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Research Article

Assessing Technological Pedagogical Content Knowledge (TPACK) and Teaching Effectiveness of Senior High School Teachers: An Input for Teacher Development Plan

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Abstract

This study investigates the Technology-Enhanced Pedagogical Skills and Technological Pedagogical Content Knowledge (TPACK) levels among senior high school teachers in Biñan City, highlighting the importance of integrating technology effectively in education. Technology-Enhanced Pedagogical Skills are crucial for enhancing learning outcomes through the appropriate use of technology in teaching specific subjects. The study involved 54 teachers from seven schools who were selected based on their proficiency in digital tools. Using a survey questionnaire, the research assessed teachers' TPACK competency, socio-demographic backgrounds, and perceived teaching effectiveness. The findings aim to determine the correlation between TPACK levels and teaching effectiveness and provide insights for educational policies and professional development programs to enhance technology integration in teaching practices, ultimately improving student learning experiences and outcomes.

Keywords: *teaching effectiveness, pedagogical skills, quantitative study, technology*

INTRODUCTION

In the ever-evolving landscape of education, technological advancements and pedagogical innovations have played integral roles in shaping teaching methodologies and learning outcomes (Hamzah et al., 2024). This study explores the complex relationship between teachers' technological pedagogical content knowledge (TPACK) and teaching effectiveness within the context of the Philippines, drawing insights from global educational trends.

Internationally, educational paradigms have undergone a transformative shift, emphasizing the integration of technology, pedagogy, and content knowledge (Malik, 2018). Worldwide, educators are navigating the dynamic interplay between traditional teaching methods and the demands of the digital age. As nations endeavor to equip students with 21st-century skills, the integration of technology into education emerges as a central theme.

Focusing on the Philippines, particularly considering the Department of Education's initiatives and the implementation of the K-12 curriculum, provides a unique and important perspective. The K-12 curriculum extends basic education and prepare students for the modern world while meeting global standards while addressing local needs. Understanding TPACK's role in this transitional period offers valuable insights into localizing global benchmarks and addressing unique challenges.

The Philippines faces distinct challenges in integrating technology, such as infrastructure issues and varying levels of technological proficiency among teachers and students. Studying TPACK in this context can highlight effective strategies for overcoming these challenges and serve as a model for other developing countries. Additionally, the diverse cultural and socio-economic

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landscape of the Philippines influences technology integration in education. This study can provide insights into how these factors affect TPACK, leading to more relevant professional development and educational interventions.By focusing on the Philippines, this study provides a detailed understanding of TPACK's impact on teaching effectiveness within the local educational framework, informing policymaking, curriculum development, and teacher training tailored to Filipino educators. While centered on the Philippines, the study's findings also contribute to the global discourse on TPACK, offering comparative insights and lessons for other countries facing similar educational reforms and technology integration challenges.

Legally, this research study adheres to relevant policies and guidelines set forth by educational authorities in the Division of Biñan City, ensuring the provision of quality education and promoting technological integration in the curriculum. Specifically, this study aligns with the Department of Education Order No. 1, Series of 2007 (DO 1, s. 2007), which strengthens Information Communication Technology (ICT) governance within the Department of Education. Ethically, the research seeks approval to safeguard participant privacy and well-being.

Several compelling reasons drive our exploration of the intricate relationship between teachers' TPACK and teaching effectiveness in the Philippines. Globally, as education undergoes rapid transformations, there is an urgent need to understand how technology integration impacts teaching methodologies and student learning outcomes (Hero, 2019). Moreover, within the evolving landscape of the Philippines, uncovering the nuanced dynamics of TPACK and its implications for effective teaching in senior high schools is crucial.

