teaching experience variable which was included in RQ1.3. as a sub-section. Accordingly, Independent Samples T-Test values were demonstrated based on the answers about previous teaching experience excluding internship. As shown on the table, there was no significant variance at the $p < .05$ level in AI-TPACK total score for "Yes" ($M=155.78$, $SD=16.82$) and "No" ($M=148.89$, $SD=17.21$); $t(301)= 3.357$, $p= .816$. In addition, similar results were acquired in the sub-dimensions. In this vein, there was no significant variance at the $p < .05$ level in Content Knowledge (CK), Pedagogical Knowledge (PK), Artificial Intelligence-Technological Knowledge (AI-TK), Pedagogical Content Knowledge (PCK),

Artificial Intelligence-Technological Content Knowledge (AI-TCK), Artificial Intelligence Technological Pedagogical Knowledge (AI-TPK), Artificial Intelligence Technological Pedagogical Content Knowledge (AI-TPACK).

Table 9
Independent Samples T-Test Results of AI-TPACK regarding Teaching Experience

		N	M	SD	t	df	Sig.
CK	Yes	190	20.5895	2.31167	2.777	301	.595
	No	113	19.7965	2.345735			
PK	Yes	190	25.4947	2.90911	3.618	301	.502
	No	113	24.1858	3.12407			
AI-TK	Yes	190	20.8421	3.11954	2.050	301	.475
	No	113	20.0177	3.53296			
PCK	Yes	190	25.05211	3.00433	2.383	301	.075
	No	113	24.2389	2.60930			
AI-TCK	Yes	190	23.3737	3.92419	2.748	301	.767
	No	113	22.0354	4.20019			
AI-TPK	Yes	190	24.0211	4.15819	2.304	301	.796
	No	113	22.8407	4.40285			
AI-TPACK	Yes	190	20.7368	3.60984	2.194	301	.130
	No	113	19.8584	3.22066			
AI-TPACK TOTAL	Yes	190	155.7895	16.82427	3.357	301	.816
	No	113	148.9823	17.21191			

4.2.4. The variance of fourth-year pre-service English language teachers' sense of efficacy levels regarding gender

According to the results acquired from the TSES scale, Table 10 presents the investigation of self-efficacy levels of pre-service English language teachers based on gender that is related to RQ1.4. as a sub-section. In this context, it can be concluded from the Table 10 that fourth-year English language pre-service teachers' sense of efficacy levels did not have significant variance at the $p < .05$ level for females ($M=162.72$, $SD=24.44$) and males ($M=160.60$, $SD=21.76$); $t(301) = .797$, $p = .152$.

Table 10
Independent Samples T-Test Results of Teachers' Sense of Efficacy Regarding Gender

		N	M	SD	t	df	Sig.
Teachers' Sense of Efficacy	Female	189	162.7249	23.44070	.797	301	.152
	Male	114	160.6053	21.76895			

4.2.5. The variance of fourth-year pre-service English language teachers' sense of efficacy levels regarding GPA

Table 11 demonstrates to what extent fourth-year pre-service English language teachers' TSES levels vary according to their GPA scores. Namely, the answer of RQ1.4. were presented in this section.

The results of the One-Way ANOVA test for Teachers' Sense of Efficacy were demonstrated. According to Table 11, there was no statistically significant variance at the $p < .05$ level of participants [$F_{(4, 298)} = 1.250$, $p = .290$].

Table 11

One-Way ANOVA Test Results regarding Teachers' Sense of Efficacy (Grade Point Average)

		N	M	SD	df	F	Sig.
Teachers' Sense of Efficacy	Under 2.00	3	139,0000	13,00000	4-298	1.250	.290
	2.00-2.49	22	155.9545	20,27778			
	2.50-2.99	98	162,4592	23,64391			
	3.00-3.49	126	162,3095	23,08297			
	3.50-4.00	54	163.7778	21,61993			
Total		303	156.7002	20,324918			

4.2.6. The variance of fourth-year pre-service English language teachers' sense of efficacy levels regarding teaching experience

Table 12

Independent Samples T-Test Results of Teachers' Sense of Efficacy Regarding Teaching Experience

		N	M	SD	t	df	Sig.
Teachers' Sense of Efficacy	Yes	190	164.1105	22.76806	2.180	301	.427
	No	113	158.2566	22.51300			

In this section, self-efficacy levels of pre-service English language teachers regarding teaching experience variable, which is included in RQ1.4., were investigated. Table 12 demonstrates Independent Samples T-Test values on the demographic item about previous teaching experience excluding internship. As illustrated on the table, there was no significant variance at the $p < .05$ level in Teachers' Sense of Efficacy (TSES) for answer "Yes" ($M=164.11$, $SD=22.76$) and "No" ($M=158.25$, $SD=22.51$); $t(301)= 2.180$, $p= .427$.

4.3. Regression analysis of the AI-TPACK and teachers' sense of efficacy perceptions of fourth-year pre-service English language teachers

Table 13

Standard Deviation, Mean and Correlation Analysis of AI-TPACK Sub-Dimensions and Teachers' Sense of Efficacy (TSES)

	Mean	Standard Error (SE)	TSES r
1. TSES	161.927	22.81	
2. CK	20.29	2.39	.515*
3. PK	25.00	3.05	.510*
4. AI-TK	20.53	3.29	.124*
5. PCK	24.72	2.88	.470*
6. AI-TCK	22.87	4.07	.280*
7. AI-TPK	23.58	4.28	.197*
8. AI-TPACK	20.40	3.49	.236*

*p<0.05

Table 13 demonstrates correlation coefficients between each sub-dimension of AI-TPACK and TSES models. It was deduced from the findings that there was a statistically significant relationship between each sub-dimension of AI-TPACK and teachers' self-efficacy. When the correlation coefficients were investigated, CK had the highest moderate positive correlation ($r = .515$; $p < .05$). In this vein, it could be observed that high CK levels of fourth-year pre-service English language teachers positively affect their self-efficacy levels. In addition, moderate positive correlation was obtained from PK ($r = .510$, $p < .05$) and PCK ($r = .470$; $p < .05$). In this line, an increase in PK and PCK levels corresponds to positive effect on self-efficacy levels of pre-service English language teachers. Lastly, weak positive correlation was obtained from AI-TK ($r = .124$; $p < .05$), AI-TCK ($r = .280$; $p < .05$), AI-TPK ($r = .197$; $p < .05$), and AI-TPACK ($r = .236$; $p < .05$). Increase in these sub-dimensions can lead

to a slight raise in self-efficacy levels of pre-service English language teachers. In addition, correlations coefficients of the independent with dependent variables are statistically significant, and relationship between sub-dimensions of AI-TPACK is not higher than 0.80 which proves that the data set is appropriate for multiple regression analysis (Büyüköztürk, 2006).

Table 14
Multicollinearity Coefficient

	Variance Inflation Factor (VIF)	Tolerance Value	Condition Index (CI)
CK	1.665	.601	13.786
PK	2.00	.500	27.163
AI-TK	2.475	.404	32.107
PCK	2.021	.495	35.461
AI-TCK	3.590	.279	36.048
AI-TPK	3.712	.269	38.048
AI-TPACK	3.302	.303	41.746

Table 14 demonstrates Variance inflation factor (VIF), Tolerance value and Condition index (CI) values. It is expected that VIF value should be below 10, tolerance value should exceed 0.10, and CI value should remain under 30 (Hair Jr et al., 2021; Tabachnick et al., 2001). In this line, it was revealed that there is no problem regarding multiple regression analysis. On the other hand, CI values of AI-TK, PCK, AI-TCK, AI-TPK, and AI-TPACK exceeded the expected value, which was 30. However, VIF and Tolerance values are appropriate for multiple regression analysis, and they are the core values for conducting multiple regression (Miles & Shevlin, 2000). Therefore, VIF and Tolerance values revealed that the data set were appropriate for multiple regression analysis.

