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Readiness of Secondary School Teachers in Teaching and Learning Mathematics from The Perspective of TPACK: Basis for In-Service Training Program

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Abstract

This study examined the demographic, professional, and school factors influencing teachers' readiness to teach mathematics through the lens of the Technological Pedagogical Content Knowledge (TPACK) framework. The study used simple random sampling to gather 76 secondary school mathematics teachers in Binangonan, Rizal. The Kruskal Wallis H-test was used to compare three or more independent groups and their TPACK level of readiness to determine if there are statistically significant differences between them in teaching and learning mathematics. The findings revealed that respondents were represented by a diverse demographic, with most possessing considerable teaching experience and strong agreement in readiness to use technology in teaching mathematics. The distribution of respondents across school sizes and socioeconomic levels highlighted a focus on larger schools, indicating that these schools were knowledgeable and capacitated in implementing technology-related approaches in teaching and learning.

The analysis of readiness in mathematics instruction demonstrated likely ready as overall readiness in Technological Knowledge (TK), Content Knowledge (CK), and Pedagogical Knowledge (PK), with teachers excelling in areas such as lesson planning, teaching basic concepts, and varied pedagogical approaches toward technology integration. However, low readiness was identified in managing technical issues, leveraging advanced technological tools like flash animations, developing online learning activities, and identifying students' mathematical misconceptions. These areas were emphasized when developing in-service training programs for mathematics teachers.

Significant differences in readiness were observed based on factors such as School Clusters, Length of Service, and Socioeconomic Level of the School. Mid-career educators and teachers from larger schools exhibited higher readiness levels, while challenges were identified in smaller clusters and schools. Conversely, variables such as gender, age group, and teaching designation showed no significance on readiness.The conclusions from this study provide the need to support and capacitate teachers in specific areas based on the findings, where they will be trained to increase their readiness level in using technology in teaching and learning, especially for those in underrepresented school clusters. Enhanced in-service training efforts can address these gaps, ensuring equitable and effective mathematics instruction across diverse educational contexts.

Keywords: TPACK, Mathematics Education, Readiness level, Secondary Schools, In-service Training

I. Introduction

Knowledge, judgement and actions were essential for teaching to be effective. These skills can be further enhanced and developed through incorporating technologies in which the 21st century skills in mathematics education have revolutionized into a greater scope of innovation and application in teaching and learning but how can teachers effectively harness technology to improve learning outcomes in the 21st century? Are they prepared to effectively integrate technology into their teaching by aligning it with both the expertise in the content and teaching strategies?

These are the leading questions that need to be answered by undertaking this study. The interplay of pedagogy, content and technology, or TPACK encourages teachers to think critically in using technology to support specific learning goals and suit content areas when paired with technology.

Theoretical Framework

TPACK, or Technological Pedagogical Content knowledge developed by Mishra & Koehler (2006), is how the teacher's domain intersects to teach and engage students with technology effectively. It combines what the teachers know, how they teach, and the role of technology to better impact student learning. Content Knowledge (CK) is the "what" part of the framework. It tells their understanding and expertise about the subject area they teach. Content knowledge contains any discipline's facts, concepts, and theories.

Pedagogical Knowledge (PK) is the "how" part of the framework. It discusses the teacher's expertise and knowledge in teaching a subject matter. It entails learning theories, instructional designs such as lesson planning, and assessing the students' knowledge like project-based learning and instructional strategies like think-pair-share.

Pedagogical Content Knowledge (PCK) determines what teaching approaches fit the content and how bits and bytes of the subject matter can be arranged for better teaching.

PCK combines Pedagogical and Content knowledge, which defines how to effectively engage learners in learning concepts and skills. These include providing different teaching styles and scaffolding content for deeper understanding.

Teaching Technological Knowledge (TK) talks about an individual's knowledge about specific technological tools or digital technologies, such as the ability to use a standard set of software tools like word processors, spreadsheets, browsers, and email. This also includes the knowledge to install or uninstall devices or software programs and create and archive documents. TK emphasizes using, interacting, and managing technology to adapt it to the curriculum. It also touches on the quality of how the students can access learning through mobile apps, websites, and video games.

Technological Content Knowledge (TCK) defines how technology can be used in profound and long-lasting learning experiences in different subject areas. Teachers need to know not just the subject matter they teach but also how the application of technology can change the subject matter.

Technological Pedagogical Knowledge (TPK) is the understanding of choosing and managing the correct technological tools suited and appropriate for your students' learning. This refers to exploring available technology in learning scientific methods. This includes maximizing collaboration within the class and sharing their knowledge with each other virtually. This knowledge of technology would make your teaching highly integrated.

Lastly, Technological Pedagogical Content Knowledge (TPACK) is an emergent form of knowledge that goes beyond all three components (content, pedagogy, and technology). TPACK is the basis of good teaching with technology. It requires understanding the representation of concepts using technologies, a pedagogical technique that uses them constructively to teach content effectively. Teachers intuitively understand the complex interplay between the three essential components of knowledge (CK, PK, TK) by teaching content using appropriate pedagogical methods and technologies.

These three components, content, pedagogy, and technology are the TPACK framework's core. The teacher's understanding of how tools can enhance their teaching and support student learning through a level of participation in various professional development or In-Service training about the use of technology to provide an innovative way of teaching in today's modern way of education. This can also connect people like teachers with different subject areas to coordinate and brainstorm how to construct better activities in line with technology for many engaging student outputs. Although everyone's ideas uniquely differ, the paradigm shift of TPACK encloses it into the broken lines that define the context of how TPACK works in different situations. This is how TPACK applies in a practical sense. This also considers that every classroom context differs uniquely due to variations in professional development, school environment, and the availability of resources.

