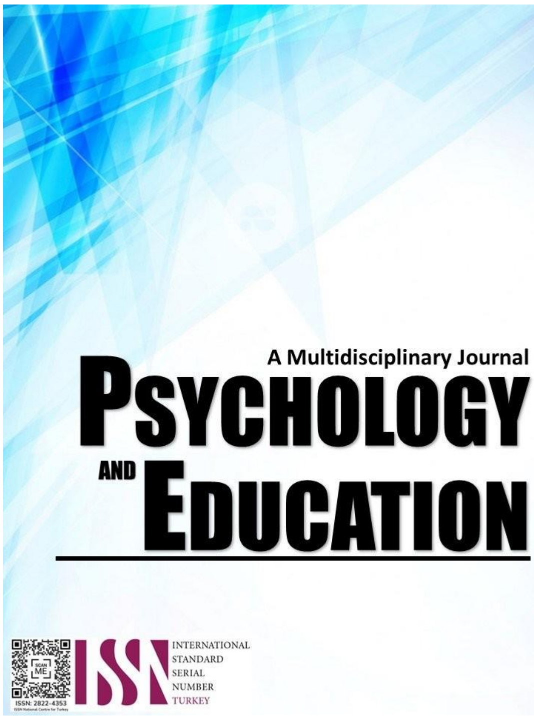
TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE OF PUBLIC SECONDARY SCIENCE TEACHERS IN THE NEW NORMAL EDUCATION



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Research Article

Technological Pedagogical Content Knowledge of Public Secondary Science Teachers in the New Normal Education

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Abstract

This study focuses in determining the TPCK of Public Secondary Science teachers in the new normal education using the TPCK framework. Through quantitative research design, survey questionnaires, descriptive statistics and inferential statistics, the results shows that the science teachers are knowledgeable in teaching science content with technological pedagogical content knowledge (TPCK) which are align with the standard of the qualities of an effective science teachers as indicated in (SEI-DOST&UP NISMED 2011) and (Deped Order 42s.2017). It is concluded that the teachers are well – equipped with ample knowledge on TK,PK,CK,TPK,TCK,PCK and TPCK based on the students, teachers and administrators perspectives. Generally, the teachers' demographic profile has no remarkable influence on their knowledge level on TK,PK,CK,TPK,TCK,PCK and TPCK. However, the students', teachers and administrators' perspectives mark significant variation pertaining to the teachers' level of knowledge on TPCK. Although they are one in agreement that the teachers are technologically knowledgeable in teaching science.

Keywords: *public secondary science teachers, new normal, TPCK, educational attainment*

Introduction

New normal education is a new set up of educational system where education must continue through online and other alternative modalities (Lambert, 2018). With this set up, it created several difficulties in teaching and learning for both teachers and students. These possibilities are seen by science teachers as an opportunities for them to become better science teachers who can adapt to changing conditions. (Dhawan, 2020). Therefore, their knowledge must be updated as always.

Science teachers are likely to be the one who successfully build adequate scientific knowledge methodologies to achieve successful technology-assisted instruction (Constantine et al., 2017). Science teachers have in-depth understanding of their scientific domains, lessons, students, teaching methodologies, and assessment procedures, which they employ in the classroom (Mishra and Koehler 2006). They inspire students to seek answer for themselves. However, in times of insufficient knowledge they must upgrade and develop new knowledge to effectively impart information to their students.

Upgraded knowledge enables teacher to perform better in a specific field, expectedly one of which is the field of science. It can be attained by the teacher through exemplifying teachers' content, pedagogical and technological knowledge. Much of teachers' ability to prepare and deliver engaging science classes is frequently enhanced by their grasp of science topic. (Nowicki et al., 2013; Oh & Kim, 2013). Sufficient content knowledge can assist in the development of some students correct conceptions (Ghazi et al., 2013).

The dynamic interaction of technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), and technical content knowledge (TCK) must be considered when combining pedagogy and technology in a certain subject area (technological content knowledge) collectively known as TPACK. TPACK is a model that examines the intricate relationship between the teacher's content knowledge (CK), pedagogy (PK), and technological knowledge (TK). TPACK is a set of seven categories of knowledge that will assist educators in enhancing their overall teaching ability. Through these interrelationships, the teacher who can navigate the system is a different kind of expert than one who specializes in a single subject, methodology, or technology (Mishra & Koehler 2006).

With the TPACK system in place, science instructors' knowledge will be tracked and updated. Thus, the present study proposes to evaluate the Technological Pedagogical and Content Knowledge (TPACK) of public secondary science teachers of Kalamansig, Sultan Kudarat particularly teachers from Kalamansig National High School and Sta. Clara National High School. The study was conducted to determine the knowledge level of public secondary science teachers using the TPCK Model in this new normal education.

Research Questions

Generally, this study aims to evaluate the rated Technological Pedagogical Content Knowledge (TPCK) of selected public secondary science teachers of Kalamansig, Sultan Kudarat during the school year 2021-2022. Specifically, it aims to answer the following questions:

1. What is the Demographic Profile of Public Secondary Science Teacher?
2. What is the knowledge level of Public Secondary Science Teachers as rated by themselves in terms of their:
   2.1 Technological Knowledge (TK);
   2.2 Pedagogical Knowledge (PK);
   2.3 Content Knowledge (CK);
   2.4 Technological Pedagogical Knowledge (TPK);
   2.5 Technological Content Knowledge (TCK);
   2.6 Pedagogical Content Knowledge (TCK); and
   2.7 Technological Pedagogical Content Knowledge (TPCK)?
3. What is the knowledge level of Public Secondary Science Teachers as rated by the students in terms of their:
   3.1 Technological Knowledge (TK);
   3.2 Pedagogical Knowledge (PK);
   3.3 Content Knowledge (CK);
   3.4 Technological Pedagogical Knowledge (TPK);
   3.5 Technological Content Knowledge (TCK);
   3.6 Pedagogical Content Knowledge (PCK); and
   3.7 Technological Pedagogical Content Knowledge (TPCK)?
4. What is the knowledge level of Public Secondary Science Teachers as rated by the administrators in terms of their:
   4.1 Technological Knowledge (TK);
   4.2 Pedagogical Knowledge (PK);
   4.3 Content Knowledge (CK);
   4.4 Technological Pedagogical Knowledge (TPK);
   4.5 Technological Content Knowledge (TCK);
   4.6 Pedagogical Content Knowledge (PCK); and
   4.7 Technological Pedagogical Content Knowledge (TPCK)?
5. Is there a significant relationship between public secondary science teachers' demographic profile and their TPACK knowledge level?
6. Is there a significant difference between and among the ratings of the PSST self-evaluation , students and administrators on the knowledge of Public Secondary Science Teachers in terms of:
   6.1 Technological Knowledge (TK);
   6.2 Pedagogical Knowledge (PK);
   6.3 Content Knowledge (CK);
   6.4 Technological Pedagogical Knowledge (TPK);
   6.5 Technological Content Knowledge (PCK);
   6.6 Pedagogical Content Knowledge (PCK); and
   6.7 Technological Pedagogical Content Knowledge (TPCK)?

Literature Review

Science Teachers' Knowledge

New normal education is a new set up of educational system where education must continue through online and other alternative modalities (Lambert, 2018). With this set up, teachers and students faced numerous obstacles in teaching and learning. These possibilities are seen by science teachers as helping them to become better science teachers who can adapt to changing conditions. (Dhawan, 2020).

Science teachers are likely to be the one who successfully build adequate scientific knowledge methodologies to acquired successful technology-assisted instruction (Constantine et al., 2017). Effective scientific instructors have a thorough awareness of their scientific domains, lessons, learners, teaching strategies, and evaluation systems, which they use in the classroom. (Mishra and Koehler 2006).

Teachers' ability in the preparation and delivery of engaging science classes is sometimes limited by a lack of science content understanding (Nowicki et al., 2013; Oh & Kim, 2013). When science professors have only a rudimentary understanding of the subject, they may convey inaccurate information, leading to misconceptions among students (Ghazi et al., 2013).

Teachers' knowledge is described as knowledge that is solely applied to teaching (Shulman 1987), and it is thought to be crucial for effective teaching (Grossman 1990). Teachers' professional development begins with having professional understanding of the ideas to be taught, methodology and assessment needed to support their students' content learning, and the technology needed to support that teaching and learning. These knowledge sets interact to create a knowledge set that combines technological, pedagogical, and content knowledge (Mishra & Koehler, 2006). Knowledge of representations, science curriculum, students' comprehension of science, varied educational contexts, affordances of ICT tools, and other topics may be included in TPACK for science teachers (Krajcik, & Borko, 1999, Angeli & Valanides, 2009; Jimoyiannis, 2010; Magnusson).

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The Concept of TPACK

TPACK serves as a model in identifying what knowledge should the instructors need to incorporate technology into their classrooms and how they might acquire it. It acknowledges the unique and interactive roles that content, technology, and pedagogy play in real teaching and learning settings, and advises that "an emergent form of knowledge" be considered in addition to content, technology, and pedagogy (Mishra & Koehler, 2006).

TPACK is a theoretical model for analyzing the mental capability of the teachers to incorporate technology effectively. The TPACK framework was created to underline the importance of placing technology knowledge within the context of content and pedagogical expertise. Teachers' knowledge is diverse and multifaceted, according to TPACK, which criticizes techno-centric approaches that segregate technology skills from pedagogy and content (Mishra & Koehler, 2006).

Furthermore, TPACK stands for Technological, Pedagogical, and Content Knowledge (TPACK), which is based on Schulmans (1986) concept of pedagogical and content knowledge (PCK) (Harris, Koehler & Mishra, 2009). Components of TPACK such as technological (TK), pedagogical (PK), content (CK), technological content (TCK), technological pedagogical (TPK), and pedagogical content (PCK) interact in a specific setting to enable the effectivity of utilizing technology in teaching (Mishra & Koehler, 2009).

