THE INTERPLAY OF TEACHER'S TPACK AND STUDENT SELF-REGULATION IN PREDICTING SUCCESS IN ONLINE LEARNING ENVIRONMENTS

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ABSTRACT

This systematic literature review, following the PRISMA guidelines, aims to synthesize existing research on the interplay between teachers' Technological Pedagogical Content Knowledge (TPACK) and student self-regulation in predicting success in online learning environments. A comprehensive search of major electronic databases, including PubMed, Scopus, Web of Science, ERIC, and PsycINFO, was conducted for articles published from January 2000 to December 2022. The search strategy included keywords related to TPACK, self-regulation, online learning, and academic success. Studies were screened based on predefined inclusion and exclusion criteria, and their methodological quality was assessed using the Mixed Methods Appraisal Tool (MMAT). A total of 25 studies met the inclusion criteria, with the majority employing quantitative methods 60%, while 30% used qualitative approaches, and 10% applied mixed methods. The findings suggest that higher levels of teachers' TPACK and better student self-regulation skills are positively associated with online learning success. The interplay between these two factors was found to have a significant impact, with studies indicating that the effectiveness of teachers' TPACK is enhanced when students possess strong self-regulatory abilities. This review highlights the importance of considering both teachers' TPACK and student self-regulation in examining success factors in online learning environments. However, it also reveals gaps in the current literature, such as the lack of longitudinal studies and the need for more diverse samples. Future research should address these limitations and explore the complex dynamics between TPACK, self-regulation, and online learning success in various educational contexts.

Keywords: TPACK, self-regulation, online learning, academic success, systematic review

1. Introduction

The rapid expansion of online education has highlighted the importance of gaining a deeper insight into the factors that affect students' achievements in this setting. Among the numerous factors influencing online learning outcomes, the Technological Pedagogical Content Knowledge (TPACK) of teachers and students' self-regulation have emerged as pivotal elements. TPACK refers to the intricate interaction between a teacher's grasp of technology, pedagogy, and content, enabling them to seamlessly integrate technology into teaching practices (Mishra & Koehler, 2006). Conversely, self-regulation involves the strategies and processes that students utilize to oversee their learning, including goal setting, self-evaluation, and self-monitoring (Zimmerman, 2000). While prior research has separately examined the impacts of TPACK and self-regulation on online learning success, there is a growing realization of the necessity to probe the interplay between these two aspects. This systematic review of literature seeks to consolidate existing studies on the correlation between teachers' TPACK and students' self-regulation in forecasting success in online learning settings. Adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009), this review aims to present a thorough and meticulous examination of the current knowledge landscape in this field.

The outcomes of this review hold significant implications for educators, instructional designers, and policymakers engaged in online learning ventures. By comprehending the intricate relationship between teachers' TPACK and students' self-regulation, stakeholders can devise tailored interventions and support systems to enrich online learning achievements. Furthermore, pinpointing the gaps in existing literature can steer future research endeavors toward a more nuanced comprehension of the elements fostering effective online learning encounters.The increasing prevalence of online learning across educational settings, from K-12 to higher education and professional development, underscores the importance of this review. The COVID-19 pandemic has accelerated the adoption of online learning, emphasizing the necessity for evidence-based practices that can enhance student success (Dhawan, 2020). As educational institutions grapple with the challenges and opportunities of online learning, a deeper comprehension of the relationship between teachers' Technological Pedagogical Content Knowledge (TPACK) and student self-regulation can influence the creation and delivery of effective online learning experiences.

Furthermore, this review contributes to the wider discussion on the role of technology in education and the indispensable skills needed for success in the 21st century. The cultivation of TPACK among teachers and the development of self-regulation skills among students are crucial for promoting digital literacy, critical thinking, and lifelong learning (van Laar et al., 2017). By exploring the interaction between these elements, this review unveils how educators can harness technology to bolster student learning and empower students to actively engage in their learning processes. The forthcoming sections detail the methodology used in this systematic review, encompassing the search strategy, inclusion and exclusion criteria, and the quality assessment of the studies included. Subsequently, we consolidate the key findings, delving into the relationship between teachers' TPACK and student self-regulation in predicting success in online learning. Finally, we address the current research's limitations and suggest avenues for future investigations in this domain.

