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# "Enhancing Teaching Performance through Technological Pedagogical Content Knowledge (TPACK): A Study of Mathematics Teachers in Private Institutions"

**Gener S. Subia[1], Jommel S.Sabado[2], Mary Grace T.Guinto[3], Francis J.Pilayan[4], Jay Ar I. Laranang[5]**

Research Director, Wesleyan University Philippines[1]

Middle School Math Teacher, Clark County School District, Las Vegas, Nevada, USA[2]

Teacher III/OIC-Sandelain Elementary School, DepEd-Nueva Ecija, Palayan City District[3]

Teacher III -Canaan East National High School, DepEd-Nueva Ecija, Rizal District[4]

Teacher-In-Charge -Ditawini Elementary School, DepEd- Aurora, Dinalungan District[5]

**Abstract:** This research, entitled "Enhancing Teaching Performance through Technological Pedagogical Content Knowledge (TPACK): A Study of Mathematics Teachers in Private Institutions," examines the TPACK and teaching performance of 100 secondary mathematics educators in private institutions in Nueva Ecija. Research indicates that educators exhibit a good level of TPACK, reflecting confidence and proficiency in utilizing technology to improve mathematics instruction. The teaching performance of these educators is positively assessed, with teachers demonstrating excellence in fundamental instructional techniques, including lesson preparation, classroom management, and instructional clarity. However, several domains, particularly in accommodating individual student differences, were recognized as requiring additional assistance and enhancement to promote inclusive learning. The study reveals a substantial positive link between TPACK and teaching performance, emphasizing the essential significance of technological integration in enhancing teaching effectiveness. The findings indicate that focused professional development designed to improve teachers' TPACK may further elevate instructional quality and student engagement in mathematics. Furthermore, providing educators with techniques to accommodate varied learner demands may enhance the whole educational experience, rendering mathematics instruction more flexible and efficient.

**Keywords:** Mathematics Teachers, Private Institutions, TPACK, Technological Integration, Teaching Performance

## INTRODUCTION

The K-12 mathematics curriculum employs a spiral development, wherein the same concepts are taught throughout grade levels with increasing complexity and depth. The educators instruct the five curriculum areas in Mathematics: Numbers and Number Sense, Measurement, Geometry, Patterns and Algebra, and Probability and Statistics, with increasing complexity from Grades 7 to 10 (Dep.Ed., 2014).

This spiral process posed challenges for many mathematics teachers, as they are accustomed to teaching a single mathematical subject throughout the year; in this instance, they must understand five subjects and teach in several disciplines across the entire academic year. The government urges mathematics educators to enhance their teaching methods by incorporating current technologies. Furthermore, newly appointed educators possess substantial topic knowledge; nonetheless, enhancing their pedagogical skills necessitates the provision of workshops, training sessions, and seminars to refine their teaching abilities (Manakul, Somabut, & Tuamsuk, 2023).

Bala (2017) asserted in the article on the challenges faced in the K to 12 curriculum in Nueva Ecija that “it is essential for teachers to have training in pedagogy, educational research, measurement and evaluation, and classroom management”. Bala stated that lack of skill is a significant issue that requires rapid attention. Nonetheless, numerous

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experts were significantly drawn to the posts provided by the DepEd due to the substantial salaries granted. However, the issue lies in their inability to convey the acquired knowledge to their respective students.

Utilizing visual aids in mathematics can assist students in identifying prevalent misunderstandings and misconceptions, and technology serves as an effective pedagogical tool for visualizing mathematical concepts (Do'stov, A'zamqulov & Yusupov, 2022). Technology offers dynamic options for learning in mathematics and STEM courses. Educators may augment the learning experience and animate concepts through captivating and interactive media. It can also provide supplementary support to meet the needs of all learners and facilitate tailored learning experiences (Scharaldi, 2018).

The ability of beginner educators to effectively utilize technology in educational settings has become increasingly significant (Robinson & Aronica, 2015). Therefore, teacher training institutions are required to equip new educators with the skills to use technology in their pedagogical practices. Numerous studies indicate that to cultivate pre-service teachers' proficiency in technology integration, teacher training institutions must assist them in linking their technological, pedagogical, and content knowledge, encompassing skills and attitudes (Mouza, Nandakumar, Yilmaz Ozden & Karchmer-Klein, 2017).

Koehler and Mishra (2009) assert in their Technological Pedagogical Content Knowledge (TPACK) paradigm that effective technology integration necessitates teachers' proficiency in, and the ability to integrate, all three types of knowledge in their practice. Technological Pedagogical Content Knowledge (TPCK) was presented in the educational research domain as a theoretical framework for comprehending the knowledge teachers need for effective technology integration (Mishra & Kohler, 2006). The term TPCK was rebranded as TPACK (pronounced "tee-pack") "to enhance memorability and to create a more cohesive representation of the three types of knowledge involved: technology, pedagogy, and content" (Thompson & Mishra, 2008). The TPACK paradigm expands upon Shulman's concept of Pedagogical Content Knowledge (PCK) by incorporating technology knowledge as integrated with content and pedagogical knowledge.

