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Characteristics of Chinese Higher Education EFL Teachers' Behaviors Based on Technological Pedagogical Content Knowledge (TPACK)

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***Abstract*—Technological pedagogical content knowledge (TPACK) is pivotal for enhancing both learning and teaching processes, and it has garnered a share of scholarly attention in recent years, although few quantitative studies have been found on English as a foreign language (EFL) teachers of higher education in Guizhou, China. This study provides a comprehensive quantitative analysis of the integration of TPACK among EFL teachers in higher education in Guizhou province, China. A detailed EFL-TPACK framework coding protocol was employed to analyze the teaching videos of six EFL teachers with varying proficiency levels. These six teachers were selected from a survey that investigated 286 EFL teachers in higher education in Guizhou Province. The analysis categorized the teaching behaviors observed in the videos into seven distinct factors, meticulously quantifying the integration of technological (TK), pedagogical (PK), and content knowledge (CK), revealing significant disparities between the teachers. High-level teachers excelled in TPACK integration more than medium-level and low-level teachers, especially older ones. This study not only enables a deeper understanding of the practical application of TPACK in classroom settings but also emphasizes the dynamic nature of EFL-TPACK frameworks. The findings highlight the urgent need for targeted professional development strategies, including comprehensive technological training, a balanced emphasis on pedagogical and content knowledge, and the establishment of collaborative learning environments. These strategies are essential for enhancing TPACK integration skills across proficiency levels.**

***Index Terms*—EFL teachers, higher education, video analysis, teaching behaviors, EFL-TPACK framework**

I. Introduction

Advances in information and communication technology (ICT), including innovations such as ChatGPT and Google Bard, have revolutionized the educational domain, prompting extensive research on technology's role in pedagogy. This evolution has emphasized the importance of teachers' mastery over subject-matter knowledge, technological fluency, and pedagogical skills—collectively termed "technological pedagogical content knowledge" (TPACK). TPACK encapsulates the essential competencies that teachers must integrate to navigate the nexus of teaching, technology, and content knowledge (Mishra & Koehler, 2006). In this context, the integration of ICT tools in education has become increasingly significant. Extensive background research highlights the transformative impact of ICT on teaching methods, learning environments, and educational outcomes. Studies have shown that effective integration of technology in teaching not only enhances student engagement and learning but also prepares students for a technology-driven world. The role of teachers has thus evolved from mere providers of knowledge to facilitators of learning, leveraging technology to make the learning process more dynamic and student-centered. This shift necessitates a comprehensive understanding of how technology can be blended with traditional pedagogical approaches to optimize learning outcomes. It is in this vein that the present study aims to explore this EFL-TPACK framework in EFL teaching in Guizhou's higher education sector, with observations and analyses of EFL teachers' teaching videos, which allows for the detailed observation of teachers' real-time interactions and technology use in the classroom, providing concrete evidence of TPACK application and pedagogical effectiveness.

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In recent years, rapid advancements in ICT technologies have focused on integrating technology across diverse educational landscapes, leading to notable progress in pedagogical methodologies for both teaching and learning (e.g., Cha et al., 2020; Singhavi & Basargekar, 2019; Willis et al., 2019). Consequently, teachers' subject-matter knowledge, technological insights, and ability to fluidly weave technologies into the educational milieu play a pivotal role in shaping the teaching and learning trajectory (Backfisch et al., 2020; Kali et al., 2019; Kim et al., 2022; Koehler et al., 2017).

Given that English is a mandatory course in China's higher education, the TPACK of EFL teachers is pivotal for enhancing both learning and teaching processes (Abubakir & Alshaboul, 2023; Alotumi, 2023; Wang, 2022). Well-organized technology integration requires complicated pedagogical knowledge and subject-content knowledge, which are the central focus of the TPACK framework. However, few quantitative studies have investigated EFL teachers' TPACK in higher education (e.g., Chuang & Ho, 2011; Liang et al., 2013), and even fewer investigations have been conducted in Guizhou, China. As one of the undeveloped provinces in China, Guizhou's education system is still inferior (Gao & Yang, 2016), not to mention EFL teaching. Many EFL teachers graduated from non-teaching English majors, having not received systematic educational training, and lack basic knowledge of the teaching theory and teaching methods (Chen, 2019; Yu, 2006; Zheng, 2021; Zhou, 2019). Most EFL teachers are non-teaching English majors who have studied mainly English literature or English linguistics; Although their English competency is quite good, they still lack knowledge in language teaching and pedagogical psychology (Jiao, 2013; Wang, 2018). Additionally, the EFL teaching method is one-dimensional, and passive learning approaches are still prevalent among many tertiary teachers in Guizhou province (Ma, 2019; Wu, 2020). Besides, EFL teachers in Guizhou are unfamiliar with the use of technology and have little motivation to use technology to assist in teaching (Fan & Yang, 2021). When the age ranges of teachers increase, teachers become more unfamiliar with the use of technology (Kazu & Erten, 2014). Therefore, the focus of this study is this region, which is currently underrepresented in literature. A greater understanding of EFL-TPACK within this context is important because it can provide insights into localized teaching strategies, enhance pedagogical outcomes, and address the unique challenges of EFL education in Guizhou, thereby improving the overall quality of English language education in the region.