Table 15

Predictor Values of AI-TPACK Sub-dimensions on Teachers' Sense of Efficacy

Predictor Variances	B	Standard Error (SE)	t	R	R²	ΔR²	F	Sig.
Constant	35.798	11.456	3.125	.599	.359	.344	23.607	.002
CK	2.710	.573	4.728					.000
PK	1.763	.493	3.579					.000
AI-TK	-.838	.507	-1.652					.100
PCK	1.011	.524	1.928					.055
AI-TCK	1.191	.494	2.410					.017
AI-TPK	-.379	.478	-.791					.429
AI-TPACK	.045	.554	.081					.935

*p<0.05

In this section, the findings on RQ1.5. which investigates the prediction degree of AI-TPACK on self-efficacy perceptions were presented. When Table 15 was investigated, it was observed that the prediction of TSES by AI-TPACK sub-dimensions is statistically significant ($F= 23.607$; $p<0.05$). In this model, independent variables explained approximately 36% ($R^2=.359$) of the dependent variable. In this line, the model, designed to predict Teachers' Sense of Efficacy based on sub-dimensions of AI-TPACK, each sub-dimension was statistically significant except for AI-TK, PCK, AI-TPK, and AI-TPACK. Acquired regression equation as follows;

$$\text{TSES} = 35.798 + 2.710 (\text{CK}) + 1.763 (\text{PK}) + 1.191 (\text{AI-TCK})$$

4.4. Findings on focus group discussions

The qualitative data collected from 13 fourth-year pre-service English language teachers through focus group discussions were analyzed based on Creswell's (2007) data analysis spiral. Accordingly, the findings to answer RQ1.6. are presented below by following the questions given in focus group discussions.

4.4.1. Question 1: How do you evaluate your competence in using AI-based tools in foreign language education?

Table 16

Focus Group Question 1: How do you evaluate your competence in using AI-based tools in foreign language education?

Code	Frequency (N)	Percentage (%)
Sufficient	4	30
Insufficient	9	69

Table 16 presents that %30 of the participants' (n=4) evaluations about their competence in using AI-based tools in foreign language education was sufficient while %69 of them (n=9) defined themselves as insufficient. In this line, participants, who explained themselves as sufficient, associated their competency with their individual effort or interest regarding integrating AI-based tools in language lessons, whereas the pre-service teachers, who defined their competency as insufficient, highlighted lack of formal training related to how to utilize AI-based tools in foreign language classes. According to the Participant 7 (P7), who related his sufficiency with personal interest toward technology, mentioned that *"I think I consider myself as a technology-mediated person. I can confess that my AI skill is sufficient. So, I can say that I am very good at."* On the other hand, Participant 1 (P1), who expressed she is not used to implementing AI-based tools; therefore, she is not good at using them. In the same line, Participant 9 (P9), who stated the reason of training deficiency, said *"I don't know all the AI tools used in foreign language education. I know some of them are useful,*

but I did not get any training on how to use them effectively, so we can do better, but we need education.

4.4.2. Question 2: Have you had any experience in using AI-based tools in foreign language lessons? If so, could you briefly explain your experience?

Table 17

Focus Group Question 2: Have you had any experience in using AI-based tools in foreign language lessons? If so, could you briefly explain your experience?

Code	Frequency	Percentage
Creating Teaching Materials	7	%53
Asking for Feedback	3	%23
Using in Lessons to Practice English	3	%23

According to Table 17, %53 of the participants (n=7) used AI-based tools for creating teaching materials, and % 23 of them (n=3) had experience in asking for feedback, which was received for providing instant feedback to students, error correction, or getting ideas. On the other side, %3 of the participants (n=3) participants used AI-based tools in classroom practices, which demonstrated a minority of the participants integrated AI-based tools in classroom practices by exposing students to use it. Accordingly, Participant 10 (P10) mentioned that she implemented AI-tools for providing input to students such as generating visuals in the classroom. Being on the same vein, Participant 11 (P11) said “*We are working with AI. For example, when I am teaching them place of preposition, they give prompts to draw me picture in which there is a cat on the table, so we are comparing the pictures that they have been provided with the help of their prompts by AI.*” On the other hand, most of the pre-service teachers emphasized lack of in-class engagement with AI-tools. In this line, Participant 12 (P12) mentioned that she had some technology-related classes; however, any teaching practice utilizing AI-based tools was not experienced with students. In addition,

Participant 8 (P8) said “*Last year, in my teaching practice observations, some students used AI while writing an essay. It was my first and last experience. I have zero experience in total.*”

4.4.3. Question 3: Which one/ones of following domains – Content Knowledge, Pedagogical Knowledge, Technological Knowledge – is more prominent in shaping your self-efficacy in foreign language teaching?

Table 18

Focus Group Question 3: Which one/ones of following domains – Content Knowledge, Pedagogical Knowledge, Technological Knowledge –is more prominent in shaping your self-efficacy in foreign language teaching?

Code	Frequency	Percentage
Pedagogical Knowledge	7	%53
Content Knowledge	4	%30
Technological Knowledge	2	%15

Table 18 demonstrates that %53 of the participants (n=7) responded that pedagogical knowledge is more prominent in shaping their self-efficacy in foreign language teaching, and %30 of the participants (n=4) gave prominence to content knowledge. Furthermore, technological knowledge is more prominent for %15 of the participants (n=2).

When it comes to PK, pre-service teachers mentioned that having knowledge relevant to teaching strategies and methods is crucial to providing effective teaching experiences. Accordingly, Participant 2 (P2) said “*I think pedagogical knowledge is the most important for me to foster engagement in class and also adapt the materials according to students’ needs and proficiency levels.*” Moreover, Participant 5 (P5) mentioned that teachers need to know their students, and they have been utilizing their pedagogical knowledge in classroom although there has not been any technological intervention. As for content knowledge, pre-service teachers relied on their domain specific knowledge related to foreign language teaching as it was regarded as the core of their teaching practices. In this line, Participant 4

(P4) said *“The forefront one is content knowledge because I can make sure that my students are able to understand and internalize what I am talking about.”*. Being on the same vein, Participant 10 (P10) stated that being a language teacher necessitates focusing on teaching language otherwise the lesson would be traditional, and she said that she would be insecure without knowing the delivery of the teaching content. When it comes to technological knowledge, teachers emphasized its enhancing and practical usage in teaching and learning process. Accordingly, Participant 3 (P3) said *“I think technological knowledge plays a crucial role because it will boost my confidence in using these tools, and it will be more efficient in terms of material.”* On the other side, it was observed that the recurring reason of pre-service teachers’ neutral perceptions toward technological knowledge was lack of knowledge and experience. In this line, Participant 9 (P9) stated that she had sufficient education on the domains of pedagogy and content; however, she recalled only one technology-related course; therefore, technological knowledge was a lack for her. In addition, Participant 5 (P5) said *“For technological knowledge, I do not have any idea about that it can also be important as well.”*

4.4.4. Question 4: How do you think the role of AI-based tools will evolve in foreign language education and teacher self-efficacy in the upcoming years?