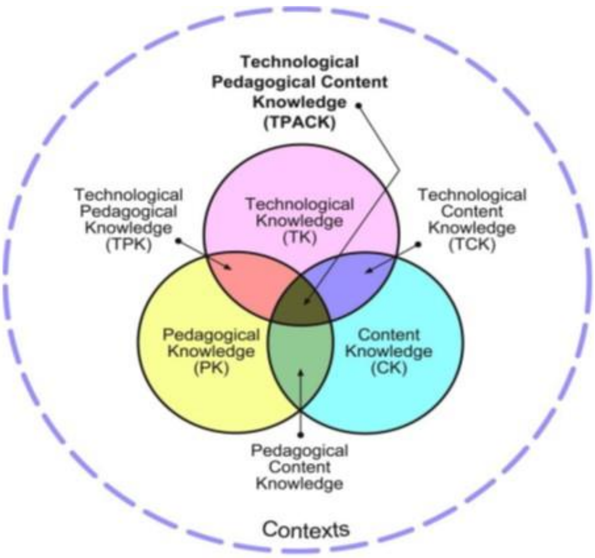

Figure 1. *TPACK framework (Koehler & Mishra, 2009)*

There are seven components of TPACK described as follows:

Technological Knowledge

Technological knowledge (TK) includes information about a wide range of technologies, from low to high-tech devices like the digital gadgets, cellphone and whiteboards (Schmidt et al., 2009). Technological knowledge refers to a teacher's capacity to employ software and hardware to accomplished learning challenges. However, Koehler and Mishra (2009) contend that technology, more than content and pedagogy, is always in flux. What is considered modern technology today may become obsolete in a matter of days or years, making it impossible to define technological knowledge clearly (Harris, Mishra & Koehler 2009).

Content Knowledge

Content Knowledge (CK) is the understanding of the subject matter to be learnt or taught (Mishra & Koehler, 2009). Content knowledge pertains to a teacher's understanding of the disciplines he or she teaches, such as mathematics or science. This includes knowledge of concepts, theories, ideas, organizational frameworks, scientific facts and theories, knowledge of evidence and proof, as well as established procedures and approaches to producing such knowledge, according to Shulman (1986) cited in Kohler & Mishra (2009).

Pedagogical Knowledge

Pedagogical Knowledge (PK) refers to a teachers' understanding of the processes and practices of teaching and learning, as well as educational purposes, goals, values, and techniques (Koehler & Mishra, 2009. Pedagogical knowledge spans a wide range of teaching methods, from lesson design through student evaluation. It entails understanding of classroom course of action or approaches, the character of students' requirements and preferences, as well as assessment measures for student comprehension (Harris, Mishra & Koehler, 2009).

Pedagogical Content Knowledge

Pedagogical Content Knowledge (PCK) relates to the knowledge of the instructional process's substance (Shulman 1986). The purpose of pedagogical content knowledge is to establish improved teaching methods in the content area by combining content and pedagogy (Schmidt et al., 2009). PCK is defined as the alteration of content in teaching, which happens when a teacher delivers a lessons and applies ample ways in presenting it, as well as adapting and tailoring instructional materials to alternative conceptions and students' prior knowledge, based on Shulman's idea (Koehler & Mishra 2009).

Technological Pedagogical Knowledge

Technological Pedagogical Knowledge (TPK) is about instructors' perceptions on how educating and learning can change as a result of the usage of specific technology in specific manners (Koehler & Mishra, 2009). It is the understanding of how various technologies can be used in the classroom, as well as the possibility that using technology will transform how teachers educate (Schmidt et al., 2009). An instructor must be knowledgeable of how and when a specific technology should be utilized to improve the delivery of content in a specific subject. An example of technology pedagogical competence is the utilization of a reactive board to attract students in the process of collaborating information in the learning procedure (Koehler & Mishra, 2009; Niess, 2005).

Technological Content Knowledge

Technological Content Knowledge (TCK) is the understanding of how technology can be used to produce new representations for certain types of content. "Understanding the impact of technology on the practices and knowledge of a certain profession is crucial to developing appropriate technological tools for educational objectives," Koehler and Mishra (2009) say (p. 65). It also entails an awareness of how content and technology interact and influence each another. Teachers must need to know not only the lesson, but also how the lesson can be transformed by utilizing technology (Koehler & Mishra, 2009).

Technological, Pedagogical and Content Knowledge

Technological Pedagogical and Content Knowledge (TPCK) refers to the knowledge that instructors must possess in order to incorporate technology into their classrooms and content areas (Schmidt et al., 2009). When expert educators teach, they use TPACK to integrate their understanding of content, pedagogy and technology. In addition, technology is just a tool and not a guarantee to be suitable to every teacher, course, or educational style. Instead, finding solutions requires a teacher's capacity to track the expanse described in the characteristics of content material, pedagogy, and technology, as well as the compound interplay among the factors in unique contexts (Koehler and Mishra 2006, 2009). TPACK is a useful model in considering what knowledge instructors need to utilized technology into their classrooms and how they might acquire it. They also argue that assessing teaching knowledge could have an impact on the types of pre-service and in-service teacher training and professional development opportunities available (Schmidt et al. 2009).

Understanding TPACK leaves a progress to teachers in their daily learning activities specially in teaching Science. Keeping technology as a different set of knowledge creates challenges, but as teachers understand the TPACK, they will incorporate technology into our classroom content and pedagogy. The integration will make the students know better. There is need to learn technology integration with our content and pedagogy to create an effective learning atmosphere, given the growing emphasis on technology.

Factor’s Affecting TPCK of Teachers

Provides research indicating that teachers' computer ability is directly influenced by their age, whereas their technology use is influenced indirectly (Robinson 2003). In addition, age may indirectly influence the use of teacher computers that is influenced by attitudes towards computers by students (Van Braak et al. (2004). Teacher ages have a negative effect on teacher computer skills; their computer skills would decline as teachers ' age and years of experience rise. Like the expected model, all factors of school environment had a major impact on technical literacy of teachers (Fethi A., Lowther, Deborah L., 2009).

Age had affected the mindset of Singapore pre-service teachers towards computer use (Teo 2008). This was associated with in-service teacher surveys that often showed older teachers to have less faith in using computers (Yaghi, 2001). Analyzed the TPCK views of Taiwanese in-service teachers for using web-based technologies and noticed that the older teachers were less optimistic (Lee and Tsai 2010). Age may be a more important consideration for in-service teachers, which requires more investigation (Koh et al. 2010).

Gender is a consideration that may affect attitudes of the TPACK staff. Studies of the instructor attitude find that male teachers appeared to be more positive than female teachers in their abilities to use computers (Markauskaite, 2006; Tsai, 2008). The findings of a broad TPACK sample survey conducted to 1,185 Singapore Pre-service teachers were quite close. This analysis showed that the male teachers were scored higher on TK and CK. The results on TPACK could not be measured in the analysis because the TPACK sample elements could not be separated as a consideration by an exploratory element evaluate (Koh, Chai, and Tsai 2010).

Male teachers in selected secondary schools positively viewed the use of ICT in education as a way of reaching social goals contrasted with women's peers. The outcome may be attributed to the availability of infrastructural facilities for teaching subjects relevant to ICT, effective administrative policies for implementing ICTs (Cornille 2003). Gender is a factor that influence teachers' integration of technology (Uslo, 2018). Men are more technologically accepting than women, which explains the gender disparity. As a result, male educators were more likely to incorporate technology into a curriculum than female educators (Hermans, 2008).

In terms of years of teaching experience, this research partly followed the path suggested that the years of teaching would explicitly and indirectly affect the use of technology (Mathews and Guarino 2000). The orientation of the course was negative as expected; suggesting that the preparation of experienced teachers and the adoption of technology is lower compared with novices. This trend is an indicator that, relative to more seasoned colleagues, recent students have more awareness about technology adoption and are more equipped. This result is not unexpected, because teachers who is recently graduated should have more technological experience (Jones and Madden 2002; O'Dwyer et al. 2004) and be better suited to integrate technology into classroom teaching (Mims et al. 2006). Veteran teachers, according to studies, may have less technological understanding and faith in incorporating technology, limiting incentives in their classrooms to improve their daily instruction activities or pursue new technologies (Robinson 2003; Snoeyink and Ertmer 2002).

The years of teaching has a strong and indirect detrimental effect on the training of the students. In comparison, age implicitly influences the feeling of readiness of students. As stated earlier, this result indicates that teacher preparation services have increased to focus over the past few years on better training teachers to incorporate technology into their teaching (Fethi A., Lowther, Deborah L., 2009). Teachers were examined in their classrooms after 10 years of experience teaching mathematics in secondary schools in urban public schools and asked about their experiences teaching mathematics and incorporating information technology into their everyday practices.

While teachers demonstrated a high degree of technological adoption, they found it difficult to purchase and manage the computing equipment. They had some trouble trying to incorporate emerging technology as the time, planning and effort needed (Stoilescu, 2011). Teaching experience has a little bearing on the ability of the teachers to integrate technology. (Inan, 2010). The ability of educators to successfully integrate technology into a curriculum was determined by their participation in technology training. (Koh et al. 2015).

There are major associations in the populations of teachers and class, with the exception of the credential of a doctoral degree holder showing a poor negative link (Adedokun 2018). Prior research have shown mixed results when it comes to the educator's academic degree or level of education preparation. However, it is reasonable to assume that higher education, particularly at the doctoral level, focuses on professional knowledge growth and theoretical development rather than the development of technology competence for health professionals. Educators at the bachelor's and master's level may be required to become more instruction-oriented, with a higher emphasis on integrating technology into the curriculum. (Chen et al. 2019).

TPCK survey was applied to explore the awareness of the technological pedagogic quality of 366 Taiwanese in-service students. The association analyzes showed that more senior teachers may demonstrate some refusal to the integration of technology in the teaching environments while higher education credentials appeared to have more technology usage experience and ICT incorporation in their teaching environment, respectively in the TK and TPCK scales. University students ' grades were slightly greater than those with lesser credentials (Liang, Chai, Koh, Yang, & Tsai 2013).

The demographic characteristics of teachers, which affect computer ability and preparation of teachers, have not been found to influence the beliefs of the teachers. This result indicates that there could be other factors at the instructor level affecting instructor attitudes such as the field of instruction and foregoing technical experience (Hew and Brush 2007; Lih-Juan et al. 2006). It was found that TPACK structures had a substantial effect on TPACK attitudes of pre-service teachers while age and gender demographic variables were not relevant. Only technical pedagogical expertise and expertise of technical material were found to be important predictors of TPACK within the TPACK constructs. The ramifications of these results are explored for the creation of ICT courses for pre-service students (Koh's analysis J. H. L. & Chai, C. S. 2011).

