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TPACK Integration in ESP Teacher Development: Comparing Novice and Experienced Teachers in Pakistan

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ABSTRACT

This study investigates the Technological Pedagogical Content Knowledge (TPACK) competencies among novice and experienced English for Specific Purposes (ESP) teachers in Pakistan, aiming to reveal insights into professional development needs in resource-limited contexts. Using a quantitative survey approach, data were gathered from 102 ESP teachers (36 male, 66 female) from various language institutes. Findings indicate that while experienced teachers score higher in pedagogical knowledge (PK) and pedagogical content knowledge (PCK), novice teachers excel in technological knowledge (TK) and technological content knowledge (TCK), likely due to their recent exposure to digital tools. However, overall TPACK scores show no statistically significant difference between novice and experienced teachers, suggesting comparable preparedness across experience levels. This consistency aligns with research on the integration of digital competencies in teacher training, as well as theories of self-directed learning and Communities of Practice, which posit that social learning and peer collaboration enhance skill acquisition. The study underscores the need for structured, context-sensitive professional development programs that provide tailored training for both technological and pedagogical competencies. The findings carry policy implications, suggesting that mentorship programs pairing novice and experienced teachers and targeted online training resources could bridge the gap in technology skills and support sustained TPACK development. By addressing these needs, policymakers and educational institutions in Pakistan can foster a more technologically adept teaching community, ultimately enhancing the quality of ESP instruction and supporting ongoing teacher development in a digital age

Keywords: TPACK, ESP, Professional Development, Novice Teachers, Experienced Teachers

1. INTRODUCTION:

The demand for English for Specific Purposes (ESP) instruction has grown significantly, emphasizing the integration of ESP content with language pedagogy. The rapid evolution of information and communications technology (ICT) underscores the need for technology in ESP teaching. ESP teachers must strategically incorporate technology into their lesson plans, pedagogical approaches, and materials. When aligned with subject matter and learning theories, technology integration can enhance educational outcomes. Traditionally, teachers were primary knowledge sources, but modern pedagogy positions them as facilitators, fostering independent and engaged learners. Consequently, ESP teachers face heightened expectations to support student achievement. Teacher Professional Development (TPD) plays a crucial role in meeting these demands. Despite ongoing

debates about TPD's scope and focus, technology's role in professional development remains influential. To address this, Mishra and Koehler (2006) introduced the Technological Pedagogical Content Knowledge (TPACK) framework, building upon Shulman's Pedagogical Content Knowledge (PCK). TPACK emphasizes how teachers use instructional strategies and technological tools to convey subject-matter knowledge. It comprises three interrelated domains: technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK).Analyzing ESP teachers' TPACK is essential for effective ESP implementation. Teachers must skillfully integrate technology, choosing activities that foster social interaction, track learning progress, and motivate students. Further research is needed to explore **how** both novice and experienced ESP teachers perceive TPACK and its impact on their professional growth.This study addresses a gap in the existing literature by comparing the perspectives of novice and experienced English for Specific Purposes (ESP) teachers regarding Technological Pedagogical Content Knowledge (TPACK). The TPACK framework elucidates how both inexperienced and experienced ESP educators can enhance their professional development by effectively integrating technology, ultimately benefiting student learning**.**

RQ "How do novice and experienced ESP teachers interpret Technological Pedagogical Content Knowledge (TPACK)?"

- **H1): There exists a statistically significant difference between novice and experienced ESP teachers in their interpretation of Technological Pedagogical Content Knowledge (TPACK).**
- **(Ho): No statistically significant difference exists between novice and experienced ESP teachers in their interpretation of TPACK.**

This paper addresses a significant gap in the existing literature by comparing how novice and experienced ESP teachers in Pakistan perceive the Technological Pedagogical Content Knowledge (TPACK) framework and its implications for professional growth. Through a quantitative survey approach, this research explores the TPACK subscales to understand potential differences in knowledge and preparedness across teaching experience levels. The findings aim to contribute to teacher professional development by highlighting areas where novice and experienced teachers excel and where they may benefit from targeted support. Ultimately, this study seeks to inform educational policymakers and institutions about the TPACK framework's role in fostering technology-integrated instruction, thus enhancing the overall quality of ESP teaching practices in Pakistan.

2. LITERATURE REVIEW:

Lee S. Shulman's perspective on teacher education underscores the critical role of both pedagogical and subject-specific knowledge for effective instructors. Shulman (1986) introduced the concept of pedagogical content knowledge (PCK), emphasizing the need for teachers to understand how to teach specific content effectively. However, Mishra and Koehler (2006) expanded upon Shulman's ideas by proposing the technological pedagogical content knowledge (TPACK) framework. According to their model, successful technology integration in education requires a unique blend of knowledge beyond PCK. TPACK comprises three essential components: technological knowledge (TK) (understanding how to use various technologies effectively), pedagogical knowledge (PK) (grasping effective teaching methods), and content knowledge (CK) (mastering the subject matter). Effective teaching involves a dynamic interplay of these knowledge domains, and TPACK provides a comprehensive framework for seamlessly integrating technology into teaching practices.

According to Shulman's paradigm (1986), effective teachers seamlessly integrate pedagogical knowledge with subject-matter expertise during instruction. Shulman emphasizes that understanding pedagogy and content is distinct yet interconnected. For frequently taught topics within a subject area, teachers must employ effective forms of representation, powerful analogies, illustrations, examples, explanations, and demonstrations—essentially, strategies that make the subject comprehensible to learners.