Table 19

Focus Group Question 4: *How do you think the role of AI-based tools will evolve in foreign language education and teacher self-efficacy in the upcoming years?*

Code	Frequency	Percentage
Reducing Teachers’ Workload	4	%30
Enhancing Language Learning	9	%69

According to Table 19, %30 of the participants (n=4) responded that AI-based tools will reduce teachers’ workload in the following years, whereas %69 of the participants (n=9)

perceptions tended to enhance language teaching. Accordingly, Participant 3 P(3) said “I think AI will reduce teachers’ workload because even now we get lots of help from ChatGPT or other AI tools”. Moreover, Participant 7 (P7) stated that “*I think AI will continue to improve making learning more interactive and personalized*”. Even though pre-service teachers touched on promising aspects regarding the future situation of AI-based tools in foreign language education, they also expressed their perceptions with some concerns. In this line, Participant 13 (P13) stated that AI provides advantages such as engaging students; however, over-dependence on it can cause laziness and can hinder creativity.

4.4.5. Question 5: In which areas of foreign language teaching (e.g., speaking, reading, vocabulary learning/grammar, writing, pronunciation, etc.) can AI-based tools be effectively used? How do you explain your self-efficacy in these areas?

Table 20

Focus Group Question 5: *In which areas of foreign language teaching (e.g., speaking, reading, vocabulary learning/grammar, writing, pronunciation, etc.) can AI-based tools be effectively used? How do you explain your self-efficacy in these areas?*

Code	Frequency	Percentage
Speaking Practice	3	%23
Writing Assistance	5	%38
Vocabulary Learning	3	%23
Reading Skills	2	%15

Table 20 demonstrates that %23 of the participants (n=3) responded that AI-based tools can be effectively used in speaking practice, and %5 of the participants (n=5) mentioned that the best profit can be acquired from AI-based tools in writing. Moreover, %23 of the participants (n=3) stated that AI-based tools can be effectively used in vocabulary learning, whereas %15 of the participants (n=2) preferred reading skills that can be effectively practiced with the help of AI-based tools. When it comes to writing assistance, which was the most recurred response during discussions, it could be observed that pre-service teachers associated the

question with their personal experiences as they frequently used writing assistance or error correction which again demonstrated the lack of knowledge and experience in implementing diverse AI-based tools in foreign language education. Accordingly, Participant 13 (P13) mentioned that she and her students used AI for errors correction, and it was perceived as useful at the end of learning process; therefore, AI-based tools can be used effectively in writing. On the other hand, error correction function of AI-based tools was also emphasized for other areas of English language. In this line, Participant 8 (P8) stated AI-based tools can be effective in building vocabulary knowledge, and it can provide correct usage of vocabulary. When the overall responses were observed, it could be understood that pre-service teachers tended to use AI-based tools outside the classroom rather than as an in-class activity due to lack of knowledge and experience related to diverse AI-based tools that can be implemented in foreign language education.

CHAPTER V

DISCUSSION, CONCLUSION, AND SUGGESTIONS

5.1. Discussion of the findings

5.1.1. Discussion on research sub-question 1.1: What is the level of pre-service English language teachers' perceptions of the AI-TPACK model?

Upon analyzing the results of the present study, it was observed that pre-service English language teachers' AI-TPACK levels were slightly above the moderate level. It was an estimated finding since pre-service teachers had insufficient training or experience that can provide positive perceptions on contemporary knowledge domains such as technology-related competencies. Therefore, it was noticed that there was a deficiency of pre-service AI training and insufficient self-confidence in content knowledge in teacher education (Hava & Babayiğit, 2024). In this vein, the findings of the present study were along the same line with the studies from different fields in Türkiye. The studies, which were conducted with both in-service and pre-service teachers, revealed that AI and content knowledge levels of pre-service English language teachers were above the average. Although it represents a significant domain of knowledge among pre-service English language teachers, the desired outcomes related to teacher training to enhance content knowledge and AI utilization have not been completely acquired in actual teaching experiences (Gess-Newsome et al., 2019; Hava & Babayiğit, 2024; Karataş & Ataç, 2024, Luckin et al., 2016).

When the sub-dimensions of the AI-TPACK were examined, it was observed that pre-service English language teachers demonstrated higher levels in PK, PCK, and AI-TPK dimensions compared to remaining the sub-dimensions, unlike the results in the study of Karataş and Ataç (2024) in which pre-service teachers exhibited highest score in AI-TK. However, the results related to AI-TPACK sub-dimensions aligned with the previous research findings indicating that AI-TPACK levels of in-service teachers had the highest score in AI-TPK (Hava & Babayiğit, 2024). Moreover, the findings revealed that pre-service English language teachers possessed good command of PK being in line with the studies (Öz, 2015;

Muhamad & Kiely, 2018; Nazari et al., 2019; Erten, 2022). These studies emphasized that teachers are more prone to rely on their PK, which enables them to overcome challenging situations in real classroom surroundings. That being the case, it was concluded that language teachers feel confident when they establish pedagogical practices such as smooth transitions and student participation. On the other hand, results were mostly incompatible with TPACK-related studies where teachers had higher levels of perceptions of CK and TK (Solak & Çakir, 2014; Ekmekçi, 2018). The results could indicate that when pre-service teachers considered their actual teaching practices, they realized that they did not have sufficient knowledge or self-efficacy about their field-specific knowledge (Kömür, 2010). In addition, inadequate levels of CK levels were obtained from the study of Cesur and Ertaş, (2018), and the reason for low levels of CK can be insufficient teaching experience since their field knowledge was shaped by real classroom experience.

When the AI-related sub-dimensions were investigated, the prominence of pedagogical-based knowledge domains was noticed. Therefore, having a lack of content and AI-related competency among fourth-year pre-service English language teachers pointed several key aspects. In this line, while AI is a contemporary and promising area in language teaching, pre-service teachers prioritize pedagogy and field-specific teaching strategies over AI-related practices. These results can also be expected according to the output of the language teacher training program as it includes very limited technology-related courses. As Sevimel and Subaşı (2018) suggested having constructive perceptions of an area necessitates experience and training. This suggests that they have not developed a completely positive perception of AI-based implementations since it is still unfamiliar content for them. For this reason, they require adequate AI-related professional development to build their beliefs related to AI (Taşçı & Tunaz, 2024). Otherwise, limited comprehension of AI and insufficient competence can hinder the implementation of AI in the classroom, and having inadequate self-efficacy toward using AI can continue in language teaching.

5.1.2. Discussion on research sub-question 1.2.: What is the level of pre-service English language teachers' perceptions of their teacher self-efficacy?

As for RQ1.2., it was revealed that fourth-year pre-service English language teachers had a high level of self-efficacy regarding language teaching practices. To provide a deeper

interpretation, since the items of the TSES scale were related to general teaching practices, pre-service teachers had positive beliefs in their competencies to effectively implement language teaching strategies. Therefore, compatible results were found with AI-TPACK levels of pre-service teachers as pre-service English language teachers had positive perceptions of effective teaching techniques and methods that are related to PK. In this line, it could be concluded that the results of self-efficacy were also relatively compatible with the pedagogical sub-dimensions of AI-TPACK as they also showed high levels in the representation of instructional techniques (PK). Hence, the descriptive findings related to pre-service English language teachers' sense of efficacy levels were in accordance with several studies conducted to examine self-efficacy levels (Kahraman et al., 2013; Demirel & Akkoyunlu, 2017, Nughoro, 2017; Şanal & Üğüten, 2019; Liu et al., 2022). Nevertheless, when the factors that contribute to the improvement of self-efficacy levels of pre-service English language teachers were considered, it was noticed that technological knowledge and experience in technology integration would increase their self-efficacy. Therefore, although pre-service teachers demonstrated high levels of beliefs on their practical implementations, having good command of knowledge in contemporary technological tools was proven to be advantageous for their self-efficacy (Dinçer et al., 2024). In addition, as Leader-Janssen and Rankin-Erickson (2013) stated that there is a highly positive correlation between content knowledge and self-efficacy; therefore, reaching higher levels of self-efficacy necessitates having sufficient knowledge in diverse professional areas.