For the purpose of this study, six EFL teachers with varying levels of proficiency in TPACK and representing diverse backgrounds and teaching experiences were identified. Using a selected modified TPACK coding protocol, which enabled a detailed examination of their teaching behavior to be obtained, an analysis of their video-recorded EFL lessons was conducted. Through this video analysis, insights into the practical integration of technology, pedagogy, and content in the EFL classroom setting were obtained.

II. Theoretical Background

Building upon the Shulman (1986) theory of pedagogical content knowledge, Mishra and Koehler (2006) contributed to the pedagogical paradigm by integrating technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). They delved into the intersections between these knowledge forms, delineating aspects of technological pedagogical knowledge (TPK), technological content knowledge (TCK), and pedagogical content knowledge (PCK; Mishra & Koehler, 2006; Rosenberg & Koehler, 2015). Figure 1 shows the original TPACK framework.

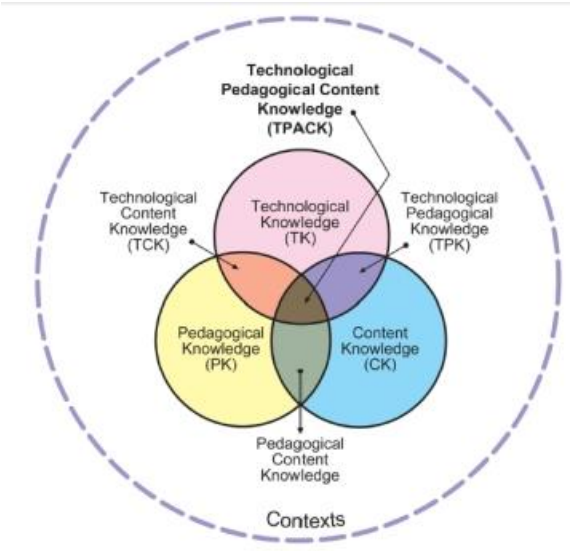

Figure 1. Technological Pedagogical Content Knowledge (TPACK) Framework (Mishra & Koehler, 2006)

This study is intended to provide a detailed examination of EFL teachers' TPACK in higher education in Guizhou, China. It rests on the understanding that TPACK offers teachers a knowledge map, guiding them in effectively integrating technology into their teaching practice (Saubern et al., 2020). Given the growing prominence of educational technology in contemporary classrooms, it is imperative that teachers possess the technological know-how needed to harness educational tools and amplify student engagement and learning outcomes (Cheok et al., 2017).

III. Research Questions

The present study investigates EFL-TPACK by observing the behavior of a sample of teachers in class. In this way, it addresses the following research question: What are the observed characteristics of the EFL-TPACK frameworks of EFL teachers in higher education in Guizhou Province, China?

IV. Methodology

To investigate the observed EFL-TPACK framework of teachers in the classroom, this study explored videos of six teachers of varying levels of proficiency. This use of video recordings allows a researcher to repeatedly play and analyze the behaviors on display. Moreover, video analysis can facilitate the systematic quantification of teaching, which is a common practice in educational research. For example, Nagro and Cornelius (2013) conclude that video analysis is a promising tool for exploring teacher development, and many other researchers have conducted video analyses to study teachers' knowledge and development (Li et al., 2019; Li et al., 2019; Maeng et al., 2013; Vinothinivasodavan et al., 2019). Quantifying EFL-TPACK behaviors in the higher education context of Guizhou Province helps to understand the real situation of EFL teachers' integration of technological pedagogical content knowledge in the classroom, guiding targeted improvements and curriculum development for policymakers. In general, video analysis can facilitate comprehensive and objective analyses of teachers' EFL-TPACK frameworks and may provide valuable references for the promotion of teachers' professional development.

