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Technological Pedagogical and Content Knowledge (TPACK) of grade 11 mathematics teachers

Ambrose, Benjamin L. ✉
Bicol University, Legazpi City, Philippines (myzackinel03@gmail.com)
Lorente, Richard M.
Bicol University, Legazpi City, Philippines (rmlorente@bicol-u.edu.ph)

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Abstract

This study assessed the Technological Pedagogical and Content Knowledge (TPACK) of selected 70 grade 11 Mathematics teachers in the DepEd Sorsogon which includes the Division of Sorsogon City and Division of Sorsogon Province for the school year 2021-2022. A descriptive correlation method of research was used in this study and with the use of the Survey Questionnaire and Assessment Test (SQAT) determine the profile of grade 11 Mathematics teachers, their TPACK and its correlation between profile and TPACK. The statistical tools utilized were frequency count, percentage, mean percentage score, Chi-square, Pearson *r* and ETA Coefficient Correlation (η) test statistic to analyze the gathered data. Results of this study revealed that half of the respondents belong to young adult teachers compared to middle-aged teachers, female teachers dominated than male teachers, majority of the respondents are still continuing their master's degree program, and related trainings and seminars along with seven sub-domains of TPACK; PK, CK, and PCK, have been the top 3 most attended by the respondents compared to other sub-domains. The over-all mastery level on seven sub-domains of TPACK of selected 70 grade 11 Mathematics teachers in Sorsogon DepEd is 49.81% *MPS* and described as average mastery. Based from the results of the study, educational background and related trainings and seminars have significant correlation to their TPACK. Therefore, an action plan was designed in other to improve teacher's TPACK.

Keywords: knowledge, grade 11 mathematics teachers, seven sub-domains of TPACK, mastery level, action plan

Technological Pedagogical and Content Knowledge (TPACK) of grade 11 mathematics teachers

1. Introduction

One of the most recent advances has been the increasing relevance of the relationship between the topic of mathematics and social realities such as technology integration and pedagogy. This is regarded as critical for the development of the student as a person and advancing to the process of becoming a more disciplined citizen and holistically growing the learners. It might be guided by a Mathematics teacher that makes knowledge accessible to them. As supported by Sammons et al. (2018), teacher effectiveness, which influences student achievement even when controlling for student characteristics, is a critical factor in educational success and progress. As a result, improving the quality of teaching is the most important way to improve student learning results.

In addition, 21st-century education is not only anchored on content knowledge (CK) and pedagogical knowledge (PK) but also on the integration of technology in the teaching-learning process. Therefore, implementers of education must be equipped with technological knowledge (TK). According to Mishra, and Koehler (2009), successful Technological Knowledge (TK) integration is rooted in curriculum content and content-related learning processes and secondary in the clever use of educational technologies. However, poor-quality teaching on student outcomes is debilitating and cumulative. The effects of quality teaching on educational outcomes are greater than those that arise from students' backgrounds. A reliance on curriculum standards or content knowledge (CK) and state-wide assessment strategies or pedagogical knowledge (PK) without paying due attention to teacher quality appears to be insufficient to gain the improvements in student outcomes sought. In addition, the advancement of technological knowledge (TK) plays an integral part in our everyday lives and our schooling landscape. Researchers in the 21st century have begun to deal with the influence of technology on teachers' knowledge.

This study aimed to assess and look into the mastery level of Technological Pedagogical and Content Knowledge (TPACK) of Mathematics teachers in grade 11 that taught the subjects Mathematics of Senior High School in the DepEd of Sorsogon Division which includes the Sorsogon City Division and Division of Sorsogon Province for the school year 2021-2022. As supported by Mishra and Koehler (2006), for effective integration of educational technologies into instruction, K-12 teachers' planning must occur at the nexus of curriculum requirements, students' learning needs, available technologies affordances, constraints, and the realities of school and classroom contexts. And the complex knowledge needed for such planning is known as the Technological Pedagogical and Content Knowledge (TPACK) framework.

In the TPACK framework by Koehler and Mishra (2008) the model aimed to investigate the interrelationships of the three main components of teachers' knowledge: technology, pedagogy, and content. Teachers' TPACK depends on seven knowledge domains namely: Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Technological Pedagogical and Content Knowledge (TPACK). These are the intersections of these main components. These intersections are the domains of the TPACK framework. Mishra and Koehler (2008) described the distinctions among the TPACK construct.

1. Technological Knowledge (TK) is knowledge about standard and advanced technologies, and the skills required to operate particular technologies (Mishra & Koehler, 2008).

2. Content Knowledge (CK) is a teacher's understanding of the subject matter to be learned or taught (in this case, General Mathematics), which includes concepts, theories, ideas, organizational frameworks, evidence, and proof, as well as established practices and approaches to developing such knowledge (Shulman, 1986).

3. Pedagogical Knowledge (PK) is a teacher's in-depth grasp of the teaching and learning process and practices, including classroom procedures and methods, the nature of the target audience, and methodologies for assessing student comprehension (Mishra & Koehler, 2008).

4. Pedagogical Content Knowledge (PCK) is the knowledge that includes knowing what teaching approaches fit the content, and knowing how elements of the content (in this study, General Mathematics) can be arranged for better teaching (Shulman, 1986: Mishra & Koehler, 2008).