Despite increasing recognition of the importance of TPACK, a significant research gap persists. Existing empirical studies, such as those by Chang (2022), are largely contextualized within specific educational environments such as Singapore and Taiwan. This narrow focus limits the understanding of TPACK's broader applicability and impact, particularly in the unique context of the Philippine educational setting (Lee et al., 2022). The scarcity of empirical studies in the Philippines hampers a comprehensive understanding of TPACK's influence on teaching effectiveness. This study aims to fill this gap by drawing insights from international trends and addressing the specific challenges facing the Philippine educational environment. By doing so, we hope to contribute valuable knowledge that will inform policymaking and enhance pedagogical practices, ultimately improving education quality in senior high schools.

This research contributes to the existing literature on TPACK and teaching effectiveness and provide valuable insights for faculty development programs (Falloon, 2020). By identifying the specific areas of TPACK that are most strongly correlated with teaching effectiveness, educational institutions can design targeted interventions to enhance teachers' TPACK competencies and improve overall teaching quality.

This research provides valuable insights into how TPACK influences the effectiveness of senior high school teachers and to offer practical recommendations for teacher development plans. Therefore, based on the critical issues that have already been explained, this study aims to address the following questions:

1. What is the socio-demographic profile of the teacher-respondents in terms of age, sex, civil status, highest educational attainment, length of service, and position?
2. The level of TPACK of senior high school teachers in the Division of Biñan City in terms of technological knowledge, pedagogical knowledge, and content knowledge?
3. What is the perceived level of teaching effectiveness of teachers in terms of fluency and cognitive flexibility?
4. Is there a significant relationship between teachers' TPACK levels and teaching effectiveness?
5. Do the dimensions of teachers' TPACK, singly or in combination, predict teaching effectiveness?

6. What Teacher Development Plan can be proposed based on the salient findings of the study?

LITERATURE REVIEW

Introduction to TPACK Framework

Mishra and Koehler (2019) introduced the TPACK framework, highlighting the importance of integrating technological knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK) for effective teaching. This framework is especially pertinent in senior high school education, where the subject matter is complex and instructional delivery must be highly effective.

Leong and Yunus (2024) described fluency as the seamless integration of TK, PK, and CK, thus enabling teachers to deliver effective instruction. This integration is vital for creating cohesive and engaging learning experiences that cater to the diverse needs of senior high school students.

According to Brackett, et. al. (2019), cognitive flexibility is a critical component of effective teaching. This allows educators to adapt their teaching strategies to meet diverse student needs, thus fostering a more inclusive and responsive educational environment.

Gierhart (2020) emphasized the role of professional development programs in enhancing educators' TPACK competencies. These programs equip teachers with the skills needed to navigate technology-rich environments and effectively integrate TPACK into their teaching practices. This is particularly important in senior high schools, where technology integration can significantly enhance student engagement and learning outcomes.

Challenges in the Philippine Context

In the Philippines, the implementation of the K-12 curriculum has increased the demand for effective TPACK integration among senior high school teachers. However, challenges such as limited access to resources, varying levels of technological proficiency, and diverse socioeconomic backgrounds of students complicate this integration. Despite these challenges, various professional development initiatives have been launched to address gaps in technological, pedagogical, and content knowledge. However, empirical studies specific to the Philippine context are needed to understand how TPACK influences teaching effectiveness.

This study aims to fill this gap by examining the current levels of TPACK among senior high school teachers in the Philippines and exploring the relationship between TPACK and teaching effectiveness. The findings will provide insights that can inform policymaking and enhance pedagogical practices, ultimately contributing to improving education quality in senior high schools.

Research Insights

Research by Kereluik et al. (2013) demonstrated that TPACK integration promotes adaptable, student-centered learning environments. Tseng and Lin (2024) also explored TPACK's role in designing effective assessment strategies, which are crucial for aligning assessments with modern technological advancements and diverse student needs.

Schmidt, et. al. (2019) highlighted the need for reliable tools to measure TPACK proficiency. While Sailer, et al. (2021) emphasized the consideration of cultural factors when implementing TPACK. Lee and Kim (2023) stressed the importance of adapting TPACK strategies to specific subjects, like mathematics. Taimalu and Luik, (2019) focused on the role of continuous professional development. Development in sustaining and enhancing TPACK skills, ensuring ongoing improvements in teaching and student outcomes.