Some studies examined the 1210 secondary school teachers in TPCK singing contextualized model TPCK. The findings showed that seasoned teachers continued to score their qualitative understanding of material and pedagogical information (PCK) considerably higher than beginner science teachers did. However, instructors with shorter length of service tended to have a much better comprehension of technology and technical material in context (TPCK) than teachers with more experience (Jang & Tsai, 2013).

Individual characteristics such as confidence and behaviors are difficult to test, while one basic criterion can accurately be used to assess social or educational standards (Strong, 2011). In comparison, others can be calculated in one series of questions by observable measures of instructor efficacy, and some need to be evaluated over a period of time. For example, incorporating technology into scientific instruction necessitates the evaluation of more than one classroom observation; also, material comprehension may be assessed using an aptitude test based on a single set of observations. Many good instructors have brains, talents, and cognitive capacity (Hill, Blunk, et al., 2008; Stronge, 2007), while others have values, dispositions, and teaching principles (Arroyo, Rhoad, & Drew, 1999; Corbett & Wilson, 2002). Others are internal or personal characteristics, while others are external or societal characteristics. Teachers need empathy and a wide range of interests, for example, as well as the ability to maintain productive and supportive relationships with 18 students, the community, colleagues, and administrators (Strong, 2011; Stronge, 2007). (Berry, 2001; Darling-Hammond, 2005).

Some characteristics of teaching can only be assessed by a single assessment process, while others can be assessed using various methods (Strong, 2011). The impact of a master's degree attainment during high school on student reading and math achievement remains uncertain. One research shows that the attainment of a master's degree would only have a conclusive effect on learners' math performance if the teacher specializes in math during the master's degree course (Horn and Jang 2017). Demographic backgrounds play a major factor in integrating TPCK in imparting knowledge to students, such as: age, gender, and years of teaching, educational attainment.

Methodology

Research Design

This study will employ descriptive-survey to tabulate, analyze and interpret data. The quantitative data will be obtained from the surveyed questionnaires on the knowledge of public secondary science teachers, students and administrators of the two (2) secondary schools of the Municipality of Kalamansig, Sultan Kudarat, namely Kalamansig and Sta. Clara National High School.

The participants of this study employed full enumeration for teachers and administrators and systematic random sampling for students. The study use descriptive statistics and inferential statistics. The standard deviation and mean for TPCK will be determined using descriptive statistics. The association between demographic variables will be determined using inferential statistics using Person's r, and the difference between students, teachers, and administrators' TPCK ratings and its components will be studied using multiple analysis of variance (MANOVA).

Locale of the Study

The study was conducted in the selected secondary schools of the Municipality of Kalamansig namely the Kalamansig and Sta. Clara National High School. The selected schools are some of the top performing school in Kalamansig that brings pride to the Municipality.

Participants of the Study

There are 124 participants of the study: 100 students, 19 public secondary science teachers and 5 administrators of Kalamansig and Sta. Clara National High Schools for the School Year 2020-2021. To distribute the number of respondents by school, there are 70 students, 15 teachers and 3 administrators from Kalamansig National High School and 30 students, 4 teachers and 2 administrators from Sta. Clara National High School.

Sampling Size and Sampling Technique

Size of sample was determined through the use of systematic random sampling in order to lessen the number of students. Out of 2981 students of Kalamansig and Sta. Clara National High School, it was down to 100 students. For the teachers and administrator, the researcher decided to use full enumeration due to small number.

Research Instrument

A demographic questionnaire and a TPACK questionnaire were included in the tool. The demographic questionnaire is intended for public secondary science teacher which includes data of respondents such age, gender, and years of teaching experience, educational attainment and academic awards. The TPACK questionnaire included 35 closed-ended questions about TPACK knowledge and components.

Data Gathering Procedure

The study utilized survey questionnaire with demographic data among 19 public secondary science teachers and full TPCK questionnaire intended for 100 students and 5 administrators of selected public secondary schools of Kalamansig. Demographic questionnaire includes data of teachers such age, gender, and years of teaching experience, educational attainment and academic awards. Each component of TPACK consist of five items with the total of 35 questions.

Statistical Treatment of Data

The demographic profile of public secondary science teachers was determined using frequency and percentage distribution. Mean was used to determine the knowledge level of the science teachers in the areas of Content (CK), Pedagogical (PK) and Technological (TK), Pedagogical Content (PCK), Technological Pedagogical (TPK) and Technological Content (TCK) and Technological Pedagogical Content Knowledge (TPCK) as rated by students and administrators. Below will be used to describe the scale of each knowledge.

Results and Discussion

Teachers Demographic Profile

The demographic profiles of the public secondary science teachers in this study are categorized and presented in terms of frequencies and percentages distribution (Table 1).

Table 1. *Frequencies and Percentage Distribution of the Public Secondary Science Teachers Demographic Profiles (n=19).*

Variables		*Frequencies (f)*	*Percentage (f %)*
Age	25-30 yrs.	7	36.8%
	31-35 yrs.	5	26.3%
	41-45 yrs.	3	15.8%
	46-50 yrs.	2	10.5%
	51-55 yrs.	1	5.3%
	Over 55	1	5.3%
Sex	Female	14	73.7%
	Male	5	26.3%
Years of Experience	4 to 10 years	13	68.4%
	More than 10 years	6	31.6%
Educational Attainment	Bachelor's Degree	11	57.9%
	Master's Degree	8	42.1%
Academic Awards	Cum laude	3	15.8%
	None	16	84.2%
Total		19	100.0%

Of the 19 respondents, the highest percentage of 36.8% are in the age group of 25 – 30 years old (f = 7, f% = 36.8). The equally lowest percentages of 5.3% are in the age group of 51-55 years old (f = 1, f% = 5.3 %) and over 55 years old (f = 1, f% = 5.3), respectively. The higher percentage of 73.7% is female (f = 14, f % = 73.7), while the lower percentage of 26.3 % is male (f = 5, f % = 26.3%).

The highest percentage of 68.4 % of the respondents has teaching experience of 4-10 years (f = 13, f% = 68.4%), while the lower percentage of 31.6% has more than 10 years of teaching experience (f = 6,f%= 31.6). In terms of educational attainment, a higher percentage of 57.9% has Bachelor's Degree (f = 11, f% = 57.9%) and the lowest percentage of 42.1% has Master's Degree (f = 8,f% = 42.1%). Of them, a higher percentage of 84.2% has obtained no academic awards (f = 16, f% = 84.2%) while 15.8% has been awarded with *Cum laude* honors (f = 3,f% = 15.8%).

Similar results as to the age group of active Science teachers are reported by the study of Lee and Tsai (2010) that the older the teacher the less confident they become in exploring TPACK perceptions for using web-based technology which will result to the decrease of their performance. Also as to the sex group, females are more represented than males which supports that female instructors had considerably higher CK, PK, PCK, and TCK scores than male teachers (Altun 2013). In addition, the higher number of females is substantiated by a study conducted for graduate studies at Cotabato State University, which found that they persevere in academics more than males in the Filipino culture. They are dedicated and willing to take risks in order to achieve their goals (Matos and Billiones, 2019).

These results suggest that the demographic profile of teachers has something to do with their TPCK which can be concluded on the result of this study.

TPCK Results of Teachers Self – Evaluation

Technological Knowledge. Particularly for technological knowledge, the science teachers rating of themselves are shown in terms of frequencies and means (Table 2).

Table 2. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Technological Knowledge as Rated by Themselves (n=19).*

Statement	*Frequencies*					*Mean*	*Description*
	1	*2*	*3*	*4*	*5*		
1. I know how to fix my own technical problems when presenting my lesson.	0	0	2	3	14	4.63	Strongly Agree
2. I know how to operate google meet	0	0	2	4	13	4.57	Strongly Agree
3. I know how to use Microsoft Office.	0	0	0	3	16	4.84	Strongly Agree
4. I have the technical skills to use technology.	0	0	2	6	11	4.47	Strongly Agree
5. I use technology tools to process data	0	0	1	5	13	4.68	Strongly Agree
Overall				4.63			Strongly Agree

Generally, high means of 4.47 - 4.84 with an overall mean of 4.63 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "they know how to solve their own technical problems when presenting their lesson (Statement 1)," "they know how to operate google meet (Statement 2)," "they know how to use Microsoft Office (Statement 3)," "they have the technical skills to use technology (Statement 4)," and "they use technology tools to process data (Statement 5)."

Their "strong agreement" signifies that the respondents are knowledgeable in all indicators when it comes to technology. These results are supported by the study that explains technological knowledge is associated with the ability to use technological tools but also the knowledge behind this technology (Mishra & Koehler, 2006). These imply that teachers are enabled to effectively apply technological knowledge to improve student learning and to be ready to any forthcoming changes.

Pedagogical Knowledge. For pedagogical knowledge, the science teachers rating of themselves are shown in terms of frequencies and means (Table 3).

Table 3**.** *Frequencies and Mean Distribution of Public Secondary Science Teachers' Pedagogical Knowledge as Rated by Themselves (n=19).*

Statement	*Frequencies*					*Mean*	*Description*
	1	*2*	*3*	*4*	*5*		
1. I use rubrics in assessing my student's performance.	0	0	0	5	14	4.73	Strongly Agree
2. I use video lesson and other resources to support my discussion.	0	0	0	2	17	4.89	Strongly Agree
3. I integrate different approaches to make my lesson more interesting.	0	0	0	4	15	4.78	Strongly Agree
4. I evaluate student learning in a variety of methods.	0	0	2	8	9	4.36	Strongly Agree
5. I adjust my teaching method to the needs of various students.	0	0	1	4	14	4.68	Strongly Agree
Overall				4.69			Strongly Agree

Generally, high means of 4.36 – 4.89 with the overall mean of 4.69 which is described as to the respondents as "strongly agree" is observed in all the statements. These "strong" indicators include: "they use rubrics in assessing their students' performance (Statement 1)," "they use video lesson and other resources to support their discussion (Statement 2)," "they integrate different approaches to make their lesson more interesting. (Statement 3)," "they assess student learning in multiple ways. (Statement 4)," and "they adapt their teaching style to different learners. (Statement 5)."

