Teachers' Technological Pedagogical and Content Knowledge (TPACK) and Implementation Capacity for Distance Learning Modalities

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Abstracts: The primary aimed of this study is to determine the teachers' Technological Pedagogical and Content Knowledge (TPACK) and their implementation capacity for distance learning. Specifically, this paper intends to design a capability-building enhancement program for basic education science teachers to implement distance learning. The study used a descriptive-correlational research design involving 35 elementary and high school science teachers from the Southwest District of Bayugan City Division. It employed frequency, percentages, a weighted mean, and Pearson's r for the data analysis. The data revealed that most science teachers had received less training in science and ICT. Compared to other TPACK domains, the participants had the lowest technological knowledge (TK) level regarding digital technologies. There is a highly significant relationship between content knowledge (CK) and the number of relevant training sessions attended in science. Moreover, the data show a highly significant positive relationship between teachers' TPACK and implementation capacity for distance learning ($R=0.476$, $p<0.01$). With the preceding information, the researcher proposed a capacity enhancement program based on the teachers' TPACK level and their ability to put it into practice in distance learning. It intends to soothe primary education teachers' level of TPACK and foster the amplification of skills that suit their diverse professional profiles.

Keywords: basic education, distance learning, implementation capacity, Technological pedagogical and content knowledge (TPACK).

1. INTRODUCTION

Readiness, in this case, means being prepared to shift from F2F to online or distance learning. Gelacio (2020) pointed out that public school teachers utilize ICT. They are confident in their skills in computer applications. Still, they needed further practice and training to offer a purely online strategy for the next few years (Sumande et al., 2016). Sacramento et al. (2021) supports this idea as they elucidated that teacher adapted technology while implementing distance learning. However, they still needed further and in-depth training.

Aside from technological competence, Pasigna and Herrera (2014) also stated that teachers must be content and pedagogically knowledgeable. Teachers must have TPACK to deploy distance learning effectively. Aside from TPACK as a factor that gravely affects educational deliverables, Baticulon et al. (2021) explained that technological, individual, home, institutional, and community constraints are identified barriers to education's success in the Philippines. On top of this, unstable internet connectivity is also a hurdle in public school teachers' ICT use, influencing various factors, notably the use of an internet connection (Alba et al.,2018). Moreover, Lapada et al. (2020) asserted that there need to be more resources, and a scarcity of training and seminars in the field offering distance learning is also becoming a hurdle to education's success.

The start of classes for the school year 2020-2021 took much work, especially among primary education teachers. Distance learning is a new concept for most public schools, and it needs more adequate preparations, posing significant operational issues during implementation. The manifestation of the barriers to education is strongly felt by the teachers during its implementation. Teachers had already experienced difficulties in teaching-learning processes before the pandemic. The challenge doubled when they were directed to conduct various distance learning modes (DL) as students could stay home. At the same time, they could report to school or work from home physically (WFH) under the Alternative Work Arrangement (AWA).

Recognizing the prevalent concerns in the field, this study sought to assess the technological pedagogical content knowledge (TPACK) and teachers' implementation capacity for distance learning in terms of planning and

preparation, teaching/delivery of learning materials and retrieval, and assessment and reporting. The study intends to ascertain teachers' strengths and training needs to determine ways to enhance their strong suits and develop their weak points to uplift quality learning.

Thus, a capacity-enhancement program to align teachers' knowledge on the utilization of technology, pedagogy, and content to make this knowledge relevant to the needs of the time, which can thereby increase proficiency to uplift primary education, is proposed in this study. The study also claims that understanding teachers' competence and needs is necessary to provide them with the appropriate intervention to enhance their skills and boost their morals as agents of knowledge, values, and attitudes during the pandemic.

2. THEORETICAL FRAMEWORK

This study is anchored on the four famous theories namely the TPACK Framework, Experiential Learning Theory, Discovery Learning Theory, and Constructivism Theory. These theories claim that through experiences, a person can learn and gain knowledge and use such for their intended purposes.

The TPACK Framework which Punya Mishra and Matthew J. Koehler wrote the foundational chapter in their book "Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge" in 2006. This framework aims to address the complex, multifaceted, and situated nature of this knowledge while attempting to capture some of the fundamental teacher knowledge qualities necessary for technology integration in teaching. According to McGraw Hill Canada (2020), TPACK is a theory that was created to describe the body of knowledge that teachers need to effectively teach a subject to their students and use technology. The framework builds on Shulman’s construct of Pedagogical Content Knowledge (PCK) to include technology knowledge as situated within the content and pedagogical knowledge (Schmidt, 2009).

Experiential Learning Theory as proposed by John Dewey, Kurt Lewin, and Carl Jung captures the meaning of the quote, "Education is life." It highlights that learning is about the process rather than the outcome. A person can learn and gain knowledge through transforming into regular encounters. It is the result of a mix of comprehending and synthesizing ordinary events. These procedures elicit teachers' understanding and skills (Kolb and Kolb, 2005). When a person appreciates the process, he would love the idea that he discovers it on his own.