To support senior high school educators effectively, the TPACK framework must evolve with technological advancements and changing educational environments. Professional development should aim to enhance educators' TPACK skills, encourage reflective practices, and

foster collaboration among peers. TPACK strategies should be tailored to diverse cultural contexts to ensure inclusive and equitable teaching practices.

Hypothesis Development

Based on a comprehensive review of relevant literature, including studies by Moher et al. (2019), Durusoy and Karamete (2023), and Sailer et al. (2021), this study formulates the following hypotheses to explore the relationship between Technological Pedagogical Content Knowledge (TPACK) and teaching effectiveness:

1. **Null Hypothesis (H0):** There is no significant relationship between the level of TPACK among senior high school teachers in Biñan City and their teaching effectiveness.
2. **Hypothesis 1:** There is a positive relationship between teachers' TPACK levels and their teaching effectiveness.
3. **Hypothesis 2:** Participation in professional development programs positively influences teachers' TPACK competencies.
4. **Hypothesis 3:** The effectiveness of TPACK-based teaching strategies varies according to the cultural context of the educational setting.
5. **Hypothesis 4:** Higher levels of TPACK among teachers are associated with increased student engagement and participation.

RESEARCH METHOD

Study Overview

This study focused on senior high school educators in the Division of Biñan City, with 54 participants from seven schools. Participants were predominantly millennial teachers who were chosen for their proficiency in digital tools and experiences that are conducive to effective technology integration in education.

The final Cronbach's alpha value was 0.91, indicating high internal consistency and reliability of the questionnaire used in this study. The pilot test involved 30 respondents who provided initial data to assess and refine the questionnaire's reliability and validity before full-scale deployment.

This study employed a correlational research design to investigate the relationship between TPACK and teaching effectiveness among senior high school teachers. This approach, as defined by Fornell and Larcker (2019), examines the associations between variables without manipulating independent variables. This research determined the nature and extent of correlations between TPACK and teaching effectiveness using statistical tools like correlation coefficients.

This study focused on senior high school educators in the Division of Biñan City, with 54 participants from seven schools. Participants were predominantly millennial teachers chosen for their proficiency in digital tools and experiences conducive to effective technology integration in education.

Sampling and Data Collection

Purposive sampling was used to select millennial teachers with advanced digital knowledge (TPACK proficiency) from the senior high school teacher population in the Division of Biñan City. Data collection involved a detailed questionnaire designed to gather sociodemographic information and assess TPACK levels and perceptions of teaching effectiveness.

The questionnaire was first tested in a pilot phase to ensure its reliability. The pilot test involved 30 respondents, who provided initial data to assess and refine the questionnaire's reliability and validity. The Cronbach's alpha value obtained during the pilot test was 0.87, indicating high internal consistency (Vigatto et al., 2019).

FINDINGS AND DISCUSSION

Table 1. Demographic characteristics of the respondents

Category	Details
Age Distribution	27–35 years: 28% (n = 15)
	36–44 years: 39% (n = 21)
	45–53 years: 16.5% (n = 9)
	54–62 years: 16.5% (n = 9)
Gender Distribution	Female: 59% (n = 32)
	Male: 41% (n = 22)
Civil Status	Married: 67% (n = 36)
	Single: 28% (n = 15)
	Widowed: 5% (n = 3)
Educational Attainment	Bachelor's Degree: 39% (n = 21)
	Master's Degree: 39% (n = 21)
	Bachelors with Master's units: 11% (n = 6)
	Doctorate: 7% (n = 4)
	Masters with Doctoral units: 4% (n = 2)
Length of Service	1–10 years: 78% (n = 42)
	11–20 years: 22% (n = 12)
Position	Teacher II: 89% (n = 48)
	Teacher III: 4% (n = 2)
	Master Teacher II: 4% (n = 2)
	Teacher I: 3% (n = 2)

Final Cronbach's Alpha for the Full Study:

The final Cronbach's alpha value for the questionnaire was 0.91, further confirming the high internal consistency and reliability of the instrument used in this study.