5.1.3. Discussion on research sub-question 1.3.: Do pre-service English language teachers' levels of AI-TPACK vary according to demographic variables, i.e., gender, GPA, and teaching experience?

To address RQ1.3., the variance values of AI-TPACK and its sub-dimensions according to gender, GPA, and teaching experience were examined. Accordingly, the results related to the demographic variables are discussed below respectively.

When the AI-TPACK levels according to gender were examined, no significant variance was observed between female and male pre-service English language teachers contrary to the studies conducted to investigate AI-TPACK and TPACK levels of pre-service English language teachers based on gender (Rodriguez Moreno et al., 2019; Wang & Xing, 2024;

Karataş & Ataç 2024; Chai et al., 2010; Ekrem & Recep, 2014; Sarıçoban et al., 2019). The previous studies showed that male participants with prior teaching experience had higher scores across sub-dimensions, particularly in AI-TK, PK, CK, and TK. However, several studies demonstrated no significant variance in terms of gender (Koh & Chai, 2011; Horzum, 2013; Atar et al., 2019). These diverse results obtained from the studies could uncover the influence of diverse local foreign language teaching contexts. That being the case, differences in opportunities to get technological training and access could be understood for different parts of Türkiye where the diversity of levels across genders could be eliminated through the dissemination of knowledge and hands-on experience related to technological tools. Furthermore, relevant literature emphasized concerns about the inequity of technological competency development in teacher training programs (Karataş & Ataç, 2024). In this context, the disparity in pre-service teachers' levels highlights further investigation of teacher education programs, technology access and, attitudes towards AI (Jafari, 2023). What's more, especially teacher education programs should provide equal training in AI-related activities in different contexts (Karataş et al., 2024).

In terms of AI-TPACK levels according to GPA, significant variance was detected only in CK, PK, and AI-TPK sub-dimensions. Similar results were observed in several studies conducted to examine TPACK levels of EFL pre-service teachers (Megawati et al., 2020; Oz, 2015). Based on these studies, it could be understood that proficiency in instructional designs, which is closely correlated with GPA scores, have also a relationship with having digital skills (Pehlevan & Ünal, 2023). In this vein, variance in CK, PK, and AI-TPK sub-dimensions according to GPA indicated an interactive relationship among content, pedagogy, and technology knowledge. These knowledge areas can influence one another to develop the skills of pre-service teachers who put emphasis on self-development. In this context, the influence of AI-based pre-service training programs proved that field-related technological practices provided an opportunity to put theory into practice by consolidating and reaching the objectives (Pitura et al., 2025). On the other hand, when the remaining technology-related sub-dimensions of AI-TPACK were considered, it was understood that pre-service English language teachers perceived themselves as incompetent in integrating AI knowledge with content and pedagogy-based competency domains. The reason of this phenomenon can be attributed to the use of technology for basic tasks such as presentations (Campbell & Baroutsis, 2011).

According to the results on the variance in AI-TPACK levels depending on teaching experience, the results related to prior teaching experience showed controversial results with the study of Nazari et al., (2019). In the study, it was revealed that novice teachers had higher levels in TK while experienced teachers had more profound knowledge in PK and CK. In this line, differences in context and opportunities to access technology could influence the levels of novice teachers (Jafari, 2023). When the AI-related sub-dimensions from the findings were examined, it could be interpreted that no variance could exist due to not having any experience in using AI. Accordingly, it was stated by Yue et al., (2024) that demographic variables such as prior AI experience significantly influence perceptions of pre-service EFL teachers. Additionally, the relationship between fundamental technology-related fields such as TPACK and teaching experience was demonstrated by emphasizing that teachers, who are experienced and received professional development, outperformed their peers in technological knowledge (Syamdianita & Cahyono, 2021; Wang et al., 2018; Abubakir & Alshaboul, 2023). Upon the relevant literature, it was noticed that AI-generated material has not been completely comprehended and trusted by pre-service teachers, and planned interventions to develop AI literacy needed to be embraced for professional development (Guggemos & Seufert, 2021).

5.1.4. Discussion on research sub-question 1.4.: Do pre-service English language teachers' perceptions of their teacher self-efficacy vary according to demographic variables, i.e., gender, GPA, and teaching experience?

To answer RQ1.4., the variance values of TSES according to gender, GPA, and teaching experience were analyzed, and no variance was observed across the demographic variables. Accordingly, the results below pertaining to the demographic information are discussed respectively.

When the TSES levels were examined based on gender, it was revealed that there was no variance between female and male pre-service English language teachers contrary to previous studies. These studies stated that female pre-service teachers were more self-efficacious than male ones (Merç, 2015; Huang, 2022; Demirel & Akkoyunlu, 2017; Panadero et al., 2017). This could be correlated with anxiety and self-regulation dimensions in language teaching since they were found to have a relationship with self-efficacy in

teaching, and they were the factors varied across genders (Ghonsooly & Ghanizadeh, 2013). Additionally, gender differences could be emerged from stereotyped professional capabilities since female participants show higher levels in teaching compared to males (Bandura, 1978). However, it was concluded from the results that there was no difference in the levels across gender being in the same line with the findings of several studies in the literature (Tschannen-Moran & Woolfolk Hoy, 2002; Karimvand, 2011; Çubukçu, 2008; Tajeddin & Khodaverdi, 2011). In this line, it was stated in previous studies that although there are various sources of self-efficacy in education, it is not significantly gender oriented. In light of these, diverse findings in different contexts could emphasize the need for an effective training program to enable preservice teachers to enhance their self-efficacy beliefs in the early years of teaching experience (Demirel & Akkoyunlu, 2017, Nugroho, 2017).

When the self-efficacy levels according to GPA scores were examined, it was observed that there was no significant variance across GPA scores, unlike the findings of studies conducted by Ghonsooly et al. (2014), Han et al. (2020), Bandura (1995), Saito (2020), Wang and Sun (2020). Although the findings of the relevant studies were primarily from different contexts, they revealed the correlation between academic success and self-efficacy. As Schunk (1991) asserted that abilities and domain-specific knowledge can indicate an individual's confidence in managing both academic and professional tasks. However, findings of previous studies demonstrated that sources of self-efficacy beliefs can be multifaceted; therefore, various external and internal sources such as personal, contextual, or socio-political can impact their self-efficacy perceptions. (Rashidi & Moghadam, 2014; Von Der Embse et al., 2016).

In addition, according to the results related to teaching experience, it was observed that there was no significant variance in self-efficacy perceptions. Accordingly, when the relevant studies conducted to explore the relationship between teaching practices and self-efficacy levels of both in-service and pre-service EFL teachers were examined, it was indicated that there was a significant relationship between prior teaching experience and self-efficacy (Adamson et al., 2011; Choi & Lee, 2018). Accordingly, it was asserted that teachers can build their self-efficacy perceptions through diverse experiences in their professional environment. Contrary to these, several similar findings were also observed in relevant studies. In this context, it was asserted that participant profiles in different contexts can include various factors that influence self-efficacy perceptions; therefore, according to the findings reached by Moafian and Ghanizadeh (2009) different factors such as affective

factors and self-awareness related to professional development could be more effective than prior teaching experience among pre-service teachers.