The teachers "strong agreement" implies that the respondents are knowledgeable in all indicators when it comes to pedagogy. These findings are confirmed by a research by Ball (2003), which found that a teacher with high pedagogical content expertise may break down knowledge into less polished and abstract forms, making it accessible to students of various cognitive abilities.

Content Knowledge. Particularly for content knowledge, the science teachers rating of themselves are shown in terms of frequencies and means (Table 4).

Table 4. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Content Knowledge as Rated by Themselves (n=19).*

Statement	*Frequencies*					*Mean*	*Description*
	1	*2*	*3*	*4*	*5*		
1. I can explain the concept of photosynthesis.	0	0	0	3	16	4.84	Strongly Agree
2. I know how to use Punnet square in determining the genetics output.	0	0	3	5	11	4.42	Strongly Agree
3. I explain the concept on what is the difference of Plant Cell and Animal Cell.	0	0	0	4	15	4.78	Strongly Agree
4. I am familiar enough with the structure of knowledge in any science subject.	0	0	0	10	9	4.47	Strongly Agree
5. I know the concept within the science subject content.	0	0	1	8	10	4.52	Strongly Agree
Overall				4.60			Strongly Agree

Generally, high means of 4.42 – 4.84 with the overall mean of 4.60 which is described as to the respondents as "strongly agree" is observed in all the statements. These "strong" indicators include: "they can explain the concept of photosynthesis. (Statement 1)," "they know how to use Punnet square in determining the genetics output. (Statement 2)," "they explain the concept on what is the difference of Plant Cell and Animal Cell (Statement 3)," "they have sufficient knowledge about structure of knowledge in any science subject content (Statement 4)," and "they know the concept within the science subject content. (Statement 5)."

Their "strong agreement" implies that the respondents are knowledgeable in all indicators when it comes to content which connotes that teachers are knowledgeable and equipped by the basic foundation of concepts in science which enable them to familiarize and understand science topics. In addition, they can apply their understanding of science concepts presented in the content, theories, and the course's overall framework to help students acquire scientific knowledge (Mishra & Koehler, 2006).

Technological Pedagogical Knowledge. Particularly for technological pedagogical knowledge, the science teachers rating of themselves are shown in terms of frequencies and means (Table 5).

Table 5. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Technological Pedagogical Knowledge as Rated by Themselves (n=19).*

Statement	*Frequencies*					*Mean*	*Description*
	1	*2*	*3*	*4*	*5*		
1. I select technology that complement a lesson's instructional methods.	0	0	0	11	8	4.42	Strongly Agree
2. I select technology that will help pupils learn more effectively.	0	0	0	8	11	4.57	Strongly Agree
3. I consider how I can use technology in my classroom thoughtfully.	0	0	0	10	9	4.47	Strongly Agree
4. I adjust my technology use to various instructional activities.	0	0	1	5	13	4.63	Strongly Agree
5. I use technology tools to increase productive learning.	0	0	0	7	12	4.63	Strongly Agree
Overall				4.54			Strongly Agree

Generally, high means of 4.42 – 4.63 or with an overall mean of 4.54 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "select technology that complement a lesson's instructional methods (Statement 1)," "they select technology that will help pupils learn more effectively (Statement 2)," "they consider how I can use technology in my classroom thoughtfully. (Statement 3)," "they adjust my technology use to various instructional activities. (Statement 4)," and "they use technology tools to increase productive learning (Statement 5)."

Their "strong agreement" means that teachers were equipped in choosing technology which is suitable in a different teaching strategy that will benefit the learners. This demonstrates that science teachers have recognized that when employing technological tools to build pedagogical tactics, teaching and learning are reformed, taking into account that such knowledge involves awareness of the instruments' limitations and capabilities. Because all technical instruments accessible are geared to meet the subject's educational goals, the TPK is likely to appear stronger (Mishra & Koehler, 2006).

Technological Content Knowledge. Particularly for technological content knowledge, the science teachers rating of themselves are shown in terms of frequencies and means (Table 6).

Table 6. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Technological Content Knowledge as Rated by Themselves (n=19).*

Statement	*Frequencies*					*Mean*	*Description*
	1	*2*	*3*	*4*	*5*		
1. I am familiar with technologies that I can use to better understand the topics of any science subject.	0	0	2	9	8	4.31	Strongly Agree
2. I know how to use specialized tools or websites to research any science topic.	0	0	5	9	5	4.00	Agree
3. I can locate and assess the materials I require for science topics.	0	0	2	8	9	4.42	Strongly Agree
4. I have the ability to communicate science content using technology.	0	0	0	6	13	4.73	Strongly Agree
5. I can manage and communicate information in science subject area using technology tools and resources.	0	0	0	7	12	4.68	Strongly Agree
Overall						4.40	Strongly Agree

Generally, high means of 4.31 – 4.68 or with an overall mean of 4.40 which is described as to which the respondents "strongly agree" is observed in 4 statement indicators. Statement 2 obtained the mean of 4.00 which described as "agree". These "strong" indicators includes: "I am familiar with technologies that I can use to better understand the topics of any science subject (Statement 1)," "I can locate and assess the materials I require for science topics (Statement 3)," "I have the ability to communicate science content using technology (Statement 4)," and "5. I can manage and communicate information in science subject area using technology tools and resources (Statement 5)."

The teacher "strong agreement" means that the teachers use appropriate technology which can contribute to the better understanding of the lesson which allows students to understand concepts in a clear way. The study of (Mishra & Koehler, 2006) supports that the teacher can select and utilize effectively the technology that will help them in teaching the science content (TCK).

Pedagogical Content Knowledge. Particularly for pedagogical content knowledge, the science teachers rating of themselves are shown in terms of frequencies and means (Table 7).

Table 7. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Pedagogical Content Knowledge as Rated by Themselves (n=19).*

Statement	*Frequencies*					*Mean*	*Description*
	1	*2*	*3*	*4*	*5*		
1. I understand how to choose effective teaching methods to guide student thinking and learning.	0	0	0	7	12	4.63	Strongly Agree
2. I understand the goals and objectives of any science subject content.	0	0	0	7	12	4.63	Strongly Agree
3. I can effectively supervise my students' science curriculum learning.	0	0	0	6	13	4.68	Strongly Agree
4. I am familiar with instructional tactics that are appropriate for any science subject.	0	0	0	8	11	4.57	Strongly Agree
5. I understand how and what to evaluate in any science field.	0	0	0	6	13	4.68	Strongly Agree
Overall						4.64	Strongly Agree

Generally, high means of 4.57 – 4.68 or with an overall mean of 4.64 which is described as to which the respondents "strongly agree" is observed for all the

5 statement indicators. These "strong" indicators include: "understand how to choose effective teaching methods to guide student thinking and learning (Statement 1)," "understand the goals and objectives of any science subject content (Statement 2)," "can effectively supervise my students' science curriculum learning (Statement 3)," "familiar with instructional tactics that are appropriate for any science subject (Statement 4)," and "know how and what to assess any science subject content. (Statement 5)."

order to strengthen their CK. This is supported from the study Fraser (2016) found that the strength of CK was important for readiness to take pedagogic risks (in the context of science education). When teachers practice their PCK, they will get insight into how to teach specific topic in specific ways, resulting in improved student understanding (Loughran, Berry, and Mulhall 2012). In addition, experienced teachers' knowledge of integrating content and pedagogy is better because they have had more opportunities to accumulate this knowledge through their actual teaching experiences than novice teachers who are still developing integrative skills and knowledge Friedrichsen et al. (2009).

Technological Pedagogical Content Knowledge. Particularly for technological pedagogical content knowledge, the science teachers rating of themselves are shown in terms of frequencies and means (Table 8).

Generally, high means of 4.31 – 4.63 or with an overall mean of 4.51 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "can teach lessons that appropriately combine science subject content, technologies and teaching approaches. (Statement 1)," "can select technologies to use in classroom that enhance their teaching, how they teach and what students can learn. (Statement 2)," "can provide leadership in helping others to coordinate the use of science subject content, technologies and teaching approaches at my school and/or district. (Statement 3)," "can choose technologies that enhance the learning of science subject content for a lesson. (Statement 4)," and "can evaluate and select new information resources and technological innovations based on their appropriateness to specific tasks in science subject content. (Statement 5)."

Their "strong agreement" signifies that the respondents are knowledgeable in all indicators when it comes to technology, pedagogy and content. The result shows that teachers are combining technology, science content and approaches for a better understanding of any science concept. Teachers are optimistic and motivated to learn new things just to ensure better service to the students. However, it contradicts to the study (Pelgrum, 2001; Yuen et al., 2008) that claims that low teacher adoption of technology is due to a lack of motivation to use technology in teaching and learning. Furthermore, this implies that teachers might follow the trend of adopting technologies to aid learning, but that the correct technology tool for a given delivery of mathematical information is not always observed. In other words, they are aware, but they are unable to select the most appropriate technological equipment. This emphasized the importance of being instructors for the 21st century, integrating technology, pedagogy, and topic content into all classroom activities.

Table 8. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Technological Pedagogical Content Knowledge as Rated by Themselves (n=19).*

Statement	*Frequencies*					*Mean*	*Description*
	1	*2*	*3*	*4*	*5*		
1. I can teach lessons that integrate science material, technologies, and instructional methods effectively.	0	0	0	9	10	4.53	Strongly Agree
2. I have the ability to choose technology to employ in my classroom that will improve what I teach, how I teach, and what students can learn.	0	0	1	5	13	4.63	Strongly Agree
3. I can lead others in my school and/or district in coordinating the use of science subject matter, technologies, and instructional styles.	0	0	1	11	7	4.31	Strongly Agree
4. I can select technologies that will aid in the understanding of science topics.	0	0	0	7	12	4.63	Strongly Agree
5. I can assess and choose new information resources and technological breakthroughs depending on their suitability for certain tasks in the science topic.	0	0	0	10	9	4.47	Strongly Agree
Overall			4.51				Strongly Agree

The findings contradict Handal's (2013) conclusion that teachers may refuse to use technology, even if it is required or suggested, based on a variety of personal experiences, such as a child's cognitive development, the complexity of the subject, classroom management issues, or simply the pressure of having to deliver a crowded curriculum on a tight schedule. Technology-related learning programs may be implicitly considered as an add-on to the school system's curriculum.