5. Technological Pedagogical Knowledge (TPK) is the understanding of the presence, components, and capacities of various technologies as they are utilized in teaching and learning environments, as well as how education may change as a result of their usage (Mishra & Koehler, 2008).

6. Technological Content Knowledge (TCK) is knowledge about how technology and content (in this study, General Mathematics) are reciprocally related (Mishra & Koehler, 2008).

7. Technological Pedagogical and Content Knowledge (TPACK) is an emergent form of knowledge that goes beyond content (in this study, General Mathematics), pedagogy, and technology. The mastery of these three principles alone is not what underpins highly effective and deeply skillful teaching using technology (Mishra & Koehler, 2008).

Objective of the Study - This study assessed the Technological Pedagogical and Content Knowledge (TPACK) of selected 70 grade 11 Mathematics teachers in the DepEd Sorsogon which includes the Division of Sorsogon City and Division of Sorsogon Province for the school year 2021-2022. Specifically, it sought answers to the following questions: What is the profile of grade 11 Mathematics teachers in terms of: a. age; b. sex; c. educational background; d. number of years teaching mathematics; e. academic rank; f. trainings and seminars attended along with seven sub-domains of TPACK; and g. their type of school? What are the Technological Pedagogical and Content Knowledge (TPACK) of Grade 11 Mathematics Teachers? What is the correlation between the profile and Technological Pedagogical and Content Knowledge (TPACK) of Grade 11 Mathematics Teachers? What an action plan may be proposed to enhance the TPACK of the Grade 11 Mathematics Teachers?

2. Methodology

This study utilized the descriptive correlation method of research with the use of the Survey Questionnaire and Assessment Test (SQAT) to satisfy the problem of the current study. As descriptive research, its principal aim is to describe the nature of a situation as it exists in the study. Likewise, this study attempts to determine the present condition of the mathematics teachers' TPACK in the senior high school in the DepEd Sorsogon. The SQAT instruments were the main tools of the study, and it subjected to test reliability, a series of validation, and pilot testing. The final SQAT was utilized to assess the selected 70 grade 11 Mathematics teachers of senior high school in the DepEd of Sorsogon. The correlation was determined the significance between the responses of the selected senior high mathematics teachers in terms of teacher's profile and their mean percentage score in seven sub-domains of Technological Pedagogical and Content Knowledge (TPACK). This affirms whether or not the profile has a relationship to the senior high Mathematics teacher's TPACK. The statistical tools utilized were frequency count, percentage, mean percentage score, Chi-square, Pearson r and ETA Coefficient Correlation (η) test statistic to analyze the gathered data.

3. Results and discussion

The following findings were revealed after carefully categorizing the acquired data pertinent to the answers of the aforementioned study concerns.

3.1 Profile of Grade 11 Mathematics Teacher

A. Age. This table below contains the distribution of the respondents in terms of their age. This implies that

selected 70 grade 11 Mathematics teachers in the DepEd Sorsogon are relatively young adult Mathematics teachers and this is likely due to the fact that some of the middle-aged and old adults' Mathematics teachers have already retired.

Table 1

Distribution of the respondents in terms of their age

Categories	Percentage (%)
22 – 26	24%
27 – 31	29%
32 – 36	23%
37 – 41	9%
42 – 46	11%
47 – 51	3%
52 – 56	1%
N = 70	100

The age findings of the selected 70 grade 11 Mathematics teachers from DepEd Sorsogon are parallel to National Statistics from the Department of Education (DepEd) Basic Information on Plantilla Positions as of February 15, 2021, which showed that the workforce diversity by age group is similar, but that teachers in the Philippines are mostly made up of young adults' teachers which is equal to 68.73 percent, while middle-aged and old adults' teachers are equivalent to 31.27 percent.

B. Sex. This figure below contains the frequency counts and percentage of the respondents regarding their sex. Based on the results, there are 45 or 64 percent females and 25 or 36 percent males. Thus, it can be reflected that there are more female Mathematics teachers' than male Mathematics in the study.

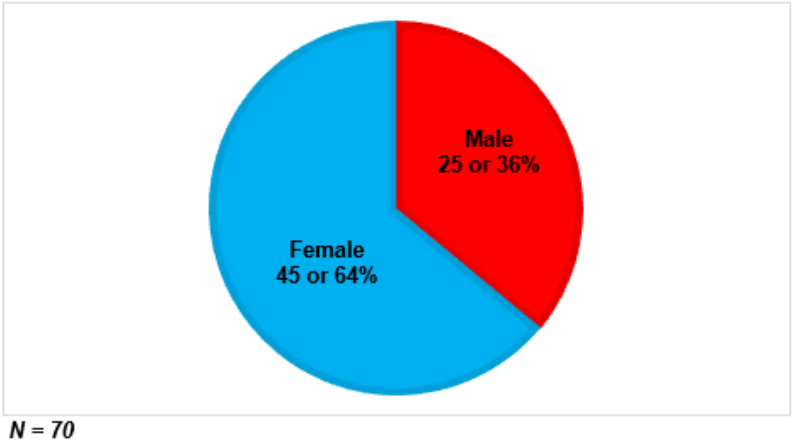

Figure 1. Distribution of the respondents in terms of their gender

This implies that females are more interested and passionate about teaching than males. Likewise, females may find teaching as satisfying as a career or fulfilling vocation, while males may otherwise. This may also be attributed to the greater motivation for females' profession than males. The study is supported by Abarro (2018) out of 76 teachers, 47 or 61.80% of the teachers are female, and 29 or 38.20 percent are male public school teachers in the Division of Antipolo City, Philippines. Thus, based on the findings of this current study and previous studies, results confirm that the teaching profession is dominated by female teachers than males in the Division of Antipolo City Philippines, Division in Iligan City, Philippines, and this current study in the Divisions of Sorsogon.