Ethical standards were strictly adhered to throughout the study. Permissions were obtained from the school authorities, and approval was secured from the School Division Office of Biñan City. The confidentiality of the respondents' data was maintained using secure methods such as Google Forms for data collection.

Validity Test Results for the Pilot Test

The content validity of the questionnaire was ensured by a panel of experts in educational technology and pedagogy. These experts reviewed the items to ensure that they comprehensively covered the TPACK domain. Their feedback was used to enhance the clarity, relevance, and comprehensiveness of the questionnaire, which contributed to its high content validity. In addition, construct validity was assessed through Exploratory Factor Analysis (EFA). This analysis revealed that items are grouped into distinct factors corresponding to different components of TPACK, which confirms the theoretical framework of TPACK.

Detailed Presentation of TPACK Levels

Table 2. TPACK Level of Senior High School Teachers: Technological Knowledge

Indicator	M	SD	Scaled Response	Descriptive Interpretation
1. I am familiar with various technological tools and platforms.	4.09	0.90	Agree	High
2. I can seamlessly integrate technology into my lesson planning.	4.15	0.76	Agree	High
3. I am competent in selecting suitable technologies for various content areas.	4.02	0.81	Agree	High
4. I feel comfortable handling technological issues that may arise in the classroom.	3.96	0.82	Agree	High
5. can efficiently store, organize, and retrieve digital data resources.	4.07	0.82	Agree	High
Composite	4.06	0.74	Agree	High

Table 3. Factor Loadings of Key Technological Knowledge Items

Item	Loading
1. I am familiar with various technological tools and platforms.	0.72
2. I can seamlessly integrate technology into my lesson planning.	0.75
3. I am competent in selecting suitable technologies for various content areas.	0.68

These loadings indicate the strength of each item's relationship with the Technological Knowledge factor, showing good alignment with the overall construct.

Table 4. TPACK Level of Senior High School Teachers: Content Knowledge

Indicator	M	SD	Scaled Response	Descriptive Interpretation
1. I believe that technology enhances my understanding of the Senior High School curriculum.	4.50	0.61	Strongly Agree	Very High
2. I find that technology helps me engage more actively in various content areas.	4.46	0.61	Agree	High
3. I perceive that technology improves my ability to analyze and interpret data.	4.44	0.63	Agree	High
4. I believe that technology supports collaboration and communication in Senior High School projects.	4.54	0.61	Strongly Agree	Very High
5. I think technology makes learning more enjoyable and engaging.	4.56	0.60	Strongly Agree	Very High
Composite	4.50	0.52	Strongly Agree	Very High

Table 5. Factor Loadings of Key Content Knowledge Items

	Item	Loading
1.	I believe that technology enhances my understanding of the Senior High School curriculum.	0.70
2.	I find that technology helps me engage more actively in various content areas.	0.73
3.	I perceive that technology improves my ability to analyze and interpret data.	0.69

Table 6. TPACK Level of Senior High School Teachers: Pedagogical Knowledge

	Indicator	M	SD	Scaled Response	Descriptive Interpretation
1.	I can select technologies that enhance social networks and scientific knowledge.	4.22	0.77	Agree	High
2.	I am adept at using technologies that enhance learning experiences.	4.11	0.82	Agree	High
3.	am capable in using technology for Senior High School activities.	4.24	0.78	Agree	High
4.	I engage in critical thinking about effectively using technology in my classroom.	4.11	0.77	Agree	High
5.	I am proficient in using technology to assess student learning and provide timely feedback.	4.11	0.74	Agree	High
Composite		4.16	0.72	Agree	High

Table 7. Factor Loadings for Key Pedagogical Knowledge Items

	Item	Loading
1.	I can select technologies that enhance social networks and scientific knowledge.	0.80
2.	I am adept at using technologies that enhance learning experiences.	0.77
3.	I am capable in using technology for Senior High School activities.	0.82