A person learns from his or her discovery of the environment due to his inherent curiosity. This is the emphasis of Discovery Learning by Bruner (2000). Teachers can be self-motivated until they resolve any problems when actively involved in their learning and will continually construct their knowledge since, they can learn how to learn. As a result, an upgrade program is a tool for continual education; people are interested in dealing with these and are motivated to study and find answers on their own independent concept gives rise to the growing constructivist theory.

Another interesting theory which is related to Discovery Learning is Bruner's Constructivism theory that focuses on engaging teachers' thinking, allowing them to achieve meaningful learning, more in-depth knowledge, and transfer learning to real-world scenarios. Learners can ask questions, construct hypotheses, and assess their validity under this paradigm. They are given their own knowledge and understanding rather recording information presented by others. These chances are tactics that set the tone for knowledge construction through predominantly social learning processes that allow students to develop their understanding through interactions with peers and teachers (Applefield et al., 2000).

Constructivism Theory further suggests that people construct understanding and meaning based on past information and experiences. Learning is an active process in which perception is formed by and molded by experience. This approach enables teachers to develop their understanding based on their own experiences, extending these concepts to new situations, and integrating new information received through pre-existing intellectual structures (Berns & Erickson, 2001).

Experiential learning, discovery learning, and constructivism all point out that when a person such as in this case a teacher is given a chance to appreciate the learning process through training and practice and he is able to get a chance to experience them on his own, he will be able to learn many things from it and he will be able to use it for personal and professional purposes.

3. METHODOLOGY

This study employed a descriptive-correlational research design utilizing the survey technique to assess the level of Technological Pedagogical and Content Knowledge (TPACK) among basic education science teachers. Additionally, it aimed to investigate the significant relationship between teachers' TPACK, professional profiles, and their capacity to implement distance learning in the field of basic education science. The research was conducted in the Division of Bayugan City Southwest District, which is in the CARAGA region in the northeastern part of the province of Agusan del Sur. The Southwest District of Bayugan City Division comprises five elementary schools and one public high school. The researcher gathered and utilized existing data from this office regarding the total number of teachers handling science.

To collect the necessary data and information, the study employed a questionnaire composed of three parts: Teachers' Educational Profile (Part I), Level of Teachers' Technological Pedagogical Content Knowledge (Part II), and Teachers' Implementation Capacity for Distance Learning Modality (Part III). The questionnaire for teachers' profile included items on educational attainment, teaching experience (number of years in teaching), and the number of trainings attended (in science and ICT-related topics).

To determine the level of teachers' Technological Pedagogical and Content Knowledge (TPACK), the study adapted a validated newly developed short assessment questionnaire for TPACK. This questionnaire was adapted from the constructed questionnaire of Schmid et al. (2020), which aims to measure TPACK of teachers. Initially, it consisted of 28 TPACK items on a 5-point Likert scale, scored from 1 (Not at All) to 5 (Complete). To align with the study's objectives, the researcher added one item in each domain, resulting in a total of 35 questions. Additionally, one open-ended question was included for each TPACK domain.

For assessing teachers' implementation capacity for distance learning, a researcher-developed questionnaire was utilized. This questionnaire was validated by educational experts and consisted of 10 questions each for planning and preparation, teaching/delivery of web-based learning activities and retrieval, and assessment and reporting. The questions were rated on a 5-point Likert scale, ranging from 1 (Never) to 5 (Always).

All administered instruments underwent validity and reliability tests. The validity test confirmed the instruments' design as valid, while the reliability test confirmed their reliability. Reliability was assessed using Cronbach's Alpha and McDonald's Omega, resulting in strong internal reliability with values of 0.949 and 0.955, respectively.

The collected data were organized, tabulated, and subjected to statistical analysis. The following statistical tests were employed, as presented in Table 2:

Frequency counts and percentage composition: Used to determine the teachers' profile in terms of highest educational attainment, teaching experience, and the number of science and ICT training. This analysis involved nominal and categorical data. Weighted mean: Utilized to determine the level of teachers' TPACK across its seven domains (TK, PK, CK, TPK, PCK, TCK, and TPACK). It was also used to assess teachers' implementation capacity for distance learning in terms of curriculum planning and preparation, teaching/delivery of web-based learning activities and retrieval, and assessment and feedback.

This analysis addressed problem number three (3). Pearson's r: Employed to determine the correlation between TPACK and teachers' professional profiles, as well as between TPACK and teachers' ability to apply distance learning. This analysis was conducted to address problem number four (4).

4. RESULTS AND DISCUSSION

As shown in Table 1, the teachers' educational attainment in Bayugan City Division Southwest District reveals that most of the teachers are graduates of education with bachelor's Degrees programs (97.14%). The findings also showed that a high number of the science teachers were Master Unit-earners with complete academic requirements (CAR) specializing in educational management (45.71%). This implies that teachers give importance to their profession by pursuing advanced study.

The data above was supported by Goldhaber and Brewer (2000) wherein he claims that a teacher with a master's and doctorate has a statistically significant positive impact on student's achievement relative to teachers with no advanced degrees.