TPCK Results of Teachers as rated by the Students

Technological Knowledge. Particularly for technological knowledge, the students rating for science teachers are shown in terms of frequencies and means (Table 9).

Table 9. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Technological Knowledge as Rated by the Students (n=100).*

Statement *My Science Teacher*	*Frequencies* 1	2	3	4	5	*Mean*	*Description*
1. knows to solve their own technical problems when presenting their lesson.	0	0	11	28	61	4.50	Strongly Agree
2. knows to operate google meet.	0	0	5	25	70	4.65	Strongly Agree
3. knows to use Microsoft Office.	0	0	9	21	70	4.61	Strongly Agree
4. have the technical skills he/she needs to use technology.	0	0	11	31	58	4.47	Strongly Agree
5. use technology tools to process data.	0	0	6	32	62	4.56	Strongly Agree
Overall				4.55			Strongly Agree

Generally, high means of 4.47 – 4.65 or with an overall mean of 4.55 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "knows to solve their own technical problems when presenting their lesson. (Statement 1)," "knows to operate google meet. (Statement 2)," "knows to use Microsoft Office (Statement 3)," ".have the technical skills he/she needs to use technology (Statement 4)," and "use technology tools to process data. (Statement 5)."

The students "strong agreement" is similar to the result of the teacher's self-evaluation that the respondents are knowledgeable in all indicators when it comes to technology. These findings are backed up by a study that demonstrates how technological knowledge is linked to not only the capacity to use technological instruments, but also the knowledge of how they work (Mishra & Koehler, 2006). These results indicate that teachers are able to effectively employ technology knowledge to boost student learning while also being prepared for future developments.

Pedagogical Knowledge. Particularly for pedagogical knowledge, the students rating for science teachers are shown in terms of frequencies and means (Table 10).

Table 10. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Pedagogical Knowledge as Rated by the Students (n=100).*

Statement *My Science Teacher*	*Frequencies* 1	2	3	4	5	*Mean*	*Description*
1. use rubrics in assessing my student's performance.	0	0	4	21	75	4.71	Strongly Agree
2. use video lesson and other resources to support his/her discussion.	0	0	4	43	53	4.49	Strongly Agree
3. integrate activities and uses different approaches to make my lesson more interesting.	0	0	6.	32	62	4.56	Strongly Agree
4. evaluate student learning in a variety of methods.	0	0	5	39	56	4.51	Strongly Agree
5. can change my teaching method to different types of students.	0	0	7	32	61	4.54	Strongly Agree
Overall				4.56			Strongly Agree

Generally, high means of 4.49 – 4.71 or with an overall mean of 4.56 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "use rubrics in assessing my student's performance. (Statement 1)," "use video lesson and other resources to support my discussion (Statement 2)," ".integrate activities and uses different approaches to make my lesson more interesting. (Statement 3)," assess student learning in multiple ways. (Statement 4)," and "can adapt with their teaching style to different learners. (Statement 5)."

The students "strong agreement" is similar to the result of the teacher's self-evaluation that the respondents are knowledgeable in all indicators when it comes to pedagogy. These findings are confirmed by a research by Ball (2003), which found that a teacher with high pedagogical content expertise may break down knowledge into less polished and abstract forms, making it accessible to students of various cognitive abilities.

Content Knowledge. Particularly for content knowledge, the students rating for science teachers are shown in terms of frequencies and means (Table 11).

Table 11**.** *Frequencies and Mean Distribution of Public Secondary Science Teachers' Content Knowledge as Rated by the Students (n=100).*

Statement *My Science Teacher*	*Frequencies* 1	2	3	4	5	*Mean*	*Description*
1. explain the concept of photosynthesis.	0	0	10	21	69	4.59	Strongly Agree
2. knows how to used Punnet square in determining the genetics output.	0	0	11	30	59	4.48	Strongly Agree
3. explain the concept on what is the difference of Plant Cell and Animal Cell.	0	0	7	25	68	4.61	Strongly Agree
4. have sufficient knowledge about structure of knowledge in any science subject content.	0	0	10	31	59	4.49	Strongly Agree
5. understands the concept, facts, theories, and procedures in the science field.	0	0	4	41	55	4.51	Strongly Agree
Overall				4.53			Strongly Agree

Generally, high means of 4.51 – 4.61 or with an overall mean of 4.53 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "explain the concept of photosynthesis. (Statement 1)," "knows how to used Punnet square in determining the genetics output. (Statement 2)," "explain the concept on what is the difference of Plant Cell and Animal Cell (Statement 3)," ".have sufficient knowledge about structure of knowledge in any science subject content. (Statement 4)," and "understands the concept, facts, theories, and procedures in the science field (Statement 5)."

The students "strong agreement" is similar to the result of the teacher's self-evaluation that the respondents are knowledgeable in all indicators when it comes to content. These result suggests that respondents are competent in all subject indicators, implying that teachers are aware and prepared with the fundamental foundation of science concepts, allowing them to acquaint and grasp science topics. Furthermore, they are able to apply their understanding of science concepts offered in the content, theories, and the overall framework of the course to help students acquire scientific knowledge (Mishra & Koehler, 2006)

Technological Pedagogical Knowledge. Particularly for technological pedagogical knowledge, the students rating for science teachers are shown in terms of frequencies and means (Table 12).

Generally, high means of 4.45 – 4.63 or with an overall mean of 4.51 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "choose technologies that enhance the teaching approaches for a lesson. (Statement 1)," "choose technologies that enhance students' learning for a lesson. (Statement 2)," "think critically on how to use technology in his/her classroom. (Statement 3)," adapt the use of the technologies that he/she learning to different teaching activities (Statement 4)," and "employ technology and information resources (Statement 5)."

Table 12. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Technological Pedagogical Knowledge as Rated by the Students (n=100).*

Statement *My Science Teacher*	*Frequencies* 1	2	3	4	5	*Mean*	*Description*
1. select technology that complement a lesson's instructional methods.	0	0	7	35	58	4.51	Strongly Agree
2. select technologies that aid in student learning.	0	0	8	39	53	4.45	Strongly Agree
3. Take a critical look at how to use technology in the classroom.	0	0	4	43	53	4.49	Strongly Agree
4. use what they've learned about technology in a variety of learning activities .	0	0	6	37	57	4.51	Strongly Agree
5. employ technology and information resources.	0	0	2	33	65	4.63	Strongly Agree
Overall				4.51			Strongly Agree

The students "strong agreement" is similar to the result of the teacher's self-evaluation that the respondents are knowledgeable in all indicators when it comes to technology and pedagogy. This demonstrates that scientific teachers have acknowledged that when employing technological tools to build pedagogical tactics, teaching and learning are reformed, taking into account that such knowledge involves awareness of the instruments' limitations and capabilities. Because all accessible technology instruments are geared to meet the subject's educational goals, the TPK is likely to appear stronger (Mishra & Koehler, 2006).

Technological Content Knowledge. Particularly for technological content knowledge, the students rating for science teachers are shown in terms of frequencies and means (Table 13).

Table 13. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Technological Content Knowledge as Rated by the Students (n=100).*

Statement My Science Teacher	Frequencies 1	2	3	4	5	Mean	Description
1. knows about technologies that he/she can use for understanding any science subject contents.	0	0	5	31	64	4.59	Strongly Agree
2. knows how to use specific software or web-sites about any science subject content.	0	0	6	39	55	4.49	Strongly Agree
3. can find and evaluate the resources that he/she need for science subject content.	0	0	5	39	56	4.51	Strongly Agree
4. can use technology for presenting science subject content.	0	0	5	34	61	4.56	Strongly Agree
5. can use technology tools and resources for managing and communicating information in science subject content.	0	0	4	31	65	4.61	Strongly Agree
Overall				4.55			Strongly Agree

Generally, high means of 4.49 – 4.61 or with an overall mean of 4.55 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "knows about technologies that he/she can use for understanding any science subject contents (Statement 1)," "knows how to use specialized software or websites to research any science topic (Statement 2)," "can locate and evaluate the resources he or she requires for science subjects (Statement 3)," can make use of technology to deliver science knowledge (Statement 4)," and "can manage and communicate information in science subject area using technological tools and resources (Statement 5)."

The students "strong agreement" is similar to the result of the teacher's self-evaluation that the respondents are knowledgeable in all indicators when it comes to technology and content. Teachers employ appropriate technology to aid in the better understanding of the lesson, allowing pupils to grasp concepts more clearly. According to the findings of (Mishra & Koehler, 2006), teachers can effectively select and use technology to assist them in teaching science topics (TCK).

Pedagogical Content Knowledge. Particularly for pedagogical content knowledge, the students rating for science teachers are shown in terms of frequencies and means (Table 14).

Table 14. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Pedagogical Content Knowledge as Rated by the Students (n=100).*

Statement My Science Teacher	Frequencies 1	2	3	4	5	Mean	Description
1. knows how to choose effective teaching tactics in any science subject to guide student thinking and learning.	0	0	7	27	66	4.59	Strongly Agree
2. understands the goals and objectives of any science subject.	0	0	4	33	63	4.59	Strongly Agree
3. able to supervise his or her students' study of science information	0	0	3	52	45	4.42	Strongly Agree
4. knows how to use instructional tactics that are appropriate for any science subject.	0	0	3	34	63	4.60	Strongly Agree
5. knows how and what to assess any science subject content.	0	0	8	47	45	4.37	Strongly Agree
Overall				4.51			Strongly Agree

Generally, high means of 4.37 – 4.60 or with an overall mean of 4.51 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "knows how to select effective teaching approaches to guide student thinking and learning in any science subject content. (Statement 1)," "knows the purposes and objectives for any science subject content. (Statement 2)," "able to manage his/her students' learning about science subject content. (Statement 3)," knows how to use instructional tactics that are appropriate for any science subject (Statement 4)," and "knows how and what to assess any science subject content. (Statement 5)."

The students "strong agreement" is similar to the result of the teacher's self-evaluation that the respondents are knowledgeable in all indicators when it comes to pedagogy and content. Therefore, CK strength was crucial for preparedness to take pedagogic risks in his study (in the context of science education) Fraser (2016). In addition, teachers will gain knowledge into how to teach specific topics in specific ways when they practice their PCK, resulting in improved student understanding Loughran, Berry, and Mulhall (2012).

