Initiation of a professional development program for science instructional leaders within the technological pedagogical content knowledge (TPACK) framework

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ABSTRACT

Knowledge related to the effective use of educational technologies has become widely recognized as an important aspect of an educator's knowledge-based for the 21st century. The study sought to assess and measure the perception of elementary teachers handling science in Pasay City on their understanding of the Technological Pedagogical Content Knowledge (TPACK) framework and its related constructs. It also aimed to find out how science teachers used technology in general. Surveys, focus group discussions, and strengths, weaknesses, opportunities, and threats (SWOT) analysis methods were used to gather data. Thematic analysis was also used to interpret the responses qualitatively. For triangulation purposes, master teachers and science coordinators were also involved in the data gathering. Among the subscales of TPACK, science teachers' pedagogical knowledge (PK) garnered the highest mean (3.48), while technological knowledge (TK) obtained the lowest mean (3.17). Technological pedagogical knowledge (TPK) had a very strong positive relationship (r = 0.854), while TK was strongly correlated (r = 0.631) to overall TPACK. The overall TPACK and other TPACK subscales are found to have a significant relationship. As revealed in the FGD, science teachers frequently used ICT tools to explore, elaborate or demonstrate a concept to pupils to further their understanding. However, some of the teachers claimed that their level of confidence in using ICT tools did not meet the required skills. This resulted in a proposed professional development program focusing on the three features of the TPACK framework: pedagogy, technology, and content.

Keywords: focal group discussion, ICT, individual performance commitment and review form, SWOT analysis, triangulation

INTRODUCTION

Knowledge related to the effective use of educational technologies has become widely recognized as an important aspect of an educator's knowledge-based for the 21st Century. The integration of information and communication technology (ICT) in classrooms has been a challenge for the educational system that aims to address the needs and demands of the 21st century (Yousef Mai and Hamzah 2016). To fully cope up with these challenges, the educational system must continue to improve and develop. For this reason, there is a worldwide trend toward producing teachers with high teaching competency specifically in Science Education. To help science teachers to become competent facilitators of learning, the use of technologies in teaching a specific content in the classroom context, the epistemology of technological pedagogical content knowledge (TPACK) is used as a basis for designing a particular arrangement of courses for science teacher education programs to meet the needs of the 21st-century teacher education development (Mercado et al. 2019).

Specifically, teachers are urged to plan various teaching materials that instill creativity and important thinking among learners through ICT, Department of Education (DepEd) Secretary Leonor Magtolis Briones said. During the recent National DepEd ICT Summit, Briones underscored the essentials of integrating ICT in both teaching and governance for the delivery of quality, accessible and relevant basic education for Filipino learners (Montemayor 2018). Further, research studies showed that ICT motivates student learning, there are numerous assumptions that students have an interest in using ICT; they found it more pleasant, more appealing, and more motivating to review with ICT tools than by traditional means (Yousef Mai and Hamzah 2016). In addition, ICT gives assistance and complementary support for both teachers and students when it comes to effective learning with the use of computers as learning aids (Ghavifekr and Rosdy 2015). Abdullahi (2014) stressed that higher level thinking, problem solving, improved communication skills, and a thorough comprehension of the learning tools and concepts to be taught are all enhanced by ICT.

It also ensures the creation of a more effective interactive learning environment through the application of a learner-centered and activity-oriented approach to teaching and learning.

However, teacher's resistance to technology integration and utilization is still evident in several studies. Many factors influence the teacher's rejection of new technology as proposed by Mac Callum et al. (2014). First, the teachers' beliefs about the perceived value of the new technology "usefulness" and the perceived effort needed to learn to use the new technology "ease of use". Second influential factor is the teachers' skills in using and integrating digital technology into their teaching "digital literacy". Another reason for resistance to technology integration is the teacher's self-efficacy beliefs about their level of competence and their attitudes towards technology adoption. Lastly, ICT anxiety is considered by a teacher to experience a level of uneasiness over his/her impending use of ICT.

In addition to these factors, the impact of technology is also of paramount concern. DepEd Secretary Briones said in her speech during the launch of *"*Sulong Edukalidad*"*, "The standards of education quality are even made more challenging by technology." She also cited Professor Schwab, the Founder and Executive Chairman of the World Economic Forum, who said that a revolution is happening immediately, which is fundamentally changing the way we live – whether we are conscious of it or not (Briones 2019).