In conclusion, the TPACK framework can define the content and pedagogy and integrate them with technology. These three domains intersect at a common denominator, making learning more interesting and meaningful for teachers and learners.

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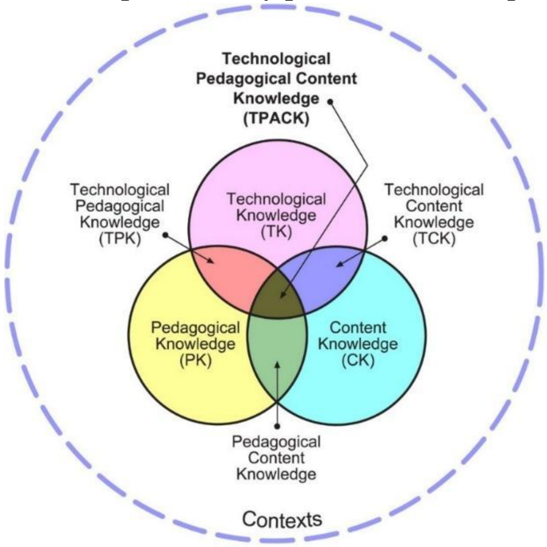
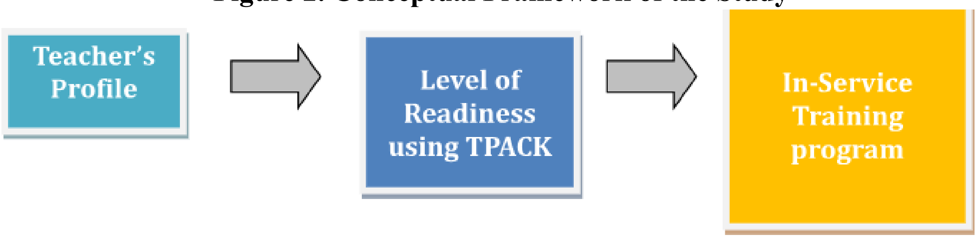
Figure 1. The TPACK Framework reproduced by permission of the publisher, © 2012 by tpack.org



Conceptual Framework

Figure 2. Conceptual Framework of the Study



The conceptual framework of the study is mainly focused on TPACK. First, teachers' demographic profiles, such as age, designation, gender, educational level, length of service, and socioeconomic status of the school, will be determined. After garnering their profile, the next is to determine their readiness level using technological, pedagogical, and content knowledge or TPACK. The significant difference based on their profile unto the level of their TPACK can measure the readiness level of the secondary school mathematics teachers to where TPACK is also a concern when respondents are grouped mainly according to their profile in which the results would be the basis for implementing in-service training for teachers to develop what lacks and needs to in modern education where technology is a necessary skill and knowledge in teaching and learning mathematics.

Research Objectives

Generally, this study aimed to determine the teachers' level of readiness in technological, pedagogical, and content knowledge from the TPACK perspective and how their readiness level was significantly different when the respondents were grouped according to their profiles.

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Specifically, it was directed at answering the following questions.

1. What is the demographic profile of the respondents in terms of the following:

    1.1 Age;

    1.2 Teaching Designation;

    1.3 Gender;

    1.4 Highest Educational Attainment;

    1.5 Grade level assignment

    1.6 Length of service;

    1.7 Socioeconomic level of the school; and

    1.8 School Cluster.

2. What is the level of readiness of the respondents in teaching and learning mathematics from the perspective of:

    2.1 Technological Knowledge;

    2.2 Pedagogical Knowledge;

    2.3 Content Knowledge;

    2.4 Technological Content Knowledge;

    2.5 Technological Pedagogical Knowledge;

    2.6 Pedagogical Content Knowledge; and

    2.7 Technological Pedagogical Content Knowledge

3. Is there any significant difference between the respondents' readiness level in teaching and learning mathematics when they are grouped according to their profile?

II. Methodology

This study was descriptive research that would describe the level of readiness of the teachers based on the teachers' demographic profile and their TPACK level of readiness to be used as a proposal plan for In-service Training or Action Plan intended to improve the necessary professional development related to technology integration in teaching and learning mathematics.

The target population of this study was the public secondary school teachers, specifically Junior High school mathematics teachers, during the school year 2024 - 2025 from Binangonan, Rizal. Target schools were named alphabetically (from A to I) based on their district cluster (Binangonan I, II, and III). There were nine (9) public junior high schools in the municipality of Binangonan, which these schools were clustered from Binangonan I (School A, School B, and School C), Binangonan II (School D, School E), and Binangonan III (School F, School G, School H, and School I) respectively. Random sampling was used to select an equal chance of being included in the sample, avoid unbiased results, and diversify the samples, which makes each representative equally distributed.

Table 1

Population and Sample Size

Cluster	#	School	Number of samples	Percentage
1	1	A	13	17%
	2	B	12	16%
	3	C	5	7%
2	4	D	4	5%
	5	E	6	8%
	6	F	8	11%
	7	G	6	8%
3	8	H	6	8%
	9	I	16	21%
	TOTAL		76	100%

Data Gathering Procedure

The researcher has two parts of data collection; the first was to gather demographic information such as age, sex, educational background, teaching designation, grade level assignment, years in service, socioeconomic level of the school, and school cluster. The second was to determine the level of their readiness in technology, pedagogy, and content through the perspective of the TPACK framework, which considers adopting a survey instrument related to TPACK from Kumala et al. (2022). Permission to carry out the assessment tool was requested and granted by the appropriate authors through e-mail.