5.1.5. Discussion on research sub-question 1.5.: Do any of the sub-dimensions of the AI-TPACK model (CK, PK, PCK, AI-TK, AI-TCK, AI-TPK, AI-TPACK) predict pre-service English language teachers' self-efficacy perceptions?

According to the findings of correlation analysis between sub-dimensions of AI-TPACK and self-efficacy perceptions of pre-service English language teachers, all of the sub-dimensions had positive relationship with self-efficacy perceptions of pre-service teachers, being in the same line with several previous studies conducted to investigate the relationship between TPACK sub-dimensions and AI and teachers' self-efficacy (Cai et al., 2024; Aksoy & Çetinkaya, 2025; Naaz & Khan, 2018). In the relevant literature, AI and TPACK dimensions were separately examined with self-efficacy perceptions of pre-service teachers. Accordingly, having sufficient content knowledge, effectively practicing it in the classroom, and utilizing appropriate technological tools, which also embody TPACK sub-dimensions, build self-efficacy toward language teaching (Aksoy & Çetinkaya, 2025). In addition, studies involving interventions acquired similar results based on the relationship between TPACK and self-efficacy. In this vein, implementing TbI (technology-based lesson) in microteaching has been shown to increase TPACK and self-efficacy levels of pre-service teachers (Muslimin et al., 2022). What is more, AI-based tools' ability to assist teachers in guidance and material development is an enhancing factor for teachers' self-efficacy levels (Huang et al., 2024; Mohammad Ghafouri et al., 2024). The consistency in the correlation results of relevant literature indicates that the interconnection of the research fields encompassing AI, TPACK, and self-efficacy is not an isolated one and contemporary issue.

When the regression values of AI-TPACK sub-dimensions were examined, CK, PK, and AI-TCK sub-dimensions predicted self-efficacy at a significant level which also showed that most of the AI-related sub-dimensions had no significant effect on self-efficacy. Accordingly, it was understood that field-specific and instructional knowledge bases can encourage teachers' beliefs on their teaching practices. In this line, teachers perceive content and pedagogical-related domains as the main sources of their self-efficacy although they have diverse knowledge levels in similar domains (Zakeri & Alavi, 2011). In addition, the

reason of low AI-related knowledge could be a lack of technological readiness to use AI as they perceived AI as an unfamiliar knowledge area, and these perceptions of teachers were affected by psychological and emotional states (Rajapakse et al., 2024). Although AI knowledge is defined as highly important, there is still limited technological establishment in both schools and training programs. In a similar vein, opportunities, which are varied based on different institutional and socioeconomic levels, affect using technology in language education in Türkiye (Aşık et al., 2019; Kaldırım & Tavşanlı, 2021). Therefore, these results emphasized the beneficial effects of TPACK and AI on self-efficacy by addressing that practical actions are necessary to eliminate misconceptions about AI and enable pre-service teachers to gain contemporary skill-development opportunities.

5.1.6. Discussion on research sub-question 1.6.: What do the pre-service English language teachers think about the role of AI-TPACK sub-dimensions in their self-efficacy perceptions?

To acquire a deeper understanding toward pre-service teachers' perceptions about the role of AI-TPACK sub-dimensions on their self-efficacy, qualitative data were collected through focus group discussion sessions. In this line, participants were asked five open-ended questions which are respectively discussed below.

According to Table 16, pre-service teachers were asked for their responses related to their competency toward using AI-based tools in foreign language education. Accordingly, the analysis of the data yielded several crucial findings about revealing pre-service English language teachers' perceptions on their competency related to AI-based tools, and inequity of technological training although the last implication was not the focus of the question. In this line, as shown in Table 16, AI-based competencies were mainly described as insufficient due to lack of knowledge and experience in using AI-based tools in foreign language education. Following the unexpected shift to the online modality during COVID-19, technological applications became widespread; therefore, developed AI-based tools were integrated into education at an unexpected pace. As these tools were penetrated into education suddenly, and they have still been regarded as novice and unfamiliar applications, the participants stated that they did not have sufficient knowledge and experience with AI-based tools, particularly during the lessons. Therefore, it could be interpreted that these led

to staying in their safe zone by relying on their instructional skills. Similar implications were identified in the previous studies highlighting the difference between perceptions of experienced and inexperienced teachers. For instance, in the studies conducted by Holstein et al. (2017) and Lin et al. (2017), less-experienced teachers showed reluctance in accepting and implementing AI-based practices. Therefore, enhancing pre-service foreign language teachers' confidence is significant to build AI and technology acceptance which was also stated by the participants during focus group discussions. Accordingly, one of the participants (P9) explained during the focus group discussion that sufficient technology or AI-related courses were not provided, and the participant did not have constructed educational knowledge about technology-related dimensions of AI-TPACK due to lack of experience. Therefore, it is essential to eliminate negative perceptions and motivate AI acceptance as it is proved that these tools empower current EFL teaching (Jiang, 2022). In addition to these, it could be concluded that there is a notable divide in terms of internet use between different social groups in the local context (Dalgıç-Tetikol, 2023). Thus, when the relevant literature and the findings were examined, the problem related to having equal opportunity in receiving AI training in foreign language education became apparent. Accordingly, it was understood that there has been a lack of AI training at the local level, which again affected pre-service teachers' perceptions and in-class practices. In this vein, education with limited technological infrastructure and training can hinder acquiring contemporary skills; therefore, a latest form of digital divide might be exacerbated when there is a gap between communities that can access technologies and those cannot (Farahani & Ghasemi, 2024).

When it comes to the second focus group discussion question, Table 17 demonstrates that the majority of the participants used AI-based tools for creating materials, and an equal number of participants used them for asking for feedback and practicing English during lessons. Thus, the findings collected through the second focus group discussion question were relatively compatible with the previous studies that pointed to foreign language teachers' perceptions were prone to utilize AI-based tools for providing personalized feedback, practice, and adaptation of teaching which indicates creating context-specific materials (Jiang, 2022; Mukhallafi, 2020; Zou et al., 2023). In this line, it could be understood that AI-based tools have been mostly used in pre-lesson and feedback periods. On the other side, since the participants mostly used AI-based tools before their lessons, they did not mention implementing AI-based tools for enhancing students' motivation or volition

although its positive effects are widely known in language teaching. In this line, previous research indicated that foreign language teachers had positive perceptions of utilizing AI-based tools to raise students' interest and motivation (Hazaymeh et al., 2024; Sumakul et al., 2022). What could be a significant interpretation is that AI-based tools have not been used during foreign language lessons or in complex tasks such as developing higher-order skills. (Campbell & Baroutsis, 2011). Since the use of AI-based tools can generate time-consuming materials easily, it may be understood that AI is generally used for simple tasks in foreign language teaching. In the same vein, Campbell and Baroutsis (2011) stated that the perceptions of teachers about AI-based tools are shaped based on how they implement it in their context-specific teaching environment, and the phenomenon of negative perceptions regarding complex AI-based tools can be derived from using it for simple tasks such as presentation. In this line, P13 stated that she was asked to use some AI-based tools in her micro-teaching courses before the internship course; however, she also mentioned that the tools were basic ones, and they were not provided any specific reason or goal for using utilizing AI-based tools which again demonstrates the effect of lack of knowledge and experience in AI-based tools.