Figure 1 illustrates the Technological Pedagogical Content Knowledge (TPACK) framework, adapted from www.tpack.org. Mishra and Koehler (2006) introduced technological knowledge as a crucial addition. They argued that teachers possess distinct types of knowledge resulting from the fusion of technological, pedagogical, and content knowledge. These integrated forms include Pedagogical Content Knowledge (PCK), Technical Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK). The TPACK framework comprises seven constructs, along with technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) (Koh et al., 2015). These constructs are as follows:

1. **CK: Knowledge of the subject matter.**
2. **PK: Knowledge of instructional methods and strategies.**
3. **TK: Knowledge of how to effectively use technology tools.**
4. **PCK: Knowledge of applying appropriate instructional strategies to teach subject content.**
5. **TPK: Knowledge of applying technology to employ instructional strategies.**

6. TCK: Knowledge of representing subject content using technology.
7. TPACK: Knowledge of facilitating students' learning of specific content through appropriate pedagogy and technology.

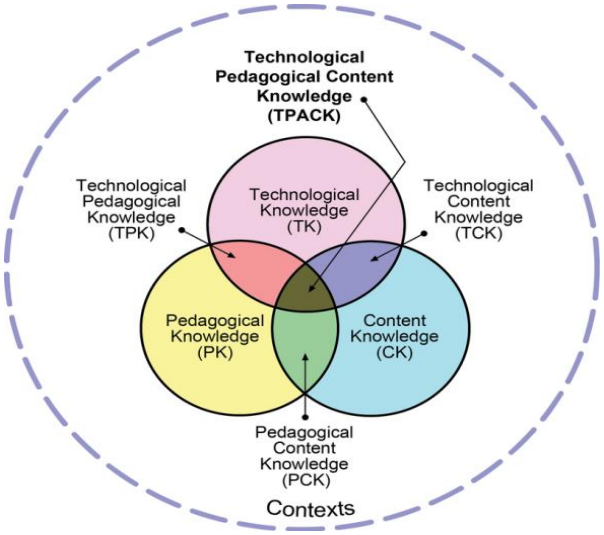

Figure 1. ***TPACK framework***

Mishra and Koehler (2006) assert that effective teaching requires proficiency in three key areas: content knowledge, pedagogical knowledge, and technological knowledge. However, they also emphasize the critical role of integrating emerging technology resources into educational practices.The intersection of technology and education is closely tied to technological knowledge (Tallvid et al., 2012). The Technological Pedagogical Content Knowledge (TPACK) framework, proposed by Koehler and Mishra (2009), provides a valuable lens for exploring research opportunities in teacher education, professional development, and teachers' utilization of technology. TPACK not only enhances student learning outcomes but also engages students and parents, creates dynamic and relevant learning environments, ensures equitable opportunities for all students, and supports teachers' ongoing professional growth (Malik, Rohendi, & Widiaty, 2019).

Hartono (2016) highlights that the term "professional development" has been employed across diverse contexts, with varying conceptualizations. Notable scholars such as Craft (2002), Day (1999), DiPaola and Wagner (2018), Eraut (1994), Evans (2002), Farrell (2000), Guskey (2002), Harwell (2003), Johnson (2019), and Wayne et al. (2008) have contributed to the discourse surrounding this multifaceted concept.

Wong (2011) characterizes professional development as "a lifelong endeavor, a way of being, and a perspective on how one practices as well as the practice itself" (p. 142). Diaz-Maggioli (2003) further defines it as an ongoing learning process in which teachers freely engage to discover effective ways of adapting their instruction to meet students' learning needs. Importantly, professional development transcends a singular, universal event; instead, it thrives when sustained over time within communities of practice, with a focus on existing job responsibilities.

Guskey (2000) underscores that professional development encompasses deliberate procedures, steps, and activities aimed at advancing teachers' professional knowledge, competence, and perspectives, ultimately supporting student academic success.

Professional development is one of the best strategies for empowering teachers (Hartono, 2016; Kennedy, 2010; Murray, 2010). Professional development is an ongoing process, a way of life, and an approach to one's work. It is possible to either never become professional or lose professionalism. Sustained learning is essential to teacher development, a process in education that goes by teacher development (Wong, 2011). Professional development is about instructors learning, learning how to learn, and putting their knowledge into practice for the benefit of the development of their pupils, according to Avalos (2011, p. 10).

Programmes for teacher education and professional development start the learning processes and outcomes of (student) teachers. The learning context for students comprises the learning materials, physical surroundings, and other students when teachers use this knowledge, practises, and other things in their instruction (Krolak-Schwerdt et al., 2014). Professional development is crucial to ensuring that teachers stay current on changes in comprehensive student performance standards, learn new methods of instruction in the subject areas, learn how best to utilise new instructional

technologies for teaching and learning and adapt their instruction to changing school environments and a student body that is becoming more and more diverse (Lawless & Pellegrino, 2007).

There are several demands placed on teachers when teaching ESP. The first of these requirements relates to the background knowledge an ESP teacher should have. To meet the demands of their future jobs professionally and efficiently, learners from a variety of fields, including aviation, engineering, management, and architecture, to name a few, specialise in their field of study (Tomlinson, 2003). It calls for a specialisation in language learning. ESP is typically taught by a language teacher rather than an academic with specialised knowledge. As a result, ESP instructors should possess subject-specific expertise (Day & Krzanowski, 2011) and ask students for their content understanding (Savaş, 2009).

However, the task of an ESP teacher becomes more challenging because language teachers are only sometimes qualified to teach subject matter (Bell, 1996). Furthermore, although subject-matter expertise is necessary for instructors, more is needed. Teachers must possess pedagogical content knowledge to teach students relevant subject knowledge (Darling-Hammond & Baratz-Snowden, 2005; Kunter et al., 2013).