Given the foregoing discussions, the researchers embarked on a study with the question "What Professional Development Program is recommended that will help science teachers enhance their technological, pedagogical, and content knowledge (TPACK)?". More specific, the study aimed to answer the following questions: 1. To what level do science teachers possess the following TPACK subscales as assessed by themselves, by their master teachers, and by their peers specifically in technological knowledge (TK), content knowledge (CK), pedagogical knowledge (PK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), and technological pedagogical content knowledge (TPACK)? 2. How significant is the relationship between reported scores for the TPACK subscales and overall TPACK? and 3. How do Science teachers use technology in teaching?

METHODS

Research Design

This study used a descriptive type of research whereby the proponents presented the holistic view of how TPACK can be of significant influence and benefit to the teachers with mixed-method research procedures that were predicated on data interpretation using both qualitative and quantitative approaches.

The research utilized a quantitative approach whereby data is generated from a large sample whilst the second aim needed an in-depth interview and Focal Group Discussion (FGD) of the actual practices of science teachers with technology in their classroom and documentary analysis via Individual Performance Commitment and Review Form. This endeavor utilized the descriptive-correlational type of research since it is the appropriate method to determine the relationship among the sub-constructs of TPACK and overall TPACK of teachers handling science. On the other hand, a thematic analysis was done to document the responses of the respondents qualitatively.

Study Site and Respondents

The research was conducted in a public elementary school in the Division of City Schools of Pasay, one of the city schools in the National Capital Region of the Philippines.

A total of 224 science teachers were chosen purposively as the respondents to determine their level of TPACK and their level of practice in using technology in their classrooms. They were chosen as respondents because, according to Mercado (2019), these teachers have direct exposure to ICT integration and utilization in their teaching episodes. Likewise, master teachers and science coordinators were included to assess the TPACK of the science teachers to substantiate the quantitative results of this study. Since master teachers conduct class observation, science coordinators were tasked with overseeing and providing technical assistance to these teachers.

All science teachers were included as respondents, except those that were involved during the pilot testing of survey questions. This study did not consider the profiling of science teachers, like years of teaching experience and the like. This was intentionally done to fully discern the outcomes, effects, influences, and impact of having a sound TPACK of these teachers towards the assigned subject they are handling.

Research Instrument

The proponents used two-pronged approaches in carrying out this research. The first part was to quantitatively assess the level of understanding of teachers handling science on the seven TPACK sub-constructs, which include objectives 1 and 2. A survey was given to the respondents to determine this goal. The forms were structured using dichotomous and likert-scale based questions to properly give a numerical rating to the attributes of TPACK that are deemed to benefit the teachers based on their level of understanding. This TPACK survey was adapted with permission from the questionnaire developed and utilized by Owusu (2014) in New Zealand.

Furthermore, a FGD was used as the second part to determine the more intrinsic answers of the respondents. To formally study the locale, the researchers asked permission from the division involved. After the approval was given, the schools under study were duly notified by the researchers to properly inform the teachers of their rights to join in the said group discussion. The proponents also asked experts in the field to validate the questionnaires and FGD plot guide. The questionnaires underwent language and content validation to ensure quality assurance of the conciseness and alignment of the questions. The validators consisted of two language teachers and three science experts – an education program supervisor and a department heads.

The FGD was done in two sessions, dividing the participants into two groups to give every participant ample time to share or discuss his or her thoughts and elicit good responses from the other participants on a certain topic. Meanwhile, for the documentary analysis, the researchers asked the FGD participants to voluntarily submit a copy of their Individual Performance Commitment and Review Form (IPCRF). The data was analyzed by looking into the scores of the participants. The ratings for each objective of the IPCRF were recorded and interpreted.

Moreover, strengths, weaknesses, opportunities, and threats (SWOT) analysis was also used to determine the strengths, weaknesses, opportunities, and threats that were revealed in the study in both quantitative and qualitative results. The result of this analysis would serve as a baseline for the creation of the professional development program.