C. Educational background. The figure displays the distribution of the respondents in terms of their educational background with the use of frequency counts.

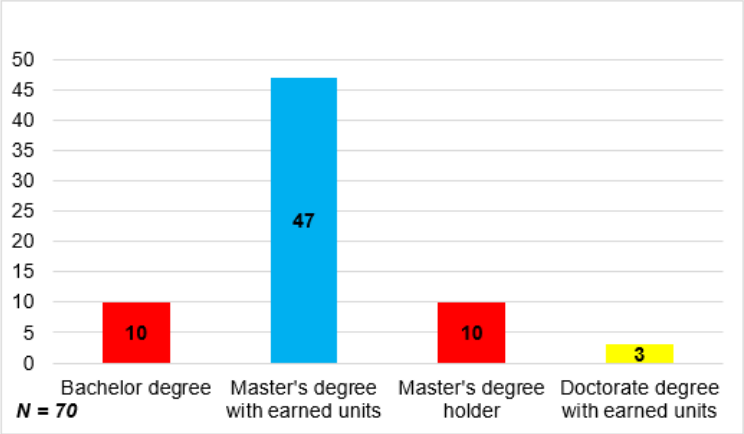

Figure 2. Distribution of the respondents in terms of their educational background

Among them have their master's degree earned units equal to 47 or 67 percent; there is 10 or 14 percent with master's degree holder and baccalaureate degree graduates, and 3 or 5 percent for those who have their doctorate units. According to the findings, half of the respondents with a master's degree have earned more units than those who have completed a master's program or obtained a doctorate. Few teachers did not pursue their professional development or post-graduate education.

This study is similar to Tanucan et al. (2021) study about Filipino Physical Education Teachers' Technological Pedagogical Content Knowledge on remote digital teaching in the three major islands of the Philippines. The study was composed of 1, 402 Physical Education teachers across the Philippines. The study has 893 or 63.69 percent with a bachelor's degree, 454 or 32.38 percent have master's degree holders, and 55 or 3.92 percent with doctorate degrees. In connections to the educational background of the selected 70 grade 11 Mathematics teachers from DepEd Sorsogon, results on educational background have more on master's degree earned units and cannot finish their master's degree or doctorate degree. This implies that the teachers may do not have the time or financial means to complete their master's degrees. Further, they may not have been granted teaching deloading or have other functions aside from teaching. Hence, they found little chance to have their complete academic requirement (CAR) or pursue their degree. In addition, family concerns may also be an attribution to these results.

D. Number of years teaching mathematics. The table below lists the distribution of the respondents in terms of their number of years teaching Mathematics with the use of a percentage.

Table 2

Distribution of the respondents in terms of their number of years teaching mathematics

Categories	Percentage (%)
1 – 5	39%
6 – 10	26%
11 – 15	20%
16 – 20	11%
21 – 25	4%
N = 70	100

Table 2 presents that 27 or 39 percent of the respondents have been teaching Mathematics between 1-5 years, 18 or 26 percent have been teaching Mathematics between 6-10 years, 14 or 20 percent have been teaching Mathematics between 11-15 years, 8 or 11 percent have been teaching Mathematics between 16-20 years, and 3 or 4 percent have been teaching Mathematics between 21-25 years. This study is parallel to Rose, Francisco & Mariano (2020) on teacher's personal and professional demographic characteristics as predictors of student's academic performance in English that there are 16 or 43.20 percent of teachers taught between 1- 5 years, 17 or 46.00 percent taught between 6-10 years and 4 or 10.80 percent taught between 11 and above. This indicates that

the respondents are still new to teaching in public schools and new to the profession. This implies that old-aged teachers have already retired, and new teachers in the DepEd Sorsogon fill up new teaching positions.

E. Academic rank. The figure below presents the academic rank or teaching position of selected 70 grade 11 Mathematics teachers in DepEd Sorsogon.