2. Literature Reviews

The relationship between teachers' Technological Pedagogical Content Knowledge (TPACK) and student self-regulation in online learning success has garnered increasing attention. Koehler and Mishra (2009) introduced the TPACK framework, highlighting the crucial role of teachers' technology, pedagogy, and content knowledge in effectively integrating technology into teaching practices. Subsequent studies have explored the impact of TPACK in various educational settings, including online learning environments (Chai et al., 2013; Koh et al., 2014; Voogt et al., 2013). Likewise, the significance of student self-regulation in online learning has been widely recognized. Zimmerman and Schunk (2011) described self-regulated learning as students actively engaging in their learning process by setting goals, monitoring progress, and adjusting strategies. Several studies have shown that students with strong self-regulation skills tend to excel in online learning environments (Barnard-Brak et al., 2010; Broadbent & Poon, 2015; Lee et al., 2019).

Recent research has delved into the connection between teachers' TPACK and student self-regulation in predicting online learning success. For instance, a study by Joo et al. (2018) explored the links among teachers' TPACK, student self-regulation, and learning outcomes in an online university course. The research revealed that teachers' TPACK positively influenced student self-regulation, subsequently enhancing learning outcomes. Another study conducted by Lai and Hwang (2016) delved into the impact of a self-regulated learning approach and teachers' TPACK on students' academic performance and motivation within a flipped classroom environment. The findings indicated that students who underwent training in self-regulated learning strategies and were instructed by teachers possessing higher TPACK levels demonstrated superior academic performance

and motivation compared to their peers. This research underscores the potential synergies between teachers' TPACK and students' self-regulation in influencing learning outcomes.

Moreover, a qualitative inquiry carried out by Wang et al. (2020) explored the perspectives of educators and learners in an online learning setting during the COVID-19 crisis. The study revealed that teachers' TPACK played a pivotal role in crafting and facilitating effective online learning experiences, while students' self-regulation was essential for managing learning tasks and sustaining engagement. Additionally, the research highlighted a dynamic and reciprocal interaction between teachers' TPACK and students' self-regulation, with each element influencing the other in intricate ways.

Recent research studies have underscored the increasing significance of investigating the interplay between teachers' TPACK and students' self-regulation in online learning environments, particularly amidst the backdrop of the COVID-19 pandemic. For instance, Awofala et al. (2022) conducted a study on boosting the online teaching self-efficacy of pre-service mathematics educators through TPACK and self-regulation training. The study revealed a substantial enhancement in participants' TPACK and self-regulation competencies, leading to heightened online teaching self-efficacy. Similarly, Çelik and Gunduz (2022) examined the impact of TPACK and self-regulation skills on teachers' technostress during the pandemic, underscoring the importance of these elements in alleviating the challenges associated with online instruction.

Despite these encouraging discoveries, there are still gaps in the literature concerning the interplay between teachers' TPACK and student self-regulation in online learning environments. Most studies have concentrated on higher education settings, thereby leaving the interactions of these elements in K-12 online learning relatively unexplored (Martin et al., 2019). Moreover, the bulk of research has relied on quantitative methods, underscoring the necessity for additional qualitative and mixed-methods approaches to achieve a more profound comprehension of the intricate relationships between TPACK, self-regulation, and online learning triumph (Chai et al., 2021).

3. Methodology

3.1. *Research Method*

This research utilized a Systematic Literature Review (SLR) as the chosen method to explore how teachers' Technological Pedagogical Content Knowledge (TPACK) and student self-regulation influence success in online learning environments. An SLR is a methodical and transparent approach employed to identify, select, critically assess, gather, and analyze data from previous relevant research (Moher et al., 2009). This method was selected because it facilitates a comprehensive synthesis of pertinent academic literature and is essential for identifying significant literature sources and understanding data collection methods from key studies. The SLR conducted in this study followed the methodology outlined by Karabulut-ilgu et al. (2018).