The research instrument has undergone validity, reliability, and pilot testing to ensure the quality and trustworthiness of the data collected from the respondents.

After the validity test was submitted, the researcher tested its reliability. This procedure would ensure the data was consistent under similar conditions, this can also reduce random error or biases in measurement, and the study would also build confidence that results were replicable. The reliability test was performed by the assigned statistician from the Institute for Data and Statistical Analysis or IDSA, PUP, through the endorsement of the research adviser. Results were released with Cronbach's Alpha overall score of 0.81 and an Internal consistency of Good. This certification was a 5-point Likert scale with 40 items to elicit the TPACK of secondary school mathematics teachers.

For the statistical Treatment of Data, the study utilized frequency distribution method, mean score, and mean rank. To test its significance, the study utilized a non-parametric test such as Kruskal-Wallis H-test among groups of indicators, then, data analysis, and computations were obtained using the Statistical Package for the Social Sciences or SPSS.

III. Results and Discussions

Results show for the demographic profile of the respondents was that the largest age group in the study was 31 to 40 years old, majority of the sample were teacher I, and most of the sample was female. Among the samples their highest education attained was a graduate of bachelor's degree. Likewise, the teacher respondents at the 6 to 10 years of experience and were employed in a large school here in Binangonan. Binangonan district has 3 clusters (Binangonan 1 to 3), and Binangonan

3 has the most representative of the sample.

For the level of readiness of the respondents in teaching and learning mathematics from the perspective of TPACK, the results show that teachers have a strong readiness in using technology, they also have strong understanding of various strategies effective in managing classes, they also show high readiness in teaching the content and applying technology in teaching these. They also have strong readiness in using technology to assess students and determine the students' difficulties but show readiness in developing online activities.

For the level of significance, results show that there was strong agreement in terms of technology but need support for technical issues, they also need training particular to pedagogical approach using technology. Furtherly, those mega schools who have a large population have strong readiness in using technology in teaching content making them significantly different to those small or medium schools in the whole school cluster, indicating that their school budget was more on supporting their teachers to utilize technology into their teaching. Also, the level of teaching experiences found significant differences among teachers, implying that the more experiences that the teacher had, the more likely they are to be ready to integrate technology into their teaching and learning.

IV. Conclusions

Based on the findings of the study, the following conclusions were made:

The age distribution of the respondents was in the middle age group (31 to 40 years old). Most of the respondents were teachers I, implying those fewer promotions or appointments at this intermediate stage. Most of the respondents are female, which means that there are lesser male math teachers in Binangonan district. Majority of the teacher respondents are on their 6 to 10 years of teaching, which are pivotal stage in their teaching career. Mega schools have dense populations of students, implying that their socioeconomic level was much higher than the small or medium schools

with a smaller population of students.

The overall mean score for the readiness has found significant differences on the length of service, socioeconomic level of the school, and the school cluster, implying that teacher respondents have strong

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readiness of using technology when the integrating them into teaching and applying to different pedagogies suited to the learnability of the students and teachers, hence the researcher highly encourage to the school administrators to provide in-service training based on the dimensions of TPACK. Moreover, for those less experienced teachers or newly hired teachers, they should have training in content and pedagogical integration and mentoring from the more experienced teachers, while tenures should be given opportunities for advanced professional development to continue their readiness especially in technological areas. Also, to make agreements for inter-school collaboration for anchoring the level of readiness of small or medium schools with mega schools. These schools may benefit from greater collaboration and resource-sharing opportunities in using technology.

Lastly, the researcher recommends to include variables such as familiarity with technology used, the level of ICT that the school has, the level of trainings related to technology, school culture, school-based management level of practice and leadership styles of the school heads as comparable variables to determine the level of readiness of the teachers using TPACK indicators for integrating technology in teaching and learning process.

Recommendations

Based on the summary of findings, the following recommendations can be inferred to improve the level of readiness in teaching and learning mathematics from the perspective of TPACK (Technological Pedagogical Content Knowledge). These recommendations are the most important revelations based on the findings and conclusions of the study. Thus, these are the focus for implementing the output of the In-service Training program, which can be found in Appendix 1.

1. The researcher highly encourages the school administrators, training facilitators, and Professional Development providers to target in-service training based on the dimensions of TPACK, which were determined to be significantly different from the rest, in which the respondents' readiness level could potentially increase. In terms of the socioeconomic level of the school, TCK, PCK, and TPACK, most of the encountered indicators were developing online learning activities, flash animations, and technological tools to identify students' misconceptions about learning mathematics. Furthermore, in-service training could also include dimensions of TPACK such as TK, PK, CK, and TPK with the highest level of readiness to strengthen, maintain, and make more capacitation for teachers, especially in those schools with identified lower level of readiness (e.g., Binangonan 2).

2. Given the significant differences in Content Knowledge (CK), Pedagogical Content Knowledge (PCK), and Technological Pedagogical Content Knowledge (TPACK) based on teachers' Length of Service, it was important to offer differentiated support to those with less experienced teachers (0 to 5 years) or newly hired teachers. They should receive additional training in content and pedagogical integration and mentoring from more experienced teachers. Furthermore, more experienced teachers (11-15 years) or tenures should be given opportunities for advanced professional development to continue enhancing their readiness, especially in technological areas.