As for the third focus group discussion question, pedagogical knowledge, which was followed by content and technological knowledge, was regarded as the most prominent factor in shaping the self-efficacy of pre-service teachers. This finding was aligned with both quantitative findings and relevant literature. Accordingly, although self-efficacy is a dynamic phenomenon, it has some common sources in the scope of education which are teaching experiences, vicarious experiences, emotional and psychological states (Bandura, 1995). These emphasized that the reason of choosing other dimensions rather than technological knowledge can be derived from lack of experience, not having any peer encouragement, and negative perceptions (Swanson, 2012; Pajares, 2002; Von der Embse et al., 2016). What is more, pre-service teachers underscored the importance of pedagogical and content knowledge by mentioning that the teaching profession cannot be effectively implemented without these two dimensions. For instance, P12 presented the example that even when necessary technological tools are provided, objectives may not be acquired without knowing how to deliver the content of the lesson by engaging students. Moreover, the pre-service teachers mentioned that AI-based tools will be better; however, they are not completely trustworthy since they can generate unauthentic or low-quality output. These indicated that perceptions on AI-based tools were diverse which included both positive and

negative aspects. Accordingly, the effect of the digital divide on perceptions could be observed. There is a necessity to bridge the technology gap that emerges from varying instructional materials, testing, multiple teaching methods, and different learning styles; therefore, keeping up with current technologies should be managed to provide higher-quality learning experiences for every student (Yaman, 2015).

In addition, Table 19 demonstrates that the majority of fourth-year pre-service language teachers thought that AI-based tools would enhance language learning. These findings aligned with previous studies pointed out that AI will be more personalized, contextualized, and interactive (Yang, 2024; Liu et al., 2023; Adipat, 2023). Moreover, reducing workload was also mentioned by pre-service teachers. Although these points of view were associated with positive advancements in AI, pre-service teachers emphasized some issues which should be taken into consideration. In this line, P2 stated that although they generate enjoyable and creative materials, AI-based tools must not be allowed to take over control over teachers because the only person who knows the students and the teaching context best is teachers. Accordingly, it could be understood that even though AI will be improved in the future, dependence on teachers will remain in education because AI has been limited in terms of contextualization and personalization. Accordingly, it can be concluded that AI has not been straightforwardly beneficial in education yet; therefore, it must be extensively analyzed by the people who integrate it into the education process (Selwyn, 2022). For this reason, designing AI training is significant in provide high-quality guidance related to AI-based tools (Pokrivcakova, 2023).

When it comes to the fifth focus group discussion, Table 20 demonstrates that pre-service teachers perceived AI as an effective tool for receiving writing assistance which was followed by speaking and vocabulary practice. When the relevant literature was examined, compatible findings were reached by the studies indicated that AI-based tools were utilized to receive feedback for textual materials or products. In addition, it was observed that the AI-related studies mostly focused on AI chatbots, particularly ChatGPT, as well as the textual assistance aspect of foreign language teaching (Zhou & Hou, 2025; Santiana & Marzuki, 2023; Zhou, 2020). Being on the same vein, P4 mentioned that he can provide instant feedback on students' writings or check for any grammar errors. Accordingly, it could be understood that AI-based tools can be beneficial for providing feedback or error-correcting. Moreover, AI-based tools were stated as effective in speaking and vocabulary practice. Even though pre-service teachers considered AI-based tools as promoting for

speaking and vocabulary practice, they also mentioned its deficiencies related to authenticity which was aligned with some studies showed that AI-based tools still lack affective and instantaneous human-like interaction aspects of foreign language (Alharbi & Khalil, 2023; Yang et al., 2022). Additionally, it was observed that the underlying reason of positive perceptions of the writing assistance dimension was that it is one of the areas that they are accustomed to utilizing in foreign language teaching. That being the case, the influence of the experience of using different features of AI was understood since it was generally used for basic. For instance, P7 stated that AI-based tools can be effectively used in writing, and she felt confident using them to assist her students in practicing writing the reason why her previous experience related to AI included using it for writing-related purposes. In this vein, it could be understood that pre-service teachers' perceptions were affected by their previous experiences. Therefore, the recurring significance of providing training and experiences could be observed to utilize AI-based tools and build high self-efficacy in diverse dimensions of foreign language teaching (Afreilyanti & Kuswandono, 2024; Zhang & Aslan, 2021). Hence, designing training programs on the effective implementation of diverse AI tools was proposed by the studies conducted to investigate the integration of AI-based tools in foreign language teaching (Moorhouse, 2024; Zhang, 2024; Kohnke et al., 2023).

5.2. Conclusion

This present study investigated the relationship between AI-TPACK and teacher self-efficacy levels, to what extent AI-TPACK sub-dimensions and self-efficacy levels vary based on demographic variables, fourth-year pre-service English language teachers' perceptions of using AI, and their effect on their self-efficacy. In this line, the AI-TPACK scale developed by Ning et al. (2024), the TSES scale developed by Tschannen-Moran and Woolfok Hoy (2006), and focus group discussion were used as data collection instruments. By analyzing quantitative and qualitative data through SPSS 20 and Creswell's data analysis spiral, the following conclusions were acquired:

- AI-TPACK levels of participants were slightly above the moderate level.
- Among the AI-TPACK sub-dimensions, participants had the highest levels in PK, PCK, and AI-TPK.

- Participants' PK, PCK, and AI-TPK levels vary based on their GPA scores.
- They had high levels of teacher self-efficacy.
- AI-TPACK and its sub-dimensions had a positive correlation with teacher self-efficacy. Among the sub-dimensions, CK and PCK had the highest positive correlation with teacher self-efficacy.
- CK, PK, and AI-TCK were the predictors of teacher self-efficacy at a significant level.
- Participants stated that the main reason for insufficient knowledge and implementation of AI in the classroom is not having professional training. For this reason, they generally use AI-based tools for lower-order tasks such as providing feedback or preparing basic instructional materials.
- The reason behind relying on their pedagogical and content knowledge is their unfamiliarity toward implementation, theory-based knowledge, and lack of training on AI-based tools.

When the results of the present study are considered, it could be deduced that the findings indicated similar results with previous studies in the literature (e. g., Luckin et al., 2016; Gess-Newsome et al., 2019; Nazari et al., 2019; Erten, 2022; Hava & Babayiğit, 2024; Koh & Chai, 2011; Horzum, 2013; Ercan Demirel, 2017; Holstein et al., 2017; Lin et al., 2017; Liu et al., 2021; Karataş & Ataç, 2024; Dinçer et al., 2024; Chai et al., 2024). The studies suggested various implications in the light of the results they acquired.

Considering all these, it could be demonstrated that the findings indicated several deficiencies in teacher education programs which should be developed contemporary technology acceptance and implementation. In this line, the study revealed that fourth-year pre-service teachers perceive themselves as insufficient in content and AI knowledge. For this reason, they have an urge to rely on their pedagogical knowledge and avoid using AI-based tools as they are unfamiliar them. To address these shortcomings, recommended actions including designing technological training and hands-on experiences are called by the study. Furthermore, the study highlights the technology divide in different parts of Türkiye where some institutions have better opportunities to access technology. These kinds of inequities can exacerbate the negative perceptions of pre-service teachers and make them deter from using contemporary techniques and methods.

Being a teacher requires a constant student who has a willingness to learn and develop. Adjusting policies of the teacher education system to strengthen the competencies of pre-service teachers would enable them to educate more talented and skilled people in the future.

