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Research on the Effectiveness of TPACK Training Module for University Teachers in Qingdao

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Abstract

This study investigates the effectiveness of a specially designed TPACK training module tailored for university teachers at Qingdao University. The TPACK module was developed based on the needs of university educators and validated by experts. To implement and evaluate the impact of the training, 37 university teachers voluntarily participated in a three-month blended training program. Data collection employed a pre-test and post-test design to assess the effectiveness of the TPACK module. The study contributes to educational management by emphasizing the critical role of targeted, integrated, and practical training modules. The training also enhanced university teachers' self-efficacy, confidence, and commitment to effectively integrating information technology into classroom teaching and management. This research deepens our understanding of teacher development and provides broader implications for educational management development, offering valuable insights for educational administrators and trainers aiming at foster innovation and technology proficiency among university educators.

Keywords: TPACK Training Module, University Teachers, Educational Management

Introduction

In the contemporary educational landscape, the rapid expansion of online learning in universities has transformed the role of university teachers. The effective integration of technology into teaching practices has emerged as a linchpin for the success of modern education. This area of study is of utmost importance due to several compelling reasons. China's substantial efforts in educational informatization, including the provision of extensive hardware resources and teacher training, have laid a solid foundation. However, the persistent issues of teachers' resistance to new technologies and lack of initiative in TPACK training cannot be overlooked. These problems not only impede the full realization of the potential of educational technology but also limit the quality of education students receive.

The study of this topic is crucial for multiple stakeholders. For teachers, it offers insights into how to overcome technological barriers, enhance their teaching skills, and better manage classrooms in the digital age. By improving their technological competencies, teachers can create more engaging and effective learning environments. For students, better - integrated technology in teaching means more interactive and personalized learning experiences, which can lead to improved academic performance. Universities, as institutions, benefit from having a more technologically - savvy teaching faculty, as it can enhance their reputation and competitiveness in the global educational market. In essence, this research is essential for bridging the gap between the availability of educational technology and its actual implementation in the classroom. By focusing on the utility and effectiveness of integrating technology into teaching, it can provide practical solutions to the current challenges faced by university teachers, ultimately leading to a more effective and efficient educational system.

Literature Review

TPACK Framework

Koehler and Mishra (2005) proposed the Technological Pedagogical Content Knowledge (TPACK) framework, highlighting that teachers need to develop a personalized learning system referred to as "technological internalization" to meet the demands of digitalization. This framework aims to integrate Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK) in teaching, providing a critical theoretical foundation for the effective application of technology in education.

TPACK is defined as a framework for teachers' knowledge in integrating technology into teaching. It comprises three primary components: Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). These components interact and combine to generate four additional elements: Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Technological Pedagogical Content Knowledge (TPACK), as illustrated in Figure 2.1.

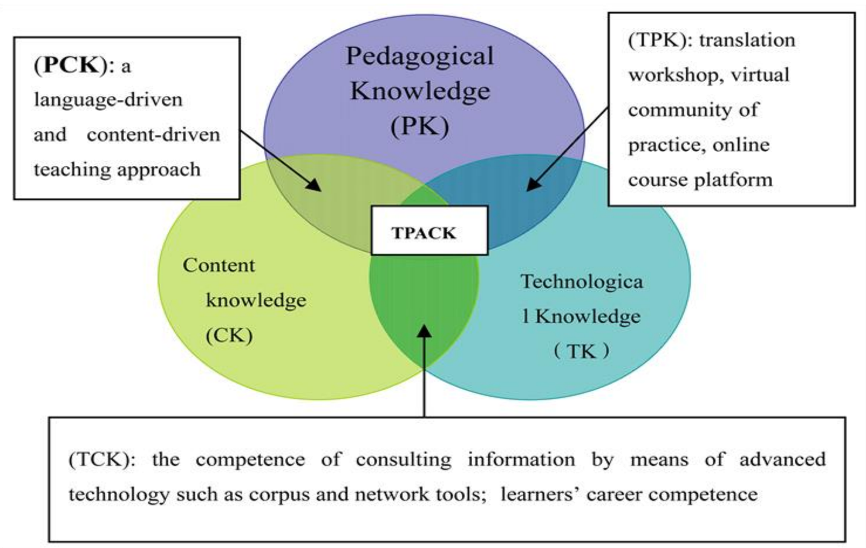

Figure1 TPACK Framework
Source: Koehler and Mishra (2005)