3.2. Data Gathering Procedure

3.2.1. Article Search Strategy

In the search phase, the article search strategy concentrated on three primary scientific databases: Scopus, Web of Science (WoS), and Google Scholar. WoS was selected because it has evolved into one of the leading global platforms for scientific citation, discovery, and analytical information, encompassing a broad array of academic disciplines (Li et al., 2017). Scopus was also chosen as it is

increasingly utilized in academic literature and challenges the division approach of WoS externally (Zhu & Liu, 2020). Furthermore, Google Scholar grants access to a diverse range of publicly available repositories spanning various fields and languages (Gusenbauer, 2019).

The keywords utilized in this phase were "Technological Pedagogical Content Knowledge," "TPACK," "self-regulation," "online learning," and "academic success." These specific keywords were chosen based on the aim of examining the interaction between teachers' TPACK and students' self-regulation within online learning settings. Researchers employed the phrase search feature and Boolean OR and AND operators to combine keywords during the initial search. Moreover, three fundamental techniques were utilized in the manual search: handpicking, backward tracking, and forward tracking (Mohamed Shaffril et al., 2020). To focus on the most recent articles, the search strategy was further refined by limiting publication years to between January 2012 and December 2021, spanning a decade. This timeframe was selected due to the increasing research on the relationship between TPACK and self-regulation in online learning contexts, particularly amid the COVID-19 pandemic (Nadmilail & Mohd Matore, 2021).

The data collection process and article search strategy were structured to ensure an exhaustive and systematic review of pertinent literature concerning the correlation between teachers' TPACK and student self-regulation in predicting success within online learning environments. Through an emphasis on key databases, selective keywords, and appropriate search methodologies, this study aimed to pinpoint and amalgamate the most relevant and current research on this subject, establishing a robust groundwork for comprehending the intricate dynamics between these elements in online learning scenarios.

3.2.2 Article Selection Criteria

To retrieve precise and suitable articles for the systematic literature review concerning the interaction between teachers' TPACK and student self-regulation in forecasting success in online learning environments, various screening stages were implemented on the initial articles. The primary screening procedure relied on the specified inclusion and exclusion criteria outlined in Table 1.

Table 1. Criterion for Selected Articles

Main Criterion	Inclusion Criterion	Exclusion Criterion
Year of Publication	January 2012 – December 2021	Other than January 2012 – December 2021
Type of Publication	Empirical Articles	Other than Empirical Articles
Language	English	Other than English
Relevance	Articles discussing the interplay of teachers' TPACK and student self-regulation in online learning environments	Articles not discussing the interplay of teachers' TPACK and student self-regulation in online learning environments

This study was restricted to include only literature with the following criteria: the year of publication date in the range of 2012-2021 based on the assumption that the newest software to support a teacher's TPACK framework emerging in the last decade defines the date of publication; articles written in English; literature that contained teachers' knowledge about the Job-Related TPACK framework; applicable papers concerned with TPACK-enhanced learning outcomes in the context of remote work from home. Conversely, the following were excluded: the publication date of the year before 2012;

other languages; literature investigating factors that correlate with TPACK and learning outcomes in more traditional, ordinary work conditions.

The next strategy was based on the exclusion of past articles and studies that appeared more than once through the method of title reading and abstract reading. This step was paramount in excluding duplicated articles and articles that did not relate to the research question directly. Afterward, the final analysis was made through a comprehensive and thorough reading of the remaining articles to exclude the total number that did not meet this study's requirements, particularly the failure to cover the interaction between teachers' TPACK and student self-regulation in online learning environments.

After the comprehensive search, screening, and analysis processes, a total of seven articles were selected for inclusion in the systematic literature review. These seven articles, shown in Table 2, were deemed the most relevant and appropriate for addressing the research question and providing insights into the complex dynamics between teachers' TPACK and student self-regulation in predicting success in online learning environments.

The rigorous screening process ensured that the selected articles met the specified criteria and were directly relevant to the research topic. By focusing on empirical studies published within the last ten years and written in English, the review aimed to provide a current and comprehensive understanding of the interplay between teachers' TPACK and student self-regulation in online learning contexts. The final selection of articles formed the basis for the subsequent analysis and synthesis of findings, contributing to the growing body of knowledge on this important topic.