For the indicators with no significant differences, the researcher highly encourages school administrators, master teachers, or training facilitators to focus on pedagogical strategies, particularly how technology enhances these and can improve overall readiness. Special workshops can focus on strengthening pedagogical content delivery through technology to bridge gaps. To support continuous learning for teachers across Age groups and Educational Levels. Since educational attainment and age are not significant factors in readiness, continuous learning opportunities should be offered to all teachers, regardless of their background. Even those with advanced degrees or older should have access to updated training on new technologies and teaching methodologies.

3. The researcher highly encourages school heads, administrators, master teachers, and all teachers to enrich and make agreements for the future of their inter-school collaboration, especially in Small or Medium-sized schools. Since they showed lower readiness levels compared to Mega schools, these schools may benefit from greater collaboration and resource-sharing with larger schools. Initiatives like inter-school workshops or shared resources can help medium-school teachers improve their technology integration capabilities.

4. Lastly, the researcher recommends that future researchers include other variables that were not mentioned or explored by the study, such as familiarity with technology used by the teachers, the level of ICT that the school has, the level of training related to technology in teaching and learning of the teachers, school-culture, School-Based Management Level of Practice, and Leadership styles of School heads as comparable variables to determine the level of readiness of the teachers using TPACK indicators for integrating technology in teaching and learning process.

V. References

1. Abebe, F. F., Gaskill, M., Hansen, T., & Liu, X. (2022). Investigating K-12 pre-service teacher TPACK in instructional technology learning. International Journal of Teacher Education and Professional Development, 5(1), 1-16. https://doi.org/10.4018/ijtepd.2022010104

2. Adulyas, L. (2017). Measuring and factors influencing mathematics teachers' technological, pedagogical, and content knowledge (TPACK) in three southernmost provinces, Thailand. AIP conf. Proc. 1868 (1): 050032. https://doi.org/10.1063/1.4995159

3. Albugami, S. & Ahmed, V. (2015) 'Success factors for ICT implementation in Saudi secondary schools: from the perspective of ICT directors, head teachers, teachers and students', International Journal of Education and Development using Information and Communication Technology (IJEDICT) [online], vol. 11, no. 1, pp. 36–54

4. Alcantara, E. C., Veriña, R. U., & Niem, M. M. (2020). Teaching and learning with technology: ramification of ICT integration in mathematics education. Teaching and Learning, 10(1)

5. Ali S.H.M, Yasmeen, R., Munawar Z., (2023). The Impact of Technology Integration on student Engagement and Achievement in Mathematics Education: A systematic Review. International Journal of Computer Integrated Manufacturing. 6(3):222-232. https://journals.researchparks.org/index.php/IJIE

6. Andarwulan, T., Fajri, T. A. A., & Damayanti, G. (2021). Elementary Teachers' Readiness toward the Online Learning Policy in the New Normal Era during COVID-19. International Journal of Instruction, 14(3), 771-786

7. Arhin, A., Abekah-Nkrumah, G., & Dzokoto, V. (2022). High school mathematics teachers' readiness to integrate ICT tools in teaching. International Journal of Educational Technology in Higher Education, 19(1), 1-14. https://doi.org/10.1186/s41239-022-00323-0

8. Asiroglu, S., & Akran, S. K. (2018). The Readiness Level of Teachers in Science, Technology, Engineering and Mathematics Education. Universal Journal of Educational Research, 6(11), 2461-2470

9. Aslan, A., & Zhu, C. (2016). Investigating variables predicting Turkish pre-service teachers' integration of ICT into teaching practices. British Journal of Educational Technology, 48(2), https://doi.org/10.1111/bjet.12437

10. Ball, Lynda; Drijvers, Paul; Ladel, Silke; Siller, Hans-Stefan; Tabach, Michal; Vale, Colleen (2018). [ICME-13 Monographs] Uses of Technology in Primary and Secondary Mathematics Education || . , 10.1007/978-3-319-76575-4(), –. doi:10.1007/978-3-319-76575-4

11. Bashir, K., & Luyima, J. (2023). Digital pedagogy readiness among pre-service teachers: The role of pedagogical and content knowledge. Journal of Teacher Education and Educators, 12(2), 45-61

12. Batanero, J.M.F., Rueda, M. M., Cerero, J.F., Martinez, I.G. (2020). Digital competences for teacher professional development. Systematic review. European Journal of Teacher Education, (), 1–19. doi:10.1080/02619768.2020.1827389

13. Baydas, O., & Yilmaz, R. M. (2018). Pre-service teachers' intention to adopt mobile learning: A motivational model. British Journal of Educational Technology, 49(1), 137-152

14. Belt, E. S., & Lowenthal, P. R. (2023). Synchronous video-based communication and online learning: an exploration of instructors' perceptions and experiences. Education and information technologies, 28(5), 4941-4964

15. Biswas, R. A., & Nandi, S. (2020). Teaching in virtual classroom: Challenges and opportunities. International Journal of Engineering Applied Sciences and Technology, 5(1), 334-337. Retrieved from https://www.ijeast.com/papers/334-337,Tesma501,IJEAST.pdf