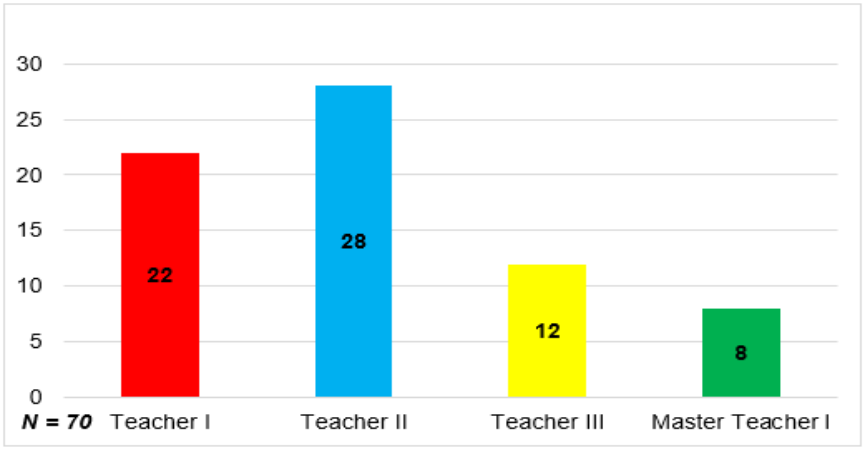

Figure 3. Distribution of the respondents in terms of their academic rank

Based on the figure above there is 28 or 40 percent of the selected Mathematics teachers in the Sorsogon DepEd are TII; 22 or 32 percent of the teachers are TI; 12 or 17 percent of the teachers are TIII, and 8 or 11 percent are MTI. Results of this study show that there are more Teachers I-II, and few are Master Teachers. This study is parallel to the study of Cahapay and Anoba (2021) about Technological Pedagogical Knowledge self-efficacy and continuance intention of the Philippine teachers in remote education amid COVID-19 crisis in City Schools Division of Koronadal from Mindanao, Philippines that their sample with the total of 1,065 teachers, 1,011 or 94.90 percent are Teachers I-III and 54 or 5.10 percent are Master Teacher I-II.

F. Trainings and seminars attended along with seven sub-domains of TPACK. The researcher utilized 15 respondents to get the numbers of training and seminars along with seven sub-domains of TPACK that represent the data of training and seminars attended. The researcher checked and classified their training and seminars attended thoroughly. Other respondents were not included since they were not included or mentioned in the training and seminars on the survey questionnaire during the conduct of the study.

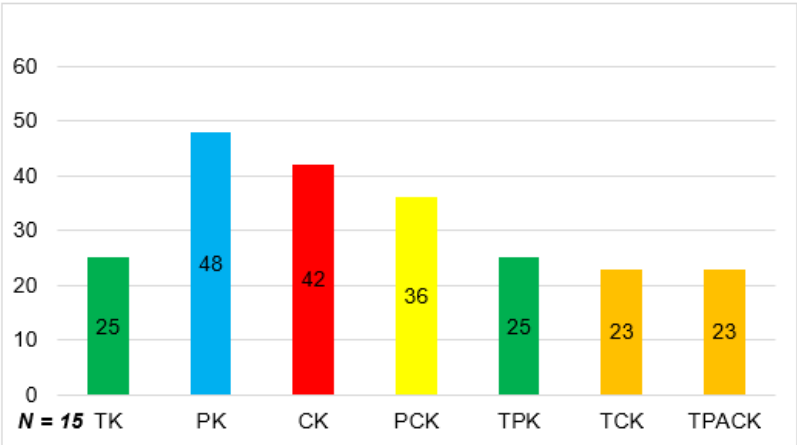

Figure 4. Distribution of the respondents in terms of their trainings and seminars attended along with seven sub-domains of TPACK

The Philippines has been under lockdown for two years because of the COVID-19 outbreak. Thus, respondents' number of related training and seminars has been affected. The result shows the least attended training and seminars along with seven sub-domains of TPACK. Based on the figure above, the trainings and seminars that

the 15 respondents most attended is pedagogical knowledge (PK) with 48 related trainings and seminars, which ranked 1st, followed by content knowledge (CK) with 42 related trainings and seminars, which ranked 2nd, pedagogical content knowledge (PCK) with 36 related trainings and seminars which ranked 3rd, while technological knowledge (TK) and technological pedagogical knowledge (TPK) with 25 related trainings and seminars which ranked 4.5th; and technological content knowledge (TCK) and technological pedagogical and content knowledge (TPACK) with 23 related trainings and seminars which ranked 6.5th.

This is supported by Malubay and Daguplo (2019) states that the technology, pedagogy, and content and their interrelatedness defines teachers' creativeness and effectiveness in developing and delivering new mode of representations and solutions to mathematical content and problems, making them responsive to the 21st-century learners, and thereby recommends to strengthen mathematics teachers' knowledge through continuous attendance to conferences and workshops on technology integration in the mathematics classroom. In addition, teacher must engage in TPACK trainings and seminars to create a learning environment that allows students to effectively learn, and other technological devices when needed to enhance mathematical understanding of concepts and processes. They would develop active learning environments that allow for the use of technologies and ensure that these environments help develop both basic and higher-order thinking skills.

F. Their type of school. The figure below contains the frequency counts of the type of schools of the respondents in terms of population, geographical classification, and location of the selected 70 grade 11 Mathematics teachers that participated in the study.

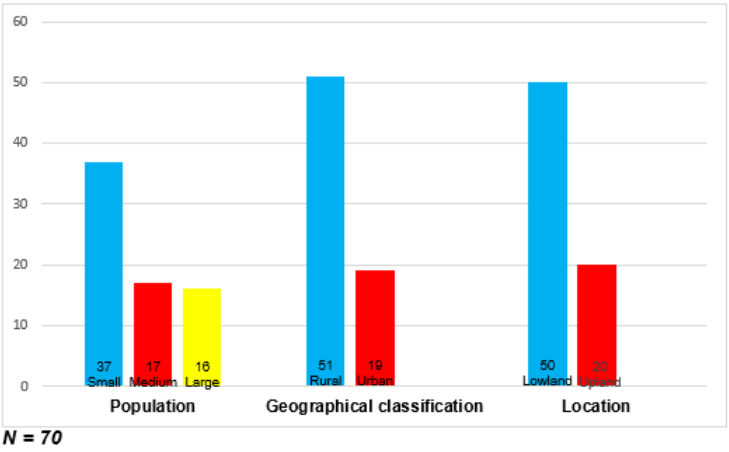

Figure 5. Distribution of the respondents in terms of their type of school.