Data Analysis

The study used the traditional tables and charts to present the knowledge level of science teachers in all TPACK subscales. Furthermore, to provide for basic data interpretation in terms of the varied and collective relationship of TPACK with the respondents based on the latter's profile, mean ratings, and standard deviation were used. A Pearson *r* correlation analysis was used to test the null hypothesis that there is no significant relationship between the overall TPACK and other TPACK subscales. The proponent used SPSS software to analyze the data.

For the qualitative portion, the researchers meticulously transcribed each response given by the selected sample group. The responses from the focal group discussion were analyzed narratively. Information gathered was arranged into categories or themes and analyzed thematically as suggested by Riessman (2008). In this study, the narratives were written with minimal interpretation.

RESULTS

Degree of Science Teachers' TPACK Subscales

Technological knowledge (TK). All remarks had "Agree" adjectival ratings, indicating that the teachers are proficient in their TK (Table 1). The greatest weighted mean (± sd) was 3.29 ± 0.521 for statement 1, while the lowest was 3.04 ± 0.586 for statement 7. One FGD participant stated that there was a fear of employing technology. According to the teacher, he lacked confidence in his ability to use such ICT tools, which hampered his ability to use technology.

Content knowledge (CK). The teachers were also competent in terms of CK (overall mean (± sd) of 3.42 ± 0.353 and adjectival rating of Agree) which signifies that science teachers are competent (Table 2). The Statement 1 obtained the highest mean (± sd) which is 3.55 ± 0.498 with an adjectival rating of "Strongly Agree", while Statement 8 got the lowest mean (± sd) of 3.28 ± 0.468 and an adjectival rating of "Agree".

Pedagogical knowledge (PK). The data for the total PK of Science teachers as determined by the three groups (Table 3). The highest mean (± sd) of 3.52 ± 0.518, with an adjectival rating of "Strongly Agree," was reached by statement 6. As a result of this finding, science teachers are extremely skilled at developing and maintaining classroom management that is appropriate for a wide range of students. On the other hand, Statement 1 "assessing student performance in a classroom" had the lowest mean (±sd) of 3.39 ± 0.501, with an adjectival rating of "Agree."

Technological content knowledge (TCK). Teachers were competent in terms of TCK (overall mean of 3.38 ± 0.401 and adjectival rating of Agree) as shown in Table 4. Statement 3 received the highest mean (±sd) of 3.45 ± 0.156 while statement 6 got the lowest with a mean (±sd) of 3.28 ± 0.507.

Technological pedagogical knowledge (TPK). The science teachers are competent in terms of TPK where all statements had "Agree" as adjectival ratings (Table 5). They are competent in deciding what technologies are appropriate for their teaching as reflected by statement 2 having the highest mean (±sd) of 3.42 ± 0.529, while statement 5 garnered the lowest mean (3.26 ± 0.480).

Pedagogical content knowledge (PCK). Statement 1 had the greatest mean (±sd) of 3.48 ± 0.535, and an adjectival rating of "Agree," according to the data in Table 6. This indicates that teachers are capable of selecting effective techniques that help students think and learn about the subject matter. On

Table 1. Technological knowledge of science teachers in a public elementary school in the Division of City School of Pasay.

Statement	Mean	Standard deviation (±sd)	Adjectival Rating	Interpretation
1. having the technical skills I need to use technologies	3.29	0.521	Agree	Competent
2. knowing about a lot of different technologies	3.19	0.483	Agree	Competent
3. keeping up with important new technologies	3.27	0.544	Agree	Competent
4. learning to use new software on my own	3.21	2.083	Agree	Competent
5. having sufficient opportunities to work with a range of technologies	3.13	0.538	Agree	Competent
6. installing a new program that I would like to use	3.06	0.511	Agree	Competent
7. solving my technical problems of technologies	3.04	0.586	Agree	Competent
Overall	**3.17**	**0.498**	**Agree**	**Competent**

Table 2. Content knowledge of science teachers in a public elementary school in the Division of City School of Pasay.