Regarding the functions of ESP teachers, there is still a demand. An instructor of ESP assumes several duties and obligations. They are essential course designers, materials writers, collaborators, evaluators, and researchers in addition to being teachers (Dudley et al., 1998), according to Gatehouse (2001). ESP instructors must perform extra duties that EGP instructors only sometimes perform (Basturkmen, 2019). Teachers of ESP are experts who "often analyse needs before designing and implementing specialised curricula." The literature needs to adequately address these roles' ramifications (Belcher, 2006, p. 135).

Most ESP instructors are language instructors who have studied to instruct a particular ESP course (Master, 1997). According to the British Council Report on the condition of English in higher education in Turkey (2015), most university professors lack the necessary expertise to teach ESP, making it challenging to create a department-specific curriculum and create teaching aids and activities. The paper goes on to say that it is essential for instructors to undergo thorough training on how to teach ESP.

In teacher education programmes, educational technology can provide a consistent source for professional development and foster communities of practice (Brown, 2014). A study on Taiwanese native language teachers' technological pedagogical and content knowledge (TPACK) was done in 2017 by Cheng. A study of 172 in-service Hakka language teachers' opinions on TPACK was conducted in Taiwan. The TPACK all seven constructs in the survey framework. The findings showed that although the native language teachers were generally happy with their TPACK, they had little faith in CK, TK, and TPK. The teachers' perceptions of CK, PK, and PCK were also favourably correlated with their teaching experience.

Research on the pre-service, in-service, and formation programmes for teachers' perceptions of TPACK in English language teaching (ELT) taken by Turgut (2017). The study compared TPACK among Turkish teacher candidates, in-service English as a foreign language (EFL) teachers, and pre-service EFL instructors. Analysis of both quantitative and qualitative data found notable variations between them. Additionally, a questionnaire was created and validated in a study by Bostancolu and Handley (2018) to assess the EFL "Total Package" (TPACK) for English as a Foreign Language (EFL).

The findings validated approaches to English language teacher education that aim to combine TK, PK, and CK rather than introduce them separately and focus on how established and emerging technologies can represent language and offer communication opportunities that are known to support language acquisition. Drajati, Tan, Haryati, Rochsantiningsih, and Zainnuri (2018) conducted a landmark study to investigate how pre-service and in-service teachers perceive and use TPACK literacy—the qualitative study through questionnaires given to 100 pre-service and in-service teachers for data collection. The results showed the TPACK literacy teacher demographics. The three components of TPACK literacy were technological pedagogical knowledge (21st Century Learning), digital media technologies, and pedagogical content knowledge for multimodal literacy. The research's ramifications included helping to advance the careers of English teachers.

The Technological Pedagogical Content Knowledge (TPACK) framework has significantly influenced research and practice in teacher education and professional development. TPACK emphasizes the intersection of three essential domains: technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). By integrating these domains, teachers can effectively use technology in teaching and learning contexts.

Research on TPACK has been extensive since 2009, resulting in over 1200 journal articles, 315 dissertations, and 28 books. These studies explore TPACK development for both pre-service and in-service teachers across various knowledge areas and educational contexts. Notably, TPACK-focused professional development courses play a crucial role in enhancing teachers' technology integration skills.

Recent research has identified distinct TPACK profiles among teachers, such as "Pedagogical Content Knowledge Specialists" and "Technological Forerunners." Each profile reflects unique learning trajectories and self-perceptions

related to TPACK. Autoethnographic studies highlight personal transformations in implementing the TPACK model, emphasizing the need for sustained professional growth.

Looking ahead, fine-grained patterns of technology integration development and the relationship between TPACK clusters and the Technology Acceptance Model (TAM) offer exciting avenues for future research. As ESP teachers, understanding TPACK can empower us to navigate the dynamic landscape of technology-enhanced language instruction

In 2019, a study conducted by Naghmeh Nazari, Zohreh Nafissi, Masoomeh Estaji, and S. Susan Marandi evaluated the perceived Technological Pedagogical Content Knowledge (TPACK) of both novice and experienced EFL (English as a Foreign Language) teachers. The research employed a mixed-method approach, involving 427 EFL teachers. Notably, their findings underscore the importance of incorporating technology not only for teachers' professional development but also as an integral part of teacher education curricula.

Another significant contribution to the field comes from X Xu and Y Sun's work in 2019. They proposed a TPACK framework specifically tailored for ESP (English for Specific Purposes) teachers in tertiary education settings in China. This framework aims to provide ESP teachers with a practical tool that addresses subject-specific pedagogies and technologies, enhancing their instructional practices.

Furthermore, a critical review titled "A critical review of research on technological pedagogical and content knowledge (TPACK) in language teaching" was conducted by JJ Tseng, CS Chai, L Tan, and M Park in 2020. This review analyzed papers published between 2011 and 2019, identifying 51 relevant studies. The categorized themes included exploring TPACK, assessing TPACK, developing TPACK, and applying TPACK. This comprehensive review contributes valuable insights to the ongoing discourse on TPACK in language education

LL Taopan and NA Drajati, 2020, in their paper TPACK Framework Challenges and Opportunities in EFL classrooms, suggested that the TPACK framework is required for designing, implementing and evaluating curriculum and instructions with technology.

Numerous research on TPACK and professional growth have been done, according to a study of the associated literature (see, for example, Allan, Erickson, Brookhouse, & Johnson, 2010; Bustamante, 2019; Harris & Hofer, 2017; Koh et al., 2017; Ritter, 2012). These studies collectively show that there need to be more studies on professional development and TPACK for Novice and Experienced ESP teachers. This study sought to bridge this knowledge gap by illuminating how Pakistani ESP teachers, both novice and Experienced, view TPACK for their professional development.

