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Technologıcal, Pedagogıcal, and Content Knowledge: Onlıne Teachıng Performance Predıctors in Hıgher Educatıon Instıtutıons in the Northwestern Philippines Towards Educatıon 5.0

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Abstract *- The Higher Education Institutions in the Philippines immediately shifted their gears from face-to-face classes to online distance learning amidst Education 5.0. This study aimed to assess the teaching performance and the level of Technological Pedagogical Content Knowledge (TPACK) of the Mathematics Teachers of Higher Education Institutions in online distance learning. Quantitative research design particularly, descriptive-cross sectional-correlational research design. Among the statistical tools used were descriptive statistics and Multiple Linear Regression. A regression model in assessing the online teaching performance of the respondents was also developed which shows that TPACK is a significant predictor of teaching performance of the mathematics teachers in online distance learning along with the number of teaching loads. This study recommends that schools should include TPACK in the in-service training or seminar workshop to address the needs of the students' literacy for education in the new normal.*

Keywords: TPACK, Higher Education, Faculty Teaching Performance, Online Distance Learning, Literacy

INTRODUCTION

In the advent of the 4th industrial revolution, researchers and educators have embraced the idea of Technological Pedagogical Content Knowledge (TPACK), framed by Mishra and Koehler, in meaningfully applying technology in Mathematics teacher education contexts. TPACK is a tool for integrating technology into teaching content along with the pedagogies and methodologies of teaching. Recent studies emphasize that it is insufficient for modern teachers to possess mastery of subject matter alone; they must also consider digital technologies as integral to the learning environment, as these tools are part of students' daily routines (Khosrow-Pour, 2023).

The Association for Mathematics Teacher Educators has highlighted that preparing mathematics teachers and all teacher candidates provides vast opportunities to acquire knowledge and experience in adopting technology within Mathematics education. This aligns with findings from Lagrange et al. (2023), who assert that technology is essential for effective teaching and learning in Mathematics, influencing not only what is taught but also how it is delivered. However, it is crucial to recognize that excessive reliance on technology can demand more time, funds, and effort from teachers. Despite this, varied pedagogies alongside technological devices enhance learning outcomes.

Moreover, Yunita et al. (2023) argue that teachers who foster a collaborative teaching environment through meaningful technology integration create a positive atmosphere conducive to inquiry and intrinsic motivation among students. This underscores the need to reassess how Mathematics teachers integrate technologies into their teaching practices, as some lack a robust and versatile approach to digital technology integration in their curriculum.

The evolution of digital technologies has not been rapid enough to keep pace with the needs of contemporary learners. Alarmingly, many students perceive that their mathematics teachers do not possess adequate competencies in utilizing digital technologies to meet the challenges of the teaching-learning process. As a mathematics educator at my institution, I have observed these trends in both experienced mathematics teachers and pre-service mathematics teachers at the university level.

Consequently, this study aims to investigate potential variables associated with the challenges faced by mathematics teachers and their education

students in integrating technology into their educational processes. Insights gained from this research can inform improvements in instructional design aimed at enhancing the teaching skills and strategies of both current and future educators. Furthermore, the findings may serve as a foundation for developing intervention strategies such as seminar-workshops and curriculum enhancements tailored for mathematics teachers.

Given this context, there is a pressing need to measure the levels of knowledge encompassing technological, pedagogical, subject matter knowledge, and their interconnections among mathematics teachers within educational institutions in the Philippines—specifically at Pangasinan State University. This assessment will ensure that pre-service mathematics teachers are equipped to address the needs of 21st-century learners through pedagogically sound and technology-integrated teaching methods

OBJECTIVE OF THE STUDY

This is a study sought to examine the Technological, Pedagogical and Content Knowledge (TPACK) of the Mathematics teachers in online learning. This study answered the specific questions as follows: (1) What is the participants' profile with respect to sex, civil status, monthly income, highest professional attainment, academic rank, years of teaching experience, number of years using technology in teaching, number of trainings/seminars related to technology, status of employment, and teaching loads? (2) What is the knowledge level of the mathematics teachers of the PSU specific to Technology, Pedagogy, Subject Matter Content; and, TPACK? (3) What is the teaching performance of the PSU mathematics teachers perceived by the students as to Commitment, Subject Matter, Independent Learning, and Management of Learning? (4) What are the significant predictors of online teaching performance of the teachers in online distance learning?

MATERİALS AND METHOD

This study employs a quantitative research methodology anchored in a descriptive correlational design. Descriptive correlational research is a non-experimental approach that seeks to explore and describe the relationships between two or more variables without manipulating them. This design is particularly valuable for understanding how variables are related in their natural settings, making it suitable for educational research where ethical considerations may prevent experimental manipulation.