Table 1. Frequency Distribution of Teacher's Professional Profile In Terms of Highest Educational Attainment, Number of Years of Teaching Experience, Number of Relevant Training Attended in Science and Information and Communication Technology (ICT).

Indicators		Interpretation	Frequency (F)	Percentage (%)
Educational Attainment				
Bachelor	Education courses	below average	34	97.14
	Non-education graduates with certificate in Teaching	below average	1	2.86
Masters	Pursued Science Education Graduate course (with units)	Average	3	8.56
	Pursued Science Education Graduate course (CAR)	Average	2	5.71
	Pursued Educational Management course (w/ units)	Average	11	31.43
	Pursued Educational Management course (CAR)	Average	16	45.71
	No Master units earned	Below average	2	5.71
	Masters Degree graduate	above average	1	2.86
	with units in a Doctoral Degree	High average	0	0
	Doctoral Degree graduate	Very high ave.	0	0
Teaching Experience				
0-5 years		Beginner	5	14.28
6-10 years		Developing	7	20

11-15 years	Experienced	6	17.14
16-20 years	Expert	7	20
More than 20 years	Distinguished	8	22.86
Relevant Trainings attended in Science			
5 times or below	needs immediate training	31	88.57
6-10 times	needs further training	3	8.57
11-15 times	moderately trained	1	2.86
16-20 times	adequately trained	0	0
21- above times	highly trained	0	0
Relevant Trainings attended in ICT			
5 times – below	needs immediate training	33	94.28
6-10 times	needs further training	1	2.86
11-15 times	moderately trained	1	2.86
16-20 times	adequately trained	0	0
21- above times	highly trained	0	0

Moreover, it can also be gleaned that there was only one moderately trained teacher in both science and ICT in the Southwest District (2.86%). Based on the data, there are no highly trained in science and ICT in the Southwest District which would help in honing beginners and developing teachers in the profession through mentoring and peer coaching.

According to the data gathered, some common purposes of these training are Workshop on Cross Specialization in Teaching Science in Early Grades. While in ICT, a school-based learning action cell (LAC) was conducted to train most teachers. These training courses were initiated in response to the implementation of the Enhanced Basic Education Act of 2013. They were oriented on the reforms, especially on the features of the k to 12 curriculum that includes contextualization and localization of the curriculum.

In view of the claims above, Boudersa (2016) concluded in her study programs for teachers' training and professional development are of central importance in any educational institution, be it in primary, middle, high school, or even at the tertiary level. Teachers need to be trained regularly if they are to change their teaching beliefs, attitudes, and daily practices in the classroom.

Tables 2 to 5 present the seven domains of teachers' level of competence namely: TK, PK, CK, TPK, PCK, TCK, and TPACK respectively.

In domain 1, which is Technological Knowledge in terms of the ability to use tools or technology resources showed that the teachers have a neutral result with an overall mean of 3.45 which has an interpretation equivalent to “moderate”. The first strand in Domain 1 (TK) which is the ability to easily manipulate new technologies has the highest mean (3.71). However, the ability to solve technical problems with the computer (strand 5) has the lowest mean (2.94). By this indicator, teachers showed not enough mastery in using digital resources fixation.

Moreover, it is also acknowledged that teachers' use of technology is crucial for students' participation in society and future jobs (UNESCO 2011). However, domain 1 Strand 5 indicates that not all teachers know how to troubleshoot technology during an alternative delivery mode of distance learning that was implemented by the Department of Education. If Bayugan City Division will have the full implementation of online distance modality, most of the teachers may have trouble in their online classes. According to Winter (2021) that those teachers who have high technological capacity have been found to have at ease in online learning compared to those who are unaware of these online platforms.

The lack of training in ICT skills is the result of the lack of opportunity to attend ICT training for all teachers in basic education. Most of the conducted training was facilitated by the school ICT coordinator who echoed the training/ workshop attended in division level.

On the other hand, the teacher's Pedagogical Knowledge (PK) in terms of science curriculum provides a good result with an overall mean of 3.80 which has an interpretation of “high”. Adapting teaching based on what students currently understand or do not understand (Strand 1) has the highest mean (3.94). During the pre-pandemic time, the teachers were already skilled in teaching diverse learners. But here came the pandemic that stopped what the teachers were regularly doing in managing science classes in distance learning modality (Strand 5) has the lowest mean (3.71).

Table 2. Teachers’ Level of Technological Knowledge (TK) in Terms of Digital Technologies (Computers, Tablets, Mobile Phones, Internet, ETC.) and Teachers’ Pedagogical Knowledge (PK) in Teaching Science.