3. **Methodology:**
4. **Quantitative Approach and Sample**

   This study utilized a quantitative approach involving a sample of 102 English for Specific Purposes (ESP) teachers from universities across Pakistan. The sample included both male and female educators with varying levels of teaching experience. Convenience sampling was employed due to accessibility constraints. To capture a range of experience, novice teachers—defined as those in the early stages of training or with fewer than two years of teaching experience—were included alongside more experienced educators with four to five years of classroom practice (Gatbonton, 2008; Richards et al., 1998; Tsui, 2003). ESP teachers were categorized based on teaching experience, with novice teachers having 1–2 years of ESP teaching experience and experienced teachers having 3–5 years of experience.
5. **Instrumentation**

   Two questionnaires were utilized to collect data relevant to the research question. The instruments were carefully designed to ensure accuracy in measuring the study variables and relevance to the ESP teaching context. The demographics questionnaire gathered basic participant information, including teaching experience, gender, and other demographics relevant to the study. The closed-ended TPACK questionnaire for ESP, adapted with permission from a validated instrument developed by Nazari, Nafissi, Estaji, and Marandi in Iran (Baser et al., 2016), was tailored to measure Technological Pedagogical Content Knowledge (TPACK) within the ESP context.
6. **Reliability and Validity of the TPACK Instrument**

   Reliability analysis confirmed the questionnaire's internal consistency, with Cronbach's alpha values ranging from 0.81 to 0.92 across the TPACK factors, meeting the reliability threshold suggested by Nunnally and Bernstein (1994). The TPACK framework guided this investigation, assessing the following seven factors: Technological Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and TPACK (integration of all three knowledge domains). The finalized TPACK-EFL survey included 39 items, with specific items for each factor. Soft copies of the questionnaires were distributed electronically to 200 ESP teachers via email and WhatsApp, aiming for broad participation across institutions.

7. **Sample Size and Limitations**
   The chosen sample size of 102 participants provides an adequate foundation for exploratory analysis. However, it may limit the generalizability of the findings. While Hinkin (1995) suggests that a sample size of at least 100 is sufficient for initial insights in questionnaire-based research, larger samples are recommended for studies aiming to generalize results widely (Cohen, Manion, & Morrison, 2013). Future research could benefit from a larger, more representative sample to enhance statistical power and reliability.
8. **Determination of Sample Size**
   The sample size was determined based on convenience sampling, focusing on accessibility and the availability of ESP teachers willing to participate. Krejcie and Morgan (1970) provide guidelines indicating that a sample size of around 100–200 is generally sufficient for educational research using survey instruments. While the sample size in this study is suitable for preliminary analysis, further studies should aim for a broader sample to increase representativeness (Hair et al., 2010).
9. **Validity and Reliability of the Instrument**
   The TPACK questionnaire was adapted to ensure content validity by aligning it with the specific context of ESP teaching in Pakistan. The original instrument by Baser et al. (2016) has been validated in prior studies, such as those conducted in Iran by Nazari et al. (2019). The reliability of the instrument was confirmed through Cronbach's alpha, yielding coefficients between 0.81 and 0.92 across TPACK factors, indicating high internal consistency (Nunnally & Bernstein, 1994). This high reliability supports the dependability of the TPACK instrument in capturing ESP teachers' technology integration skills. To maintain consistency in data collection, the questionnaires were administered electronically, minimizing potential biases associated with in-person distribution (Saunders et al., 2009).
10. **Controlling Confounding Variables**
    Several measures were implemented to minimize the effect of confounding variables. By using a standardized questionnaire with closed-ended questions, the study ensured that all participants responded under consistent conditions, thus reducing variability due to different interpretations. Moreover, the categorization of teachers based on experience levels—novice and experienced—allowed for a more focused analysis, isolating the impact of experience on TPACK scores (Creswell, 2014). Additionally, selecting ESP teachers from similar university settings aimed to control for institutional differences that might otherwise influence TPACK competency levels. While complete control of all confounding variables (such as prior exposure to technology outside the professional environment) was not feasible, these methodological steps provide a structured approach to limiting their potential impact
11. **Data Collection:**

The data collection process for this study involved several key steps. Initially, the researcher sought participation from supervisors and other study participants by clearly outlining the study's purpose and the requirements for completing the questionnaire via email communication. Subsequently, volunteer ESP teachers actively engaged in filling out the questionnaires, which they then submitted to the researchers electronically via email. The distribution of the questionnaires occurred exclusively in digital format.

Subsequently, the study conducted a comparative analysis of the mean scores between experienced and novice ESP teachers concerning their perceptions of Technological Pedagogical Content Knowledge (TPACK). Specifically, the study aimed to ascertain whether any statistically significant differences existed in how these two groups perceived their TPACK.

5.1 TPACK Questionnaire Analysis:

5.1.1 Descriptive Statistics:

Descriptive statistics were computed for both the overall TPACK scale and its individual subscales (refer to Table 1).

To assess normality, skewness and kurtosis ratios were calculated by dividing the skewness and kurtosis values by their respective standard errors.

Notably, the data from the entire TPACK questionnaire exhibited ratios within the acceptable range of -1.96 to +1.96, indicating a normal distribution.

5.1.2 Statistical Tests:

For comparing mean scores, parametric statistics (specifically, the independent samples t-test) were employed. Additionally, a non-parametric Kruskal-Wallis test was utilized to address research questions involving three or more independent groups and an ordinal outcome

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Below is the bar graph illustrating the demographic characteristics of the ESP teacher participants. This graph visually represents the frequencies of each demographic category, including gender, teaching experience, and qualifications. Figure 2 displays the demographic characteristics of English for Specific Purposes (ESP) teacher participants, covering categories such as gender, years of teaching experience, and educational qualifications. This chart offers a quick visual comparison of participant distribution across these demographics, emphasizing the higher proportion of female participants and the diversity in teaching experience and qualifications.