16. Boonmoh, A., Jumpakate, T., Karpklon, S., (2021). Teachers' Perception and Experience in Using Technology for the Classroom. Computer-Assisted Language Learning Electronic Journal (CALL-EJ),22(1), 1-24. http://callej.org/journal/22-1/Boonmoh-Jumpakate-Karpklon2021.pdf

17. Bora, Ashim & Ahmed, Sahin. (2018). AN INVESTIGATION ON MTPACK OF SECONDARY SCHOOL MATHEMATICS TEACHERS IN ASSAM. International Journal of Technical Innovation in Modern Engineering & Science, 5(05)

18. Bramwell, D. (2021). Enhancing pedagogical knowledge through teacher preparation programs. Journal of Teacher Education and Educators, 10(2), 203-218. https://doi.org/10.5578/jtee.1533

19. Cabanero, M. J., Kaur, K., & Sharma, S. (2022). Understanding the impact of digital pedagogy on pre-service teachers' readiness. Frontiers in Education, 7, Article 834712

20. Cai, Z., Fan, X., & Du, J. (2017). Gender and attitudes toward technology use: A meta-analysis. Computers & Education, 105, 1-13. https://doi.org/10.1016/j.compedu.2016.11.003

21. Çakıroğlu, Ü., & Aydın, M. (2023). The effects of emergency remote teaching on instructors' technological pedagogical content knowledge. Technology, Knowledge and Learning, 28(1), 55-73. https://doi.org/10.1007/s10758-021-09546-5

22. Castéra, J., Marre, C.C., Yok, M.C.K. et al. (2020). Self-reported TPACK of teacher educators across six countries in Asia and Europe. Educ Inf Technol 25, 3003–3019. https://doi.org/10.1007/s10639-020-10106-6

23. Cheng, S., & Parker, M. (2023). The role of school socioeconomic status in school-wide technology integration in the U.S. Contemporary Educational Technology, 15(2), Article ep422. Retrieved from https://eric.ed.gov/?id=EJ1385458

24. Dantes, G. R., Audina, I. P., Marsakawati, N. P. E., & Suwastini, N. K. A. (2022). Investigating The Zoom Application as A Video Conferencing Platform in The Online Learning Process Based on Teacher's Perception. Jurnal Nasional Pendidikan Teknik Informatika : JANAPATI, 11(2), 133–144. https://doi.org/10.23887/janapati.v11i2.48456

25. Das, K. (2019). Role of ICT for Better Mathematics Teaching. Shanlax International Journal of Education, 7(4), 19-28. https://doi.org/10.34293/education.v7i4.641

26. De Freitas, G., & Spangenberg, E. D. (2019). Mathematics teachers' levels of technological pedagogical content knowledge and information and communication technology integration barriers. Pythagoras, 40(1), Article 431. https://doi.org/10.4102/pythagoras.v40i1.431

27. De Las Peñas, M.L.A.N., Versoza, D.M., Aberin, M.A.Q., Garciano, A., Sarmiento, J.F., & Tolentino, M.A.C.;(2021). Designing Performance Tasks in Mathematics Using Technological Tools. Archīum.ATENEO. https://archium.ateneo.edu/mathematics-faculty-pubs/208

28. DeCoito, I. & Richardson, T. (2018). Teachers and Technology: Present Practice and Future Directions. Contemporarywassues in Technology and Teacher Education, 18(2), 362-378. Waynesville, NC USA: Society for Information Technology & Teacher Education. Retrieved July 17, 2023 from https://www.learntechlib.org/primary/p/180395/

29. Elshareif, E. & Mohamed, E. (2021). The effects of e-learning on students' motivation to learn in higher education. Online Learning, 25(3), 128-143. doi:10.24059/olj.v25i3.2336

Engelbrecht, J., Borba. (2024) M.C. Recent developments in using digital technology in mathematics education. ZDM Mathematics Education 56, 281–292. https://doi.org/10.1007/s11858-023-01530-2

30. Ensminger, D. C. (2016). Technology Planning in Schools. In N. Rushby, & D. W. Surry (Eds.), The Wiley Handbook of Learning Technology (p. 461). John Wiley & Sons, Inc. https://doi.org/10.1002/9781118736494.ch24

31. Erden, A., Aytaç, T., & Erden, H. (2016). Gender effect on classroom management skills and competencies of teachers: A meta-analysis study. International Journal of Human Sciences, 13(1), 1543-1557. https://doi.org/10.14687/ijhs.v13i1.3607

32. Gamit, A. M. (2023). Embracing digital technologies into mathematics education. Journal of Curriculum and Teaching, 12(1), 283-294

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 1 Issue 2 (2025)

33. Garcia-Morales, V.J., Garrido-Moreno, A., & Rojas, R.M., (2021). The Transformation of Higher Education After the COVID Disruption: Emerging Challenges in an Online Learning Scenario. Frontiers in Psychology, 12, pp. 1 pp. 1 – 6. https://doi.org/10.3389/fpsyg.2021.616059

34. Gaspard, H., Parrisius, C., Nagengast, B., & Trautwein, U. (2022). Understanding the interplay between targeted motivation interventions and motivational teaching practices in mathematics classrooms. ZDM – Mathematics Education, 55(2), 345–358. https://doi.org/10.1007/s11858-022-01446-3

35. Giménez, A., & Bechara, M. (2022). The influence of pedagogical content knowledge on teacher practices in mathematics. Educational Studies in Mathematics, 111(2), 225-246. https://doi.org/10.1007/s10649-022-10057-6