Statement	Mean	Standard deviation (±sd)	Adjectival Rating	Interpretation
1. sufficient knowledge about the subject I teach	3.55	0.498	Strongly Agree	Highly Competent
2. various ways and strategies of developing my understanding of the subject I teach	3.45	0.507	Agree	Competent
3. a deep and wide knowledge of the subject that I teach	3.47	0.526	Agree	Competent
4. planning the scope and sequence of concepts that need to be taught within my class	3.46	0.509	Agree	Competent
5. various examples of how my subject matter applies in the real world	3.44	0.515	Agree	Competent
6. the scientific way of thinking	3.36	0.491	Agree	Competent
7. good knowledge of the Nature of Science (NOS)	3.37	0.502	Agree	Competent
8. up-to-date resources and developments in my subject area	3.28	0.468	Agree	Competent
Overall	**3.42**	**0.353**	**Agree**	**Competent**

Table 3. Pedagogical knowledge of science teachers in a public elementary school in the Division of City School of Pasay.

Statement	Mean	Standard deviation (±sd)	Adjectival Rating	Interpretation
1. assessing learner performance in a classroom	3.39	0.501	Agree	Competent
2. adapting my teaching based upon what learners currently understand or do not understand	3.50	0.510	Strongly Agree	Highly Competent
3. adapting my teaching style to cater to diverse learners.	3.43	0.505	Agree	Competent
4. using a wide range of teaching approaches in a classroom setting	3.42	0.522	Agree	Competent
5. using different assessment tools and techniques	3.44	0.515	Agree	Competent
6. organizing and maintaining classroom management	3.52	0.518	Strongly Agree	Highly Competent
7. determining the strategy best suited for the lessons I teach	3.50	0.510	Strongly Agree	Highly Competent
8. preparing lesson plans for the various topics I teach	3.50	0.501	Strongly Agree	Highly Competent
Overall	**3.48**	**0.385**	**Agree**	**Competent**

Table 4. Technological content knowledge of science teachers in a public elementary school in the Division of City School of Pasay.

Statement	Mean	Standard deviation (±sd)	Adjectival Rating	Interpretation
1. understanding technologies that I can use for teaching specific concepts in my subject matter	3.42	0.520	Agree	Competent
2. knowing how my subject matter can be represented by the application of technology	3.40	0.500	Agree	Competent
3. knowing about technologies that I can use for enhancing the understanding of specific concepts in my subject matter	3.45	0.516	Agree	Competent
4. using technological representations (i.e. multimedia, visual demonstrations, etc.) to demonstrate specific concepts in my subject matter	3.44	0.557	Agree	Competent
5. using various types of technologies to deliver the content of my subject matter	3.33	0.549	Agree	Competent
6. using technology to make students observe a phenomenon that would otherwise be difficult to observe in my subject matter	3.28	0.507	Agree	Competent
7. using technology to create and manipulate models of scientific phenomenon (e.g. animations, modeling, etc)	3.33	0.558	Agree	Competent
Overall	**3.38**	**0.401**	**Agree**	**Competent**

Table 5. Technological pedagogical knowledge of science teachers in a public elementary school in the Division of City School of Pasay.

Statement	Mean	Standard deviation (±sd)	Adjectival Rating	Interpretation
1. choosing technologies that enhance the teaching approaches for a lesson	3.37	0.511	Agree	Competent
2. choosing technologies that are appropriate for my teaching	3.42	0.529	Agree	Competent
3. choosing technologies that enhance learners' learning of a concept	3.36	0.526	Agree	Competent
4. applying technologies to different teaching activities	3.36	0.533	Agree	Competent
5. managing a technology-rich classroom effectively	3.26	0.480	Agree	Competent
6. using technology to help assess pupil learning	3.29	0.517	Agree	Competent
7. using technology to actively engage learners in teaching and learning.	3.31	0.551	Agree	Competent
Overall	**3.34**	**0.401**	**Agree**	**Competent**

the other hand, Statement 8 had the lowest mean of 3.34 ± 0.493 and an adjectival rating of "Agree." Surprisingly, teachers were also competent in terms of their total PCK with weighted mean of 3.41 and an adjectival rating of "Agree".

Technological pedagogical content knowledge (TPACK). The total mean (±sd) is 3.33 ± 0.395 and an adjectival rating of "Agree," indicating that teachers are proficient in their TPACK (Table 7). The greatest weighted mean (± sd) was 3.37 ± 0.511 for statement 1, while the lowest were 3.31 for statements 2, 3 and 4.

Relationship Between Overall TPACK and TPACK Subscales.