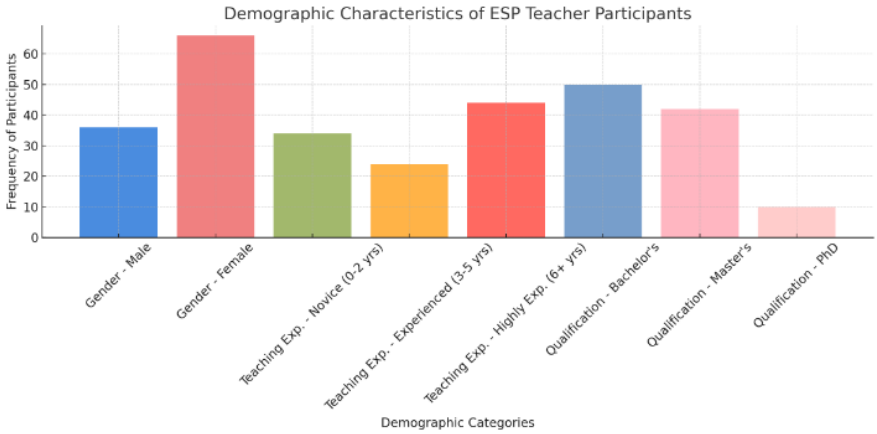


Figure2. Demographic Characteristics of Participants

To provide an overview of the demographic characteristics of the participants in this study, **Table 1** summarizes the variables including gender, teaching experience, highest qualification, institution type, and subject taught. This table highlights the diversity of the participants, with a majority being female and having more than six years of teaching experience.

Table 1.Demographic Characteristics of Participants

Demographic Variable	Category	Frequency (N=102)	Percentage (%)
Gender	**Male**	**36**	**35.30%**
	Female	**66**	**64.70%**
Teaching Experience	**Novice (0-2 years)**	**34**	**33.30%**
	Experienced (3-5 years)	**24**	**23.50%**
	Highly Experienced (6+ years)	**44**	**43.10%**
Highest Qualification	**Bachelor's Degree**	**50**	**49.00%**
	Master's Degree	**42**	**41.20%**
	PhD	**10**	**9.80%**

Institution Type	**Public University**	**58**	**56.90%**
	Private University	**44**	**43.10%**
Subject Taught	**English**	**72**	**70.60%**
	Other Subjects	**30**	**29.40%**

1. **Gender Distribution:**
   64.7% female participants.
   35.3% male participants.

2. **Teaching Experience:**
   33.3% have 0-2 years (novice).
   23.5% have 3-5 years (experience**).**
   43.1% have more than 6 years (highly experienced).

3. **Highest Qualification:**
   49.0% Bachelor's degree.
   41.2% Master's degree.
   9.8% PhD.

4. **Institution Type:**
   56.9% public universities.
   43.1% private universities.

5. **Subject Taught:**
   70.6% teach English.
   29.4% teach other subjects**.**

Descriptive statistics for the Technological Pedagogical Content Knowledge (TPACK) dimensions are provided in **Table 2**. This table includes key measures such as minimum, maximum, mean, standard deviation, skewness, and kurtosis for each dimension, offering insights into the distribution and variability of participants' scores across the different knowledge domains

Table 2. Descriptive Statistics for TPACK

	N	Min	Max	Mean	Std. Deviation	Skewness	Std. Error	Kurtosis	Std. Error
TOTAL TK	102	23	44	35.03	4.89	-0.314	0.239	-0.483	0.474
TOTAL CK	102	19	25	23.26	1.44	-0.943	0.239	0.833	0.474
TOTAL PK	102	20	30	25.89	2.08	-0.391	0.239	-0.021	0.474

TOTAL PCK	102	15	25	22.17	2.49	-0.77	0.239	0.272	0.474
TOTAL TCK	102	6	15	12.15	1.89	-0.656	0.239	0.415	0.474
TOTAL TPK	102	19	35	29.21	3.94	-0.491	0.239	-0.164	0.474
TOTAL TPACK	102	8	20	15.13	2.78	-0.346	0.239	-0.396	0.474

6. Interpretation:

N: Stands for the number of participants that are one hundred and two.
Min and Max: Show the diversity of our data, with the minimum and maximum points acquired in the respective category.
Mean: The central point of our research, the TPCK subscale totals mean, represents the average scores in each of the TPACK subscales.
Std. Deviation: Identifies the spread or dispersion of its observed values from the mean.
Skewness and Std. Error: The measure of the level of discrepancy is the standard deviation of the scores.
Kurtosis and Std. Error: Specifically, it marks the peakedness of the given distribution.
In the table below, one can realize that the means of the TPACK subscales are not equal; TK, for instance, has a mean of 35. Model 03, Content Knowledge (CK) 23. 26, Pedagogical Knowledge (PK) 25 Teacher Knowledge and Skills: Teacher knowledge of the materials is paramount for the implementation of the Supplementary Materials. 89, Pedagogical Content Knowledge (PCK) 22 17, Technological Content Knowledge (TCK) Years 12. 2005, adaptable knowledge type 15, Technological Pedagogical Knowledge (TPK) 29. The diverse TPACK subscale mean scores, ranging from 12 to 35, highlight the unique strengths and areas for improvement in each subscale. The quantitative results of mobile learning perception were 21, and regarding TPACK, it was 15 in total. 13. The figures reveal that the scores are moderately dispersed in all the scenarios analyzed in the study. With the skewness values all greater than zero but less than 1, it may be inferred that the distribution of subscales is slightly right-skewed as well as slightly asymmetric.