University Teacher TPACK Training Development

University teachers are the primary focus of TPACK training research, and scholars have extensively studied the development of TPACK among university educators from various perspectives. Alsofyani et al. (2012) found that adult learners tend to prefer a combination of teaching methods, including lectures, demonstrations, practice, and feedback, particularly when these methods are structured, teacher-led, and delivered within effective time frames. Rienties et al. (2013) argued that universities should provide sufficient training for teachers to enhance their understanding of the complex interplay between technology, pedagogy, and content knowledge within their disciplines.

Zhang et al. (2015) incorporated the TPACK framework into school-based educational technology training programs for university teachers, noting that it significantly improved the scientific rigor and effectiveness of such training. Leiva et al. (2018) emphasized the importance of systematically integrating ICT into teaching processes at Playa Ancha University, highlighting the need for educators to develop ICT-related competencies. Zhang and Zhou (2023) underscored the critical role of acquiring Technological Pedagogical Content Knowledge (TPACK) in the professional development of novice university teachers. Research indicates that the TPACK training module significantly enhances teacher training in classroom teaching and management by addressing contextual factors and supports their initial training efforts (Ortiz Colón et al., 2023).

TPACK Training Module Development and Application Research
The application and implementation of training modules for the development of university teachers' TPACK have been widely explored. Alsofyani et al. (2012) discussed the use of Short-term Blended Online Training (SBOT) to enhance TPACK and found it to be an excellent method for promoting e-learning adoption. Perla et al. (2018) established a "traceability" model linking the DigiCompEdu framework to school-based TPACK training through Italy's National Digital Plan (PNSD).

Souphanh (2019) proposed a CDIO training model centered on improving teachers' TPACK competencies, demonstrating its effectiveness in enhancing TPACK and IT application skills in resource-limited developing countries. Li (2021) designed a training model for empowering teachers with RALL (Robot-Assisted Language Learning) knowledge based on the TPACK framework. Cheng et al. (2022) validated the DECODE model as a comprehensive process for improving pre-service teachers' TPACK and supporting them in designing technology-integrated lessons.

Zhang *et al.* (2023) developed a BOPPPS–TPACK training model based on four key design principles: digital tool-based, pedagogy-driven, micro-teaching integrated, and creativity-enhanced. These efforts collectively highlight diverse approaches to strengthening TPACK through structured and innovative training modules.

In summary, the current research on TPACK ability enhancement training for university teachers is a hot topic and a relatively important research direction in the future. However, there are few experimental research. Thus, this study did the one-group pre-post test design to prove the effectiveness of the TPACK training module.

Research Methodology

The one-group pre-post test design is a type of quasi-experimental research design where a single group of participants is tested on a particular variable or outcome before and after an intervention or treatment. The goal is to measure the change in the group's performance or behavior due to the intervention, using pretest and posttest measurements. It is a relatively simple design to implement, especially when resources for a control group or randomization are not available (Zabor et al., 2020).

For this study, the researcher validated the TPACK training module through one-group pre-post test design. All teachers in the faculty of the author's university were selected as the study population, and the TPACK training course was conducted for all teachers over a period of 10 weeks with a total of 38 hours.To evaluate the effectiveness of the TPACK training modules, A pre-test is done to the university teachers before the training process. The teachers then participate in a ten-week TPACK training program, which integrates various technological tools into pedagogy and content delivery. After the training, the same test paper is given to the teachers to measure any changes in their abilities to integrate technology, pedagogy, and content knowledge. The results will be analyzed through a paired t-test to see if there is a statistically significant improvement in the teachers' TPACK levels.

Findings

Normality Analysis of the Pre-post Test

Based on the provided Shapiro-Wilk normality test results, an analysis of the normality of pre-test and post-test data can be conducted. The Shapiro-Wilk test is a statistical method which is often used to determine whether a sample follows a normal distribution. Its primary outputs include the test statistic, degrees of freedom (df), and significance level (Sig.) (De Souza et al., 2023).