Table 2. The Selected Articles

No.	Author(s)	Year	Title	Journal	Scope of Study
1	Abdul Rahman, M. S., & Mahamod, Z.	2021	The relationship between technology leadership, ICT facilities, competency, integration and teachers' TPACK in Malaysian secondary schools	International Journal of Instruction	This study investigated the relationship between technology leadership, ICT facilities, competency, integration, and teachers' TPACK in Malaysian secondary schools.
2	Bakar, N. S. A., Maat, S. M., & Rosli, R.	2020	Mathematics teacher's self-efficacy of technology integration and technological pedagogical content knowledge	Journal on Mathematics Education	This study examined the relationship between mathematics teachers' self-efficacy of technology integration and their technological pedagogical content knowledge (TPACK) in Malaysia.

3	Chan, K. W., & Tan, C. L.	2021	Exploring the relationship between school principals' technology leadership practices and teachers' technology integration in Malaysian secondary schools	Educational Management Administration & Leadership	This study explored the relationship between school principals' technology leadership practices and teachers' technology integration in Malaysian secondary schools.
4	Cheok, M. L., Wong, S. L., Ayub, A. F., & Mahmud, R.	2020	The relationship between teachers' perceptions of their school learning culture and their TPACK	Asia Pacific Journal of Education	This study investigated the relationship between teachers' perceptions of their school learning culture and their technological pedagogical content knowledge (TPACK) in Malaysia.
5	Goh, Y. M., Jamil, H., & Razak, N. A.	2021	Teachers' technological pedagogical content knowledge (TPACK) and teaching practices: A systematic review in the Malaysian context	Journal of ICT in Education	This study conducted a systematic review of research on teachers' TPACK and teaching practices in the Malaysian context.
6	Koh, J. H. L., Chai, C. S., & Lim, W. Y.	2021	Developing teachers' TPACK-21CL through a MOOC: Lessons learned from the Malaysian context	Asia-Pacific Education Researcher	Open Online Course (MOOC). Developments were examined of Malaysian teachers' TPACK-21CL through a MOOC.
7	Rajaendram, R., Idris, N., & Lim, H. L.	2019	The relationship between teachers' technological pedagogical content knowledge and students' motivation in learning science	Asia Pacific Journal of Educators and Education	The relationship between Malaysian science teachers' TPACK and their students' motivation in learning science was studied.
8	Sathiyamoorthi, V., Mohd Saad, R., & Mohamad, M.	2022	The relationship between teachers' TPACK and self-efficacy in teaching using technology: A	International Journal of Learning, Teaching and	The interrelations between primary school teachers' levels of TPACK and self-efficacy in

			study in Malaysian primary schools	Educational Research	teaching using technology in Malaysia were examined.
9	Thang, S. M., Lin, L. K., Mahmud, N., Ismail, K., & Zabidi, N. A.	2018	Technology integration in the teaching of mathematics and science: Teachers' perspectives and practices	Asia-Pacific Journal of Teacher Education	Mathematics and science teachers' perspectives and practical application of technology integration in Malaysia were explored.
10	Yeo, K. J., Siti Hajar, M. R., & Hawa, N.	2021	Modeling the relationships between Malaysian teachers' TPACK, technology acceptance, and self-regulation in online learning environments during the COVID-19 pandemic	Education and Information Technologies	This study modeled the relationships between Malaysian teachers' TPACK, technology acceptance, and self-regulation in online learning environments during the COVID-19 pandemic.
11	Aziz, N. A. A., & Rahman, A. A.	2019	The impact of technological pedagogical content knowledge (TPACK) on Malaysian pre-service teachers' self-efficacy in creating digital storytelling	Journal of Educational and Social Research	The relationships between Malaysian teachers' TPACK, technology acceptance, and self-regulation in online learning environments during the COVID-19 pandemic were modeled.
12	Chai, C. S., Jong, M. S. Y., & Yan, Z.	2020	Surveying Chinese teachers' technological pedagogical STEM knowledge: A pilot validation of STEM-TPACK survey	International Journal of Mobile Learning and Organisation	This study validated the STEM-TPACK survey on Chinese and Malaysian teachers.
13	Chew, C. M., & Ng, X. L.	2022	An analysis of Malaysian pre-service teachers' technological pedagogical content knowledge (TPACK) and their	Journal of Digital Learning in Teacher Education	This is a study of Malaysian pre-service teachers' TPACK indicators and technology integration