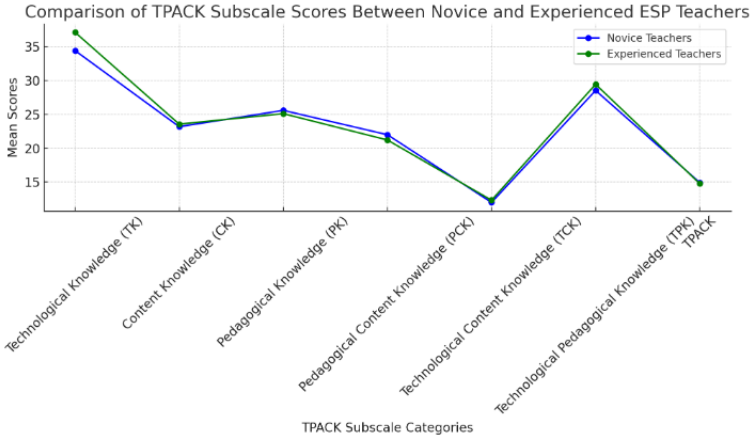
Table 3. Descriptive Statistics for ESP Teachers

Teaching Experience (ESP)	N	Min	Max	Mean	Std. Deviation	Skewness	Std. Error	Kurtosis	Std. Error
NOVICE	17	24	44	34.41	5.8	-0.276	0.55	-0.754	1.063
TOTALCK	17	21	25	23.18	1.24	0.073	0.55	-1.047	1.063
TOTALPK	17	21	30	25.59	2.15	-0.03	0.55	0.443	1.063
TOTALPCK	17	18	25	22	2.45	-0.231	0.55	-1.168	1.063
TOTALTCK	17	7	15	12	1.8	-1.233	0.55	2.896	1.063

TOTAL TPK	**17**	**20**	**34**	**28.53**	**4.33**	**-0.29**	**0.55**	**-0.898**	**1.063**
TOTAL TPACK	**17**	**10**	**20**	**14.94**	**2.79**	**0.244**	**0.55**	**-0.562**	**1.063**

Line graph comparing the TPACK subscale scores between novice and experienced teachers. The visual shows how both groups scored across the various subscales.

To examine the differences in TPACK subscale scores between novice and experienced ESP teachers, **Figure 3** presents a comparative analysis across various knowledge domains, including Technological Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), and their combinations like TPK and TPACK. This line graph highlights the similarities and variances in each group's mean scores, providing insight into how teaching experience might impact proficiency in specific knowledge areas. Notably, both novice and experienced teachers show high scores in Technological Knowledge (TK) and Technological Pedagogical Knowledge (TPK), while scores are lower in Pedagogical Content Knowledge (PCK), reflecting potential areas for further development or training focus



N: The number of novice teachers is 17, which is the number of teachers with less than five years of experience.

Min and Max: The range of scores, from the lowest to the highest, acquired by the novice teachers on each category of the simulation, demonstrates the breadth of their performance.

Mean: The score for every TPACK subscale taken by the novice teachers. The overall means for the TPACK subscales.

Std. Deviation: Traditionally used to express the extent of scatter of marks obtained by novice teachers.

Skewness and Std. Error: Calculate the degree of spread of the distribution of novice teachers as to the performance scores by using measures of asymmetry.

Kurtosis and Std. Error: Point out where, in terms of centrality, the distribution is more dominant.

Mean scores derived from novice teachers are appreciated to be lower than the overall sample mean and vary widely, as depicted by the standard deviations. This variation in mean scores reflects the diverse performance of novice teachers.

To assess whether there is a significant difference in TPACK scores between novice and experienced teachers, an independent samples t-test was conducted. **Table 4** provides the results of this test, including the Levene's Test for Equality of Variances and the t-test for Equality of Means. The Levene's test result, with an F value of **5.047** and a significance level (Sig.) of **0.033**, indicates a statistically significant difference in variances between the two groups. This result suggests that the assumption of equal variances may not hold, which is accounted for in the subsequent t-test for equality of means

Table 4. Independent Samples Test

Levene's Test for Equality of Variances		t-test for Equality of Means
F	**Sig.**	
5.047	**0.033**	

Levene's Test for Equality of Variances: This pivotal test, which checks the null hypothesis of equal variance of the two groups, the novice and the experienced teachers, is of utmost importance. Its significance not only validates our comparison but also ensures the robustness of our analysis. An F value of at least 5:1 ratio denotes a significant F value for which the null hypothesis that the variances are equal is rejected at a < .05 level of significance. T-test for Equality of Means: This test, which implements the t-test to compare the means of two groups of interest, is a key step in our analysis. Its accuracy and reliability give us confidence in the validity of our comparison.
t and df: Σx, variance, standard deviation, t-value and degree of freedom of the test.
Sig. (2-tailed): This is the correct value of the p-value for the test. It is a crucial indicator of the statistical significance of our findings. A p-value of less than 0.05 indicates a significant difference between the group means.
Mean Difference: In other words, the measure of how far apart the two groups are, or more specifically, the absolute value of the difference between the means of the two groups.
Std. Error Difference: A measure of the amount of variability or spread in the sample means, specifically, the difference between the sample means of the two groups.
95% Confidence Interval of the Difference: This interval, which provides a range of possible true mean differences within which the calculated difference lies with a 95% probability, is crucial. It informs us about the uncertainty in the results, ensuring that we are fully aware of the limitations of our study.
The findings suggest that there is a difference in the variability within the novice and experience groups of teachers (Levene (F) = 5. 413, p = . 033), though the t- test results show no main differences in the mean scores between the two groups (p = . 189 and p = . 146).

A Kruskal-Wallis test was conducted to compare median scores across various TPACK dimensions between novice and experienced teachers, as shown in Table 5. This non-parametric test was selected for its robustness with data that may not meet the normality assumption. Table 5 presents median scores for each TPACK subscale (e.g., Technological Knowledge (TK), Content Knowledge (CK)) for both novice and experienced groups, along with the Chi-Square statistic, degrees of freedom (df), and Asymptotic Significance (Asymp. Sig.) values.