Teaching Effectiveness Evaluation

Table 8. Level of Teaching Effectiveness of Senior High School Teachers

	Indicator	M	SD	Scaled Response	Descriptive Interpretation
1.	My lessons incorporate technology to enhance student engagement.	4.11	0.71	Agree	High
2.	I use technology to differentiate instruction to meet diverse learning needs.	4.13	0.75	Agree	High
3.	My assessments incorporate technology to measure student understanding effectively.	4.09	0.78	Agree	High
4.	I use technology to facilitate student collaboration and communication.	4.24	0.68	Agree	High

Indicator	M	SD	Scaled Response	Descriptive Interpretation
5. I am proficient in using technology to provide timely and constructive feedback.	4.20	0.74	Agree	High
Composite	4.15	0.68	Agree	High

Table 9. Factor Loadings for Key Teaching Items

Item	Loading
1. My lessons incorporate technology to enhance student engagement.	0.75
2. I use technology to differentiate instruction to meet diverse learning needs.	0.70
3. My assessments incorporate technology to measure student understanding effectively.	0.73

Key Findings

Table 10. Summary of TPACK Levels of Senior High School Teachers in the Division of Biñan City

Parameters	M	SD	Scaled Response	Descriptive Interpretation
Technological	4.06	0.74	Agree	High
Content Knowledge	4.50	0.52	Strongly Agree	Very High
Pedagogical	4.16	0.72	Agree	High
Composite	4.24	0.58	Agree	High

***Note**. The scale for the descriptive interpretation is as follows:*
4.50–5.00 = Strongly Agree (Very High);
3.50–4.49 = Agree (High);
2.50–3.49 = Moderately Agree (Average);
1.50–2.49 = Disagree (Low);
1.00–1.49 = Strongly Disagree (Very Low).

Table 11. Summary of Teaching Effectiveness of Senior High School Teachers in the Division of Biñan City

Parameters	M	SD	Scaled Response	Descriptive Interpretation
Fluency	4.11	0.59	Agree	High
Cognitive Flexibility	4.07	0.68	Agree	High
Composite	4.09	0.60	Agree	High

***Note**. The scale for the descriptive interpretation is as follows:*
4.50–5.00 = Strongly Agree (Very High);
3.50–4.49 = Agree (High);
2.50–3.49 = Moderately Agree (Average);
1.50–2.49 = Disagree (Low);
1.00–1.49 = Strongly Disagree (Very Low).

Table 12. Test of the Significant Relationship Between Teachers' TPACK Level and Teaching effectivenesses

TPACK	Teaching Effectiveness	Strength of Correlation	Cognitive Flexibility	Strength of Correlation	Overall Teaching Effectiveness	Strength of Correlation
Technological	.607**	Moderate to Strong	.742**	Strong	.716**	Strong
Content	.545**	Moderate	.437**	Moderate	.511**	Moderate
Pedagogical	.677**	Moderate to Strong	.831**	Very Strong	.800**	Very Strong
Overall TPACK	.695**	Moderate to Strong	.783**	Strong	.781**	Strong

***Note**. The correlation is significant at the 0.01 level (2-tailed). Strength of correlation:*
0.00–0.19 = Very weak;
0.20–0.39 = Weak;
0.40–0.59 = Moderate;
0.60–0.79 = Strong;
0.80–1.00 = Very strong.

Table 13. Test of the Impact of Teachers' TPACK levels on Teaching Effectiveness

	Unstandardized Coefficients	Standardized Coefficients	t	p
	B	Std. Error	Beta	
(Constant)	0.882	0.442		1.994
Technological	0.009	0.146	0.011	0.064
Content	0.144	0.115	0.125	1.248
Pedagogical	0.607	0.148	0.724	4.087

***Note**. $R = .807$, Adjusted $R^2 = .630$, $F(3, 50) = 31.101$, $p < .01$. **p** < 0.01 indicates significance.*

Table 14. Descriptive Statistics for Technological, Content Knowledge, and Pedagogical Parameters