36. Goktas, Y., & Yildirim, S. (2014). Technology Integration in Public Schools in Turkey: An Analysis of Socioeconomic Disparities. Educational Technology Research and Development, 62(4), 631-650. doi:10.1007/s11423-014-9341-6

37. Gong, Jie; Lu, Yi; Song, Hong. (2017). The Effect of Teacher Gender on Students' Academic and Noncognitive Outcomes. Journal of Labor Economics, (), 696203–. doi:10.1086/696203

38. Hennessy, S., D'Angelo, S., Mcintyre, N., Koomar, S., Kreimeia, A., Cao, L., Brugha, M., Zubairi, A., 2022. Technology Use fo Teacher Professional Development in Low-and Middle-Inccome Countries: A systematic Review. Computers and Education Open. https://doi.org/10.1016/j.caeo.2022.100080

39. Hill, J.E. & Uribe-Florez, L. (2020). Understanding secondary school teachers' TPACK and technology implementation in mathematics classrooms. International Journal of Technology in Education (IJTE), 3(1), 1-13.

40. Hung, M. L. (2016). Teacher readiness for online learning: Scale development and teacher perceptions. Computers & Education, 94, 120-133. https://doi.org/10.1016/j.compedu.2015.11.012

41. Hsu, L., & Chen, Y. J. (2018). Teachers' knowledge and competence in the digital age: Descriptive research within the TPACK framework. International Journal of Information and Education Technology, 8(6), 455-458

42. Insorio, A. O., & Macandog, D. M. (2022). Video Lessons via YouTube Channel as Mathematics Interventions in Modular Distance Learning. Contemporary Mathematics and Science Education, 3(1), ep22001. https://doi.org/10.30935/conmaths/11468

43. Irwanto, I. (2021). Research trends in technological pedagogical content knowledge (TPACK): A systematic literature review from 2010 to 2021. European Journal of Educational Research, 10(4), 2045-2054. https://doi.org/10.12973/eu-jer.10.4.2045

44. Ismail, R. A. M., Arshad, R., & Abas, Z. (2018). Can teachers' age and experience influence teacher effectiveness in HOTS. International Journal of Advanced Studies in Social Science and Innovation, 2(1). http://dx.doi.org/10.30690/ijassi.21.11

45. Jiménez Sierra, Á. A., Ortega Iglesias, J. M., Cabero-Almenara, J., & Palacios-Rodríguez, A. (2022). Development of the teacher's technological pedagogical content knowledge (TPACK) from the Lesson

Study: A systematic review. Frontiers in Education, 7, Article 796642. https://doi.org/10.3389/feduc.2022.796642

46. Joo, Y. J., Park, S., & Lim, E. (2018). Factors influencing pre-service teachers' intention to use technology: TPACK, self-efficacy, and technology acceptance model. Journal of Educational Technology & Society, 21(3), 48–59

47. Joshi, S. (2023). TPACK and Teachers' Self-Efficacy: A Systematic Review. Canadian Journal of Learning and Technology / Revue canadienne del'apprentissage et de la technologie, 49(2), 1–23.https://doi.org/10.21432/cjlt28280

48. Jwaifell, M., Abu-Omar, A., & Al-Tarawneh, M. (2018). The Readiness of Arabic Language Teachers for Integrating Flipped Classroom: Case of Ma'an. International Journal of Instruction, 11(4), 855-868. https://doi.org/10.12973/iji.2018.11454a

49. Kasa Ayten, D. (2021). The relationship between classroom teachers' technological pedagogical content knowledge and their self-efficacy beliefs in technology use. International Technology and Education Journal, 5(1), 62-74. https://doi.org/10.46328/itej.v5i1.173

50. Kaur, K., & Sharma, S. (2020). Exploring pre-service teachers' content knowledge and its impact on teaching effectiveness. International Journal of Education Research, 12(3), 21-35

51. Kim, D., Tosuntas, S., & Francom, G. (2020). The effect of school socioeconomic status and teachers' perception of school culture on teachers' use of information and communications technology tools in the classroom. Contemporary Educational Technology, 14(1), 1-16.

Retrieved from https://getd.libs.uga.edu/pdfs

52. Koehler, M. J., Mishra, P., & Cain, W. (2013). Whatwas Technological Pedagogical Content Knowledge (TPACK)? Contemporarywassues in Technology and Teacher Education, 13(1), 36–51

53. Kumala, F. N., Ghufron, A., & Pujiastuti, P. (2022). Elementary school teachers' TPACK

profile in science teaching based on demographic factors. International Journal of Instruction, 15(4), 77-100. https://doi.org/10.29333/iji.2022.1545a

54. Kyeremeh, P. O., Amoah, E. K., & Sabtiwu, R. (2021). Junior High School Mathematics Teachers' Practice of Differentiated Instruction and Associated Challenges in Tano South Distict. Journal of Mathematics and Science Teacher, 1(1), em001. https://doi.org/10.29333/mathsciteacher/10914

55. Layco, E.P., (2020), Mathematics Education 4.0: Teachers' Competence and Skills' Readiness in Facing the Impact of Industry 4.0 on Education. Jour of Positive School Psychology, vol 6, No. 2 https://www.journalppw.com/index.php/jpsp/article/view/1642

56. Li, S., Liu, Y., & Su, Y. S. (2022). Differential analysis of teachers' technological pedagogical content knowledge (TPACK) abilities according to teaching stages and educational levels. Sustainability, 14(12), 7176