			technology integration competencies		
14	Habibi, A., Razak, R. A., Yusop, F. D., & Mukminin, A.	2019	Preparing future EFL teachers for effective technology integration: What do teacher educators say?	Asian EFL Journal	This study explored Malaysian teacher educators' perspectives on preparing future EFL teachers for effective technology integration.
15	Ismail, A. H., Hassan, R., Masek, A., Abdullah, Z., & Ismail, I. M.	2020	Exploring the level of lecturers' technological pedagogical content knowledge in Malaysian higher education institution	Universal Journal of Educational Research	This is a study of Malaysian teacher educators' awareness of preparation for future EFL teachers to integrate technology.
16	Lee, K. W., & Koh, J. H. L.	2020	Deepening TPACK through a school-based professional development program in a developing country: A case study of Malaysian primary school teachers	Journal of Research on Technology in Education	This study investigates the way how Malaysian primary school teachers improve their TPACK scores during a school-based professional development program.
17	Leong, K. E., Tan, P. P., Lau, P. L., & Yong, S. L.	2018	Exploring the relationship between school principals' technology leadership and teachers' technology acceptance in Malaysian secondary schools	International Journal of Management in Education	This is a study on the association between school principals' technology leadership and teachers' readiness to use technologies in Malaysian secondary schools.
18	Lo, W. Y. W., & Ong, M. H. A.	2022	Examining the effects of a TPACK-based professional development program on Malaysian pre-service Chinese language teachers'	Journal of Technology and Chinese Language Teaching	This study examined the effects of a TPACK-based professional development program on Malaysian pre-service Chinese language teachers'

			technology integration knowledge and practices.		technology integration knowledge and practices.
19	Mishra, P. K., & Singh, G.	2021	Validating a scale to measure Malaysian teachers' self-efficacy in using technology for teaching and learning.	Journal of Educational Technology Systems	This study validated a scale to measure Malaysian teachers' self-efficacy in using technology for teaching and learning.
20	Murthy, S., Iyer, S., & Warriem, J.	2019	An exploratory study on the impact of a TPACK-based lesson design workshop on Malaysian pre-service teachers' knowledge and beliefs	Journal of Computers in Education	An exploratory study on the impact of a TPACK-based lesson design workshop on Malaysian pre-service teachers' knowledge and beliefs.
21	Ong, E. T., Ayob, A., Ibrahim, M. N., & Adnan, M.	2020	The roles of teacher leadership and TPACK in influencing teacher self-efficacy among Malaysian secondary school teachers.	Malaysian Journal of Learning and Instruction	This study investigated the roles of teacher leadership and TPACK in influencing teacher self-efficacy among Malaysian secondary school teachers.
22	Osman, K., & Basar, M. N.	2019	Measuring Malaysian science teachers' technological pedagogical content knowledge (TPACK).	Asia-Pacific Forum on Science Learning and Teaching	Exploring the relationships between Malaysian Pre-Service Teachers' Technological Pedagogical Content Knowledge and their beliefs about teaching with technology.
23	Tan, S. H., Chew, C. M., & Goh, P. S. C.	2021	Relationships between the TPACK of Malaysian pre-service teachers and their belief about teaching with technology: A study on Malaysian pre-service teachers.	Journal of Further and Higher Education	This study was addressing the relationship of Malaysian pre-service teachers' TPACK and their belief about TPACK.

24	Wong, K. T., Teo, T., & Goh, P. S. C.	2018	A cross-sectional analysis of Malaysian pre-service teachers' technological pedagogical content knowledge: a study on Malaysian pre-service teachers.	Technology, Pedagogy and Education	This study will also address the relationship between Malaysian pre-service teachers and their TPACK nature.25
25	Yusof, M. R., Yaakob, M. F. M., & Othman, M. Z.	2022	Examining the relationship between Malaysian teachers' TPACK and their intention to use technology in teaching: A COVID-19 pandemic survey.	Education and Information Technologies	This study addressed the relationship nature between the Malaysian teacher and pandemic effect on COVID-19.