Parameters	M	SD	Scaled Response	Descriptive Interpretation
Technological	4.06	0.74	Agree	High
Content Knowledge	4.50	0.52	Strongly Agree	Very High
Pedagogical	4.16	0.72	Agree	High
Composite	**4.24**	**0.58**	**Agree**	**High**

The study explored the relationship between TPACK (Technological Pedagogical Content Knowledge) and teaching effectiveness among senior high school teachers in the Division of Biñan City. The key findings of this study, based on data gathered from 54 millennial educators, are summarized as follows:

1. **Demographics of Respondents**

   Participants predominantly belonged to the 36–44 years age group (39%), and the majority were female (59%). A significant proportion of the respondents were married (67%), had

either a Bachelor's or Master's degree (78% combined), and had between 1 and 10 years of service (78%).

- **TPACK Levels**:
  Teachers demonstrated a **high level of proficiency in all aspects of the TPACK** (Technological Knowledge, Content Knowledge, and Pedagogical Knowledge), as indicated by the composite mean scores. Notably:
- **Technological Knowledge**: Teachers scored an average of 4.06, interpreted as "High."
- **Content Knowledge**: Teachers had a composite mean score of 4.50, interpreted as "Very High."
- **Pedagogical Knowledge**: The composite mean was 4.16, which was also interpreted as "High."

2. **Teaching Effectiveness**:
   Teachers were evaluated as having **high teaching effectiveness**, with a composite mean score of 4.15 for the various indicators. This suggests that the school effectively used technology to enhance student engagement, differentiate instruction, and provide timely feedback.
3. **Correlational Analysis**:
   The study found **strong positive correlations** between various TPACK components and teaching effectiveness.
   - **Technological Knowledge**: Displayed a moderate to strong correlation with overall teaching effectiveness ($r = 0.716$, $p < 0.01$).
   - **Pedagogical Knowledge**: Showed the strongest correlation with teaching effectiveness ($r = 0.800$, $p < 0.01$).
   - **Overall TPACK**: Had a strong correlation with teaching effectiveness ($r = 0.781$, $p < 0.01$), indicating that a higher level of TPACK proficiency leads to enhanced teaching effectiveness.
4. **The predictive power of TPACK on Teaching Effectiveness**:
   The regression analysis revealed that **Pedagogical Knowledge** was the strongest predictor of teaching effectiveness ($\beta = 0.724$, $p < 0.01$). The overall model explained 63% of the variance in teaching effectiveness, as indicated by the adjusted R^2 value of 0.630.

In summary, the findings highlight that senior high school teachers in the Division of Biñan City possess high TPACK levels, particularly in content knowledge, which has a significant positive impact on their teaching effectiveness.

This study sought to assess the levels of Technological Pedagogical Content Knowledge (TPACK) among senior high school teachers in Biñan City and its relationship to teaching effectiveness. The results provide insights into the sociodemographic profile of the respondents, their TPACK levels, and their teaching effectiveness, answering the research questions posed and supporting the key hypotheses.

1. **Sociodemographic Profile of Teacher Respondents**
   Most respondents were seasoned educators with considerable experience, highlighting the influence of service length on TPACK acquisition. This finding suggests that more experienced teachers may have gained greater exposure to technology integration, thus contributing to higher TPACK levels. This is supported by the study of Agustin et al. (2023), which explored the relationship between teachers' attitudes toward ICT, collegial support, and TPACK, noting that veteran teachers demonstrated higher TPACK proficiency due to their accumulated experience with technology integration.
2. **Level of TPACK Among Senior High School Teachers**
   Teachers demonstrated high levels of TPACK, particularly excelling in Technological Knowledge, Pedagogical Knowledge, and Content Knowledge. The strongest area was integrating technology with content, which aligns with the argument by Mishra and Koehler

(2019) argument on the significance of content-specific technological applications. Teachers' ability to effectively apply digital tools in their teaching suggests they have mastered combining subject knowledge with relevant technology, enhancing student learning experiences. This finding is further supported by Koh et al. (2019), who emphasized that reflective thinking and design tasks are key processes in developing TPACK, particularly in content and technology integration.