The participants of this study were the mathematics teachers of the higher education institutions in Pangasinan, as well as their respective students during the academic year 2023-2024. The 34 teachers were randomly selected using stratified random sampling. Their immediate superior and thier 250 students who were randomly selected also participated in the study in assessing their online teaching performance.

Various methods of data treatment were used to analyze the data sets corresponding to the requirements in each of the research questions. In describing the profile of the Mathematics Teachers along sex, age, civil status, monthly family income, and number of trainings and seminars attended, counts and percentage analysis employed. In determining the knowledge level of the mathematics teachers regarding to technology, pedagogy, and content, sum of scores employed. Likewise, in determining the teaching performance of the mathematics teachers as perceived by their students, sum of scores was employed as well. Multiple Linear Regression was used to formulate the module assessing the teaching performance of the mathematics teachers.

The researcher-developed instrument was used in data gathering. It was validated by 10 faculty members of different higher educational institutions, before it was subjected for reliability testing. İt was pilot-tested for 30 sets of teachers, students and immediate superior. The instrument has a decent Cochran value of 0.94 which is highly reliable and valid.

RESULTS AND DISCUSSION

The profile of the participants with respect to sex, civil status, monthly income, highest educational attainment, academic rank, years of teaching experience, number of years using technology in teaching, number of trainings/seminars related to technology, status of employment, and teaching loads was described using frequency counts with corresponding percentage.

Table 1: Profile of the Respondents

Variables	Categories	f	%
Sex	Male	20	58.80
	Female	14	41.20
Civil Status	Single	15	44.10

	Married	19	55.90
	P20001-P30000	20	58.82
	P30001-P40000	11	32.35
	Above P40000	3	8.82
Highest Educational Attainment	Bachelor's Degree	13	38.24
	Master's Degree	14	41.18
	Doctorate Degree	7	20.59
	Instructor I-III	20	58.80
Academic Rank	Asst. Professor I-IV	11	32.40
	Assoc. Professor I-IV	3	8.80
Years of Teaching Experience	Below 10 years	18	52.94
	11-20 years	12	35.29
	Above 20	4	11.76
Years of using technology in teaching	Below 10 years	19	55.88
	11-20 years	11	32.35
	Above 20	4	11.76
Number of trainings/seminars related to technology	No Trainings	10	29.41
	1-10	22	64.71
	More than 10 trainings/seminars	2	5.88
Status of Employment	Contract of Service	1	2.94
	Temporary	13	38.24
	Permanent	20	58.82
Teaching Loads	15 units, below	3	8.82
	16-20 units	11	32.35
	21-25 units	20	58.82

The profile of the respondents regarding sex, civil status, monthly income, highest educational attainment, academic rank, years of teaching experience, number of years using technology in teaching, number of trainings/seminars related to technology, status of employment, and teaching loads is presented in using counts and percentage analysis.

It can be noticed that regarding sex, there are 20 (58.8%) male respondents, and 14 (41.2%) female respondents. This shows that most of the respondents are male. This implies that mathematics teaching profession is dominated by male educators.

In terms of civil status, out of 34 respondents, 15 (44.1%) respondents are single, and 19 (55.9%) respondents are married. This shows that mathematics teaching is predominated by married instructors and professors.

As to monthly income, the data reveal that 11 (32.35%) respondents are earning P20001-P30000, 9 (26.47%) respondents are earning P30001-P40000, and 14 (41.18%) respondents are earning P40000 and above. This means that most of the respondents have a monthly income of P40001 and above.

Likewise, it can be gleaned that in terms of the highest educational attainment, there are 13 (38.2%) respondents are only Bachelor's Degree holder, 14 (41.18%) respondents are Masters' Degree holder, 7 (20.59%) respondents are Doctor's Degree Holder. This means that most of the respondents are Master's Degree holder.

Regarding academic rank, the data also reveal that there are 20 (58.8%) respondents who are Instructors I-III, 11 (32.4%) respondents are Assistant Professor I-IV, and 3 (8.8%) respondents are Associate Professor I-IV.

Regarding years of teaching experience, there are 18 (52.94%) respondents who have less than 10 years, 12 (35.29%) respondents have 11-20 years of experience, and 4 (11.8%) respondents have 21 years and above. This shows that most of the respondents have less than 10 years of teaching experience.

