Technological Pedagogical and Content Knowledge (TPACK) of the Pre-service Science Teachers in Caraga Region

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***Abstract:* - TPACK is a dynamic and transactional relationship between content, pedagogy, and technology. It is vital for good teaching with technology to understand the mutual relationship between the three components taken together to create suitable, context-specific, strategies and representations. The purpose of the study is to evaluate the level of technology pedagogy and content knowledge of pre-service science teachers. The respondents were the 428 pre-service science teachers from the different higher education institutions in Caraga Region. Results showed that the overall mean score of the level of technology pedagogy and content knowledge (TPACK) of the pre-service science teachers was low (4.11). Moreover, technological knowledge (TK) obtained the highest mean score of 5.19 while technological pedagogical and content knowledge (TPACK) was the lowest (3.18). It implied that the pre-service science teachers have insufficient training and practice to include technology in their instructions. Further, there are two (2) models that predict the TPACK of the pre-service science teachers namely: (Model 1) TPACK = f(TK) and (Model 2) TPACK = f(TK + PCK). TK influenced the TPACK in model 1 while TK and PCK influenced the TPACK in model 2. TK and PCK showed a positive relationship to TPACK. Hence, to have an effective network between technology, pedagogy, and content in teacher education programs, it is hereby recommended the inclusion of professional development in the curriculum of the preservice teachers through the conduct of capability training and hands-on exposure to acquiring additional knowledge in integrating technology in the classroom instructions within their content areas.**

***Keywords:* education, integration, preservice, teachers, technology, TPACK**

I. INTRODUCTION

Teaching is a complex practice that requires an intertwining of numerous kinds of a specialized body of knowledge. It requires teachers to apply complex knowledge structures across different cases and contexts. Teachers need to continuously change and evolve understanding to practice expertise in an enormously complex and dynamic classroom setting. Teachers also viewed teaching with technology is complicated with the consideration of the challenges brought by the newer technologies (Koehler et al., 2013).

At present, the existence of computer and instructional technologies have played a vital part in every life of individuals through affecting learning and communication. The uses of these technologies have become widespread in the daily lives of the people in general by providing with several advantages and opportunities. It also carries substantial innovations to educators with respective classroom instruction (Sahin 2011).

For the successful integration of technology, it must be rooted mainly to the curriculum content and content-related learning processes and then followed by the understanding of educational technologies (Harris et al.,2009; Harris and Hofer, 2011). The integration of technology in education brought several advantages to the learnings of the students. The students become more interested in the subject when the teachers integrate technology in delivering their lessons to the students (Schrum et al., 2007; Sweeder and Bednar, 2001) thus, increases their performance (Margenum-Leys and Marx, 2002). The more teachers consider ICT as an essential part of the students learning in science, the more the advancement in students' achievements (Kafyulilo, 2010).

Studies showed that the pre-service teachers' way of integrating technology into class instruction is the same way they were taught during their undergraduate course (Kafyulilo, 2010). For the pre-service teachers to be competent in using the technology available in school (Almekhlafi and Almeqdadi, 2010), they need to engage in the hands-on activities that reflect the real teaching with technology to enhance the competency in integrating technology (Kafyulilo, 2010). Pre-service teachers also need to gain the necessary of teaching competence to meet the students' needs during the pre-service education (Zhou, Zhao, Hu, Li and Xing, 2010). Nevertheless, there are some pre-service teachers who failed to do such practice. Because they are neophytes in the field, least experience, and lack self-esteem (Aslan, 2017). Because of this, they are required to have adequate competencies to have competent teaching (Goktas, 2009). Hence, this study attempted to investigate the Technological Pedagogical and Content Knowledge (TPACK) of Pre-Service and In-service Science Teachers in the Caraga Region.

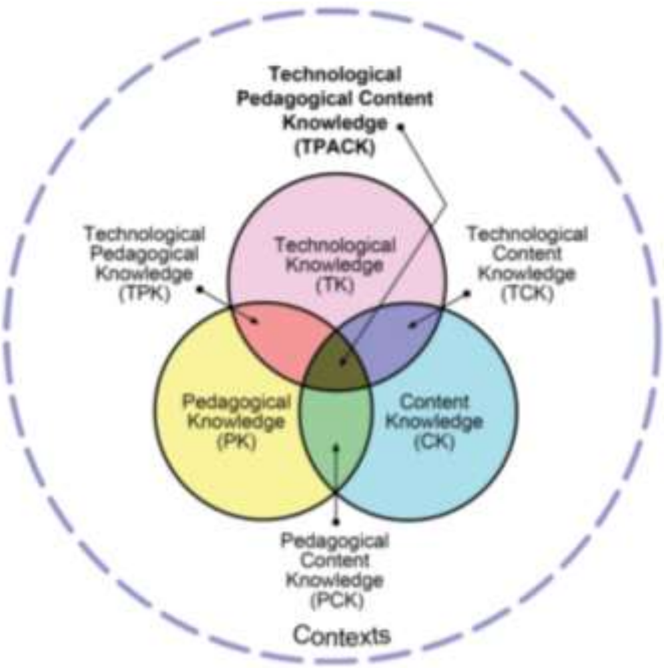

Figure 1: Technological, Pedagogical and Content Knowledge Framework (TPACK) (Mishra and Koehler, 2006)