3. **Perceived teaching effectiveness**
   The respondents reported high levels of teaching effectiveness, especially in fluency and cognitive flexibility. Teachers with higher TPACK proficiency were more successful at engaging students and adapting teaching methods to the dynamic demands of a technology-enhanced classroom. The ability to adapt teaching strategies based on the classroom environment supports claims about the value of cognitive flexibility in education (Villegas & Lucas, 2002). This result aligns with the findings of Hsu and Liang (2021), who demonstrated that TPACK significantly influences teaching beliefs and performance among senior high school teachers.
4. **Relationship Between TPACK and Teaching Effectiveness**
   This study confirmed a significant positive relationship between teachers' TPACK levels and their teaching effectiveness, thus supporting H1. Teachers with high TPACK proficiency created engaging, student-centered learning environments that led to better student outcomes. This reinforces the notion that integrating TPACK into teaching practices enhances overall teaching performance. This finding is consistent with Yang and Cheng (2020), who demonstrated that TPACK positively affects teaching effectiveness, with teaching engagement as a mediator and ICT self-efficacy as a moderating factor.
5. **The Predictive Values of the TPACK Dimensions on Teaching Effectiveness**
   The dimensions of TPACK—Technological Knowledge, Pedagogical Knowledge, and Content Knowledge—when integrated significantly contribute to teaching effectiveness, thus confirming Hypothesis 4. Higher TPACK levels are correlated with increased student engagement and participation, which underscores the need for a comprehensive understanding of TPACK for modern educators. This is consistent with the findings of Hsu and Lin (2023), who highlighted the positive relationship between TPACK integration and teaching performance, particularly in classrooms that utilize digital tools.
6. **Teachers' development plan**
   Although teachers exhibited strong TPACK proficiency, the study identified areas for improvement, such as managing technical issues. A tailored professional development plan could address these gaps, particularly by emphasizing technical troubleshooting skills. Continuous training programs focusing on integrating TPACK with cultural awareness, as outlined in Hypothesis 3, would further enhance teachers' effectiveness in adapting technology to local contexts. This aligns with the findings of Sari and Yilmaz (2020), who emphasized the positive impact of TPACK-based professional development programs on teaching effectiveness and reinforced the importance of ongoing teacher education.

Summary of Findings

The results revealed that teachers demonstrated high levels of TPACK, particularly in integrating technology with content and pedagogy. A significant positive correlation between TPACK proficiency and teaching effectiveness was observed, thus supporting the hypothesis that TPACK contributes to improved teaching outcomes. However, the findings also indicated areas for improvement, such as handling technical challenges in the classroom. Addressing these gaps through ongoing professional development would enhance the overall teaching effectiveness of educators (Parilla, 2024).

Implications for Policy and Practice

According to Corpuz (2024), continuous professional development in TPACK is crucial for teachers effectively integrating technology into teaching. This study emphasizes the need for professional development programs to enhance technical skills and cognitive flexibility and suggests that teacher education programs should focus on culturally responsive pedagogical practices to apply TPACK in a context-sensitive manner.

Pedagogical Knowledge and Teaching Effectiveness

This research highlights essential teacher competencies, including technology proficiency, which is directly aligned with TPACK (Karacaoğlu, 2024). This emphasizes the need for continuous professional development and reflective practices to improve teachers' technological, pedagogical, and content knowledge. This study expands on previous research by emphasizing the critical role of Pedagogical Knowledge in teaching effectiveness, with a focus on the specific contributions of Cognitive Flexibility and TPACK (Technological Pedagogical Content Knowledge). While earlier studies, such as those by Anud and Caro (2023), highlighted the importance of balancing content and pedagogy, this research offers new insights into how TPACK integration in real-world classroom contexts significantly enhances teaching performance. The stronger correlations between TPACK components and teaching effectiveness suggest that this framework provides a holistic approach to improving instructional quality in contemporary education (Karacaoğlu, 2024).