Furthermore, experienced instructors' understanding of integrating subject and pedagogy is superior to rookie teachers' knowledge since they have had more opportunity to gather this information from actual teaching experiences Friedrichsen et al (2009).

Technological Pedagogical Content Knowledge. Particularly for technological pedagogical content knowledge, the students rating for science teachers are shown in terms of frequencies and means (Table 15).

Table 15. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Technological Pedagogical Content Knowledge as Rated by the Students (n=100).*

Statement	*Frequencies*					*Mean*	*Description*
My Science Teacher	*1*	*2*	*3*	*4*	*5*		
1. can teach lessons that appropriately combine science subject content, technologies and teaching approaches.	0	0	6	46	48	4.42	Strongly Agree
2. can select technologies to use in his/her classroom that enhance what he/she teach, how he/she teach and what students can learn.	0	0	21	35	44	4.23	Strongly Agree
3. can lead others in my school and/or district in coordinating the use of science subject matter, technologies, and instructional styles.	0	0	4	40	56	4.52	Strongly Agree
4. can choose technologies that enhance the learning of science subject content for a lesson.	0	0	4	31	65	4.61	Strongly Agree
5. can evaluate and select new information resources and technological innovations based on their appropriateness to specific tasks in science subject content.	0	0	3	49	48	4.45	Strongly Agree
Overall				4.44			Strongly Agree

Generally, high means of 4.23 – 4.61 or with an overall mean of 4.44 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "can teach lessons that appropriately combine science subject content, technologies and teaching approaches. (Statement 1)," "can select technologies to use in his/her classroom that enhance what he/she teach, how he/she teach and what students can learn. (Statement 2)," "can lead others in my school and/or district in coordinating the use of science subject matter, technologies, and instructional styles (Statement 3)," can select technologies that will aid in the understanding of science topics (Statement 4)," and "can evaluate and select new information resources and technological innovations based on their appropriateness to specific tasks in science subject content. (Statement 5)."

The students "strong agreement" is similar to the result of the teacher's self-evaluation that the respondents are knowledgeable in all indicators when it comes to technology, pedagogy and content. The findings reveal that teachers are using technology, science information, and teaching methods to help students grasp any science idea. Teachers are upbeat and eager to master new skills in order to provide better service to their pupils. However, it contradicts a study (Pelgrum, 2001; Yuen et al., 2008) that claims that low teacher adoption of technology is due to a lack of motivation to use technology in teaching and learning.

Furthermore, this implies that teachers might follow the trend of adopting technologies to aid learning, but that the correct technological tool for a given delivery of mathematical information is not always observed. In other words, they are aware, but they are unable to select the most appropriate technological equipment. This emphasized the importance of being instructors for the twenty-first century, incorporating technology, pedagogy, and topic content into all classroom activities.

The findings contradict Handal's (2013) conclusion that teachers may refuse to use technology, even if it is required or suggested, based on a variety of personal experiences, such as a child's cognitive development, the complexity of the subject, classroom management issues, or simply the pressure of having to deliver a crowded curriculum on a tight schedule. Technology-related learning programs may be implicitly considered as an add-on to the school system's curriculum.

TPCK Results of Teachers as rated by the Administrators

Technological Knowledge. Particularly for technological knowledge, the administrators rating for science teachers are shown in terms of frequencies and means (Table 16).

Generally, high means of 4.60 – 5.00 or with an overall mean of 4.84 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "know how to solve my own technical problems when presenting my lesson. (Statement 1)," "know how to operate google meet (Statement 2)," "know how to use Microsoft Office (Statement 3)," have the technical skills to use technology. (Statement 4)," and "use technology tools to process data (Statement 5)."

Table 16. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Technological Knowledge as Rated by the Administrators (n=5).*

Statement The teacher	Frequencies 1	2	3	4	5	Mean	Description
1. know how to solve my own technical problems when presenting my lesson.	0	0	0	1	4	4.80	Strongly Agree
2. know how to operate google meet	0	0	0	0	5	5.00	Strongly Agree
3. know how to use Microsoft Office.	0	0	0	0	5	5.00	Strongly Agree
4. have the technical skills to use technology.	0	0	0	1	4	4.80	Strongly Agree
5. use technology tools to process data	0	0	0	2	3	4.60	Strongly Agree
Overall			4.84				Strongly Agree

The administrators "strong agreement" is similar to the result of the teacher's self-evaluation and students that the respondents are knowledgeable in all indicators when it comes to technology. These conclusions are supported by a study that shows how technological knowledge is linked to not just the ability to operate technological instruments, but also the understanding of how they work (Mishra & Koehler, 2006). These findings suggest that teachers can effectively use their technological skills to improve student learning while also anticipating future changes.

Pedagogical Knowledge. Particularly for pedagogical knowledge, the administrators rating for science teachers are shown in terms of frequencies and means (Table 17).

Generally, high means of 4.60 – 5.00 or with an overall mean of 4.72 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "use rubrics in assessing his/her student's performance. (Statement 1)," "use video lesson and other resources to support my discussion (Statement 2)," "integrate activities and uses different approaches to make his/her lesson more interesting. (Statement 3)," assess student learning in multiple ways. (Statement 4)," and "can change his/her teaching method to different types of students (Statement 5)."

The administrators "strong agreement" is similar to the result of the teacher's self-evaluation and students that the respondents are knowledgeable in all indicators when it comes to pedagogy. This means that a teacher with strong pedagogical content expertise may break down knowledge into less polished and abstract forms, making it accessible to pupils of diverse cognitive levels Ball (2003).

Table 17. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Pedagogical Knowledge as Rated by the Administrators (n=5).*

Statement The teacher	Frequencies 1	2	3	4	5	Mean	Description
1. use rubrics in assessing his/her student's performance.	0	0	0	1	4	4.80	Strongly Agree
2. use video lesson and other resources to support my discussion.	0	0	0	0	5	5.00	Strongly Agree
3. integrate activities and uses different approaches to make his/her lesson more interesting.	0	0	0	3	2	4.40	Strongly Agree
4. assess student learning in multiple ways.	0	0	0	1	4	4.80	Strongly Agree
5. can change his/her teaching method to different types of students.	0	0	0	2	3	4.60	Strongly Agree
Overall			4.72				Strongly Agree

Content Knowledge. Particularly for content knowledge, the administrators rating for science teachers are shown in terms of frequencies and means (Table 18).

Generally, high means of 4.40 – 5.00 or with an overall mean of 4.80 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "explain the concept of photosynthesis (Statement 1)," "use Punnet square in determining the genetics output. (Statement 2)," "explain the concept on what is the difference of Plant Cell and Animal Cell (Statement 3)," have sufficient knowledge about structure of knowledge in any science subject content. (Statement 4)," and "know the concept and procedure within the science subject content. (Statement 5)."

The administrators "strong agreement" is similar to the result of the teacher's self-evaluation and students that the respondents are knowledgeable in all indicators when it comes to content. These findings indicate that respondents are proficient in all subject indicators, meaning that teachers are aware of and prepared with the essential foundation of science concepts, allowing them to familiarize and grasp science issues. They can also use their expertise of science topics presented in the content, theories, and overall structure of the course to assist students in acquiring scientific knowledge (Mishra & Koehler, 2006).

Table 18. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Content Knowledge as Rated by the Administrators (n=5).*

Statement *The teacher*	*Frequencies* 1	2	3	4	5	*Mean*	*Description*
1. explain the concept of photosynthesis.	0	0	0	0	5	5.00	Strongly Agree
2. use Punnet square in determining the genetics output.	0	0	0	1	4	4.80	Strongly Agree
3. explain the concept on what is the difference of Plant Cell and Animal Cell.	0	0	0	0	5	5.00	Strongly Agree
4. have sufficient knowledge about structure of knowledge in any science subject content.	0	0	0	1	4	4.80	Strongly Agree
5. know the concept and procedure within the science subject content.	0	0	0	3	2	4.40	Strongly Agree
Overall						4.80	Strongly Agree

Technological Pedagogical Knowledge. Particularly for technological pedagogical knowledge, the administrators rating for science teachers are shown in terms of frequencies and means (Table 19).

Generally, high means of 4.60 – 4.80 or with an overall mean of 4.72 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "choose technologies that enhance the teaching approaches for a lesson (Statement 1)," "choose technologies that enhance students' learning for a lesson (Statement 2)," "think critically on how to use technology in his/her classroom. (Statement 3)," adapt the use of the technologies that he/she learning to different teaching activities (Statement 4)," and "use technology tools and information resources to increase productivity (Statement 5)."

The administrators "strong agreement" is similar to the result of the teacher's self-evaluation and students that the respondents are knowledgeable in all indicators when it comes to technology and pedagogy. This illustrates that when scientific teachers use technology tools to develop pedagogical techniques, teaching and learning are reformed, taking into consideration that such knowledge requires awareness of the instruments' limitations and capacities. The TPK is likely to appear stronger because all available technology instruments are targeted to meet the subject's educational aims (Mishra & Koehler, 2006).

Table 19. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Technological Pedagogical Knowledge as Rated by the Administrators (n=5).*

Statement The teacher	*Frequencies* *1*	*2*	*3*	*4*	*5*	*Mean*	*Description*
1. choose technologies that enhance the teaching approaches for a lesson.	0	0	0	1	4	4.80	Strongly Agree
2. choose technologies that enhance students' learning for a lesson.	0	0	0	1	4	4.80	Strongly Agree
3. think critically on how to use technology in his/her classroom.	0	0	0	2	3	4.60	Strongly Agree
4. adapt the use of the technologies that he/she learning to different teaching activities.	0	0	0	2	3	4.60	Strongly Agree
5. use technology tools and information resources to increase productivity.	0	0	0	1	4	4.80	Strongly Agree
Overall						4.72	Strongly Agree

Technological Content Knowledge. Particularly for technological content knowledge, the administrators rating for science teachers are shown in terms of frequencies and means (Table 20).

Generally, high means of 4.40 – 5.00 or with an overall mean of 4.60 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "knows about technologies that can use for understanding any science subject contents. (Statement 1)," "knows how to use specific software or web-sites about any science subject content. (Statement 2)," "find and evaluate the resources that he/she needs for science subject content. (Statement 3)," use technology for presenting science subject content (Statement 4)," and "use technology tools and resources for managing and communicating information in science subject content (Statement 5)."