Of selected 70 grade 11 Mathematics teachers, 37 or 53 percent come from small schools; 17 or 24 percent and 16 or 23 percent are from both medium and large schools, respectively. Thus, the respondent from rural schools has 51 or 73 percent and 19 or 27 percent come from urban schools in DepEd Sorsogon. In addition, the teachers are come from lowland schools which is equal to 50 or 71 percent, whereas 20 or 29 percent are from the upland schools. The data showed that most of the teachers who participated in the study were small, rural and lowland schools.

3.2 Technological Pedagogical and Content Knowledge (TPACK) of grade 11 mathematics teachers

Table 3 shows the mastery level gained by selected 70 grade 11 Mathematics teachers in Sorsogon DepEd after taking the TPACK assessment test. The assessment test was composed of seven sub-domains, namely: Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Technological Pedagogical and Content Knowledge (TPACK).

Table 3

TPACK of the respondents

Seven sub-domains of TPACK	Mastery level	Interpretation
Technological Knowledge (TK)	57.33%	Average mastery
Pedagogical Knowledge (PK)	49.39%	Average mastery
Content Knowledge (CK)	64.38%	Average mastery
Technological Pedagogical Knowledge (TPK)	41.90%	Average mastery
Technological Content Knowledge (TCK)	42.76%	Average mastery
Technological Pedagogical and Content Knowledge (TPACK)	48.70%	Average mastery
	44.18%	Average mastery
Over- all mastery level	49.81%	Average mastery

The overall mastery level on seven sub-domains of TPACK selected 70 grade 11 Mathematics teachers in DepEd Sorsogon with 49.81% MPS and described as average mastery. However, to strengthen their TPACK, teachers must participate in professional developments or pursue additional college courses in all sub-domains of TPACK to integrate the three basic knowledge – TK, PK, and CK. To improve the TPACK, teachers must also engage in an evaluation through example demonstration teachings. As supported by Wahlstrom and Louis (2008) suggest that increased visibility of classroom practice through teacher peer observation translates to improved instruction, enhanced teacher self-efficacy, and better teacher attitudes toward professional development. As a result, teachers must keep up to date on all current trends and developments in the mathematics teaching and learning process to increase teachers' TPACK.

3.3 Correlation between profile and Technological Pedagogical and Content Knowledge (TPACK) of grade 11 mathematics teachers

Chi-square is used to investigate a statistically significant relationship between the TPACK knowledge of grade 11 Mathematics teachers' profiles in terms of sex, their type of school in terms of geographical classification, and location. Pearson *r* is utilized to check and verify if there is a correlation between grade 11 Mathematics teachers' profiles in terms of age, number of years teaching Mathematics, training and seminars attended, and seven sub-domains of TPACK and their TPACK knowledge. ETA coefficient correlation test statistics are used to see a correlation between grade 11 Mathematics teachers' TPACK knowledge and their educational background, academic rank, and type of school in terms of population. The researcher utilized the IBM SPSS Statistics software.

A. Correlation Between Age and TPACK. The table includes the statistical bases and analyses of the relationship between age and their knowledge on seven sub-domains on TPACK of selected 70 grade 11 Mathematics teachers in DepEd Sorsogon using Pearson r.

Table 4

Correlation between age and TPACK

Profile	TK	PK	CK	PCK	TPK	TCK	TPACK
Age	-0.21	-0.11	-0.16	-0.12	-0.14	-0.10	-0.20

As seen in the table, the correlation between the age of the selected 70 grade 11 Mathematics teachers along with their knowledge of TK, PK, CK, PCK, TPK, TCK, and TPACK is a very low negative correlation since the computed Pearson r value is -0.21, -0.11, -0.16, -0.12, -0.14, -0.10 and -0.20, respectively. Results confirm that the age of the teachers has a significantly negative correlation to their knowledge along with seven sub-domains of TPACK. This implies that the age of the teachers has a negatively significant influence on mastery level in seven sub-domains of TPACK.

The results are supported by Lee and Tsai (2010) found that both the participants' age and their teaching experience had a significantly negative relationship to their self-efficacy regarding TPACK. Furthermore, Zafer and Aslihan (2012) discovered that senior teachers, aged 41 and up, are more effective teachers and have better classroom management abilities than younger high school teachers. In addition, Aloka and Bojuwoye (2013)

discovered that, owing to their lack of experience and maturity, younger teachers make riskier judgments and do not thoroughly assess the situation while dealing with students' disciplinary problems than older teachers. The findings are comparable to those of Nyagah and Gathumbi (2017), who found that in a cross-sectional study in Kenya, older instructors were more likely to improve students' learning than middle-aged and younger teachers.

B. Correlation Between Sex and TPACK. The table includes the statistical bases and analyses of the relationship between the sex whether male or female and their knowledge on seven sub-domains of selected 70 grade 11 Mathematics teachers in DepEd Sorsogon using Chi-square.