II. METHODOLOGY

Research Locale

The study was conducted to both public and private higher education institutions in Caraga Region, specifically those institutions offering Bachelor of Secondary Education major in Science/Biology.

Respondents of the Study

The respondents of the study were the 428 Pre-Service Science Teachers from both public and private higher education institutions in Caraga Region. The respondents were chosen through purposive sampling on the criterion that they are currently Pre-Service Science Teachers and taking up Bachelor of Secondary Education major in Science/Biology.

Research Instrument

The questionnaire was composed of two (2) parts: Part 1 comprised the Respondent's Information, and Part 2 comprised of ten (10) questions on each of the seven (7) constructs namely: technological knowledge, pedagogical knowledge, content knowledge, technological content knowledge, technological content knowledge, pedagogical content knowledge, and technological pedagogical and content knowledge.

Data Gathering Procedure

The respondents were asked to answer the questionnaire which was composed of 70 items for 1 and half (1 1/2) hours. After which, the questionnaire was collected, checked, and the scores were recorded.

Statistical Treatment

The following statistical tools were used to analyze and interpret the data:

Mean was used to describe the level of Technological, Pedagogical and Content Knowledge (TPACK) of the respondents along the seven constructs namely: Technological knowledge (TK), Pedagogical knowledge (PK), Content knowledge (CK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), and Technological Pedagogical Content Knowledge (TPACK).

t – test was used to determine if there were significant difference between the level of the Technological, Pedagogical and Content Knowledge (TPACK) of the respondents.

Multiple regression analysis was used to determine which constructs singly or in combination, predict the TPACK of the respondents.

III. RESULTS AND DISCUSSIONS

Table 1. Pre-service Science Teachers' Level of TPACK.

Technological Pedagogical and Content	**Mean**	**Standard**	**Descriptive**
Knowledge (TPACK) Constructs	**Scores**	**Deviation**	**Level**
1. Technological knowledge (TK)	5.19	1.77	Moderate
2. Pedagogical knowledge (PK)	4.70	1.62	Moderate
3. Content knowledge (CK)	3.33	1.70	Low
4. Technological Pedagogical Knowledge (TPK)	4.76	1.74	Moderate
5. Technological Content Knowledge (TCK)	3.32	1.47	Low
6. Pedagogical Content Knowledge (PCK)	4.29	1.92	Low
7. Technological Pedagogical Content Knowledge (TPACK)	3.18	1.55	Low
Overall Mean Score	**4.11**	**1.68**	**Low**

The data in table 1 showed the mean scores of the pre-service science teachers' level of TPACK in the following constructs: Technological knowledge (TK), Pedagogical knowledge (PK), Content knowledge (CK), Technological Pedagogical knowledge (TPK), Technological content knowledge (TCK), Pedagogical content knowledge (PCK) and Technological Pedagogical and Content Knowledge (TPACK).

It is reflected in the above table 1 that the technological knowledge (TK) obtained the highest mean score of 5.19 (SD= 1.77), followed by technological pedagogical knowledge (TPK) with a mean score of 4.76 and SD= 1.74, next is the pedagogical knowledge (PK) with a mean of 4.70 and SD= 1.62, pedagogical content knowledge (PCK) has a mean score of 4.29 and SD of 1.92, content knowledge (CK) with a mean score of 3.33 and SD= 1.70, technological content knowledge (TCK) has a mean score of 3.32 and SD of 1.47 and the lowest is the technological pedagogical and content knowledge (TPACK) which has a mean score of 3.18 with and SD of 1.55. The whole technological pedagogical and content knowledge (TPACK) has a mean score of 4.11 with an SD of 1.55.

Furthermore, table 1 revealed that the overall mean score of the pre-service science teachers in TPACK is low (4.11) which means that the TPACK of the respondents is manifested oftentimes. Moreover, technological knowledge (TK) obtained the highest mean score of 5.19 (moderate) which means it is manifested sometimes to the pre-service science teachers while TPACK construct was the lowest (3.18), interpreted as seldom manifested.