The relationship between overall TPACK and other TPACK subscales of science instructional leaders is exhibited in Table 8. It should be noted that the correlation coefficients for all TPACK subscales ranged from 0.631 to 0.854, indicating a strong to very strong link when compared to total TPACK. TPK had a strong positive association (0.854) with overall TPACK, while TK had a high positive relationship (0.631). The null hypothesis that there is no significant link between total technological pedagogical content knowledge (TPACK) and other TPACK subscales is thus rejected because the *P*-value, which is 0.000 in all subscales, is lower than the given level of significance (0.05).

Use of Technology in Teaching Science

The participants in the focal group discussion (FGD) indicated that they regularly used technology to support the teaching and the learning of their pupils. All the teachers used ICT tools frequently to explore, elaborate or demonstrate a concept to pupils to further their understanding. Again, the teachers frequently allowed their pupils to observe images through ICT tools and most of them regularly used presentational software to deliver content material to pupils. They asserted that it brought higher pupil engagement, facilitated better pupil's understanding of concepts and provided avenues for pupils' out of learning and continuous learning.

DISCUSSION

Level of Science Teacher's Technological Pedagogical and Content Knowledge (TPACK)

As revealed in the study, pedagogical knowledge had the highest mean, similar to the findings made by Yousef Mai and Hamzah (2016), where primary science teachers perceived higher self-confidence in PK in general. This describes those science teachers who are competent in the processes and practices of teaching and learning. It includes knowledge about classroom management and organization; curricular analysis and planning; and student learning (Roig-Vila et al. 2015). This is followed by CK and PCK.

Meanwhile, TK obtained the lowest mean, followed by TPACK. Roig-Vila et al. (2015) underscored that TK encompasses knowledge about diverse technologies, evolving from low-tech technologies like paper and pencils to digital technologies such as the use of the internet, digital video, interactive whiteboards, and others. This is like the findings made by Roig-Vila et al. (2015), where they discovered that teachers are more competent in terms of their PK and CK as compared to their TK. Furthermore, the teacher's TK does not meet or satisfy the ICT integration into their teaching episodes. In contrast, Yousef Mai and Hamzah (2016) revealed in their study that science teachers had higher TK than the other TPACK subscales. Further, Blau et al. (2016) ascertained that professors' TK had significantly improved after using phenomenological research techniques and addressed in terms of TPACK and "digital wisdom" approaches. Only moderate links between technology and pedagogy, as well as technology and content, were discovered.

With regards to the overall TK of science instructional leaders, it was realized that they are competent when it comes to using technologies because they possess the technical skills they need, while "solving my technical problems with technologies" got the lowest weighted mean. One respondent in the FGD narrated that there was fear of using technology in the teaching episodes.

Table 6. Pedagogical content knowledge of science teachers in a public elementary school in the Division of City School of Pasay.

Statement	Mean	Standard deviation (±sd)	Adjectival Rating	Interpretation
1. selecting effective teaching approaches to guide learner thinking and learning in my subject matter	3.48	0.535	Agree	Competent
2. producing lesson plans with a good understanding of the topic in my subject matter	3.44	0.524	Agree	Competent
3. anticipating learner misconceptions within a particular topic	3.38	0.514	Agree	Competent
4. assisting learners in identifying connections between various concepts in my subject matter	3.38	0.495	Agree	Competent
5. distinguishing between correct and incorrect problem-solving attempts by students in my class	3.40	0.543	Agree	Competent
6. familiarizing with common learner understandings and misconceptions in my subject matter	3.39	0.507	Agree	Competent
7. meeting the objectives described in my lesson plans	3.42	0.521	Agree	Competent
8. targeting aspects of the Nature of Science when teaching explicitly	3.34	0.493	Agree	Competent
Overall	**3.41**	**0.381**	**Agree**	**Competent**

Table 7. Technological pedagogical content knowledge of science teachers in a public elementary school in the Division of City School of Pasay.