Table 5

Correlation between sex and TPACK

Statistical bases	TK	PK	CK	PCK	TPK	TCK	TPACK
X^2 critical value	5.25	5.86	10.04	12.07	6.87	10.08	8.41
X^2 computed value	0.87	0.66	0.53	0.28	0.55	0.43	0.49

N = 70

Table 5 shows the relationship of sex of selected 70 grade 11 Mathematics in DepEd Sorsogon and TPACK on seven sub-domains. The researcher found out that in terms of sex it shows that there is no significant relationship between the two since the computed value of X^2 are 0.87, 0.66, 0.53, 0.28, 0,55, 0.43, and 0.49, along with seven sub-domains of TPACK is lower than the critical value of 5.25, 5.86, 10.04, 12.07, 6.87, 10.08, and 8.41, respectively. Results confirm no correlation between sex and their knowledge on their TPACK at a 0.05 level of significance with the degree of freedom 10, 8, 11, 10, 8, 10, and 9, respectively. Therefore, do not reject the "Ho: There is no significant relationship between sex and their knowledge on TPACK" and do not accept the "Ha: There is a significant relationship between sex and their knowledge on TPACK." This implies that whatever the sex of the teachers, whether male or female, there is no influence on the knowledge of the seven sub-domains of TPACK. In addition, it indicates that sex has no significant relationship in seven sub-domains of TPACK knowledge.

The results of the study are parallel to the study of Adulyasas (2017) Mathematics teachers' TPACK in the southernmost province of Thailand gender does not correlate with TPACK of Mathematics teachers. This may be due to the fact that today, both males and females have equal opportunities to study. Females and males have the ability to learn how to use technology in the classroom, learning the subject matter and its process or approach to dealing the teaching-learning. Therefore, gender does not influence teachers' TPACK. Further, Acıkgul and Aslaner (2015) and Koh and Sing (2011) found that pre-service teachers' TPACK confidence did not differ significantly with regard to gender. Hence, it was thought essential to investigate TPACK levels of mastery of Mathematics teachers according to gender and their correlation. Some precautions, like in-service training, should improve mathematics teachers' TPACK.

C. Correlation Between Educational background and TPACK. The statistical bases and analyses of the relationship between the educational background and their knowledge on seven sub-domains on TPACK of selected 70 grade 11 Mathematics teachers in DepEd Sorsogon using ETA Coefficient Correlation.

Table 6

Correlation between educational background and TPACK

Profile	TK	PK	CK	PCK	TPK	TCK	TPACK
Educational background	0.37	0.25	0.45	0.41	0.46	0.51	0.33

N = 70

The table above presents the correlation between the educational background and their knowledge of seven sub-domains on TPACK of the selected 70 grade 11 Mathematics in DepEd Sorsogon. The researcher found out in terms of educational background, the relationship is medium correlation along with the knowledge of CK, PCK, TPK, and TCK since the computed (η) is 0.45, 0.41, 0.46, and 0.52, respectively. While in terms of educational background, the relationship is a weak correlation along with the knowledge of PK, TK, and TPACK since the

computed (η) is 0.25, 0.37, and 0.33, respectively. This implies that the teachers' educational background influences the mastery level of CK, PCK, TPK, and TCK. At the same time, the knowledge along with PK, TK, and TPACK are less affected by the mastery level.

The study results are supported by Vandersall, Vruwink, and LaVenia (2019) on "Master's degrees and teachers' effectiveness: new evidence for the state assessments". It was found that teachers who earn master's degrees demonstrate greater teaching effectiveness than those who do not pursue their education. The study found out also that students whose teachers held a master's degree performed better in reading and writing tests. The researcher examined over 4,000 teachers and 205,000 students, discovering that the knowledge gained in a master's program leads to improved student outcomes.

D. Correlation Between Number of years teaching mathematics and TPACK. The table includes the statistical bases and analyses of the relationship between the number of years teaching mathematics and their knowledge of seven sub-domains of selected 70 grade 11 Mathematics teachers in DepEd Sorsogon using Pearson correlations.

Table 7

Correlation between number of years teaching mathematics and TPACK

Profile	TK	PK	CK	PCK	TPK	TCK	TPACK
Number of years teaching mathematics	-0.25	-0.15	-0.06	-0.08	-0.11	-0.09	-0.22

N = 70

The number of years teaching mathematics and knowledge along with the TK, PK, TPK, and TPACK is interpreted as a very low negative correlation since the computed Pearson r value is -0.25, -0.15, -0.11, and -0.22, respectively. While the relationship between the number of years teaching Mathematics and knowledge along with CK, PCK, and TCK is described as markedly low and negligible correlation since the computed Pearson r value is -0.06, -0.08, and -0.10, respectively. Results confirm that the number of years teaching mathematics of teachers and their knowledge of seven sub-domains of TPACK that reflected has significantly negative or negligible correlation. This implies that the more years a teacher has spent teaching Mathematics, the more TPACK they have and the greater their chances of achieving a high level of mastery than the new in the teaching profession. Hence, teachers with more teaching experience are more knowledgeable in the seven sub-domains of TPACK.