Moreover, only three (3) out of the seven (7) TPACK constructs were rated as moderate namely: TK, PK, and TPK with a mean score of 5.19, 4.70, and 4.76 respectively. It means the these three (3) constructs were manifested sometimes only to the pre-service science teachers. It further implies that the pre-service science teachers are knowledgeable in these constructs. However, the remaining four (4) constructs especially those associated with content such as: content knowledge (CK), technological content knowledge (TCK), pedagogical content knowledge (PCK), and technological pedagogical and content knowledge (TPACK) have a mean score of 3.33, 3.32, 4.29, and 3.18 respectively were rated as low and manifested oftentimes in the pre-service science teachers together with the whole TPACK. It means that the pre-service science teachers are not knowledgeable in these constructs and were not able to deliver the knowledge in a way that can give a better understanding of the students (Ariani, et al., 2014). It implied further that the pre-service science teachers do not have sufficient knowledge about the content of the learning area. The result is somewhat similar to Koehler et al., (2014) that in all the TPACK constructs, pre-service teachers naturally commence with minimal levels. Also, Dong et al. (2015) and Pamuk (2012) also says that the pre-service teachers were less knowledgeable and confident with regards to the application of technology with appropriate pedagogies in representing science concepts. For the reason that they have not yet experience with the school curriculum, and the methods of the courses associated with the teaching of the content. Hence, they have to realize the need to consider technology in partnership with pedagogy and content when integrating technology into their classroom instructions (Koh and Chai, 2011).

However, there are several factors that may affect the development of teachers' TPACK which includes: experiences to use suitable technologies when learning science (Niess et al., 2009); learning environment for technology integration competency (Angeli and Valanides, 2009; Agyei and Voogt, 2012, Gao et al., 2011); lack the essential knowledge and practice to include technology in their instructions (Buckenmeyer and Freitas, 2005; Niess, 2005). The primary reason for having insufficient skills in integrating technology is the lack of training during the undergraduate courses (Angeli and Valanides, 2005; Koehler, Mishra, & Yahya, 2007). Besides, pre-service teachers do not have adequate experience in making tight connections between the TPACK constructs during the practice teaching. Likewise, Chai et al. (2010) found out that pre-service teachers can make better associations between the TPACK constructs after these teachers attended an ICT training course. Thus, pre-service teachers can only appreciate the contributions of the TPACK constructs when these teachers obtain knowledge through ICT integration and methods courses (Koh and Chai, 2011).

Table 2. Prediction Model of the Pre-service Science Teachers' TPACK

Model	Prediction Model	Description
1	TPACK = f(TK)	TPACK is influenced by technological knowledge
2	TPACK = f(TK + PCK)	TPACK is influenced by technological knowledge and pedagogical content knowledge

Table 2 showed that there are two (2) models that can predict the TPACK of the pre-service science teachers namely: TPACK = f(TK) (Model 1) and TPACK = f(TK + PCK) (Model 2). Further, it can be observed in Model 1 that TK (Technological Knowledge) is the predictor of pre-service science teachers' TPACK. on the other hand, model 2 described the relationship between pre-service science teachers' TPACK to their TK (Technological Knowledge) and PCK (Pedagogical Content Knowledge). Moreover, model 2 showed that TPACK is predicted by TK and PCK which means that pre-service science teachers' scores in TPACK was influenced by their TK and PCK scores. It implies that as pre-service science teachers' scores in TK and PCK increases their TPACK scores also increases. The result supports the findings of Koh et al., (2012) on their study about the TPCK perception of the pre-service teachers. They found out that the following constructs namely; TK, PK, TPK, and TCK have positive influenced in their TPCK. Results also infers that when pre-service science teachers gained more knowledge, competencies, and skills through educational trainings and experiences on how to appropriately apply technology in science lessons and aligning science concepts with their chosen pedagogies, the better is their understanding on how to match technology and pedagogy for effective science concept assimilation. Hence, it enables them to make direct connections between basic TPCK knowledge sources and TPCK when they experience the curriculum and teaching practices grow (Chai et at., 2013).

IV. CONCLUSION

Based on the findings of the study, the level of the technological pedagogical and content knowledge (TPACK) of the preservice science teachers is low and manifested oftentimes because of the insufficient training and exposure during their undergraduate courses and during their practice teaching. Further, their TPACK scores is influenced by TK and PCK. Pre-service science teachers may gain knowledge and experiences with a wider range of technologies and more advanced technologies that can support their future role as teachers, and help them understand that technology can be used as a media not only for expression and communication but also for inquiry and instruction. Hence, it is therefore recommended the inclusion of professional development in the curriculum through training and hands-on exposure of the preservice teachers to acquire additional knowledge in integrating technology into their classroom instructions within their content areas. Thus, effective networks between technology, pedagogy, and content in teacher education programs are expected.

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