Table 20. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Technological Pedagogical Knowledge as Rated by the Administrators (n=5).*

Statement *The teacher*	*Frequencies* 1	2	3	4	5	*Mean*	*Description*
1. knows about technologies that can use for understanding any science subject contents.	0	0	0	2	3	4.60	Strongly Agree
2. knows how to use specific software or web-sites about any science subject content.	0	0	0	3	2	4.40	Strongly Agree
3. find and evaluate the resources that he/she needs for science subject content.	0	0	0	2	3	4.60	Strongly Agree
4. use technology for presenting science subject content.	0	0	0	0	5	5.00	Strongly Agree
5. use technology tools and resources for managing and communicating information in science subject content.	0	0	0	3	2	4.40	Strongly Agree
Overall						4.60	Strongly Agree

The administrators "strong agreement" is similar to the result of the teacher's self-evaluation and students that the respondents are knowledgeable in all indicators when it comes to technology and content. The result suggest that the teachers use appropriate technology to help students understand the lesson better, allowing them to grasp topics more clearly. Teachers can effectively pick and employ technology to assist them in teaching science topics, according to (Mishra & Koehler, 2006). (TCK).

Pedagogical Content Knowledge. Particularly for pedagogical content knowledge, the administrators rating for science teachers are shown in terms of frequencies and means (Table 21).

Table 21. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Pedagogical Content Knowledge as Rated by the Administrators (n=5).*

Statement *The teacher*	*Frequencies* 1	2	3	4	5	*Mean*	*Description*
1. knows how to select effective teaching approaches to guide student thinking and learning in any science subject content.	0	0	0	2	3	4.60	Strongly Agree
2. knows the purposes and objectives for any science subject content.	0	0	0	0	5	5.00	Strongly Agree
3. is able to manage his/her students' learning about science subject content.	0	0	0	1	4	4.80	Strongly Agree
4. knows instructional strategies that are suitable for the topic of any science subject content.	0	0	0	3	2	4.40	Strongly Agree
5. knows how and what to assess any science subject content.	0	0	0	0	5	5.00	Strongly Agree
Overall						4.76	Strongly Agree

Generally, high means of 4.40 – 5.00 or with an overall mean of 4.76 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "knows how to select effective teaching approaches to guide student thinking and learning in any science subject content (Statement 1)," "knows the purposes and objectives for any science subject content (Statement 2)," "able to manage his/her students' learning about science subject content (Statement 3)," knows instructional strategies that are suitable for the topic of any science subject content. (Statement 4)," and "knows how and what to assess any science subject content. (Statement 5)."

The administrators "strong agreement" is similar to the result of the teacher's self-evaluation and students that the respondents are knowledgeable in all indicators when it comes to pedagogy and content. Therefore, CK strength was crucial for preparedness to take pedagogic risks in his study (in the context of science education) Fraser (2016). Furthermore, when teachers practice their PCK, they will gain knowledge on how to teach specific topics in specific ways, resulting in improved student understanding Loughran, Berry, and Mulhall (2012).

In addition, experienced instructors' expertise of integrating subject and pedagogy is greater to that of rookie teachers because they have had more

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opportunities to gain this information from actual teaching experiences Friedrichsen et al (2009).

Technological Pedagogical Content Knowledge. Particularly for technological pedagogical content knowledge, the administrators rating for science teachers are shown in terms of frequencies and means (Table 22).

Generally, high means of 4.40 – 5.00 or with an overall mean of 4.60 which is described as to which the respondents "strongly agree" is observed for all the 5 statement indicators. These "strong" indicators include: "teach lessons that appropriately combine science subject content, technologies and teaching approaches. (Statement 1)," "select technologies to use in his/her classroom that enhance what his/her teach, how I teach and what students can learn. (Statement 2)," " provide leadership in helping others to coordinate the use of science subject content, technologies and teaching approaches at his/her school and/or district. (Statement 3)," choose technologies that enhance the learning of science subject content for a lesson (Statement 4)," and "evaluate and select new information resources and technological innovations based on their appropriateness to specific tasks in science subject content (Statement 5)."

Table 22. *Frequencies and Mean Distribution of Public Secondary Science Teachers' Technological Pedagogical Content Knowledge as Rated by the Administrators (n=5).*

Statement The teacher	*Frequencies*					*Mean*	*Description*
	1	*2*	*3*	*4*	*5*		
1. teach lessons that appropriately combine science subject content, technologies and teaching approaches.	0	0	0	3	2	4.00	Strongly Agree
2. select technologies to use in his/her classroom that enhance what his/her teach, how I teach and what students can learn.	0	0	0	1	4	4.40	Strongly Agree
3. provide leadership in helping others to coordinate the use of science subject content, technologies and teaching approaches at his/her school and/or district.	0	0	0	1	4	4.80	Strongly Agree
4. can select technologies that will aid in the understanding of science topics.	0	0	0	1	4	4.80	Strongly Agree
5. evaluate and select new information resources and technological innovations based on their appropriateness to specific tasks in science subject content.	0	0	0	0	5	5.00	Strongly Agree
Overall						4.60	Strongly Agree

The administrators "strong agreement" is similar to the result of the teacher's self-evaluation and students that the respondents are knowledgeable in all indicators when it comes to technology, pedagogy and content. This indicates that the teachers are combining technology, science knowledge, and teaching approaches to assist pupils grasp any science concept. Teachers are enthusiastic and willing to learn new skills in order to better serve their students. It does, however, contradict a study (Pelgrum, 2001; Yuen et al., 2008) that suggests limited teacher adoption of technology is due to a lack of enthusiasm to use it in teaching and learning.

Furthermore, this means that while teachers may follow the trend of using technology to enhance learning, the proper technological tool for delivering mathematical information is not always followed. To put it another way, they are aware, yet unable to choose the most appropriate technological equipment. This highlighted the need of having twenty-first-century instructors who incorporate technology, pedagogy, and topic information into all classroom activities.

In the contrary, teachers may refuse to use technology for a variety of reasons, including a child's cognitive development, the complexity of the subject, classroom management issues, or simply the pressure of having to deliver a crowded curriculum on a tight schedule. Technology-related learning initiatives may be viewed as an afterthought in the school system's curriculum Handal's (2013).

Demographic Profiles and TPCK

The correlations of demographic profiles and TPCK of teachers are shown in the following analysis (Table 23).

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Table 23. *Correlation Results Between Demographic Profile (Age, Sex, Years of Experience, Educational Attainment and Academic Awards) and TPCK of Teachers.*

Independent Variable	*Dependent Variable*	*r value*	*p value*	*Interpretation*	*Decision*
Age	TK	-.305	.204	Not significant	Accept $H_{01}a$
	PK	-.156	.504	Not significant	Accept $H_{01}b$
	CK	-.426	.067	Not significant	Accept $H_{01}c$
	TPK	-.467	.044	Significant	Reject $H_{01}d$
	TCK	-.347	.146	Not Significant	Accept $H_{01}e$
	PCK	-.546	.016	Significant	Reject $H_{01}f$
	TPCK	-.590	.008	Significant	Reject $H_{01}g$
Sex	TK	-.427	.069	Not significant	Accept $H_{01}a$
	PK	.711	.676	Not significant	Accept $H_{01}b$
	CK	-.107	.661	Not significant	Accept $H_{01}c$
	TPK	-.194	.427	Not significant	Accept $H_{01}d$
	TCK	-.384	.105	Not significant	Accept $H_{01}e$
	PCK	.120	.624	Not significant	Accept $H_{01}f$
	TPCK	-.235	.332	Not significant	Accept $H_{01}g$
Years of Experience	TK	-.480	.037	Significant	Reject $H_{01}a$
	CK	-.348	.145	Not significant	Accept $H_{01}b$
	PK	-.407	.084	Not significant	Accept $H_{01}c$
	TPK	-.521	.022	Significant	Reject $H_{01}d$
	TCK	-.318	.185	Not Significant	Accept $H_{01}e$
	PCK	-.514	.024	Significant	Reject $H_{01}f$
	TPCK	-.569	.011	Significant	Reject $H_{01}g$
Educational Attainment	TK	.402	.088	Not significant	Accept $H_{01}a$
	CK	.348	.144	Not significant	Accept $H_{01}b$
	PK	.575	.010	Significant	Reject $H_{01}c$
	TPK	.370	.119	Not significant	Accept $H_{01}d$
	TCK	.342	.152	Not significant	Accept $H_{01}e$
	PCK	.434	.063	Not significant	Accept $H_{01}f$
	TPCK	.377	.112	Not significant	Accept $H_{01}g$
Academic Awards	TK	-.309	.198	Not significant	Accept $H_{01}a$
	CK	-.120	.625	Not significant	Accept $H_{01}b$
	PK	-.130	.596	Not significant	Accept $H_{01}c$
	TPK	-.338	.158	Not significant	Accept $H_{01}d$
	TCK	-.463	.046	Significant	Reject $H_{01}e$
	PC	-.026	.916	Not significant	Accept $H_{01}f$
	TPCK	-.433	.064	Not significant	Accept $H_{01}g$

On age the analysis demonstrate that the age of the Science teachers and their TPK (r = -.467) (p = .044), PCK (r = -.546) (p = .016), and TPCK (r = -.590) (p = .008) are significantly related, respectively. Therefore, HO1 is rejected. However, their age and their TK (p = .204), PK (p = .504), CK (p = .067) and TCK (p = .146) are not significantly related. Age is inversely proportional with TPK, PCK and TPCK. This only means that when the ages rises the TPK, PCK and TPCK decreases. These results support the study of Teo (2008) that Singapore pre-service teachers' attitude for computer use were influenced by their age. This matched research on in-service teachers, revealed that older teachers were less comfortable using computers (Yaghi, 2001). Similarly to the study that the older the teacher the less confident they become in exploring TPACK perceptions for using web-based technology (Lee and Tsai 2010).

On sex and all of their TK, PK, CK, TPK, TCK, PCK and TPCK (p = .069 to .676) are not significantly related and therefore HO1 is accepted. The result opposes the studies of Markauskaite (2006) and Tsai (2008) among Singaporean teachers that male teachers seemed to be more positive than female teachers in their abilities to use computers. Their analysis showed that the male teachers scored higher on TK and CK.