A. Instrument

The instrument in this study is an EFL-TPACK coding protocol based on TPACK theory. The EFL-TPACK-based observation protocol (see Table 1) was adapted from the TPACK behavior observation protocol developed by Luo (2019).

Table 1
EFL-TPACK Framework Behavior Observation Protocol

Coding	Definition	Behaviors
CK	English subject-content knowledge to be acquired by the student.	Behaviors involved with teaching vocabulary, grammar, and any other content knowledge will be coded as CK.
PK	Knowledge of teaching methods and teaching practices.	Behaviors only involved with teaching strategies and methods will be coded as "PK."
TK	Knowledge of ICT tools.	Behaviors only involved with technological knowledge, such as ICT tools, will be coded as "TK."
TCK	Knowledge of how to use technology to present EFL content knowledge.	Behaviors will be coded as "TCK" when teaching only involves the use of technological knowledge to deliver content knowledge.
TPK	Knowledge of how to use technology to accomplish instructional strategies.	Behaviors will be coded as "TPK" when teaching only involves technological and pedagogical knowledge.
PCK	Knowledge of how to use strategies and methods to deliver content knowledge in a way that students can easily acquire.	Behaviors will be coded as "PCK" when teaching involves only using teaching strategies or methods to deliver content knowledge.
TPACK	Knowledge of how to integrate technological pedagogical content knowledge into teaching.	Behaviors will be coded as "TPACK" when EFL teachers deliver content with pedagogical knowledge and technological knowledge in their classrooms.

B. Participants

Six participants were selected based on an EFL-TPACK survey, among which EFL teachers were grouped into quartile levels based on their overall EFL-TPACK score. SPSS was used to calculate the quartile percentile for each range. The possible score range of EFL-TPACK is 36-180, but the survey results for this study produced a range of 93-180. Table 2 shows the levels of EFL teachers' EFL-TPACK quartile percentiles.

Table 2
Levels of EFL Teachers' EFL-TPACK

Level	Range	Number	Percentage
Lower quartile	36-120	76	26.6%
Middle quartile	121-144	140	48.5%
Upper quartile	145-180	70	23.8%

The lower quartile, with a range of 36-120, consists of 76 teachers, accounting for 26.6% of the total respondents. The middle quartile, ranging from 121-144, includes 140 teachers, representing 48.5% of the respondents. Lastly, the

upper quartile, with a range of 145-180, comprises 70 teachers, making up 23.8% of the total respondents. For this study, EFL teachers in the lower quartile were classified as having low EFL-TPACK level, EFL teachers in the middle quartiles were classified as having average EFL-TPACK level, and EFL teachers in the upper quartile were classified as having high EFL-TPACK level.

The findings of the EFL-TPACK survey revealed a significant gender disparity, with 80.44% of the EFL teachers in Guizhou being female and a majority (82.25%) holding a Master's degree. That is why the six chosen teachers for this study, under EFL-expert recommendations and the EFL-TPACK scale, all hold a Master's degree, and five out of six are female. Their basic demographic information is presented in Table 3 below.

TABLE 3
OBSERVATION PARTICIPANTS

Number	Code	Age	Teaching Age	Educational Background	Gender	Level
1	H1	30	4	Master	Female	High
2	H2	32	6	Master	Female	High
3	M1	33	7	Master	Female	Medium
4	M2	38	21	Master	Female	Medium
5	L1	29	3	Master	Female	Low
6	L2	54	30	Master	Male	Low

H1 and H2 belong to high-level EFL teachers who have been teaching English for 4 and 6 years, respectively. M1 and M2 belong to medium-level EFL teachers who have been teaching English for 6 and 7 years, respectively, and L1 and L2 belong to low-level EFL teachers who have been teaching English for 3 and 54 years, respectively. Generally, the selected teachers in the study can represent the general EFL population in higher education in Guizhou Province, reflecting prevalent gender and educational qualifications within this group.

C. Sampling Scheme and Data Collection

We used the purposive sampling method to select videos of six EFL teachers of varying levels of EFL-TPACK, teaching regular classes in universities in Guizhou. Then, the teaching behaviors were coded in chronological order. For instance, in the first minute of Teacher L1's class, the observed behaviors included turning on the computer and presenting slides. There was no teaching strategy or CK involved, so the behavior was coded "TK." The frequency and duration data of all the behaviors were calculated in this way.