Concerning number of years using technology in teaching, there are 3 (8.8%) respondents who have 2 years and below, 16 (47.1%) respondents have 3-10 years, 11 (32.4%) respondents have 11-20 years, and 4 (11.8%) respondents have 21 years and above. This means that most of the respondents have been using technology in teaching for 3-10 years.

With respect to the number of trainings/seminars related to technology, 10 (29.41%) of the respondents have no trainings/seminars, 22 (64.71%) respondents have 1-10 trainings/seminars, and 2 (5.88%) respondents have more than 10 trainings/seminars. This implies that most of the respondents have 1-10 trainings/seminars related to technology and teaching.

Regarding status of employment, there is 1 (2.9%) respondents Contract of Service, 13 (38.2%) respondents have temporary status, and 20 (58.8%) respondents have permanent status. This means that most of the respondents have permanent status of employment.

With respect to teaching load, there are 11 (32.4%) respondents with 15 units and below, 6 (32.4%) respondents have 16-20 units, and 17 (50%) respondents have 21-25 units. This means that most of the respondents have 21-25 units of teaching loads.

Table 2: Knowledge Level of the Mathematics Teachers assessed by Teacher, their Immediate Superior, and Students

Knowledge Domain	Group	WM	DE
Technology Knowledge	Teachers	3.23	S
	Immediate Superior	4.18	HS
	Students	3.86	HS
	Mean	**3.76**	**HS**
Pedagogy Knowledge	Teachers	3.54	HS
	Immediate Superior	3.88	HS
	Students	4.08	HS
	Mean	3.83	HS
Content Knowledge	Teachers	4.27	HS
	Immediate Superior	3.94	HS
	Students	4.39	HS
	Mean	4.20	HS
Technological	Teachers	3.02	S

Pedagogical Knowledge	Content	Immediate Superior	4.05	HS
		Students	3.96	HS
		Mean	3.68	HS

Note: 1.00-1.50: Poor (P), 1.51-2.50: Fair (F), 2.51-3.50: Satisfactory (S), 3.51-3.50: Highly Satisfactory, 4.51-5.00: Outstanding (O)

The assessment of technological knowledge among Mathematics teachers reveals a "Very Satisfactory" level, with a weighted mean of 3.89 as evaluated by their superiors. Similarly, self-assessments by the teachers indicate an even higher score of 4.18, reflecting their confidence in their technological skills. Student evaluations also align with these findings, reporting a "Very Satisfactory" mean of 3.86 regarding the teachers' technological knowledge.

In terms of pedagogical knowledge, the Mathematics instructors at State Universities and Colleges also demonstrate a "Very Satisfactory" level, with a weighted mean of 3.69 as assessed by their superiors. Student assessments further corroborate this, yielding a mean score of 4.08 for pedagogical knowledge.

When evaluating content knowledge, the Mathematics teachers scored exceptionally well, achieving a weighted mean of 4.41, which indicates a "Very Satisfactory" level according to both superior and student assessments, with students rating the content knowledge at 4.39.

However, when it comes to Technological Pedagogical Content Knowledge (TPACK), the immediate superiors rated the teachers' competency at a lower average of 3.08, indicating only a Satisfactory level in this area. In contrast, student evaluations revealed a "Very Satisfactory" mean of 4.05, while their overall TPACK assessment yielded a mean of 3.69, also categorized as "Very Satisfactory."

Recent literature supports these findings and emphasizes the importance of TPACK in teacher education. For instance, a study by Said et al. (2023) highlights that effective integration of technology into teaching requires not only strong content and pedagogical knowledge but also an understanding of how these elements interact within specific educational contexts . This aligns with the findings from Aquino (2023), who investigated TPACK self-efficacy among pre-service teachers in the Philippines and found that gender differences exist, with female teacher candidates exhibiting higher TPACK levels than their male counterparts. Aquino recommended that higher education institutions prioritize enhancing TPACK through targeted professional development initiatives.

Furthermore, recent research underscores the necessity for continuous professional development focused on TPACK to improve teaching practices effectively (Absari et al., 2023). This study reiterates that fostering an environment where teachers can collaboratively develop their TPACK is crucial for adapting to the demands of modern education.