Jang and Tsai (2013) discovered that the CK, PCK, TCK, and total TPACK of more experienced elementary science and mathematics teachers were considerably higher than those of less experienced teachers. Similarly, Altun (2013) discovered that teachers with 16 or more years of experience had considerably higher mean scores than those with 0 to 15 years of experience. In terms of teaching experience, Kartini and Ahamad (2010) discovered that science instructors with more than six years of experience were more knowledgeable than those with less years of experience.

In addition, Zafer and Aslihan (2012) discovered that teachers with more years of teaching experience showed significantly different attitudes toward classroom management. They seem to be more in control of their classrooms, have good interactions with students, and make better decisions than teachers with fewer years of teaching experience. For Fatma and Tugay (2015), teachers with a minimum of ten years of teaching experience are more effective in teaching and have good classroom management skills.

E. Correlation Between Academic rank and TPACK. The statistical bases and analyses of the relationship between academic rank and their knowledge on seven sub-domains on TPACK of the selected 70 grade 11 Mathematics teachers in DepEd Sorsogon using ETA Coefficient Correlation.

Table 8

Correlation between academic rank and TPACK

Profile	TK	PK	CK	PCK	TPK	TCK	TPACK
Academic rank	0.42	0.23	0.38	0.46	0.19	0.27	0.47

N = 70, *Correlation at (η) > 0.00

The researcher found out that the correlation between academic rank and the relationship along with the knowledge of TK, PCK, and TPACK is a medium correlation since the computed (η) is 0.42, 0.46, and 0.47, respectively. While in terms of academic rank, the relationship has a weak correlation with the knowledge of PK, CK, and TCK since the computed (η) is 0.23, 0.38, and 0.37, respectively. The relationship between academic rank along with the knowledge of TPK is described as a negligible correlation since the computed (η) is 0.19. This implies that the academic rank of teachers has a medium effect on the mastery level of TK, PCK, and TPACK compared to PK, CK, TPCK, and TPK. Thus, rather than the dominating functions and responsibilities and qualification criteria of the roles, teaching positions are categorized primarily on the personal qualifications of the holders.

F. Correlation Between Trainings and Seminars and TPACK. The statistical bases and analyses of the relationship between their attended trainings and seminars and seven sub-domains on TPACK and their knowledge on seven sub-domains of the selected 15 grade 11 Mathematics teachers in DepEd Sorsogon the use of Pearson r. The correlation computation is based on the training and seminars attended by selected 15 grade 11 Mathematics teachers and their scores on the assessment test of TPACK.

Table 9

Correlation between trainings and seminars attended along with TPACK and TPACK

Seven Sub-domains	TK	PK	CK	PCK	TPK	TCK	TPACK
TK	0.05	0.00	0.13	0.58	0.51	0.13	0.34
PK	0.06	0.34	0.51	0.44	0.10	0.15	0.11
CK	-0.15	0.45	0.69	0.67	0.40	0.47	0.33
PCK	0.12	0.42	0.50	0.40	0.14	0.34	0.10
TPK	0.05	0.00	0.13	0.58	0.51	0.13	0.34
TCP	0.31	0.06	0.15	0.20	0.48	0.16	0.18
TPACK	0.47	-0.01	0.06	0.14	0.40	0.11	0.03

N = 15, *Correlation is significant at the 0.05 level (Pearson r > 0.51)

Thus, results indicated as an average mastery level in seven sub-domains of TPACK and correlation on related trainings and seminars among CK, PCK, and TCK are significantly related and influence their knowledge of TK, PK, CK, and TPK, the enhancement program would help teachers to raise this to a closing approximating mastery or mastered the TPACK. Teachers should value having a high personal regard for the teaching profession, concern for professional development, and continuous improvement as teachers by participating in educational seminars and workshops to enhance the teaching and learning process, according to Domain 7 of the Philippine Professional Standards for Teachers.

G. Correlation Between Their Type of School and TPACK. The statistical bases and analyses of the relationship between their type of school and their knowledge on seven sub-domains on TPACK of the selected 70 grade 11 Mathematics teachers in DepEd Sorsogon.

Table 10

Correlation between their type of school in terms of population and TPACK

Profile	TK	PK	CK	PCK	TPK	TCK	TPACK
Population	0.36	0.38	0.42	0.50	0.35	0.29	0.24

N = 70, *Correlation at (η) > 0.00

The researcher found out that the correlation between their type of school in terms of population relationship along with the knowledge of CK and PCK is a medium correlation since the computed (η) is 0.42 and 0.50,

respectively. While in terms of their type of school in terms of population, the relationship along with their knowledge of TK, PK, TPK, TCK, and TPACK since the computed (η) is 0.36, 0.38, 0.35, 0.29, and 0.24, respectively. This implies that their types of schools in terms of the population have a medium effect on the knowledge of CK and PCK compared to TK, PK, TPK, TCK, and TPACK. There is a weak significant correlation in the mastery level of the teachers.