The test statistic reflects the degree of normality in the sample, with values closer to 1 indicating that the data more closely approximate a normal distribution (Pinkovetskaia et al., 2021). Degrees of freedom (df) represent the sample size and are used in the calculation of the test statistic (Ryan, 2013). The significance level, commonly referred to as the p-value, is used to decide whether to reject the null hypothesis (i.e., that the data follow a normal distribution). When $p > 0.05$, the null hypothesis is accepted, indicating that the data are normally distributed. Conversely, when $p < 0.05$, the null hypothesis is rejected, suggesting that the data do not follow a normal distribution (Biau et al., 2010).

Table 1
The Normality of Pre-post Test

Test	Shapiro-Wilk		
	Statistic	df	Sig.
Pre-test	0.9442	37	0.0628
Post-test	0.9572	37	0.1645

Resource: Lilliefors Significance Correction

The Shapiro-Wilk test results indicate that the statistic for the pre-test is 0.9442 ($W = 0.9442$), which is close to 1, suggesting that the data distribution is approximately normal. The significance level for the pre-test is 0.0628 ($P = 0.0628 > 0.05$). Since the P-value exceeds 0.05, the null hypothesis is accepted, indicating that the pre-test data conforms to a normal distribution. Similarly, the statistic for the post-test is 0.9572 ($W = 0.9572$), which is even closer to 1, further confirming that the data distribution is nearer to normality. The significance level for the post-test is 0.1645 ($P = 0.1645 > 0.05$). Given that the P-value is greater than 0.05, the null hypothesis is accepted, suggesting that the post-test data also adheres to a normal distribution.

In summary, according to the Shapiro-Wilk test results, the significance levels for both the pre-test and post-test data exceed 0.05, indicating that both datasets are consistent with a normal distribution (Ikhlas & Abidin, 2024). Consequently, subsequent data analysis may employ statistical methods based on the assumption of normal distribution, such as the paired samples t-test, to further examine the differences between pre-test and post-test data (Afifah et al., 2022). With the confirmation of this normality assumption, researchers can proceed with greater confidence in applying analytical methods that assume a normally distributed dataset, such as Analysis of Variance (ANOVA) or linear regression (Jain, 2019).

Mean Score and Standard Deviation Analysis of the Pre-post Test

Prior to assessing the differences in post-intervention test scores, this study first analyzed the mean scores and standard deviations of the two test administrations to determine whether the training participants had improved their knowledge and abilities after the training. The results are presented in the following table.

Table 2
Mean Value and Standard Deviation of the Pre-post Test

Test	N	Mean	SD
Pre Test	37	83.19	4.47
Post Test	37	86.27	5.70

Based on the descriptive statistics of pre-test and post-test outcomes, an analysis was conducted to evaluate the performance changes of the 37 participants. The mean score in the post-test was higher than that of the pre-test, with a difference of 86.27 - 83.19 = 3.08. The increase in mean scores indicates an improved performance among participants following the intervention, training, or instructional module. Lachner et al. (2021) similarly found that teachers in courses incorporating a TPACK module achieved higher TPACK scores compared to those in control courses without a TPACK module. Diamah et al. (2022) conducted a paired t-test on teachers' TPACK training and revealed that post-test scores on all TPACK dimensions were significantly higher than pre-test scores, with a substantial effect. Additionally, they identified through qualitative analysis of student reflections that pre-service teachers understood the role of integrating technology within the TPACK framework to create meaningful learning experiences.

The standard deviation in the post-test was slightly higher than that in the pre-test (5.70 > 4.47), suggesting greater variability in post-test scores. This may indicate a more diverse response to the training intervention among participants, potentially reflecting differences in individual learning outcomes or engagement with the material.

The increase in mean scores suggests a general improvement in performance, which may be attributed to the TPACK training or educational intervention. However, the higher standard deviation in the post-test indicates that, although the intervention may have been effective for most participants, there was some variability in the outcomes. This could be due to differences in prior knowledge, learning pace, or the application of training content (Absari et al., 2020).