57. Li, X., & Ma, J. (2022). A Review of Literature on the Effective Pedagogy Strategies for Online Teaching and Learning in Higher Education Institutions. Education and Information Technologies, 27, 1119-1142. https://doi.org/10.1007/s10639-021-10765-4

58. Lidolf, S., & Pasco, D. (2020). Educational technology professional development in higher education: A systematic literature review of empirical research. In Frontiers in Education (Vol. 5, p. 35). Frontiers Media SA

59. Lumagbas, Jedaiah Joel; Smith, Wally; Care, Esther; Scoular, Claire (2019). Tablet computers in Philippine public schools: school-level factors that influence technology management and use. Technology, Pedagogy and Education, (), 1–17. doi:10.1080/1475939X.2019.1572535

60. Mailizar, M., Hidayat, M., & Artika, W. (2021). The effect of demographic variables on mathematics teachers' TPACK: Indonesian context. In Journal of Physics: Conference Series 1882 (1) p. 012041. IOP Publishing

61. Mailizar, M., Hidayat, M., & Al-Manthari, A. (2021). Examining the Impact of Mathematics Teachers' TPACK on Their Acceptance of Online Professional Development. Journal of Digital Learning in Teacher Education, 37(3), 196-212

62. Mahdi, H. S., & Al-Dera, A. S. (2013). The impact of teachers' age, gender and experience on the use of information and communication technology in EFL teaching. English Language Teaching, 6(6), 57-67. http://dx.doi.org/10.5539/elt.v6n6p57

63. Manzano-León, A., Camacho-Lazarraga, P., Guerrero, M. A., Guerrero-Puerta, L., Aguilar-Parra, J. M., Trigueros, R., & Alias, A. (2021). Between level up and game over: A systematic literature review of gamification in education. Sustainability, 13(4), 2247

64. Maria, M., Shahbodin, F., & Pee, N. C. (2018). Malaysian higher education system towards industry 4.0–current trends overview. In AIP Conference Proceedings (Vol. 2016, No. 1). https://doi.org/10.1063/1.5055483

65. McCulloch, A. W., Hollebrands, K., Lee, H., Harrison, T., & Mutlu, A. (2018). Factors that influence secondary mathematics teachers' integration of technology in mathematics lessons. Computers & Education, 123, 26-40.

66. McKnight, Katherine; O'Malley, Kimberly; Ruzic, Roxanne; Horsley, Maria Kelly; Franey, John J.; Bassett, Katherine . (2016). Teaching in a Digital Age: How Educators Use Technology to Improve Student Learning. Journal of Research on Technology in Education, (), 1–18. doi:10.1080/15391523.2016.1175856

67. Mishra, P., & Koehler M.J.. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. Teachers College Record, 108(6), pp. 1017 - 1054

68. Muhazir, A., Retnawati, H. (2020). The teachers' obstacles in implementing technology in mathematics learning classes in the digital era.Journal of Physics: Conference Series 1511 010222, International Conference on Science Education and Technology DOI 10.1088/1742-6596/1511/1/012022

69. Munyengabe, D., Chigwada, J., & Wawire, N. (2017). Teachers' readiness to integrate technology into teaching and learning in Rwandan primary schools. Education and Information Technologies, 22(6), 2433-2449. https://doi.org/10.1007/s10639-017-9666-6

70. Nazari, N., Nafissi, Z., Estaji, M., & Marandi, S. S. (2019). Evaluating novice and experienced EFL teachers' perceived TPACK for their professional development. Cogent Education, 6(1), 1632010. https://doi.org/10.1080/2331186X.2019.1632010

71. Ndlovu, M., Meyer, D. (2023). Teachers' TPACK readiness to teach mathematics with technology. A case study of a private high school in South Africa. Information and Communications Technology in STEM Education. 145 – 159. Routledge.

72. Nikolopoulou, K., Gialamas, V., & Lavidas, K. (2022). Mobile learning-technology barriers in school education: teachers' views. Technology, Pedagogy and Education, 32(1), 29–44. https://doi.org/10.1080/1475939x.2022.2121314

73. Nikolopoulou, K., Gialamas, V., Lavidas, K. et al. (2021). Teachers' Readiness to Adopt Mobile Learning in Classrooms: A Study in Greece. Tech Know Learn 26, 53–77. https://doi.org/10.1007/s10758-020-09453-7

74. Ning, Y., Zhou, M., & Wijaya, T. T. (2022). The impact of school context on teachers' TPACK integration: A meta-analysis of professional development in clustered school environments. Journal of Educational Technology Development and Exchange, 15(2), 91-108. https://doi.org/10.1016/j.jedutech.2022.105148

75. Ozudogru, M., & Ozudogru, F. (2019). Technological Pedagogical Content Knowledge of Mathematics Teachers and the Effect of Demographic Variables. Contemporary Educational Technology, 10(1), 1-24. https://eric.ed.gov/?id=EJ1203218

76. Paidican, M. A., & Arredondo, P. A. (2022). The Technological-Pedagogical Knowledge for In-Service Teachers in Primary Education: A Systematic Literature Review. Contemporary Educational Technology, 14(3), ep370. https://doi.org/10.30935/cedtech/11813

77. Patalinghug. J.S. & Arnado A.A.(2021).Mathematics Teachers' Technological Pedagogical and Content Knowledge and their Capacity for Differentiated Instruction. International Journal of Multidisciplinary: Applied Business and Education Research.2(7), 574–586 doi: 10.11594/ijmaber.02.07.05

78. Pozdniakov, S., & Freiman, V. (2021). Technology-supported innovations in mathematics education during the last 30 years: Russian perspective. ZDM–Mathematics Education, 53(7), 1499-1513. https://doi.org/10.1007/s11858-021-01279-6

79. Power, T., Gater, R., Grant, C., & Winters, N. (2014). Educational technology topic guide. London: The Health & Education Advice & Resource Team (HEART).