5.3. Limitations and suggestions for further research

Several limitations happened in the data collection and procedure of the present study. Data was collected from four different regions of Türkiye. Although the findings of the present study statistically represented the whole population of participants, comprehensive data could have been acquired to analyze the results of different regions. In addition, allocated time for answering the data collection instruments and open-ended questions could sometimes become limited due to the availability of the participants. This could also restrict the length of answers to the questions. Furthermore, since qualitative data was collected voluntarily, and the nature of focus group discussions includes talking on various topics with people, challenges were faced in finding participants in the qualitative data collection procedure. To overcome the limitations in the present study, future research should conduct the study by broadening the setting in different regions in Türkiye and raising the sample size for the qualitative part would produce more comprehensive findings.

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APPENDICES

Appendix A

AI-TPACK (Artificial Intelligence-Technological Pedagogical Content Knowledge) Scale

Dear participant,

You are invited to participate in research titled “The Relationship Between AI-TPACK and Self-Efficacy of Pre-Service English Language Teachers”. The aim of this study is to reveal to what extent fourth-year pre-service English language teachers' AI-TPACK levels predict their sense of self-efficacy by examining their AI-TPACK and sense of self-efficacy levels according to demographic variables (gender, GPA, teaching experience) and the relationship between AI-TPACK and sense self-efficacy levels. The survey includes 4 items for demographic information, AI-TPACK scale including 39 items, and Teachers' Sense of Efficacy scale including 12 items. Completing the survey takes approximately 10 minutes. To reach the study's purpose, it is expected that you should complete the whole survey. In the first part, there is personal information form including questions about personal data. The second part includes items relevant to data about your AI-TPACK level(s). The findings of this study can provide insights to enhance current teacher competencies. In the third part, there are statements in relation to your self-efficacy perception(s) in your language teaching. Participation in this study is voluntary basis. You can withdraw your participation at any time or choose not to participate. All data acquired from this study will be kept confidential and used only for scientific purposes. If you need further information about the study, please contact the researcher via e-mail or phone number below.

Thank you for your valuable participation.

Mert Acar

MA Student in English Language Teaching - Sakarya University

E-mail:

Phone Number:

I want to participate in this study.

Yes

No

PART 1. Demographic Information

1. What is your gender?

Female

Male

Other

2. What is your GPA (Grade Point Average)?

Under 2.00

2.00 – 2.49

2.50 – 2.99

3.00 – 3.49

3.50 – 4.00

3. Do you have teaching experience excluding internship?

Yes

No

4. What is the name of university you study?

.....

AI-TPACK (Artificial Intelligence-Technological Pedagogical Content Knowledge)

Scale

Please choose the option that best corresponds to your actual circumstances from the choices A, B, C, D, and E and mark it with a checkmark (✓). The meaning of each alternative answer is as follows:

A. Strongly Conformant: This category denotes that the statement is highly conformant to personal experiences encountered in nearly all instances.

B. Conformant: This classification indicates that, under typical circumstances, the statement is conformant to personal situation.

C. Uncertain: This category signifies that the statement is conformant to personal situation in approximately half of the cases.

D. Non-conformant: This designation signifies that, under typical circumstances, the statement is non-conformant to personal situation.

E. Strongly Non-conformant: This category suggests that the statement is highly non-conformant to personal circumstances in nearly all instances.

Items	Options				
	Strongly Conformant	Conformant	Uncertain	Non-Conformant	Strongly Non-Conformant
Content Knowledge (CK)					
I possess a strong understanding of the concepts and principles within my discipline.					
I completely understand the historical evolution of concepts and principles in the subject I teach.					
I am knowledgeable about how the subject matter I teach can be applied in everyday life.					
I have a deep understanding of the knowledge structure					

(organization) of the content I teach.					
I possess a substantial depth of subject-specific knowledge and am highly familiar with the instructional materials and curriculum standards.					
Pedagogical Knowledge (PK)					
I am capable of using a variety of diverse teaching methods in the classroom.					
I can select appropriate teaching methods based on the instructional content.					
I can adjust my teaching methods based on the performance or feedback of the students.					
I possess knowledge of effective classroom organization and management.					
I take into consideration students backgrounds, interests, motivations, and other needs during teaching.					
I am proficient in using multiple assessment methods to evaluate students learning outcomes.					
AI-Technological Knowledge (AI-TK)					
I am familiar with commonly encountered AI technologies in the educational environment.					
I possess the capability to easily acquire AI technologies necessary for teaching.					

I frequently incorporate AI technologies in the pedagogical context.					
I am proficient in using AI technologies to enhance the instructional process.					
I am knowledgeable about using AI technologies for interactive teaching purposes.					
Pedagogical Content Knowledge (PCK)					
I am proficient at formulating curriculum plans with ease.					
I am well-acquainted with the focal points and challenging aspects of teaching.					
I prioritize analyzing students learning situations and am capable of altering instructions to suit their individual needs.					
I am capable of creating engaging group activities for students.					
I am aware of the common mistakes students frequently make during their learning process.					
I can assist students in correcting the learning errors they often commit.					
AI-Technological Content Knowledge (AI-TCK)					
I am familiar with AI in specific academic domains, such as mathematical intelligent tutoring systems.					
I am capable of effortlessly using AI in specific academic domains.					

I am proficient in using AI to update my knowledge base within the academic discipline.					
I can select appropriate AI tools based on the subject matter I am teaching.					
I am adept at using AI to effectively enhance students' comprehension of the material.					
I can use AI to broaden the knowledge horizons of students.					
AI-Technological Pedagogical Knowledge (AI-TPK)					
I am capable of using AI to enhance my pedagogical perspectives.					
I am able to apply appropriate AI in various teaching activities.					
I have the capacity to select AI to sustain students' motivation and interest.					
I can apply AI to assess the learning outcomes of students.					
I am proficient in using AI to optimize classroom instructional management.					
I possess the ability to explain information derived from AI to provide real-time feedback.					
AI- Technological Pedagogical Content Knowledge (AI-TPACK)					

I am knowledgeable in integrating AI with educational content and teaching methods to improve classroom teaching efficiency and effectiveness.					
I am capable of selecting appropriate teaching methods and AI based on the educational content for instruction.					
I can use AI to create, simulate, and adapt scenarios that are in line with the educational content.					
I can use personalized AI to select suitable teaching methods as well as guide students in practical learning.					
I will use AI for self-directed learning, further deepening my subject knowledge and understanding of educational pedagogical theories.					

Appendix B.

Teachers' Sense of Efficacy Scale

Teacher Beliefs									
Directions: This questionnaire is designed to help us gain a better understanding of the kinds of things that create difficulties for teachers in their school activities. Please indicate your opinion about each of the statements below. Your answers are confidential.									
	How much can you do?								
	Nothing		Very Little		Some Influence		Quite a bit		A Great Deal
	1	2	3	4	5	6	7	8	9
1) How much can you do to get through to the most difficult students?									
2) How much can you do to help your students think critically?									
3) How much can you do to control disruptive behavior in the classroom?									
4) How much can you do to motivate students who show low interest in school work?									
5) To what extent can you make your expectations clear about student behavior?									