	Indicators	**Mean**	**Verbal Description**	**Interpretation**
	Domain 1. Technological Knowledge (TK)			
1	I can easily manipulate new technologies.	3.71	Agree	High
2	I frequently play around with new technology.	3.63	Agree	High
3	I know about a lot of different technologies.	3.40	Neutral	Moderate
4	I have the technical skills I need to use technology.	3.60	Agree	High
5	I can solve a technical problem with the computer.	2.94	Neutral	Moderate
Total Weighted Mean		3.45	Neutral	Moderate
	Domain 2. Pedagogical Knowledge (PK)			
1	I can adapt my teaching based upon what students currently understand or do not understand.	3.94	Agree	High
2	I can adapt my teaching style to different learners.	3.80	Agree	High
3	I can use a wide range of teaching approaches in a	3.83	Agree	High

	classroom setting.			
4	I can assess student learning in multiple ways.	3.74	Agree	High
5	I can manage my science class in distance learning modality.	3.71	Agree	High
Total Weighted Mean		3.80	Agree	High

The low level of TK maybe influenced by the age as more than 42% have higher age teachers teaching 16 years in service or more. Age is cited as a significant TK-influencing factor in Castera et al.'s (2020) study of the various TPACK in six (6) Asian and European countries. In comparison to the three older groups, the 30-39-year-old teachers' group had a higher significant Technology score.

Pedagogical knowledge of teachers in the implementation of ADM during pandemic time was not enforced if the school has adapted printed modular mode. However, teachers were called to craft printed-modular lessons as authors/writers in designing an alternative delivery mode (ADM) selecting only the most essential learning competencies (MELC) in the K to 12 curricula. The teaching strategies were already integrated into the module. As most of the teachers in distance learning with printed modular instruction were relying on the material, individual teachers cannot manifest the deep knowledge about how teaching is done in DL. However, in online classes, Vikas and Mathur (2022) suggested that teachers must become ready for the new normal by employing the appropriate pedagogical tools to set up a successful online classroom.

Moreover, in research done by Sun and Chen (2016) on the success of online learning, the authors claim that it depends on well-designed course materials, qualified teachers, motivated interactions between the teachers and their students, and quick technical improvement. Yet, most of the teachers were lacking the necessary ICT and pedagogical training to engage in online teaching and learning (Tsegay et al, 2022).

Based on the results, the teachers' content knowledge (CK) has a "high" interpretation with a mean of 3.61. Although teachers in basic education, especially in elementary, do not have a specialization of any subject that they can teach science even without becoming an expert, their CK may be developed and or enhanced in attending training and or pursuing a master's degree related to science.

Table 3. Teachers' Content Knowledge (CK) in Relation to Science Subjects and Technological Pedagogical Knowledge (TPK).

Indicators		**Mean**	**Verbal Description**	**Interpretation**
Domain 3. Content Knowledge (CK)				
1	I have sufficient knowledge about the science subjects	3.66	Agree	High
2	I can use a science-specific way of thinking in my science subject.	3.57	Agree	High
3	I know the basic theories and concepts in science	3.63	Agree	High
4	I know the history and development of important theories in science	3.57	Agree	High
5	I can develop class activities and projects in science	3.66	Agree	High
Total Weighted Mean		3.61	Agree	High

Domain 4. Technological Pedagogical Knowledge (TPK)				
1	I can choose technologies that enhance the teaching approaches for a lesson.	3.80	Agree	High
2	I can choose technologies that enhance students' learning for a lesson.	3.97	Agree	High
3	I can adapt the use of technologies that I am learning about to different teaching activities.	4.00	Agree	High
4	I am thinking critically about how to use technology in my classroom.	3.89	Agree	High
5	I evaluate the appropriateness of a new technology for teaching and learning.	3.97	Agree	High

While training and workshops in science were not readily available during the onset of the COVID-19 pandemic, teachers were able to enrich their knowledge in science by browsing the internet. Moreover, 85.71% of high school teachers in Southwest District pursued science education master's degree graduate courses.

Thus, it relates to the study conducted by Goldenberg et al. (2015) which states that useful application of knowledge plays a vital role in making science meaningful to learn. This enables teachers to demonstrate an accurate and in-depth understanding of the concepts to satisfy the needs of the learners.

According to Khan, Cooper, and Bethea (2003) that if the teacher knows more about concepts in different fields in science, the students learn more also according to the review. This is because the teacher cannot give what she does not have. So, it is vital for the teacher to know the content of the subject taught.

Technological Pedagogical Knowledge (TPK) of teachers has a total mean of 3.92 which shows that most of the teachers have "a high" interpretation of using technology in terms of teaching. This knowledge of teachers is required to effectively use technology in the classroom especially in online classes delivery mode. In the interview of teachers, they were asked how knowledge in technology connects them with their learners in the type of distance modality that was implemented in school.

The study of Capahay and Anoba (2021) showed a significant positive correlation between teachers' intentions to continue teaching and their level of TPK self-efficacy. As the teachers resume to use technology in the teaching-learning process, its TPK will increase. Due to this, the study offers recommendations for the continued use of technology in Philippine classrooms.

In online classes, knowledge is inevitable to effectively deliver the lessons. Even so, in printed ADM, social media like Facebook Messenger helped teachers associate the learners especially if they have queries or concerns. However, most of our learners, especially in grade 7, do not have gadgets and internet connectivity. As a result, it is very difficult for the teachers to connect with them.

In teachers' PCK, the data reveals that it had a total weighted mean of 3.76 which is interpreted as "high". This indicator determined that teachers' PCK has developed over time with the length of experience, as most elementary teachers in Bayugan City southwest district have rendered more than 10 years' service. For that reason, teachers may be able to teach even without the use of technology although technology was inevitable as used to conduct online classes during distance learning.