D. Data Analysis

We employed a rigorous and systematic approach to analyze the EFL-TPACK frameworks of the six teachers. The instructional videos were played carefully so that each teacher's instructional behavior could be meticulously documented and coded in Microsoft Word, capturing the nuances of the classroom dynamics. This coding involved identifying, timestamping, and recording the frequency and duration of each teaching behavior.

Our analysis centered on the following metrics: the frequency and duration of the behaviors and the frequency and duration of each category as a percentage of the total teaching behaviors. Frequency was calculated as the number of times a behavior occurred, while duration was the total time spent engaging in each behavior. To contextualize these behaviors within the instructional environment, the researchers computed the frequency and duration of each behavior as a percentage of the total number of behaviors and total teaching time, respectively.

This detailed analysis provided a granular view of how the teachers had integrated TK, PK, and CK into their teaching practices. This quantification allowed for a comprehensive evaluation of each teacher's EFL-TPACK framework, providing empirical data crucial for understanding the effectiveness of technology-integrated teaching strategies in EFL classrooms. The statistical results for each factor of the EFL-TPACK frameworks of the six EFL teachers are given in the following chapter.

V. FINDINGS

The findings present a comprehensive analysis of the EFL-TPACK behaviors observed in teachers of varying proficiency levels. Here, we meticulously dissect and interpret the frequency and duration of seven key EFL-TPACK factors – TPACK, PCK, TCK, TPK, PK, CK, and TK – as exhibited by high, medium, and low-level EFL teachers. The findings illustrate the disparities and commonalities in the application of EFL-TPACK among EFL teachers. Table 3 shows the frequency and duration statistics for each factor of EFL-TPACK frameworks of high-level teachers.

TABLE 4
FREQUENCY AND DURATION STATISTICS FOR EACH FACTOR OF EFL-TPACK FRAMEWORKS OF HIGH-LEVEL TEACHERS

	H1				H2			
Factor	Frequency	Frequency Percentage	Duration (Seconds)	Duration Percentage	Frequency	Frequency Percentage	Duration (Seconds)	Duration Percentage
PK	5	13.51%	455	8.43%	8	11.76%	334	6.19%
CK	3	8.11%	104	1.93%	0	0.00%	0	0.00%
TK	1	2.70%	39	0.72%	2	2.94%	23	0.43%
TCK	5	13.51%	489	9.06%	2	2.94%	78	1.44%
TPK	4	10.81%	256	4.74%	1	2.94%	131	2.43%
PCK	1	2.70%	237	4.39%	14	20.59%	634	11.74%
TPACK	18	48.65%	3820	70.74%	41	60.29%	4200	77.78%

Table 1 shows that Teacher H1 engaged in TPACK behavior on 18 occasions, PK 5 occasions, TCK 5 occasions, TPK 4 occasions, CK 3 occasions, and TK once. The TPACK behaviors lasted for 3,820 seconds, TCK for 489 seconds, PK for 455 seconds, TPK for 256 seconds, PCK for 237 seconds, CK for 104 seconds, and TK for 39 seconds. For Teacher H2, the behaviors ranged in frequency (from highest to lowest) as follows: TPACK (41 observations), PCK (14), PK (8), TCK (2), TK (2), TPK (1), and CK (0). The duration of the behaviors was as follows: 4,200 seconds for TPACK, 634 seconds for PCK, 334 seconds for PK, 131 seconds for TPK, 78 seconds for TCK, 23 seconds for TK, and 0 seconds for CK.

There was generally a direct correlation between the frequency of a behavior and its duration, with a higher frequency typically aligning with a longer duration (Na et al., 2017). Teacher H1 received her highest scores for both frequency of TPACK behavior (18 observations) and duration (3,820 seconds). PK and TCK behaviors were observed only five times, with durations of 489 seconds and 455 seconds, respectively. This was because Teacher H1 spent more time on reading practice in their class. When the students read independently, Teacher H1 presented the reading materials with slides. As a result, PK and TCK behaviors were second only to TPACK behaviors in terms of frequency and duration in Teacher H1's classroom.