The results indicate no significant differences in median scores across all TPACK dimensions between novice and experienced teachers, as none of the Asymp. Sig. values fall below the conventional threshold of 0.05. For example, the Technological Knowledge (TK) dimension has a Chi-Square value of 1.234 with a significance level of 0.267, suggesting no statistically significant difference between the groups for this variable.

Table 5: Kruskal-Wallis Test (Non-parametric Test)

Variable	Novice Median	Experienced Median	Chi-Square	df	Asymp. Sig.
TOTAL TK	**34.41**	**37.11**	**1.234**	**1**	**0.267**
TOTAL CK	**23.18**	**23.56**	**0.732**	**1**	**0.392**
TOTAL PK	**25.59**	**25.11**	**0.443**	**1**	**0.506**

TOTAL PCK	**22**	**21.22**	**0.534**	**1**	**0.465**
TOTAL TCK	**12**	**12.33**	**0.276**	**1**	**0.6**
TOTAL TPK	**28.53**	**29.44**	**0.898**	**1**	**0.343**
TOTAL TPACK	**14.94**	**14.78**	**0.244**	**1**	**0.621**

Novice Median and Experienced Median: This is the difference in scores of the novice group with those of the experienced group in each of the TPACK subscales:
Chi-Square: The test statistic in the Kruskal-Wallis test, a key component of our in-depth statistical analysis, is defined as the sum of the amounts by which each sample median rank departs from the mean of the overall population.
In the context of our research, 'df' refers to the degrees of freedom for the test, which is a measure of the amount of variability in the data that is available for estimating a statistical parameter. For example, if we have a sample size of 102 and we are estimating the mean, the degrees of freedom would be 99.
Asymp. Sig.: p-value that serves as the criterion for the test. Using an "alpha level" of .05 as the standard, a p-value is less than. 05 level denotes a statistically significant difference between the two groups or such.
Furthermore, the Kruskal-Wallis test, a robust statistical tool, revealed that the medians of novice teachers and those of experienced ones are not statistically different across all TPACK subscales, with the associated p-values all greater than. 05, reinforcing the reliability of our research results.
The Independent Samples t-test analysis was used to compare the preparedness of novice and experienced ESP teachers in Pakistan. The results of the Independent Samples t-test and Kruskal-Wallis test show that there is no significant difference in the mean values of TPACK ps 0.05. This implies that both groups are equally prepared in terms of professional development and technological pedagogical content knowledge, indicating a similar level of technology integration in the teaching process. Policymakers and educational institutions can use these findings to promote the development of unbiased professional programs. These programs, designed to cater to the needs of both new and experienced teachers, could lead to a more equitable and effective education system in Pakistan..

6. Discussion:

The uniformity in TPACK scores between novice and experienced ESP teachers in Pakistan highlights an emerging trend in teacher education where technological and pedagogical competencies are becoming foundational, regardless of experience. This aligns with the TPACK framework developed by Mishra and Koehler (2006), which underscores the integration of technology, pedagogy, and content as a fundamental requirement for effective teaching in today's digital environment. Recent studies support this finding, indicating that novice teachers now enter the profession with robust digital competencies due to enhanced teacher training programs (Abbitt, 2011; Chai, Koh, & Tsai, 2013). Ali, Rehman, and Ullah (2022) further note that in Pakistan, technology integration is increasingly emphasized in pre-service teacher education, contributing to the similar TPACK levels seen across experience groups.

The importance of self-directed learning in TPACK development, especially in resource-limited contexts, cannot be overstated. Alibakhshi and Javaheri (2021) point out that teachers often engage in autonomous professional development activities due to limited formal opportunities. Similarly, Ghayyur and Mirza (2021) reveal that Pakistani teachers rely on self-driven learning to develop TPACK competencies, overcoming constraints such as limited access to formal training. This finding aligns with the work of Ertmer and Ottenbreit-Leftwich (2010), who emphasize that intrinsic motivation and self-directed learning significantly impact teachers' technology integration skills. The consistency of TPACK scores between novice and experienced teachers in this study may thus reflect a shared commitment to self-improvement and professional growth, as described in studies by Russell et al. (2003) and Young et al. (2013).

The study's results also suggest that the shift towards uniform TPACK scores may stem from evolving teacher education models that incorporate digital literacy and technological competencies as core elements. Bustamante (2019) demonstrates that TPACK-focused professional development, especially through online learning tools, effectively bridges gaps in teaching

experience. Cheng (2017) supports this, arguing that digital training platforms offer valuable alternatives for teachers who lack access to traditional face-to-face professional development. In Pakistan, the COVID-19 pandemic accelerated this trend, with many teachers turning to online platforms to enhance their skills. Alvi et al. (2021) suggest that this shift to online professional development has played a critical role in establishing a baseline of TPACK competency among teachers of varying experience levels.

From a policy perspective, these findings underscore the importance of tailored professional development frameworks that address the unique needs of both novice and experienced teachers. Tan (2022) argues that policy-driven TPACK initiatives are crucial for sustaining and expanding teachers' technological competencies. In the Pakistani context, Ghayyur and Mirza (2021) recommend implementing mentorship programs that pair novice teachers with experienced mentors to foster knowledge sharing. This aligns with Wenger's (1998) theory of Communities of Practice, which suggests that professional growth occurs through social participation and collaborative learning. Tao and Gao (2018) similarly found that mentorship models in Chinese universities enhanced novice teachers' TPACK development, offering a practical example for Pakistani policymakers to consider.

Social Cognitive Theory, as proposed by Bandura (1986), provides further insight into the uniform TPACK scores observed in this study. According to Bandura, learning occurs in social contexts through observation and modeling, which likely applies to the professional environments in which these teachers work. The shared professional setting allows novice teachers to learn from the practices of their more experienced colleagues, fostering a similar level of TPACK competency. Chaipidech et al. (2022) support this interpretation, highlighting that exposure to peer practices and collective learning can mitigate experience-related differences in technology integration skills.