According to the research done by Goldenberg et al. (2015), teachers should carefully choose tasks that make students work hard and give students the support they require without lowering the cognitive demands of the work or providing them with excessive assistance. More diverse topics, tools, designs, and methodologies appear to be used in PCK research on science and math teachers (Tuitof, 2019). Because of this, it would seem worthwhile to use different tools, designs, and research techniques to learn more about PCK and how it develops.

Based on the results, the TCK of teachers' total weighted mean of 3.54 with a total interpretation of "High". The results also imply that teachers were able to use the technology to teach science lessons. This domain may not be applicable to schools in which ADM is printed modules as there are not enough resources available for the learners during the DL. Because of that, the Weekly Home Learning Plan (WHLP) was given to students as their guide, being attached to modules on what they are expected to accomplish in each week.

Table 4. Teachers' Level of Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK) AND Technological Pedagogical Content Knowledge.

	Indicators	**Mean**	**Verbal Description**	**Interpretation**
Domain 5. Pedagogical Content Knowledge (PCK)				
1	I know how to select effective teaching approaches to guide student thinking and learning in my teaching subject	3.69	Agree	High
2	I know how to develop appropriate tasks to promote students complex thinking of my teaching subject	3.69	Agree	High
3	I know how to develop exercises with which students can consolidate their knowledge of my teaching subject.	3.66	Agree	High
4	I know how to evaluate students' performance in my teaching subject.	3.83	Agree	High
5	I make connections between science and other subjects.	3.94	Agree	High
Total Weighted Mean		3.76	Agree	High
Domain 6. Technological Content Knowledge (TCK)				
1	I know how technological developments have changed the field of my subject.	3.60	Agree	High
2	I can explain which technologies have been used in research in my field.	3.49	Neutral	Moderate
3	I know which new technologies are currently being developed in the field of my subject.	3.46	Neutral	Moderate
4	I know how to use technologies to participate in scientific discourse in my field.	3.60	Agree	High
5	I develop class activities and projects involving use of instructional technologies.	3.57	Agree	High

Total Weighted Mean		3.54	Agree	High
Domain 7. Technological Pedagogical and Content Knowledge (TPACK)				
1	I can use strategies that combine content, technologies, and teaching approaches that I learned in training.	3.69	Agree	High
2	I can choose technologies that enhance the content for a lesson.	3.71	Agree	High
3	I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn.	3.86	Agree	High
4	I can teach lessons that appropriately combine my teaching subject, technologies, and teaching approaches.	3.74	Agree	High
5	I can teach science subjects with different instructional strategies and computer applications	3.69	Agree	High
Total Weighted Mean		3.73	Agree	High

Besides, the teacher needs to undergo some training and seminars to enhance their skills and knowledge of the science competencies on the utilization of appropriate technological devices as an aid to science teaching. This result implied that there was a limited use and application that resulted in “moderate” interpretation due to some limited resources of the devices like computers and LCD projectors that are supposed to be used by the teachers.

Although the Department of Education implemented the computerization program in which every school was provided a set of computers to be utilized by the teachers and integrated into their lessons by using these technologies, these computers do not accommodate the number of students in each school.

The teachers' TPACK in the Bayugan City Division Southwest District had an interpretation of “high” with an overall mean of 3.73. This indicator determined the teachers’ ability to integrate technology, pedagogy and content in teaching science was evident during the onset of the COVID-19 pandemic. It showed there was an acknowledgement of technology in the classroom although the latter has the barrier in implementing the effective teaching of science content.

According to the study of Li et al. (2022) between the elementary school group and the high school group, there were significant differences in CK, TCK, and TPACK. That is, the teachers in the high school group scored higher on average for these three domains. This may be because the teachers in elementary are generalists when they are assigned to teach different subjects. Also, the teaching material and student characteristics are different for teachers in these two teaching stages, which may have contributed to the differences. Anent to this, it's still necessary to enhance teachers' TPACK considering less exposure to ICT training and many teachers struggle on online teaching (Fuad et al., 2020).

Furthermore, it can be gleaned in the study of Istiningsih (2022) that TPACK has been helpful to teachers during the pandemic times in resolving problems that occur during online learning activities and providing learning assessment values that are appropriate for their students' skills and learning performance. As a result of these implications, schools must offer more efficient and professionally focused ICT support and training to enhance teacher proficiency and prepare vocational students for a digital future. The government can consider the need for ICT integration in educational curriculum design to improve teachers' TPACK skills in light of the digital revolution.

Table 5 presents the teacher's curriculum planning in science subjects during the implementation of DL.

As browsed from the table, the actual level of curriculum planning of distance learning and its preparation with a total mean of 3.50 which has the interpretation of "High". The lowest mean is about the curriculum preparation needed to teach science in distance learning and the highest mean is collegial support is useful in the implementation of distance learning in school. The result means that although science curriculum planning is demanding, collegial support helps facilitate the successful implementation of DL.

Because all the schools in the southwest district have implemented printed modular learning modality with only one online class, teachers were not having difficulties in curriculum planning as to what to teach in science because the WLAS were available for DL use.