Teacher H2's highest frequencies were for TPACK and PCK behaviors, which were observed 41 times and 14 times, respectively. H2 engaged in more TPACK behaviors than H1 (who recorded just 18 observations), as H2 performed more practice activities. As a result, H2's TPACK duration was as high as 4,200 seconds. Teacher H2 also scored higher for the proportion of TPACK behaviors than for any other behavior teachers, accounting for 77.78% of the total, indicative of H2's effective integration of pedagogical, technological, and content knowledge. This accounted for up to 77.78% (4,200 seconds) of classroom time—closely followed by PCK, which accounted for 634 seconds. This implies that, even without using technological knowledge, H2 was able to effectively integrate pedagogical knowledge with content knowledge. H2 spent the least amount of time on TCK and TK, seldom using technological or content knowledge by themselves in class, instead preferring to integrate that knowledge. This is further confirmed by the zero utilization rate for CK.

The findings for high-level teachers, showcasing a robust integration of TPACK, resonate with the core tenets of EFL-TPACK research that emphasize the necessity of harmonizing technology, pedagogy, and content knowledge to foster effective language teaching environments (Schmidt et al., 2009). This highlights the advancement in applying TPACK among proficient teachers.

For medium-level EFL teachers, the frequency and duration statistics for each factor of EFL-TPACK frameworks are shown in Table 5.

TABLE 5
FREQUENCY AND DURATION STATISTICS FOR EACH FACTOR OF THE EFL-TPACK FRAMEWORKS OF MEDIUM-LEVEL TEACHERS

	M1				M2			
Factor	Frequency	Frequency Percentage	Duration (Seconds)	Duration Percentage	Frequency	Frequency Percentage	Duration (Seconds)	Duration Percentage
CK	4	8.16%	121	2.24%	12	29.27%	2140	39.63%
PK	2	4.08%	67	1.24%	3	7.32%	69	1.28%
TK	3	6.12%	201	3.72%	2	4.88%	137	2.54%
PCK	2	4.08%	64	1.19%	3	7.32%	65	1.20%
TCK	3	6.12%	131	2.43%	2	4.88%	61	1.13%
TPK	13	26.53%	2037	37.72%	4	9.76%	688	12.74%
TPACK	22	44.90%	2779	51.46%	15	36.59%	2240	41.48%

Teacher M1 engaged in TPACK behaviors 22 times, followed by PCK (13), PK (4), TPK (3), TK (3), TCK (2), and CK (2). The TPACK behaviors had a total duration of 2,779 seconds, while PCK behaviors lasted 2,037 seconds, TK 201 seconds, TPK 131 seconds, PK 121 seconds, CK 67 seconds, and TCK 64 seconds. These data are consistent with those of the high-level teachers, with higher-frequency behaviors also tending to have longer durations (Li et al., 2019).

For Teacher M1, TPACK behaviors were observed most frequently, occurring 22 times and having the longest duration (2,779 seconds), followed by PCK behaviors, which occurred 13 times and had a total duration of 2,037 seconds. This indicates that, even without TK, Teacher M1 was able to integrate PK and CK effectively. This mirrors the findings for Teacher H2, with both receiving their highest percentage scores for TPACK behaviors, followed by

PCK behaviors. On the other hand, the frequencies and durations of the TPK, TCK, PK, CK, and TK behaviors of M1 were relatively low, which may imply that M1 is more inclined to integrate TK into PCK than to rely on PK or CK alone.

Teacher M2's behaviors, from highest to lowest, were as follows: TPACK (15 observations), PK (12), PCK (4), CK (3), TCK (3), TPK (2), and TK (2). TPACK accounted for 2,240 seconds, PK 2,140 seconds, PCK 688 seconds, TK 137 seconds, CK 69 seconds, TCK 65 seconds, and TPK 61 seconds. These data indicate that Teacher M2 allocated a significant amount of time to PK, predominantly by engaging the students in extensive independent reading. During this time, M2 did not use TK to present the reading material or questions, nor did she present anything related to CK. In terms of duration, PK was closely followed by PCK behaviors, which accounted for 688 seconds, indicating that M2 had fully integrated PCK in her classroom.

For M1, TPACK behaviors accounted for the largest percentage of her total behaviors, at 51.46%, followed by PCK at 37.72%. Thus, these two factors combined accounted for 89.18% of the total. TK accounted for 3.72% of the total, followed closely by TPK (2.43%) and PK (2.24%), while CK and TCK were just 1.24% and 1.19%, respectively.