Retrieved from http://www.heart-resources.org/topic/educational-technology/

80. Pramudyani, A. V. R., Indratno, T. K., & Rohmadheny, P. S. (2019). Early Childhood Education Teacher's Readiness of Computer Literacy for Facing The 4.0 Industrial Revolution. Journal of Early Childhood Care and Education, 2(2), 55-63. DOI: 10.26555/jecce.v2i2.1150

81. Rahimi, M., & Pourshahbaz, S. (2019). English as a foreign language teachers' TPACK and self-efficacy: The case of private language institutes in Iran. Australian Journal of Teacher Education, 44(4), 67-80. https://doi.org/10.14221/ajte.2019v44n4.5

82. Ratheeswari, K. (2018). Information communication technology in education. Journal of Applied and Advanced research, 3(1), 45-47. https://dx.doi.org/10.21839/jaar.2018.v3S1.169

83. Roble, D., Ubalde, M., Roble, D. B., Ubalde, M. V., & Castillano, E. C. (2019). Teachers' Perceptions of Integrating Technology in Mathematics Classroom Among School Teachers in Cagayan De Oro City, Philippines. Sci. Int.(Lahore), 31(6), 841-845

84. Ryoo, J. H., Molfese, V. J., Heaton, R., Zhou, X., Brown, E. T., Prokasky, A., & Davis, E. (2014). Early mathematics skills from pre-kindergarten to first grade: score changes and ability group differences in Kentucky, Nebraska, and Shanghai samples. Journal of Advanced Academics, 25(3), 162-188 https://doi.org/10.1177/1932202X14538975

85. Salim, K., & Tiawa, D. H. (2015). The Student's Perceptions of Learning Mathematics Using Flash Animation Secondary School in Indonesia. Journal of Education and Practice, 6(34), 76-80.

86. Scherer, R., and Siddiq, F. (2015). Revisiting teachers' computer self-efficacy: A differentiated view on gender differences, Computers in Human Behavior. 53, 48 - 57. https://doi.org/10.1016/j.chb.2015.06.03

87. Soriano, J., & Vargas, D. (2021). KNOWLEDGE AND READINESS OF HIGH SCHOOLS'TEACHERS IN THE IMPLEMENTATION K TO 12 BASIC EDUCATION PROGRAM. Available at SSRN 3813268

88. Teplá, M., & Klímová, H. (2015). Using Adobe Flash animations of electron transport chain to teach and learn biochemistry. Biochemistry and Molecular Biology Education, 43(4), 294-299. https://doi.org/10.1002/bmb.20867

89. Tokac, U., Novak, E., & Thompson, C. G. (2019). Effects of game-based learning on students' mathematics achievement: A meta-analysis. Journal of Computer Assisted Learning, 35(3), 407-420

90. Tondeur, J., Krug, D., Bill, M., Smulders, M., & Zhu, C. (2015). Integrating ICT in Kenyan secondary schools: An exploratory case study of a professional development programme. Technology, Pedagogy and Education, 24,565–584

91. Tondeur, J., van Braak, J., Sang, G., Voogt, J., Fisser, P., & Ottenbreit-Leftwich, A. (2012). Preparing Pre-service Teachers to Integrate Technology in Education: A Synthesis of Qualitative Evidence. Computers & Education, 59(1), 134–144

92. Urbina, M., & Polly, D. (2017). Examining technology integration in elementary math instruction: Insights from a TPACK study. International Journal of Technology in Teaching and Learning, 13(1), 1-15

93. Valtonen, T., Sointu, E., Kukkonen, J., Kontkanen, S., & Mäkitalo-Siegl, K. (2018). Differences in Pre-Service Teachers' Knowledge and Readiness to Use ICT in Education. Journal of Computer Assisted Learning, 34(2), 174–182

94. Veletsianos, George; Houlden, Shandell (2019). An analysis of flexible learning and flexibility over the last 40 years of <i>Distance Education</i>. Distance Education, (), 1–15. doi:10.1080/01587919.2019.1681893

95. Voithofer, Rick; Nelson, Michael J.; Han, Guang; Caines, Autumm. (2019). Factors that influence TPACK adoption by teacher educators in the US. Educational Technology Research and Development, (), –. doi:10.1007/s11423-019-09652-9

96. Wang, Z., Utemov, V. V., Krivonozhkina, E. G., Liu, G., & Galushkin, A. A. (2017). Pedagogical readiness of mathematics teachers to implement innovative forms of educational activities. EURASIA Journal of Mathematics, Science and Technology Education, 14(1), 543-552

97. Weinhandl, R., Lavicza, Z., Hohenwarter, M., & Schallert, S. (2020). Enhancing fipped mathematics education by utilising GeoGebra. International Journal of Education in Mathematics, Science and Technology, 8(1), 1–15

98. Yue, M., & Ng, D. T. K. (2024). K–12 teachers' TPACK readiness and attitudes toward AI education. Computers & Education, 184, 104561. https://doi.org/10.1016/j.compedu.2022.104561