Another study of Cornille (2003) that male teachers in selected secondary schools positively viewed the utilization of ICT in education as a way of reaching social goals contrasted with women's peers. Also the result contradicts the study of Uslo (2018) that gender is an influencing factor of educator technology integration (TCK). An equivalent against Hermans (2018), in which male educators were more likely to integrate technology during a curriculum than female educators.

It also opposes to the study of Altun (2013) that female teachers' CK, PK, PCK and TCK scores were significantly higher than those of the male teachers. Similarly, pre-service teachers studying at computer and instructional technologies education had different TPACK scores based on gender (Karaca 2015).

On year of experience, science teachers and their TK (r = -.480) (p = .037), TPK (r = -.521) (p = .022), PCK (r = -.514) (p = .024), TPCK (r = -.569) (p = .011) are significantly related, respectively. However, their year of experience and PK (p =.145), CK (p = .084), TCK (p = .185) are not significantly related. Years of experience is inversely proportional with TK, TPK and TPCK while directly proportional with PCK. This mean that when the teaching experience of teacher rises their knowledge level decreases in terms of TK, TPK and TCK while their PCK increases.

This result supports the study of Mathews and Guarino (2000), which suggested that the years of teaching would explicitly and indirectly affect the utilization of technology (TK). Aside from that, it is also supported in the study of of Robinson (2003) and Snoeyink et al (2002) that veteran teachers might have fewer technological knowledge and faith to include technology (TCK); thereby restricting incentives in their classrooms to enhance their everyday teaching activities or to pursue new technologies (TPK).

In addition, study by Liang et al (2013) on the association analysis showed that more senior teachers may demonstrate some degree of resistance to technology-integrated teaching environments with education credentials that seemed to have more technology usage experience and ICT incorporation in their teaching environment, respectively within the TK and TPCK scales. Furthermore, experienced instructors tend to have greater content and pedagogical knowledge since the longer they teach, the more content and pedagogical knowledge they can build via their actual teaching experience (Friedrichsen et al. 2009).

On Educational Attainment, TK (p = .088), PK (p = .144), TPK (p = .119), TCK (p = .152), PCK (p = .063) and TPCK (p = .112) were marked as not significant therefore educational attainment has no significant relationship with the above mentioned indicators. On the other hand, CK (r = .575) (p = .010) is the only indicator that has a significant relationship. Educational attainment is directly proportional with CK. This means that once the educational attainment of the teachers increases his/her CK also increases. A teacher who has a masters' or doctorates degree has more content knowledge compared to a bachelor's degree since in masters' degree concepts are being studied properly to have the exact idea of the specific topic.

According to the results, in-service teachers with a master's level of education have higher mean scores in all sub-dimensions of the TPACK than their undergraduate peers in all sub-dimensions. Similarly, according to the limited research literature, in-service teachers with a postgraduate degree of education have higher mean scores than their undergraduate counterparts (Karakaya, 2013). As a result, the research literature backs up the study's findings. This could be related to the type of education provided at the postgraduate level in teacher education. This finding can also be explained in terms of the length of time spent in formal university study. In addition, the higher the level of teacher education, the greater the TPACK mastery. It has been demonstrated that teachers with a master's degree have a higher TPACK mastery score (Khine 2015).

On Academic awards TK (p = .198), PK (p = .625), CK (p = .596), TPK, (p = .158), PCK (p = .916) and TPCK, p = .064) were marked as not significant due to their p - value which is above the level of significance 0.05. Therefore, the above mentioned indicators have no significant relationship towards academic awards. However, TCK (p = .046) is significantly related with the academic awards. This means that a teacher who has the academic awards has the potential of utilizing technology in delivering science content in an effective way compared to those teachers who are just content in the traditional way of teaching.

As a result, those with higher academic self-efficacy can choose a tough task and successfully complete it; they put in more effort, persevere through obstacles, and succeed when faced with big problems. Furthermore, preservice teachers with higher career objectives had strong and positive academic self-efficacy, according to this study. Previous study has shown that academic self-efficacy has a number of implications on student performance. It is also considered an individual variable that has a substantial impact on academic performance. (Chemers et al., 2001; Lent et al., 2008Doménech, 2013; Doménech-Betoret, Gómez-Artiga and Lloret-Segura, 2014).

Furthermore, it was discovered that preservice teachers with better academic self-efficacy had higher university accomplishment. This finding matched the findings of previous studies (Gasco J., Villarroel, 2014).

Comparison of TPCK Result

The significant differences among the ratings of the 3 types of participants are shown in terms of Multiple Analysis of Variance (MANOVA) (Table 24).

Table 24**.** *MANOVA Results on the Significant Difference among the Ratings of the PSST Self-evaluation, Students and Administrators on TPCK.*

Independent Variables	*Dependent Variables*	*Test between Subject Effect*	*F Value*	*p value*	*Interpretation*	*Decision*
Students vs Administrators Teachers vs	TK	-	.837	.594	Not Significant	AcceptH_o2a
	PK	-	3.066	.001	Significant	Reject H_o2b
	-	PK2	-	.003	Significant	Reject H_o2b
	CK	-	1.561	.119	Not Significant	AcceptH_o2c
	TPK	-	.697	.727	Not Significant	AcceptH_o2d
	TCK	-	3.934	.000	Significant	Reject H_o2e
		TCK2	-	.010	Significant	Reject H_o2e
	PCK	-	1.8253	.057	Not Significant	AcceptH_o2f
	TPCK	-	2.333	.012	Significant	Reject H_o2g

The analysis demonstrates that the ratings of the three (3) types of respondents has a significant difference in analyzing the 7 components of TPCK. It is found out that PK (p = .001), PK2 (p = .003), TCK (p = .000), TCK2 (p = .010) and TPCK (p = .012) are significant and therefore HO2 is rejected. However, TK (p = .594), CK (p = .119), TPK (p =.727) and PCK (p = .057), was all marked as not significant.

The result of the 3 types of respondents has a significant difference in TK, TK2, TCK, TCK2 and TPCK. The significant difference among the results can be supported using mean as shown in the bar graph.

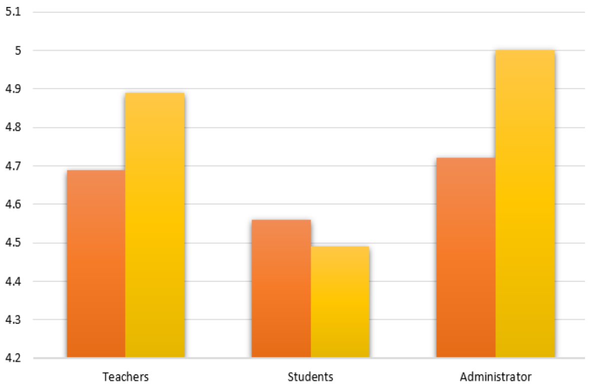

Figure 3. PK and PK2 mean of the 3 types of respondents

Students rating on PK (4.56) and PK2 (4.49) which states that "science teachers' uses video lesson and other resources to support his/her discussion "are the lowest among the ratings while the administrators PK (4.72), PK2 (5.00) are the highest followed by the teachers PK (4.69), PK2 (4.89). This means that the administrators knows better the qualities of their teachers and observed a very satisfactory performance every time they observed their teachers. This only suggest that the observation of students towards their teacher differ from the observation of the administrators. Although the student's ratings are lowest, still it is described as "strongly agree". Therefore, the teachers are still excellent in dealing the science classes with the application of different teaching approaches which will enable the student's participation. These findings are confirmed by the research of Ball (2003), which found that a teacher with high pedagogical content expertise may break down knowledge into less polished and abstract forms, making it accessible to students of various cognitive abilities.

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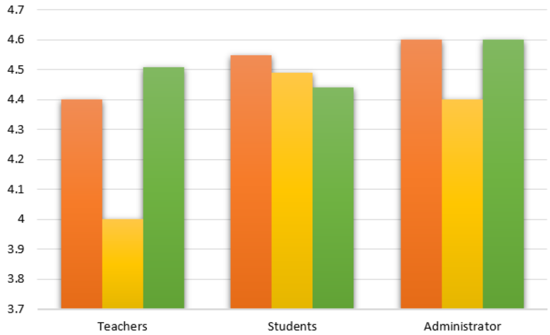

Figure 4. TCK, TCK2 and TPCK mean of the 3 types of respondents

Among the respondents, teacher's self- evaluation obtained the lowest mean in TCK (4.40) particularly in TCK2 (4.00) which states that "Teacher knows how to use specialized tools or websites to research any science topic." This result means that the teachers are still open for room for improvement in TCK although they have better knowledge about this indicator. With these results, administrators can formulate trainings and seminars that are necessary for the development of their teachers in terms of TCK. However, on the students and administrators observation, teachers are demonstrating an integration of technology and content which the respondents described as "strongly agree". This implies that the teachers are capable of integrating technology in a specific content for the better understanding of science concept. Teachers employ appropriate technology to aid in the better understanding of the lesson, allowing students to grasp concepts more clearly and teachers effectively select and use technology to assist them in teaching science topics (TCK) (Mishra & Koehler, 2006).

In terms of TPCK, student's observation towards their teachers obtained the lowest mean of 4.44 among the ratings which described as "strongly agree". As a result, it continues to have a favorable impact on teacher performance. This finding suggests that teachers are still integrating technology, pedagogy, and content in the teaching of science subjects. This also implies that the teachers are interested in incorporating technology into their teaching methods. This contradict with the study of S. Stweart, P. Antonenko, J. S. Robinson, and M. Mwavita, (2013) that if teachers are uninterested in using technology in the classroom, it is doubtful that technology will be implemented, and TCK, TPK, and TPACK will remain low.

Conclusion

Based on the findings, tt is concluded that the teachers are well – equipped with ample knowledge on TK,PK,CK,TPK,TCK,PCK and TPCK based on the students, teachers and administrators perspectives. Generally, the teachers' demographic profile has no remarkable influence on their knowledge level on TK,PK,CK,TPK,TCK,PCK and TPCK. However, the students', teachers and administrators' perspectives mark significant variation pertaining to the teachers' level of knowledge on TPCK. Although they are one in agreement that the teachers are technologically knowledgeable in teaching science.

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