As educators in the new curriculum, the researchers are encountering many of the same challenges. This shared experience has motivated them to conduct this study, aiming to identify the specific difficulties mathematics teachers in private schools in Nueva Ecija face with integrating technology into their instruction and to explore how these challenges relate to their overall teaching performance.

## METHODOLOGY

The researchers utilized the descriptive-correlational research design using a questionnaire technique to gather the necessary information. According to Patten (2002) as cited by Subia, Salangsang and Medrano (2018) "Correlational research is employed to test the degree of relationship between two variables. In this study, the researchers described and correlated the technological pedagogical content knowledge (TPACK) and teaching performance of the Junior Mathematics Teachers (Grades 7 to 10).

The respondents of the study are 100 selected Grade 7 to 10 secondary Mathematics teachers teaching in the private secondary schools in the province of Nueva Ecija (Fronda, 2023; Subia, Mangiduyos & Turgano, 2020). They were chosen using purposive sampling based on the following criteria (Subia, 2018): 1. Mathematics is their major; 2. At least 3 years teaching Mathematics; and 3. With access to technology and the internet.

Two adopted data-gathering instruments were utilized in this study. The TPACK questionnaire used the instrument made by Sumangil (2019) and the teaching performance of the teachers was measured using the Department of Education adopted Performance Appraisal for Teachers (PAST), specifically the area regarding instructional competence of teachers.

Appropriate statistical tools such as mean, weighted means and correlational formulas were used to compute the data gathered in this study. All computations were done using Statistical Package for Social Sciences.

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## RESULTS AND DISCUSSION

### 1. Technological Pedagogical Content Knowledge (TPACK) of the Grades 7 to 10 Mathematics Teachers

Table 1. TPACK

| TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (n=100) | WM | Verbal Description |
|---|---|---|
| 1. I use technologies that enhance the content for my lessons in Mathematics. | 4.02 | Agree/Good |
| 2. I select technologies which I use in my classroom that develop what and how I teach in Mathematics. | 4.22 | Strongly Agree/Excellent |
| 3. I hand-picked technologies that I use in my classroom which improve what students learn in Mathematics. | 4.05 | Agree/Good |
| 4. I can use Facebook, email or Twitter to disseminate information about my lessons in Mathematics. | 3.32 | Moderately Agree/Fair |
| 5. I utilize modern technologies to help my students better understand the topics in Mathematics. | 3.99 | Agree/Good |
| 6. I use various technologies to make my teaching in mathematics more meaningful to my students. | 3.92 | Agree/Good |
| 7. I use different technologies to better assess my students' performance in Mathematics. | 3.38 | Moderately Agree/Fair |
| 8. I utilize several technologies that adapt to the learning styles and cater for the multiple intelligences of my students. | 3.34 | Moderately Agree/Fair |
| 9. I employ graphical calculators or Android applications in teaching some topics in mathematics. | 3.14 | Moderately Agree/Fair |
| 10. I apply modern technologies to intensify my teaching approaches in Mathematics that make my students enjoy learning the subject. | 3.89 | Agree/Good |
| 11. I use technologies that help me identify my students' common understanding and misconceptions in Mathematics. | 3.66 | Agree/Good |
| 12. I utilize technologies that help my students in Mathematics develop their higher-order thinking skills. | 3.70 | Agree/Good |
| **Overall Weighted Mean** | **3.72** | **Agree/Good** |

Table 1 shows the overall weighted mean for Technological Pedagogical Content Knowledge (TPACK) is 3.72, suggesting that instructors, on average, concur that they utilize technology effectively to improve their mathematics instruction. The overall mean indicates that educators possess confidence in employing diverse technologies to enhance teaching and learning, hence positively impacting content delivery and student engagement in mathematics (Quintero, et al., 2022). Nonetheless, there exists a variation in the intensity of teachers' sentiments on their technological applications, revealing both strengths and areas for prospective enhancement across individual things.

The highest mean of 4.22 indicates teachers' robust consensus on choosing technologies that enhance both their instructional techniques and mathematical content, underscoring a proactive strategy in employing digital tools to improve teaching quality. In contrast, the lowest mean of 3.14 indicates only moderate agreement about the utilization of graphical calculators or Android applications, implying that although educators may recognize the importance of technology, they may lack confidence, experience, or access to specialized tools. This difference highlights opportunities for improvement, especially in enhancing teachers' access to and proficiency with a wider array of technological tools that could augment mathematical learning experiences (Bertolone-Smith, et al., 2023).