Paired Sample T-test Analysis of the Pre-post Test
To further validate these findings, a paired samples t-test was conducted to determine if the improvement in scores was statistically significant. The data collected are as follows.

Table 3
Paired Sample T-test of Pre-post Test

	Paired Sample T-test		Significance
Pre-Test	t	df	two-tailed P-value
Post-Test	-2.586	73	0.01172

The analysis of the provided paired samples t-test data reveals the following regarding the difference between pre-test and post-test scores:
The test statistic is -2.586 (t=-2.586), indicating a negative average difference between pre-test and post-test scores. This implies that the mean score in the post-test is significantly higher than that of the pre-test, aligning with the anticipated trend of a positive improvement. The negative t-value, in conjunction with the mean scores (a lower mean in the pre-test and a higher mean in the post-test), suggests a significant enhancement in participants' performance following the intervention.

The two-tailed P-value is 0.01172 (P=0.01172), which is below the significance threshold of 0.05. At the 95% confidence level, this indicates that the average difference between the pre-test and post-test is statistically significant, leading to the rejection of the null hypothesis (i.e., there is no difference between the two means). The two-tailed P-value less than 0.05 confirms a significant difference between the pre-test and post-test, suggesting that the intervention or training (e.g., the TPACK training module) has a substantial impact on enhancing participants' skills (Shah, 2022).

The results demonstrate a positive effect of the intervention, as evidenced by the significant improvement in participants' abilities post-training. The outcomes of the paired samples t-test reveal a statistically significant difference between the pre-test and post-test, supporting the efficacy of the TPACK training module in enhancing participants' knowledge and skill levels and underscoring its value in achieving the intended outcomes. Diamah et al. (2022) also suggested that teachers' awareness of TPACK increased at the conclusion of the training. They recommended that TPACK training programs, which facilitated future teachers' integration of technology, content, and pedagogy to create effective technology-enriched learning environments in their subject areas, should be incorporated into teacher education programs. Soko and Samo (2023) noted that teaching and training experiences have a positive impact on teachers' TPACK.

Discussion
The effectiveness of the TPACK training module for university teachers typically emphasizes the positive impact of such training on enhancing their ability to integrate technology, pedagogy, and content knowledge. Through structured learning modules, educators have augmented their skills in using technology to design innovative teaching methods and address real-world educational challenges (Chaipidech et al., 2021). Hubbard (2022) has

demonstrated that the training enhances their professional growth, supports the development of modern teaching strategies, and bridges the gap in technological proficiency. Evaluation data often reveal significant improvements in pre- and post-training assessments, further validating its effectiveness (Saralar-Aras & Güneş, 2024).

Beyond the marked enhancements in their pre-post test score comparisons, university teachers' weekly learning records, such as online video learning sessions, check-in times, assignment scores, and classroom test scores, also indicate substantial learning and engagement within their TPACK training courses. Ammade et al. (2020) found that teachers reported improvements in their teaching abilities following online TPACK training courses, which corresponded to a moderate improvement in teaching efficiency. Lachner et al. (2021) conducted research on teachers and discovered that those enrolled in courses with a TPACK module acquired a greater degree of TPACK.

Conclusion

The implementation of a three-month blended TPACK training program demonstrated a significant enhancement in the participants' TPACK competencies, as evidenced by the pre-post test outcomes.

The findings underscore the strategic role of TPACK in educational innovation and provide recommendations for educational policymakers and administrators to integrate technology-focused training into institutional frameworks. This includes fostering interdisciplinary collaboration and optimizing resources through the use of digital tools.

The study offers a replicable model for professional development initiatives that promote sustained growth among university teachers and the integration of technology into teaching practices. This aligns with the global trend towards the digital transformation of education, particularly within higher education settings.

Furthermore, the research suggests several directions for future inquiry, such as conducting longitudinal studies to assess the long-term impact of TPACK training, expanding research on personalized learning pathways within the TPACK framework, and exploring the cross-cultural adaptability of TPACK training modules across diverse educational contexts.

In conclusion, this study makes a significant contribution to the advancement of teacher professional development and the integration of technology in education. By addressing both theoretical and practical dimensions, it paves the way for enhancing teaching efficiency and supporting the digital transformation of global educational systems.

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