Table 11

Correlation between their type of school in terms of geographical classification and TPACK

Statistical bases	TK	PK	CK	PCK	TPK	TCK	TPACK
X^2 critical value	13.78	6.15	17.14	12.34	8.44	16.59	8.16
X^2 computed value	0.18	0.63	0.10	0.26	0.39	0.08	0.52

N = 70

The table above presents the relationship of their type of school in terms of geographical classification and knowledge on seven sub-domains on TPACK of the selected 70 grade 11 Mathematics in DepEd Sorsogon. The researcher found out that in terms of their type of school in terms of geographical classification, whether the teacher is teaching in an urban or rural school it shows that there is no significant relationship between the two variables since the computed value of X^2 is 0.18, 0.63, 0.10, 0.26, 0,39, 0.08 and 0.52 along with seven sub-domains of TPACK knowledge is lower than the critical value of 13.78, 6.15, 17.14, 12.34, 8.44, 16.59, and 8.16, respectively. Therefore, do not reject the "Ho: There is no significant relationship between their type of school in terms of geographical classification and their knowledge on TPACK" and do not accept the "Ha: There is a significant relationship between their type of school in terms of geographical classification and their knowledge on TPACK ."This implies that the geographical classification, whether the teacher is teaching in an urban or rural school, does not influence the knowledge of the seven sub-domains of TPACK.

Table 12

Correlation between their type of school in terms of location and TPACK

Statistical bases	TK	PK	CK	PCK	TPK	TCK	TPACK
X^2 critical value	8.84	6.65	8.98	13.68	7.37	14.56	14.23
X^2 computed value	0.55	0.58	0.62	0.19	0.50	0.15	0.11

N = 70

The table above shows the relationship of their type of school in terms of location and knowledge on seven sub-domains on TPACK of the selected 70 grade 11 Mathematics in DepEd Sorsogon. The researcher found out that in terms of their type of school in terms of location, whether the teacher is teaching in a lowland or upland school it, shows that there is no significant relationship between the two since the computed value of X^2 is 0.55, 0.58, 0.62, 0.19, 0.50, 0.15 and 0.11 along with seven sub-domains is lower than the critical value of 8.84, 6.65, 8.98, 13.68, 7.37, 14.56 and 14.23, respectively. Therefore, do not reject the "Ho: There is no significant relationship between their type of school in terms of location and their knowledge on TPACK" and do not accept the "Ha: There is a significant relationship between their type of school in terms of location and their knowledge on TPACK." This implies that whatever the location, whether the teacher is teaching in lowland or upland, does not affect the knowledge of the seven sub-domains of TPACK.

Teachers also play an important part in nation-building. The Philippines can generate holistic learners who are immersed in values, armed with 21st century abilities, and capable of propelling the country to development and advancement through great instructors. This aligns with the Department of Education's goal of generating "Filipinos who fervently love their country and whose values and competences enable them to fulfill their full potential and meaningfully contribute to the nation's construction" (DepEd Order No. 36, series of 2013). Therefore, the development of teacher's Technological Pedagogical and Content Knowledge (TPACK) involving the efforts of fostering positive attitudes was a major agenda to strengthen the teaching profession and to ensure great development of the education quality in many countries around the world, everything is interconnected is assuring the standard of quality. To this regard, particular attention is given on the quality of Mathematics subjects in order

to create an effective teacher. As a result, the researcher is developed an action plan that is integrated into mandatory workshops and trainings during school days that is relevant to them and does not require them to pay a higher fee just to attended trainings and seminars. Action plan includes professional development by attending educational seminars and workshops to improve the teaching and learning process. These will be more effective if implemented and used by the schools and the Schools Division.

4. Conclusions

To precisely answer the research issues, the results mentioned in the preceding part might be summarized through the following conclusions:

- Mathematics teachers in DepEd Sorsogon are relatively young adult teachers, and females are more interested in the teaching profession and find satisfying as a career than males. Meanwhile, teachers do not have time, the difficulty or complexity of the program, financial constraints, family concerns, and heavy workloads in DepEd are some of the factors that teachers can not finish their master's degree. Trainings and seminars attended by teachers along with seven sub-domains are limited and few because of the Covid-19 pandemic.

- The mastery level of Mathematics teachers along with Technological Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Technological Pedagogical and Content Knowledge (TPACK) are average mastery which means low knowledge on seven sub-domains TPACK has not yet mastered. Therefore, this study suggests that there is highly needed to improve their mastery level.

- The profile of teachers in terms of age, sex, number of years teaching Mathematics, academic rank, and their type of school does not contribute to the mastery level on TPACK. At the same time, educational background and trainings and seminars attended significantly contributed to their TPACK.

- An action plan for grade 11 Mathematics teachers may be designed to improve their mastery level in seven sub-domains of TPACK knowledge.

4.1 Recommendations

Following are some recommendations based on the study's main findings:

- Department of Education (DepEd) is encouraged to conduct training and seminars for the teachers on TPACK and motivate teachers to continuously progress in the teaching profession and keep up with developments in the field. Further, the DepEd would provide the classrooms with a variety of technology for teaching and learning, which the teachers in their instructions can use.

- Teachers are encouraged to undertake graduate degrees to advance their knowledge of the subject matter they teach. The teachers should explore including a Technology Pedagogical and Content Knowledge (TPACK) framework into their curriculum design to assist teachers in facilitating the teaching-learning process.

- An action plan for grade 11 Mathematics teachers was designed to improve their mastery level in seven sub-domains of TPACK.

- Further studies might be conducted to examine the effectiveness of the other variables not covered in this study concerning the TPACK framework. Likewise, utilization of other assessments such as classroom observations, self-evaluation, pre/post interviews or questionnaire responses, written reflections or journals, demonstrations of teaching, and peer feedback are advised to assess teachers'

TPACK.

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