Visualizing mathematics can assist students in identifying prevalent misunderstandings and misconceptions, and the application of current technology serves as an effective pedagogical tool for this purpose. Technology offers dynamic options for learning in mathematics and STEM courses. Educators may augment the learning experience and animate concepts through captivating and interactive media. It can also provide supplementary assistance to meet the needs of all learners and develop tailored learning experiences (Scharaldi, 2018).

Similarly, educators must improve their proficiency in utilizing graphical calculators or Android applications in the instruction of Mathematics 7. Educators should utilize these tools to enable their students to see and engage with

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mathematical concepts. Students can investigate and uncover insights through games, simulations, and digital instruments. Hindy (2018) proposed ten optimal mathematics applications for Android that educators can utilize to augment their TPACK and foster student engagement in mathematics instruction. These include Brainly, HiPer, Khan Academy, Lecture Notes, MyScript Calculator, Photomath, Socratic, Wabbitemu, Wolfram, and YouTube.

### 2. Teaching Performance of the Grades 7 to 10 Mathematics Teachers

Table 2. Teaching Performance

| *The teacher…* | WM | Verbal Description |
|---|---|---|
| 1. Select contents and prepare appropriate instructional materials/teaching aids | 4.11 | Agree/Good |
| 2. Utilizes appropriate teaching methods/strategies | 3.96 | Agree/Good |
| 3. Relates new lesson with previous knowledge/skills | 4.40 | Strongly Agree/Excellent |
| 4. Provides appropriate motivation | 4.15 | Agree/Good |
| 5. Presents and develops lessons | 4.31 | Strongly Agree/Excellent |
| 6. Conveys ideas clearly | 4.12 | Agree/Good |
| 7. Utilizes the art of questioning to develop a higher level of thinking | 3.75 | Agree/Good |
| 8. Ensures pupils/students participation | 4.09 | Agree/Good |
| 9. Addresses individual differences | 3.74 | Agree/Good |
| 10. Shows mastery of the subject matter | 4.41 | Strongly Agree/Excellent |
| 11. Assesses lesson to determine desired outcomes within the allotted time | 4.12 | Agree/Good |
| 12. Maintains orderly classroom | 4.55 | Strongly Agree/Excellent |
| **Overall Weighted Mean** | **4.14** | **Agree/Good** |

Overall, the weighted mean for the teachers' performance indicators is 4.14, which shows the respondents think that they are good at many different parts of teaching. According to this ranking, teachers always do things that help students learn, like choosing appropriate lessons, keeping the classroom organized, and managing the students (Humaeroah, Sardi & Ermawati, 2023). The "Agree/Good" rating means that teachers meet standards, but there may still be ways they can improve their teaching to get to the highest level of excellence across all indicators.

The highest mean, 4.55, is for keeping the classroom in order, which shows that the teacher is very good at managing the class. This means that teachers put a high value on a structured and well-run setting, which is important for a good learning experience. The lowest mean, 3.74, is for dealing with individual differences. This shows that teachers may find it hard to change their lessons to meet the needs of all their students. The difference between the highest and lowest means shows that differentiating teaching needs more help or strategies to make sure that all students, no matter their abilities or learning styles, get enough attention and chances to grow (Anugrah & Dianawati, 2020).

### 3. Relationship Between TPACK and Teaching Performance

Table 3. TPACK & Teaching Performance

| **Correlation** | Teaching Performance | Interpretation |
|---|---|---|
| Technological Pedagogical Content Knowledge (TPACK) | .772** | Significant Relationship |
| p-value | .000 | |
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| Technological Pedagogical Content Knowledge (TPACK) | .772** | Significant Relationship |
| p-value | .000 | |

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| **Correlation** | Teaching Performance | Interpretation |
| Technological Pedagogical Content Knowledge (TPACK) | .772** | Significant Relationship |
| p-value | .000 | |

***correlation is significant @ 0.01 level*

The relationship between teaching performance and Technological Pedagogical Content Knowledge (TPACK) among math teachers in Grades 7–10 is shown in Table 3. The null hypothesis is rejected because of the substantial positive and significant link between TPACK and teaching performance, as indicated by the r-value of 0.772**. This research highlights the significance of TPACK in effective teaching by showing that teachers' overall teaching performance improves as their TPACK does.

This strong correlation suggests that instructors who possess more pedagogical, technological, and subject-matter expertise are more competent educators. Their increased proficiency in successfully incorporating technology into their subject matter enhances the quality of their instruction. Therefore, improving teachers' TPACK can be seen as a key component of encouraging improved teaching performance, indicating that professional development in technology integration is vital for improving the quality of instruction (Fahrurrozi, et al., 2021).

## CONCLUSIONS

The following are concluded based on the findings of the study:

1. Teachers' Technological Pedagogical Content Knowledge and performance are at a decent level.
2. Teachers perform well in essential teaching tasks, though some areas, like addressing individual differences, may benefit from further development.
3. The significant positive correlation between TPACK and teaching performance emphasizes the critical role of technology integration knowledge in enhancing teaching effectiveness in mathematics.

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