For Teacher M2, TPACK accounted for the largest percentage of the total behaviors, at 41.48%. CK followed closely, with a significant 39.63%—a figure 37.39% higher than that of Teacher M1 for CK (i.e., 2.24%). This high figure is due to Teacher M2's dissemination of self-reading exercises for the students, during which no TK or CK behaviors were observed. As a result, M2's percentages for CK and TK behaviors alone were very low, at 2.54% and 1.28%, respectively. For the same reason, the percentages for TCK and TPK behaviors were also very low, at 1.20% and 1.13%, respectively. Furthermore, the duration of M2's PCK behaviors as a percentage of her total teaching time was 12.74%, which is in third place for M2's behaviors and is much lower than M1's PCK figure of 37.72%. Thus, although they all belong to the same category of teachers—each having a medium EFL-TPACK level—their PCK classroom behaviors vary significantly.

M1 and M2 share a commonality in their EFL-TPACK behaviors: namely, the TPACK constitutes a relatively large portion of their total behaviors, exceeding 40% in each case. However, these figures are much lower than those of the high-level teachers in H1 and H2 (with the latter surpassing 70% of the total durations). Meanwhile, for both M1 and M2, TK and CK behaviors accounted for relatively small percentages, which is consistent with the results for the high-level teachers (H1 and H2).

Generally, the observed discrepancies in EFL-TPACK application among medium-level teachers align with recent discussions in EFL-TPACK literature, pointing toward the varying levels of technological pedagogical integration and its impact on teaching efficacy (Tondeur et al., 2017). It underscores the complexity of achieving TPACK fluency.

TABLE 6
FREQUENCY AND DURATION STATISTICS FOR EACH FACTOR OF EFL-TPACK FRAMEWORKS OF LOW-LEVEL TEACHERS

	L1				L2			
Factor	Frequency	Frequency Percentage	Duration (Seconds)	Duration Percentage	Frequency	Frequency Percentage	Duration (Seconds)	Duration Percentage
CK	8	23.53%	1808	33.48%	16	34.78%	637	11.80%
PK	2	5.88%	81	1.50%	1	2.17%	154	2.85%
TK	3	8.82%	301	5.57%	4	8.70%	138	2.56%
PCK	1	2.94%	72	1.33%	3	6.52%	177	3.28%
TCK	2	5.88%	302	5.59%	3	6.52%	185	3.43%
TPK	4	11.76%	315	5.83%	15	32.61%	3720	68.89%
TPACK	14	41.18%	2521	46.69%	4	8.70%	389	7.20%

Teacher L1's most frequently observed behavior was TPACK, which occurred 14 times and for a total duration of 2,521 seconds. This was followed by PK (8 observations, 1,808 seconds), PCK (4 observations, 315 seconds), TPK (2 observations, 302 seconds) and TK (3 observations, 301 seconds), CK (2 observations, 81 seconds), and TCK (1 time, 72 seconds). In contrast, Teacher L2 exhibited PCK behaviors most frequently, with 15 occurrences lasting a total of 3,720 seconds. This was followed by PK (16 observations, 637 seconds), TPACK (4 observations, 389 seconds), TPK and TCK (3 observations each, 185 seconds and 177 seconds, respectively), TK (4 observations, 138 seconds), and CK (1 time, 154 seconds).

For Teacher L1, the most frequent behavior was TPACK, occurring 14 times over 2,521 seconds. This was unexpected, as this duration was comparable to that of the EFL teachers with medium EFL-TPACK levels. This suggests that L1 is paying significant attention to TPACK in the classroom. Additionally, PK behavior was observed 8 times, lasting a total duration of 1,808 seconds. The other factors—namely, CK, TK, TCK, TPK, and PCK—were less frequent.

For Teacher L2, the behavior observed with the highest frequency (15 observations) and lasting the longest duration (3,720 seconds) was PCK, followed by PK behavior, which was observed 16 times and accounted for 637 seconds. TPACK behavior was the third-most frequent in Teacher L2's classroom, occurring only four times, with a total duration of 389 seconds, indicating that Teacher L2 is a traditional EFL teacher with very traditional teaching methods. Specifically, L2 did not integrate TK, PK, and CK in the class and instead relied on traditional teaching tools, such as chalk and a blackboard. In this setting, TK tools seem to be more of a decorative element than an integral part of the learning environment.

Despite L1 and L2 being categorized at the same low EFL-TPACK level, Teacher L1 more frequently exhibited TPACK behaviors than Teacher L2 did, perhaps because Teacher L1 was younger and more willing to embrace the integration of TK, PK, and CK in the classroom. These differences reflect the different emphases of the two teachers in their respective applications of TPACK in EFL teaching, thus providing valuable perspectives on teachers' individualized strategies for using technology in foreign-language teaching.