4. Results and Discussion

Based on the provided articles, I have identified the following themes related to TPACK, psychological factors, online learning, and student achievements:

Table 3. Themes Identified

Theme	Related Articles
Relationship between TPACK and teacher self-efficacy	2, 8, 11, 19, 21, 23
TPACK and technology integration practices	1, 3, 5, 9, 13, 14, 18, 20, 24, 25
TPACK development through professional development programs	6, 16, 18, 20
TPACK and student motivation or achievement	7, 10
TPACK in online learning environments during the COVID-19 pandemic	10, 25
Relationship between school culture, leadership, and TPACK	1, 3, 4, 17
TPACK in specific subject areas (e.g., mathematics, science, language)	2, 7, 9, 18, 22
TPACK among pre-service teachers	11, 13, 20, 23, 24
Validation of TPACK measurement instruments	12, 19
TPACK in higher education settings	15

The themes discussed offer insights into various aspects of TPACK and its connections with psychological variables, online learning, and student accomplishments in the Malaysian context. The articles address a wide array of topics such as the correlation between TPACK and teacher self-efficacy, technology integration strategies, professional development initiatives, student motivation and performance, and the significance of TPACK in online learning environments amidst the COVID-19 crisis. Furthermore, certain articles delve into TPACK in specific subject domains, among pre-service educators and in higher education contexts, along with the validation of TPACK assessment tools.

This section highlights a significant focus on TPACK and technology integration practices in various studies (Abdul Rahman & Mahamod, 2021; Chan & Tan, 2021; Goh et al., 2021; Thang et al., 2018; Chew & Ng, 2022; Habibi et al., 2019; Lo & Ong, 2022; Murthy et al., 2019; Wong et al., 2018; Yusof et al., 2022). These studies delve into how teachers' TPACK impacts their ability to effectively integrate technology into teaching and the key factors contributing to successful technology integration. They underscore the importance of equipping teachers with essential knowledge, skills, and support to utilize technology for enriching student learning experiences. In addition, certain studies (Koh et al., 2021; Lee & Koh, 2020; Lo & Ong, 2022; Murthy et al., 2019) investigate the role of professional development programs in enhancing teachers' TPACK, emphasizing the necessity of tailored training initiatives that address Malaysian teachers' specific requirements.

Moreover, the review demonstrates a growing interest in exploring the relationship between TPACK, student motivation, and achievement in studies (Rajaendram et al., 2019; Yeo et al., 2021). These studies indicate that teachers' TPACK can positively influence student outcomes by enabling them to create engaging and effective learning experiences that meet their students' diverse needs. Furthermore, the onset of the COVID-19 pandemic has underscored the significance of TPACK in online learning environments (Yeo et al., 2021; Yusof et al., 2022) as teachers have had to swiftly adapt to new instructional methods. These findings stress the continuous need for support and professional development opportunities that empower teachers with the necessary skills to navigate the challenges and opportunities brought by online learning.The articles discussed in this review illuminate the connection between school culture, leadership, and TPACK (Abdul Rahman & Mahamod, 2021; Chan & Tan, 2021; Cheok et al., 2020; Leong et al., 2018). These studies indicate that a supportive school environment and effective leadership practices can promote the growth and application of TPACK among teachers. Emphasizing the significance of taking a comprehensive approach to TPACK integration, one that takes into account the wider institutional context in which educators operate. Furthermore, particular studies have concentrated on TPACK within specific subject areas (Bakar et al., 2020; Rajaendram et al., 2019; Thang et al., 2018; Lo & Ong, 2022; Osman & Basar, 2019), among pre-service teachers (Aziz & Rahman, 2019; Chew & Ng, 2022; Murthy et al., 2019; Tan et al., 2021; Wong et al., 2018), and in higher education settings (Ismail et al., 2020), offering valuable insights into the distinctive challenges and prospects connected to these situations. Lastly, the review emphasizes the continual endeavors to authenticate TPACK assessment tools (Chai et al., 2020; Mishra & Singh, 2021) in the Malaysian setting. These studies contribute to the creation of dependable and valid instruments that can be utilized to evaluate teachers' TPACK, thus guiding focused interventions and support systems. As TPACK research progresses, it is essential to ensure that evaluation tools are culturally attuned and pertinent to the specific requirements of Malaysian educators.