Table 3: Teaching Performance of the Teachers in Online Distance Learning

Teaching Performance	WM	Descriptive Rating
Commitement	3.88	Highly Satisfactory
Knowledge of the Subject Matter	4.08	Highly Satisfactory
Teaching for Independent Learning	3.82	Highly Satisfactory
Management of Learning	4.14	Highly Satisfactory
Mean	**3.98**	**Highly Satisfactory**

Note: 1.00-1.50: Poor (P), 1.51-2.50: Fair (F), 2.51-3.50: Satisfactory (S), 3.51-3.50: Highly Satisfactory, 4.51-5.00: Outstanding (O)

The teaching performance of Mathematics teachers at Pangasinan State University (PSU) has been assessed through evaluations by both their immediate superiors and students. In terms of commitment, the teachers received weighted means of 3.91 and 3.85, respectively, resulting in an overall mean of 3.88, which is classified as “Very Satisfactory.” This indicates that the performance of the teachers consistently meets and often exceeds the expectations associated with their responsibilities.

Regarding knowledge of subject matter, the assessments yielded weighted means of 3.96 from superiors and 3.85 from students, culminating in an overall mean of 4.08, also categorized as “Very Satisfactory.” This reflects a strong grasp of the content being taught, further contributing to effective teaching practices.

When evaluating independent learning, the performance scores were slightly lower, with weighted means of 3.79 from superiors and 3.85 from students, resulting in a grand mean of 3.82, which still falls within the “Very Satisfactory” range. This suggests that while the teachers are competent in fostering independent learning, there may be opportunities for enhancement in this area.

In terms of management of learning, the teachers received impressive scores, with weighted means of 4.16 from superiors and 4.11 from students,

leading to a grand mean of 4.14, again classified as "Very Satisfactory." This indicates that the teachers effectively manage classroom dynamics and learning environments, meeting and often exceeding job demands.

These findings align with the research conducted by Bingimlas (2023), which emphasizes the importance of real-time feedback on teacher commitment and classroom management. Bingimlas argues that schools should prioritize ongoing assessments that focus on these critical aspects, as they are vital for enhancing teaching effectiveness and ensuring that educators possess a strong mastery of their subjects.

Table 4: Teaching Performance of the Mathematics Teachers with Profile Variables and TPACK as Determinants

Significant Predictor	Coefficient Unstan.	Stand.	Sig.
Constant	-5.982		0.000
Number of Teaching Loads (TL; 16-20 units)	0.827	0.45	0.000
TPACK	1.98	1.104	0.002

F_t = 53.630; *$F_{sig.}$ = 0.000;* *R^2 =0.626*

The coefficient of determination Rsquare indicating the per cent of how much of the total variance is explained by the independent variables is 62.6%. It is shown that number of teaching load and TPACK are the only significant predictors of the teaching performance. It can also be noticed that TPACK has the highest impact on the teaching performance of the Mathematics teachers as indicated by standardized coefficient (beta = 1.104; p = 0.002), then followed by the number of teaching loads (beta = 0.45; p = 0.000). Thus, the regression model is Y = -5.982 + 0.45TL + 1.104TPACK.

CONCLUSION AND RECOMMENDATIONS

The profile of the Mathematics teachers with respect to sex, civil status, monthly income, highest educational attainment, academic rank, years of teaching experience, years using technology in teaching, number of trainings/seminars related to technology, status of employment, and teaching loads is worthy to consider in determining the knowledge level of the Mathematics teachers specific to technology, pedagogy, and content, and performance in teaching. The Mathematics teachers have Very Satisfactory knowledge level on Technological, Pedagogical and Content Knowledge. The teaching performance of the Mathematics teachers as to their commitment, subject matter, students' independent learning, and classroom management is Very Satisfactory. The regression model to assess the teaching performance of the Mathematics teachers is Y = -5.982 + 0.45TL + 1.104TPACK.

To enhance their academic rankings and improve teaching performance further, Mathematics teachers should prioritize ongoing professional development and personal growth. Teacher Education Programs that exhibit lower TPACK levels should implement capability-building activities aimed at equipping teachers with the necessary skills for successful technology integration. This approach will not only elevate their TPACK but also enrich the overall teaching-learning process.

Additionally, areas where Mathematics teachers received lower performance ratings must be addressed. Institutions should develop action plans or programs that focus on professional development related to TPACK. This initiative will help increase the effective integration of technology with pedagogy in their teaching practices.

Future research should aim to identify specific challenges faced by Mathematics teachers regarding the alignment of technology with pedagogy and content knowledge. Understanding these challenges will allow for targeted interventions that address the actual needs of educators and help elevate their TPACK levels. Research by Absari et al. (2024) emphasizes the importance of contextual factors—such as demographic variables and teaching experience—in shaping teachers' self-efficacy in TPACK . This highlights the need for tailored support mechanisms that consider individual teacher profiles when designing professional development programs.Acknowledgements: Special acknowledgements to the faculty members of the State Universities and Colleges (SUCs) in Pangasinan and thier students for gracing this study by participating on the survey conducted.

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