TPACK behaviors accounted for 46.7% of the total in Teacher L1's classroom, indicating that Teacher L1 was able to incorporate TK, PK, and CK appropriately in her classroom. The second-highest percentage was for PK, which accounted for 33.5% of the total. In contrast, PCK accounted for the largest percentage of the behaviors observed in Teacher L2's classroom (68.9%), which implies that Teacher L2 is a very traditional teacher who rarely incorporates TK in his classroom. PK received the second-highest score in L2's classroom (11.8%). This highlights a commonality between Teachers L1 and L2 at the very basic level, with pedagogical knowledge (PK) accounting for a substantial proportion of their classroom time (i.e., being the second-most dominant factor in both cases).

In teaching, PK primarily involves knowledge and methods toward engaging more students in the class, including in non-content-related conversations that do not involve CK. However, in a standard EFL classroom, PK behaviors are less common because teaching focuses on developing language skills (Alsowat, 2017; Kawinkoonlasate, 2019). However, in the classrooms of L1 and L2, the rate of PK as a percentage of the total behaviors reached as high as 33.5% and 11.8%, respectively, indicating that these two teachers spent unnecessarily too much time on PK. Conversely, CK, TK, TCK, and TPK were much less commonly observed in both teachers' classrooms.

In summary, although both L1 and L2 exhibited EFL-TPACK behaviors in their classrooms, there was significant variation among the rates of their EFL-TPACK factors. L2 appeared to be more of a traditional EFL teacher, with a teaching approach that primarily relied on conventional methods. In comparison, Teacher L's TPACK behaviors accounted for 46.7% of the total, while PK alone occupied 33.5% of the classroom time and PCK 5.8%. This suggests that L1, when not integrating TK into the lessons, spent too much time on PK and failed to integrate it with CK. The challenges faced by low-level teachers in effectively integrating EFL-TPACK into their teaching practice mirror concerns highlighted in contemporary EFL-TPACK research, stressing the barriers to technology adoption and the urgent need for comprehensive professional development programs (Ertmer et al., 2012). This reflects broader systemic issues in technological integration within EFL contexts.

Meanwhile, the high-level teachers possessed a solid foundation in basic TK, PK, and CK. These teachers had in-depth understandings of CK and PK, including grammar, vocabulary, and cultural context; how to design instructional activities; and which methods to use to motivate students. Furthermore, these high-level teachers studied TK in depth, enabling them to use technology proficiently in the classroom and integrate it smoothly into their teaching (Alhababi, 2017). Additionally, the high-level teachers could seamlessly integrate TK, PK, and CK into their classrooms through a wide range of practices, with TPACK behaviors ultimately accounting for over 70% of all the teaching behaviors observed in their respective classrooms. Even when technology was not being used, the use of PCK remained relatively frequent.

The medium-level teachers, as characterized by their individual EFL-TPACK frameworks, exhibited solid foundational level TK, PK, and CK. However, their integration of these elements—as evidenced by their TPACK behaviors—was weaker than that of the high-level teachers. Their TPACK behaviors usually accounted for around 50% of the total duration of all teaching behaviors, a figure much lower than those of the high-level teachers (which were all over 70%).

Furthermore, considering the TPACK behaviors of low- and medium-level EFL teachers, ranging from 7.2% to 51.46%, which is far less than the 70.74% to 77.78 % of high-level teachers, there is a need for low- and medium-level EFL teachers to catch up with high-level teachers. In addition, both medium- and low-level EFL teachers tend to invest too much time in PK, with these teachers often sharing their personal opinions and life experiences in their classrooms in order to improve the relations between themselves and the students. This suggests that medium-level teachers have a relatively average ability to integrate TK, PK, and CK into their classrooms (Yang et al., 2023).

In contrast, low-level teachers lack TK and PK and do not understand how to integrate TK into PCK. For older teachers, there was a lack of competence in the use of technology to assist teaching, an unfamiliarity with modern teaching tools, and difficulties effectively integrating these tools into teaching practice (Liang et al., 2013; Nursiah et al., 2021). This reduced the potential for integration of TK into teaching. Instead, this group of teachers was characterized by a greater integration of PK and CK, leading to higher frequencies of PCK behaviors in their classrooms.