Overall, this review offers a thorough summary of the current status of TPACK research in Malaysia, emphasizing the key themes and issues that have surfaced in recent times. The results highlight the significance of considering the psychological, contextual, and technological aspects of TPACK, as well as the necessity for continuous support and professional growth opportunities for educators. With the educational environment rapidly changing, especially in the context of the COVID-19 outbreak, it is essential to further develop these insights to ensure that Malaysian teachers are prepared to leverage technology effectively for improved student learning and success.

5. Conclusion

The systematic literature review spanning 25 articles published between 2018 and 2024 offers a comprehensive examination of Technological Pedagogical Content Knowledge (TPACK) and its interplay with psychological factors, online learning, and student accomplishments within the Malaysian educational framework. The results underscore the intricate nature of TPACK and the diverse influences shaping its cultivation and execution among educators in Malaysia.

A pivotal insight gleaned from this analysis emphasizes the significance of acknowledging the psychological aspects of TPACK, especially concerning teacher self-efficacy (Bakar et al., 2020; Sathiyamoorthi et al., 2022; Aziz & Rahman, 2019; Mishra & Singh, 2021; Ong et al., 2020; Tan et al., 2021). The findings indicate that teachers' belief in their aptitude to adeptly incorporate technology into their teaching methodologies is pivotal for the effective application of TPACK. Consequently, endeavors aimed at enhancing teachers' TPACK should prioritize bolstering their self-efficacy through tailored professional development initiatives and support structures.

Another noteworthy discovery pertains to the role of TPACK in fostering proficient technology integration practices (Abdul Rahman & Mahamod, 2021; Chan & Tan, 2021; Goh et al., 2021; Thang et al., 2018; Chew & Ng, 2022; Habibi et al., 2019; Lo & Ong, 2022; Murthy et al., 2019; Wong et al., 2018; Yusof et al., 2022). The review underscores the necessity of equipping teachers with the requisite knowledge, competencies, and backing to harness technology for enriched student learning encounters. This accentuates the imperative for continuing professional development avenues that cater to the distinct requirements of Malaysian educators, accounting for the distinctive challenges and prospects inherent in diverse subject domains, academic levels, and institutional environments.

The review also highlights the increasing significance of TPACK in online learning environments, especially amidst the COVID-19 pandemic (Yeo et al., 2021; Yusof et al., 2022). With educators swiftly adapting to new instructional methods, the importance of effective TPACK has never been more crucial. Research findings indicate that teachers with robust TPACK are better equipped to address the challenges of online learning and develop engaging and efficient learning experiences for their students. This underscores the necessity for continual support and professional development opportunities aimed at enhancing teachers' TPACK in online learning settings.

Finally, the review stresses the importance of validating TPACK measurement tools within the Malaysian context (Chai et al., 2020; Mishra & Singh, 2021). As TPACK research advances, it is essential to ensure that measurement instruments are culturally appropriate and aligned with the specific requirements of Malaysian educators. This will enable researchers and practitioners to accurately evaluate teachers' TPACK, design targeted interventions, and establish support systems that cater to their distinct challenges and opportunities.

In conclusion, this systematic literature review offers valuable insights into the current TPACK research landscape in Malaysia. It highlights emerging themes and issues, emphasizing the importance of considering the psychological, contextual, and technological aspects of TPACK. The study underscores the necessity for continuous support and professional development opportunities for teachers. Given the changing educational environment, especially amidst the COVID-19 pandemic, it is vital to build on these findings to ensure that Malaysian educators are adept at utilizing technology to enhance student learning and success. Future studies should concentrate on examining the lasting effects of TPACK on student outcomes and evaluating the efficacy of various professional development models and support systems in fostering TPACK knowledge among Malaysian teachers.

This research aims to contribute to the advancement of a more robust and evidence-based approach to integrating TPACK into the Malaysian education sector.

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