Also, based on the result, the teachers needed preparation of science curriculum to implement DL such as learner's modules, which was very challenging during the onset of the COVID-19 pandemic. The progress of the preparation of the curriculum was made as the teachers were assigned as writers/ authors of these WLAS while the beginning of the school year 2020-2021 was moved to October instead of June.

Table 5. Teachers' Extent of Curriculum Planning and Preparation for Distance Learning Modality.

Indicators		**Mean**	**Verbal Description**	**Interpretation**
1	I am well-versed in science teaching methodologies that have been shown to be effective in distant learning.	3.54	Agree	High
2	I am well-equipped with skills in digital technologies needed in teaching via distance learning	3.40	Neutral	Moderate
3	I am aware of alternate methods for teaching scientific concepts in order to promote student learning in distance learning modality in our school.	3.63	Agree	High
4	I have immediate access to materials and resources needed to implement distance learning.	3.74	Agree	High
5	The curriculum preparation needed to teach science in distance learning is unchallenging.	2.97	Neutral	Moderate
6	I create varied and scaffolded scientific teaching and learning sequences to meet the requirements of all students.	3.40	Neutral	Moderate
7	I have the capacity to further my scientific education.	3.63	Agree	High
8	There is enough time in preparation to teach science via distance learning.	3.40	Neutral	Moderate
9	I work in groups to ensure that curriculum implementation, pedagogical methods, and assessment methodologies are aligned throughout the school.	3.49	Neutral	Moderate
10	Collegial support is useful in implementation of distance learning in our school.	3.83	Agree	High

Total Weighted Mean	3.50	Agree	High

Basic education teachers, as shown in the results, assert that to address learners' needs especially in science curriculum planning, it needs time to scaffold the curriculum in DL having a "moderate" interpretation. But because science WLAS was not readily available in the division, we teachers have borrowed a soft copy from another region and or other division in Caraga Region and reproduced it to supply the need in DL.

Table 6 shows the teachers' extent of teaching /delivery of WLAs and retrieval for distance learning modality.

Table 6. Teachers' Extent of Teaching /Delivery of WLAS and Retrieval for Distance Learning Modality.

Indicators		**Mean**	**Verbal Description**	**Interpretation**
1	I have the knowledge and skills in technology that I utilized in the implementation of distance learning (DL).	3.71	Agree	High
2	I have no difficulty in terms of teaching strategies to meet the learning requirements of my learners in distance learning modality.	3.43	Neutral	Moderate
3	I make my own instructional material based on WLAS in Science.	3.26	Neutral	Moderate
4	I can easily design science performance tasks for the learners in DL.	3.43	Neutral	Moderate
5	I supply on time the adequate teaching / learning resources that are appropriate for our school's distance learning approach.	3.57	Agree	High
6	I ensure that delivery of science lesson to learners is effective even in distance learning modality	3.71	Agree	High
7	I've built a network of communication among stakeholders, such as parents, to provide assistance at home.	3.89	Agree	High
8	I answer promptly to student inquiries and queries in conversations.	3.89	Agree	High
9	I establish deadlines for the submission of learning output that are appropriate for the learners.	3.94	Agree	High
10	I examine the submission of outputs of module or weekly learning activity sheets (WLAS) of my learners on a continuous basis	3.91	Agree	High
Total Weighted Mean		3.67	Agree	High

As displayed in the table, during the teaching of science lessons in pandemic time, teachers demonstrated competence in the delivery of DL with a total mean of 3.67 which has the interpretation of "high" level. The lowest means is making instructional material based on WLAS in Science (3.26) and the highest mean is establishing deadlines for the submission of learning output that are appropriate for the learners (3.94). This indicates that teachers find it hard to make their own instructional materials as it takes time and effort, but they are still regarding the submission of outputs during DL and reminded the students of the submission.

The online platforms that the teachers used and found to be helpful during the pandemic time are Messenger in Facebook and Google Meet. These online tools were used to contact students in both online classes and in the printed modular mode of delivery.

It only conveys that teachers were able to deliver lessons in printed modular form as ADM. However, the implementation of online distance learning with regards to the skills to implement, the availability of resources were the concerns of teachers as the curriculum preparation needed to teach science in distance learning is challenging. Also, in online classes, time has to do with the operative planning and preparation of DL.

The data in Table VII below disclose that teachers' assessment and feedback in the implementation of DL has a total weighted mean of 4.1 with a "high" interpretation. As teachers have a high level of TPACK during DL implementation, there is a possibility that teachers used an appropriate assessment in evaluating students' performance to diagnose their learning. However, the fact that this school district used a distance learning modality that was primarily printed modules did not imply that teachers were able to effectively provide assessment feedback during DL. Niss (1993) stated in his study that assessment was a crucial issue in the teaching and learning of Science and one that requires careful consideration by teachers and preservice teachers alike.

Table 7. Teachers' Extent of Assessment & Feedback for Distance Learning Modality.