6) How much can you do to get students to believe they can do well in school work?	1	2	3	4	5	6	7	8	9
7) How well can you respond to difficult questions from your students?	1	2	3	4	5	6	7	8	9
8) How well can you establish routines to keep activities running smoothly?	1	2	3	4	5	6	7	8	9
9) How much can you do to help your students value learning?	1	2	3	4	5	6	7	8	9
10) How much can you gauge student comprehension of what you have taught?	1	2	3	4	5	6	7	8	9
11) To what extent can you craft good questions for your students?	1	2	3	4	5	6	7	8	9
12) How much can you do to foster student creativity?	1	2	3	4	5	6	7	8	9
13) How much can you do to get children to follow classroom rules?	1	2	3	4	5	6	7	8	9
14) How much can you do to improve the understanding of a student who is failing?	1	2	3	4	5	6	7	8	9
15) How much can you do to calm a student who is disruptive or noisy?	1	2	3	4	5	6	7	8	9
16) How well can you establish a classroom management system with each group of students?	1	2	3	4	5	6	7	8	9
17) How much can you do to adjust your lessons to the proper level for individual students?	1	2	3	4	5	6	7	8	9

18) How much can you use a variety of assessment strategies?	1	2	3	4	5	6	7	8	9
19) How well can you keep a few problem students from ruining an entire lesson?	1	2	3	4	5	6	7	8	9
20) To what extent can you provide an alternative explanation or example when students are confused?	1	2	3	4	5	6	7	8	9
21) How well can you respond to defiant students?	1	2	3	4	5	6	7	8	9
22) How much can you assist families in helping their children do well in school?	1	2	3	4	5	6	7	8	9
23) How well can you implement alternative strategies in your classroom?	1	2	3	4	5	6	7	8	9
24) How well can you provide appropriate challenges for very capable students?	1	2	3	4	5	6	7	8	9

Appendix C

Focus Groups Discussion Questions

1. □ □ How do you evaluate your competence in using AI-based tools in foreign language education?
2. □ □ Have you had any experience in using AI-based tools in foreign language lessons? If so, could you briefly explain your experience?
3. □ □ Which one/ones of following domains – Content Knowledge, Pedagogical Knowledge, Technological Knowledge – is more prominent in shaping your self-efficacy in foreign language teaching?
4. □ □ How do you think the role of AI-based tools will evolve in foreign language education and teacher self-efficacy in the upcoming years?
5. □ □ In which areas of foreign language teaching (e.g., speaking, reading, vocabulary learning/grammar, writing, pronunciation, etc.) can AI-based tools be effectively used? How do you explain your self-efficacy in these areas?

Appendix D

Permission to Use Artificial Intelligence-Technological Pedagogical Content Knowledge (AI-TPACK) Scale

Seeking Permission to Use Scale

Harici

Gelen Kutusu x

21 Nis Paz 18:41 (3 gün önce)

☆ ↶ ⋮

Dear Yimin Ning,

My name is Mert Acar. I am a student in Sakarya University which is a state university in Turkey. I am continuing my MA program at Sakarya University. To use the data collection tool in my master thesis, I am writing this email to request permission to use the AI-TPACK scale in your "Teachers' AI-TPACK: Exploring the Relationship between Knowledge Elements" study, and I kindly request you to send a scoring document for determining teachers' AI-TPACK levels as low or high. I will include a statement of attribution and reference in my study. Thanks in advance.

Best regards.

Türkçe diline çevir x

22 Nis Paz 03:26 (2 gün önce)

☆ ↶ ⋮

Dear Mert Acar,

Thank you very much for your interest in the Teacher AI-TPACK and for recognizing our research. We are delighted that you find our scale valuable and accessible for your use. We grant you permission to utilize the items of our developed scale. Our scale demonstrates a degree of generalizability, and we eagerly anticipate observing its effectiveness within the Turkish cultural context and look forward to any new discoveries you may uncover. We are also intrigued by your research and hope for future exchanges and discussions. We eagerly await your insights and suggestions!

Best regards,

Yimin Ning

East China Normal University

----- Replied Message -----

Appendix E

Permission to Use Teachers' Sense of Efficacy (TSES) Scale



William & Mary
School of Education

MEGAN TSCHANNEN-MORAN, PhD
PROFESSOR OF EDUCATIONAL LEADERSHIP

April 24, 2024

Mert Acar,

You have my permission to use the Teacher Sense of Efficacy Scale (formerly called the Ohio State Teacher Sense of Efficacy Scale), which I developed with Woolfolk Hoy, A., in your research.

You can find a copy of the measure and scoring directions on my web site at <https://mxtsch.pages.wm.edu/>.

Please use the following as the proper citation:

Tschannen-Moran, M & Hoy, A. W. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education*, 17, 783-805.

I will also attach directions you can follow to access my password protected web site, where you can find the supporting references for this measure as well as other articles I have written on this and related topics.

All the best,

Megan Tschannen-Moran
William & Mary School of Education

Appendix F

Focus Group Discussion Protocol

Date:

Number of Participants:

This focus group discussion protocol is prepared to conduct discussion effectively and ethically. This outline scrutinizes the purpose, the selection of participants, the role of moderator, discussion process, questions to be asked to participants, and the confidentiality and ethical guidelines.

Purpose

The aim of this focus group discussion is to acquire deep insight about the perception and experiences of fourth-year pre-service English language teachers regarding their competency in using artificial intelligence (AI) in language teaching and its effect on their professional self-efficacy.

Participant Selection

The participants of the present study consist of fourth-year pre-service English language teachers as they completed the relevant technological, theoretical, and practical courses. Therefore, they are expected to contribute more qualified and reliable data in line with the study's aims. Hence, homogeneous groups are formed for the focus group discussion. In addition, due to participants' specialized knowledge in their domain and challenges in availability of participants, mini-focus groups discussion is more suitable to make participants start discussion without any hesitation as well (Casey & Krueger, 1994; Morgan, 1996; Kamberelis & Dimitriadis, 2013). In this line, the number of participants in each group is 2-5, and total number of participants are expected to be approximately 20.

Role of Moderator

In the course of focus group discussion, the moderator creates a session in which participants can comfortably express their opinions. At this point, the moderator introduces the participants and himself, provides information about the study, and clarifies that the discussion is not conducted to judge them or seek any correct answer. In addition, the

moderator behaves neutral to the opinions of participants by giving equal opportunity to speak. The main topics of the discussion is prevented from deviation by guiding participants with follow-up questions related to the questions. Finally, the moderator claims that the collected data will remain confidential and will not be shared with anyone. Participants are also informed that they can withdraw their participation at any time, and the moderator ensures voluntary participation by asking the consent of participants.

Confidentiality and Ethics

Participants are informed that the discussion is conducted for scientific purposes, and the collected data will not be shared with anyone. Additionally, participants' consent will be asked for audio and video recording before the discussion begins.

Questions

1. How do you evaluate your competence in using AI-based tools in foreign language education?
2. Have you had any experience in using AI-based tools in foreign language lessons? If so, could you briefly explain your experience?
3. Which one/ones of following domains – Content Knowledge, Pedagogical Knowledge, Technological Knowledge – is more prominent in shaping your self-efficacy in foreign language teaching?
4. How do you think the role of AI-based tools will evolve in foreign language education and teacher self-efficacy in the upcoming years?
5. In which areas of foreign language teaching (e.g., speaking, reading, vocabulary learning/grammar, writing, pronunciation, etc.) can AI-based tools be effectively used? How do you explain your self-efficacy in these areas?

Focus Group Discussion Process

1. Introduction (2 minutes)

- The moderator introduces himself and gets to know participants.
- The purpose of the discussion and how it will be conducted are explained.
- The confidentiality policy is explained.

2. Discussion (8 minutes)

- Discussion questions are asked to participants by allocating equal time to participants.
- Follow-up questions are asked to participants when the answer is too brief, and guiding questions are asked to prevent deviation from the main topic.
- All answers are respected, and participants are encouraged to share their thoughts comfortably.

Conclusion

- Participants are asked for their final thoughts or additional comments.
- A brief explanation is given about how the present study and their answers will contribute to the related field. Lastly, the discussion is concluded with gratitude for participants' contribution.