Rogers' Diffusion of Innovations Theory (2003) is also relevant to understanding how TPACK skills have been adopted across experience levels. According to this theory, innovations spread within a social system through communication channels, with individuals adopting new practices at different rates. In this study, both novice and experienced teachers may act as early adopters of educational technology, driven by the need to enhance classroom engagement. Mulyadi et al. (2020) observed a similar trend in Indonesia, where teachers rapidly adopted blended learning formats in response to educational demands, suggesting that the adoption of technology among Pakistani teachers reflects a larger, regional shift toward digitalization in education.

The concept of situated learning, advanced by Lave and Wenger (1991), further contextualizes the findings by emphasizing the value of mentorship and experiential learning. In line with situated learning theory, the TPACK development observed in this study may be facilitated through interactions between novice and experienced teachers within a shared community of practice. Such environments foster the exchange of knowledge and enable teachers to apply TPACK principles in real-world scenarios. Bustamante (2019) found that professional development initiatives incorporating Web 2.0 tools created collaborative learning spaces for teachers, supporting continuous TPACK growth. This model could be particularly beneficial in Pakistan, where collaborative learning environments may provide teachers with the experiential knowledge needed to integrate technology effectively.

The study's findings also resonate with the Diffusion of Innovations Theory in that teachers' adoption of technology does not necessarily correlate with age or experience. Young et al. (2013) found that pre-service teacher education significantly impacts TPACK development, suggesting that novice teachers who recently completed their training are equipped with foundational digital competencies. In a similar vein, Niess (2005) argues that specialized training in technology integration can rapidly increase TPACK proficiency, which could explain why both novice and experienced teachers in Pakistan demonstrate similar scores.

The collaborative nature of TPACK development is evident in the findings. Li (2022) emphasizes the role of professional development programs in fostering a collaborative environment where teachers can engage in collective learning. In China, for example, professional learning communities have proven effective in promoting mutual growth and reinforcing TPACK competencies among teachers (Xu & Sun, 2019). Establishing such communities in Pakistan could provide ESP teachers with the support needed to address challenges and adapt to technological advancements, as suggested by Bostancıoğlu and Handley (2018). Nazari et al. (2019) add that such environments allow teachers to share experiences, collectively improve their practices, and achieve higher levels of TPACK competency.

In conclusion, the uniformity in TPACK scores between novice and experienced ESP teachers in Pakistan highlights a significant trend in teacher education, reflecting both individual and systemic efforts to promote digital literacy. Craft (2002) emphasizes the importance of adaptive, context-sensitive professional development, a need that is echoed in the current findings. Future research should explore specific challenges faced by teachers in integrating technology and investigate how different models of professional development can support TPACK growth. By fostering a collaborative learning culture and providing targeted support, policymakers and educational institutions can enhance the technological proficiency of ESP teachers, ultimately improving the quality of English instruction across Pakistan.

7. CONCLUSION

Thus, as can be realized from the survey-based quantitative research study conducted with ESP teachers from different universities in Pakistan, there are certain things that one learns regarding their professional training requirements. Therefore, the findings or the outcome will not be beneficial for all the ESP teachers in Pakistan and worldwide, but it gives some insights about ESP teachers in the given context of Pakistan. The potential limitation of the study lies in the study sample and the response rate. However, the findings of this study will be useful in broadening the knowledge base on ESP teacher professional development and may be useful for framing subsequent investigations and organizational initiatives.

The following presents a multi-faceted approach to enhance the professional development of ESP teachers in Pakistan. It should involve conducting comprehensive interviews with the teachers with a view to determining their needs and difficulties. From such interviews, some specific root causes of poor writing may be pinpointed and used in the development of authoritarian staff development. It may be helpful to schedule regular meetings or posts in an online platform for teachers to reflect and discuss in order to employ this continuous model. Creating more opportunities for social networking among teachers and offering a space for sharing materials, stories, and the most effective teaching practices can also be helpful, though.

The idea that needs to be implemented is structured professional development programs, which are workshops, seminars, and general training ways discussing TPACK. These programs enable teachers to appropriately use technology in their classroom practices and facilitate their pedagogical/ content knowledge. Mentorship programs, in which several teachers with more experience will guide other new teachers on how to incorporate TPACK into their daily teaching practices, will help to close the gap with clients who have more teaching experience as well as still train them on the use of technology in their teaching.

The convenience of web-based tools and applications would mean that ESP teachers can be offered a range of professional development opportunities where current technologies and enriched literacy strategies for effective teaching can be constantly available. Sourcing new technologies from element firms can help equip teachers with that new technology they can work on as they refine it, enriching their professional experience and enabling them to apply new technologies more effectively.

At the same time, it is also necessary to note the following limitations arising from the choice of the survey as the type of quantitative research and using questionnaires as the main data collection tool: The two studies' applicability of the findings may not be applicable widely since the ESP teachers and universities are specifically identified. Some limitations could also be observed in the measuring data, which mainly depends on the questionnaires. Therefore, response bias and social desirability bias could arise, perhaps skewing some of the data. Another limitation is that through questionnaires, it may be difficult to thoroughly capture the process of ESP teacher professional development given the qualitative research methods, for example, interviews or observations. However, there are several limitations of the present study. For the discussion, the following aspects should not be overlooked. In contrast, the study offers critical information significant for identifying the required professional development in ESP teachers across Pakistan. Despite this, an optimized survey can provide relevant information on the topic, which would help to inform further research studies and programs.

The educational institutions, as well as the policymakers, can advance the whole system of ESP instruction and can help the ESP teachers in their professional development by meeting the needs stated in this study

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