Indicators		**Mean**	**Verbal Description**	**Interpretation**
1	I determine what proof is required to demonstrate a student's knowledge in the subject.	3.77	Agree	High
2	I utilize formative assessment to track and help students as they work toward their learning objectives.	4.09	Agree	High
3	In performance tasks, I choose, arrange, and employ sound assessment on a routine basis	3.83	Agree	High
4	For performance tasks, I give rubrics for evaluation.	4.09	Agree	High
5	I check and record my students' output on a regular basis.	5.03	Agree	High
6	I assessed the effectiveness of my teaching by looking at the outcomes of my learners.	4.17	Agree	High
7	In terms of curriculum preparation, teaching, and assessment, I reflect and offer feedback to stakeholders.	3.91	Agree	High
8	I provide feedback on learners' performance to help improve learning outcomes.	4.14	Agree	High

9	I call the attention of learners or parents of learners who have no output or lack of output in the weekly learning activity sheets (WLAS).	4.20	Agree	High
10	I give parents progress reports on their children to track their learning outcomes.	4.31	Agree	High
Total Weighted Mean		4.1	Agree	High

Giving students feedback helps them take control of their education and develop confidence in their skills (Bain, 2004; Ferlazzo, 2015, as cited in Johnson, 2017). During the COVID-19 pandemic, it was clear that most of the parents submitted their children's work (young children were not permitted to attend school), and teachers followed ups and feedback to students who didn't submit their subject requirements by the due date.

A test on the significant association between teachers' professional profile and TPACK yields the following results: overall, data do not provide sufficient evidence to show the relationship between teachers' professional profile and level of TPACK as we can see in Table 10 that overall p-value is above the 0.05 level of significance. This suggests that the highest level of education and the number of years of experience are irrelevant in the teacher's TPACK. However, the following significant results were obtained: first, there is a highly significant relationship between Content Knowledge (C) and the number of relevant trainings attended in Science (M); that is, the p-value is 0.002 which is below the 0.05 level of significance set for analysis. Thus, the null hypothesis is rejected.

Table 8. Relationship between Teachers' Technological Pedagogical Content Knowledge and Professional Profile.

Professional Profile	**Stat**	**Level of TPACK**							**Overall**
		TK	**PK**	**CK**	**TPK**	**PCK**	**TCK**	**TPACK**	
Highest Educational Attainment (K)	R-coeff	-0.253	-0.136	-0.112	0.144	0.022	-0.145	-0.062	-0.017
	p-value	0.142	0.436	0.520	0.409	0.902	0.405	0.722	0.906
Number of Years in Teaching Science (L)	R-coeff	-0.241	-0.256	-0.014	-0.012	-0.057	-0.151	0.006	0.036
	p-value	0.162	0.138	0.937	0.946	0.745	0.387	0.972	0.782
Number of Relevant Trainings Attended in Science (M)	R-coeff	0.205	-0.011	0.508	0.165	0.151	0.096	0.170	0.212
	p-value	0.238	0.948	0.002**	0.343	0.388	0.583	0.330	0.091
Number of Relevant Trainings Attended in ICT (N)	R-coeff	0.430	0.067	0.106	-0.037	-0.004	-0.001	0.071	0.094
	p-value	0.010**	0.702	0.546	0.834	0.981	0.995	0.684	0.453

The results suggest that with an increase in the number of exposures to training in science or teaching science, without specialization they handled almost all subjects will be an increase in the content knowledge of novice teachers. Because most of the participants are elementary teachers who are generalists, that is, they may be able to teach all subjects, often in different grade levels, the opportunity to attend science training is low since only the science coordinator in school is most likely to be sent to attend the training.

Therefore, continuing professional development and/or in-service teachers' training in the discipline is needed and must be provided to all basic teachers in order to effectively teach the content of science (Avalos, 1995).

Second, there is a highly significant relationship between Technology Knowledge (TK) and number of relevant trainings attended in ICT (N); that is, the data provide sufficient evidence that the p-value is 0.010 which is below the 0.05 level of significance set for analysis. The correlation is supported by the study of Zhao (2003) that providing teachers with training will persuade them that technology will benefit them and will learn how to integrate technology in the proper way from this.

The foregoing results imply that the data provided evidence to reject the null hypothesis which anticipates that there is no significant relationship between the teachers' level of technological, pedagogical, and content knowledge (TPACK) and teachers' professional profile.

The increase of training attended in ICT is also an increase of TK. Continuing professional development essentially ensures that they continue to be proficient and competent in their profession while also furnishing them with essential skills that could help you progress with your career. This implies that there is a need for training of teachers related to ICT to deliver lessons in distance learning. Gallagher (2018) and Mishra, Koehler, and Henriksen (2011) reveal that the knowledge society considers teacher preparation (as cited by Batanero et al., 2020) to be one of the most important aspects of a great education, not only raising their level of knowledge but also via the combination of pedagogy and technology.

Table 9 presents the results of the correlation analysis on the relationship between teachers' Technological Pedagogical Content Knowledge and the implementation capacity of distance learning.

Table 9. Relationship between Teachers' Technological Pedagogical Content Knowledge and Implementation Capacity of Distance Learning.