Cognitive Flexibility and Contextual Learning

The findings revealed that teachers in the Division of Biñan effectively applied real-world examples in their lessons, improving student comprehension and engagement. The high levels of Cognitive Flexibility exhibited by the teachers enabled them to modify their instructional approaches to cater to diverse learning needs. This aligns with previous findings by Li and Han (2020) and Villegas and Lucas (2002), which emphasize the value of differentiated instruction. This study highlights Cognitive Flexibility as a key element in creating inclusive, adaptable and effective teaching environments.

CONCLUSION

This research confirms a strong positive relationship between TPACK and teaching effectiveness among senior high school teachers in Biñan City, thus supporting the alternative hypothesis that higher TPACK levels contribute to improved teaching outcomes. These findings underscore the importance of integrating TPACK into professional teacher development programs to enhance instructional quality and student learning.

Although the study contributes to our understanding of TPACK's role in education, it also identifies areas for further professional growth, such as technical troubleshooting and culturally responsive teaching. These insights can inform local educational policies and practices and offer broader lessons for regions seeking to improve teaching effectiveness through TPACK integration.

Recommendations

To enhance the effectiveness of teaching through Technological Pedagogical Content Knowledge (TPACK), schools must prioritize professional development programs that specifically focus on advancing TPACK skills. This includes targeting areas such as technical troubleshooting and the use of advanced technological applications in pedagogy. By addressing these areas, educators can become more adept at managing and integrating technology into their teaching practices.

Moreover, teacher education programs should incorporate comprehensive TPACK training as a core component of their curriculum. This approach will ensure that future educators are well-prepared to integrate technology effectively into their teaching. Provided a solid foundation in TPACK will equip new teachers with the necessary skills to meet the demands of modern educational environments.

Additionally, ongoing support and resources are crucial for maintaining and updating teachers' TPACK competencies. Schools and educational institutions should offer continuous professional growth opportunities and access to the latest technological tools and teaching strategies. This support will help teachers stay current with evolving technologies and pedagogical approaches, ensuring that TPACK remains relevant and effective in enhancing teaching and learning.

LIMITATION & FURTHER RESEARCH

This study demonstrates that higher levels of Technological Pedagogical Content Knowledge (TPACK) significantly enhance teaching effectiveness by integrating technology, pedagogy, and content knowledge, leading to better student outcomes. This finding underscores the critical role of TPACK in professional teacher development and suggests that enhancing TPACK can substantially elevate educational quality. The importance of continuous training programs in terms of developing TPACK cannot be overstated, and investing in both technology and training resources is essential to support this development. Educational policies should prioritize TPACK-focused initiatives, including mandatory training and technology funding.

This study provides empirical evidence supporting the impact of TPACK on teaching effectiveness, indicating the need for further research in diverse educational settings. While the study's context is specific to Biñan City, the principles of enhancing TPACK can be adapted to other regions and countries, allowing for local adjustments. These insights are valuable for global educational practices, emphasizing the universal importance of integrating technology, pedagogy, and content knowledge in teaching.

Overall, the findings confirmed that TPACK proficiency is a significant predictor of teaching effectiveness, highlighting the need to incorporate TPACK into teacher training and development. This has implications for both practical policymaking and theoretical research in education.

Limitations

This study did not explore several factors that could impact TPACK levels and teaching effectiveness, such as the quality and availability of technological resources. The study also did not examine the role of teacher collaboration in developing TPACK or its influence on teaching outcomes. Additionally, this study did not consider how educational policies could affect the implementation and success of TPACK. Cultural and socioeconomic factors that could influence TPACK and teaching effectiveness were also not addressed. Furthermore, the the long-term sustainability of improvements in teaching effectiveness associated with TPACK were not evaluated.

Future Research

Future research could explore the impact of TPACK on student outcomes, such as student engagement and academic performance, to provide a more comprehensive understanding of its benefits. Additionally, comparative studies across different cultural contexts could shed light on how cultural factors influence the effectiveness of TPACK-based teaching strategies.

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