The gap between traditional low-level teachers and high-level teachers in terms of their respective TPACK behaviors reached up to 70.58%, highlighting significant disparities in their teaching approaches. The younger teachers, who generally possessed stronger TK than their older counterparts, actively sought to integrate TK, PK, and CK in their classrooms, though this integration was not always reflected in higher percentages of use. In addition, both young and older EFL teachers evidenced some limitations in their PK, which is reflected in the classroom as a monotonous teaching activity; for instance, their classes have repetitive chit-chats and less dynamic and interactive sessions, reducing opportunities for students to participate actively in learning.

Every EFL teacher has an EFL-TPACK framework that is dynamic, complex, and influenced by many factors (Taopan, 2020). EFL teachers' own teaching experiences and teaching topics all have an impact on the frequency and

duration of their EFL-TPACK behaviors (Baser et al., 2016; Hsu, 2016). Among teachers of varying proficiency levels, there are both similarities and differences that are attributable to numerous factors. Although all of the teachers in this study attempted to incorporate technology into their classrooms, they each had a different focus, with high-level teachers focusing on the integration of TK, PK, and CK. As a result, the high-level teachers had the highest frequency of TPACK behaviors, followed by the medium-level teachers and then the low-level teachers. Teachers at the lower level exhibited predominantly PCK behaviors, which can be attributed to the less-effective integration of technology into their teaching practice (Çam & Erdamar Koç, 2021). These results underscore the need for targeted professional development in the integration of TK, PK, and CK.

This study's limitations lie in the potential observer bias and the limited observation participants. Hence, future research could explore longitudinal changes in TPACK application post-intervention or examine similar frameworks in different cultural or regional contexts. This study contributes to a deeper understanding of the TPACK framework in EFL instruction, emphasizing the importance of ongoing teacher development in educational technology integration.

VI. Conclusions

This study provides a comprehensive analysis of EFL-TPACK behaviors among EFL teachers of varying proficiency levels, revealing significant disparities and commonalities in the application of TPACK. High-level teachers demonstrated superior frequency and duration in TPACK behaviors, reflecting their adept integration of technological, pedagogical, and content knowledge. In contrast, while medium-level teachers possessed foundational TPACK frameworks, their integration capabilities fell short of those exhibited by high-level teachers. Low-level teachers showed considerable gaps in the TPACK application, predominantly relying on traditional teaching methods and showing lower technological integration skills. These findings underscore the challenges faced by EFL teachers of different levels in enhancing teaching efficiency and student learning, highlighting the urgent need for targeted professional development and technology integration training. Improving teachers' TPACK abilities, especially in the use of technology, is crucial for enhancing the quality of language teaching and student learning outcomes. This study offers deep insights into the TPACK framework within EFL instruction and emphasizes the importance of ongoing teacher development in educational technology integration.

VII. Implications

To address the disparities between EFL teachers in Guizhou's higher education settings in terms of EFL-TPACK frameworks, it is imperative to devise strategies that cater to varying levels of teaching proficiency. The study's findings indicate a pronounced gap in the effective integration of these components, particularly between high-level and low-level teachers.

One pivotal implication strategy involves the enhancement of technological integration skills. This is crucial for low-level teachers who demonstrate a less-effective integration of technology in their practice. Comprehensive training sessions focusing on the utilization of digital tools and their incorporation into language teaching are essential. These sessions should be interactive and practical, allowing teachers to experiment with and adapt to various technological tools relevant to the teaching context. Furthermore, the establishment of mutual-learning programs in which high-level teachers can share their successful practices and experiences could significantly benefit less-experienced teachers. This would foster a collaborative environment and provide a platform for ongoing professional development.

In addition, a balance between emphases on pedagogical and content knowledge is crucial. This study has highlighted instances of disproportionate focus on PK, necessitating a more-balanced approach to lesson planning. This balance could be achieved through workshops and training sessions that focus on innovative pedagogical strategies and content-delivery methods tailored to the needs of EFL learners. In addition, reflective teaching practices in which teachers analyze their instructional videos to identify strengths and areas for improvement could lead to more effective and engaging teaching methodologies. Such reflective practices should be complemented by regular assessments and constructive feedback, facilitating a continuous learning and improvement process for teachers.

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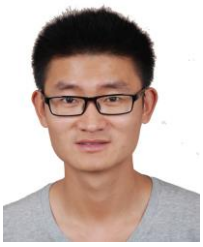

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