Teachers' Implementation Capacity in DL	**Stat**	**Level of TPACK**						
		TK	**PK**	**CK**	**TPK**	**PCK**	**TCK**	**TPACK**
Curriculum Planning and Preparation	R-coeff	0.503	0.454	0.527	0.464	0.627	0.521	0.446
	p-value	0.002**	0.006**	0.001**	0.005	< .001**	0.001**	0.007**
Teaching /Delivery of WLAs and Retrieval	R-coeff	0.572	0.404	0.485	0.460	0.552	0.561	0.546
	p-value	< .001**	0.016*	0.003**	0.005**	< .001**	< .001**	< .001**
Assessment & Feedback	R-coeff	0.296	0.257	0.179	0.411	0.326	0.183	0.304

	p-value	0.084	0.136	0.302	0.014*	0.056	0.293	0.076
Overall	R-coeff							0.476**
	p-value							<0.01

It can be gleaned from the data overall that do provide sufficient evidence to show there is a highly significant positive relationship between teacher's TPACK and implementation capacity of distance learning ($R=0.476$, $p<0.01$). In particular, this significant relationship is shown to be evident based on the following significant results obtained: First, there is a highly significant relationship between TPACK parameters and the teacher's implementation capacity of distance learning in terms of Curriculum Planning and Preparation, Teaching /Delivery of WLAs and Retrieval, that is, the data provide that the p- value is below the 0.05 level of significance set for analysis.

Few of the academic functions of a teacher in the ODL System according to Gunawardena and Mcisaac (2013) are curriculum development coordinator, self-directed learning design, course writer, media facilitator, course editor which enable them to plan for the curriculum for DL. Some teachers were chosen to write the weekly activity sheets and modules for the printed modular mode of delivery, allowing teachers to put their TPACK to use during the COVID-19 pandemic apparently. Because without these abilities, teachers who are also authors are unable to develop educational materials (Davidson, 2017).

Second, though Assessment and Feedback do not show a significant relationship with TPACK, some parameters like Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical and Content Knowledge (TPACK) provide evidence of the desired relationship. Thus, the null hypothesis that "there is no significant relationship between the teachers' level of technological, pedagogical, and content knowledge (TPCK) and Implementation capacity for distance learning in basic education science" is rejected.

In the study of Rahman et al. (2022) reveal that there were many problems and challenges in terms of assessment for students learning in distance learning such as the physical distance. The teachers in modular mode will only base on the written output of the students which sometimes may be the work of parents or another close individual. Because of that, the assessments for learning during the COVID-19 pandemic are not taken as reliable by the teachers in printed modular. Also, the basic education teachers have no difficulty in constructing assessments in this mode as this is already in the printed module. Thus, this may explain why the assessment for learning and feedback is not correlated in teachers' TPACK.

An increase in TPACK of science teachers implies an increase in the implementation capacity particularly in curriculum planning and teaching delivery and retrieval of WLAS. Continuing professional development and/or in-service teachers' training in the discipline is necessary to equip the teachers with the needed skills for them to be proficient and competent in their profession. These results suggest more data or evidence may be needed to show this desired relation; that is, assessment and feedback may be needed in the implementation of distance learning; hence, more strategies may be devised to make this distance learning implementation more meaningful.

5. CONCLUSIONS

Based on the findings of the study, the following conclusions were drawn:

In terms of teacher's characteristics, it can be concluded that the teachers give importance to their profession by pursuing graduate study. Moreover, most of the teachers were experienced and developed and most of them are hired after more than ten years in service. Furthermore, most of the participants have not attended enough relevant

training in science and ICT. They needed further training that will help them enhance their skills in science and in ICT. Based on the data, there are no highly trained science teachers in the district that may help hone their skills in science as well as ICT.

In the seven (7) domains of TPACK, TK is the only one of the seven domains with a moderate level of interpretation; the other six all have high levels. In general, the teachers' TPACK of Bayugan City Southwest District is high as most of them are in DepEd for more than ten years of service but not developed enough skills in technological knowledge (TK) in terms of digital technologies (computers, tablets, mobile phones, internet, etc.)

On the implementation capacity of distance learning, basic education science teachers are competent enough to implement DL as most schools in the district have implemented printed modular alternative delivery mode during the onset of COVID-19 pandemic. On assessment and feedback during the distance learning modalities, teachers contributed in their own way.

It is strongly advised that teachers take part in ICT training to improve their knowledge, abilities, and skills related to distance learning modalities. There are fewer teachers with high TK because of less ICT training. The more ICT training will increase TK. Therefore, reject the null hypothesis and accept the alternative hypothesis that TPACK is related to teachers' professional profiles.

An increase in TPACK of science teachers implies an increase in the implementation capacity particularly in curriculum planning and teaching delivery and retrieval of WLAS. Though teachers' experience and exposure as practitioners on the field naturally improve his/her competence, they must be provided with sufficient training and workshops to help improve their competence in the implementation of DL.

Lastly, the design for the teachers' enhancement program should be considered in continuing professional development, essentially ensuring that they continue to be proficient and competent in their profession while also furnishing them with essential skills that could help implement DL.

Conflict of Interest

The author declares no conflict of interest.

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