Statement	Mean	Standard deviation (±sd)	Adjectival Rating	Interpretation
1. teaching lessons that appropriately combine my subject matter, technologies, and teaching approaches	3.37	0.511	Agree	Competent
2. selecting technologies to use in my classroom that enhance what I teach, how I teach, and what students learn	3.31	0.502	Agree	Competent
3. using technology to create effective representations of content that departs from textbook approaches	3.31	0.518	Agree	Competent
4. using technology to facilitate scientific inquiry in the classroom	3.31	0.545	Agree	Competent
5. finding and using online materials that effectively demonstrate a specific scientific principle	3.33	0.550	Agree	Competent
6. choosing technologies that enhance the understanding of the content for a lesson	3.32	0.512	Agree	Competent
7. providing leadership in helping others to coordinate the use of content, technologies, and teaching approaches at my school	3.36	0.517	Agree	Competent
8. using strategies that combine content, technologies, and teaching approaches in my classroom	3.32	0.505	Agree	Competent
Overall	**3.33**	**0.395**	**Agree**	**Competent**

Table 8. Relationship between the science teachers' overall technological pedagogical and content knowledge and TPACK subscales.

Variables	N	Correlation Coefficient	Significant value	Strength of Relationship	Interpretation
TPACK*TK	224	0.631	0.000	Strong	Significant
TPACK*CK	224	0.732	0.000	Strong	Significant
TPACK*PK	224	0.773	0.000	Strong	Significant
TPACK*PCK	224	0.740	0.000	Strong	Significant
TPACK*TCK	224	0.831	0.000	Very strong	Significant
TPACK*TPK	224	0.854	0.000	Very strong	Significant
TPACK*TPCK	224	0.820	0.000	Very strong	Significant

Science teachers, on the other hand, were highly competitive concerning their knowledge of the subject they teach in terms of the overall CK. This is true of what Jauss (2002), posited that science teachers are expected to have mastery over the subject they teach. Further, it was also evident in the findings of Yousef Mai and Hamzah (2016) that claimed that science teachers were competent in applying science concepts as presented in the content, and theories for students to gain scientific knowledge.

In terms of the PK, science teachers should adopt various ways of assessing learner performance to address the diversity of learners. This supports the suggestion of Tanner (2018) that teachers should be able to understand how students construct knowledge and learn, as well as have appropriate and varied ways of assessing students.

Accordingly, science teachers are competent in understanding the technologies to be used for deepening learners' knowledge of specific concepts. This finding was supported by Neiss (2012) who found that teachers are required to have a comprehensive understanding of students' thinking and learning processes with the presence of digital technologies in their teaching for a particular subject matter.

Regarding the TPK, science teachers are competent in choosing and deciding what technologies are appropriate for their teaching. As Mishra and Koehler (2009) have mentioned, teachers should realize that the technology they want to use does affect their teaching approaches, methods, and design. This claim was also evident during the FGD, where teachers mentioned that using technology should match the curriculum. Conversely, Statement 5 ("managing a technology-rich classroom effectively") clearly reveals that science teachers should organize and maintain an atmosphere where technology integration inside the classroom is well used. Kurt (2018) emphasized the use of ICT effectively and more frequently to solicit the utmost interest and interaction among the students.

It could be noted from the findings that teachers are competent in terms of their TK, PK, and CK. However, looking into some of the indicators mentioned in the results, teachers' competence needs to be addressed, especially in their TK. This means that science teachers must equip themselves with the ability to solve technical problems in technology on their own. Gonzales (2018) found that respondents struggle to come up with laboratory activities and lack knowledge about manipulating technical problems when using technology. In addition, by definition, technology is a tool that encourages and supports independent learning (Gonzales 2018).

Relationship Between Overall TPACK and TPACK Subscales

The overall TPACK is related to other TPACK subscales. This only shows that teachers should always consider the complex relationship among the TPACK constructs to empower them in the technology utilization that centers on student learning and fosters and develops inquiry learning among students, as Chai et al. (2013) mentioned. Likewise, Yousef Mai and Hamzah (2016) believe that TPACK is the knowledge expected of teachers to integrate technology into their teaching and content area. This means that those teachers are competent in delivering lessons that suitably consider the subject matter, technologies, and teaching approaches. But teachers must consider the appropriateness of a certain technology before using it to enhance the delivery of the lesson, understanding of concepts, and development of scientific inquiry among learners. It is then highly recommended for the elementary science teachers to be recalibrated and undergo upskilling through professional development programs and participate in such training, particularly in terms of integrating technology into content and pedagogy. Professional development can start before a teacher even begins teaching in the classroom and can go until the conclusion of a teacher's career, according to Luft and Hewson (2014).

A professional development program was formulated based on the TPACK framework, focusing on its three features: pedagogy, content, and technology. This proposal is in response to and for the realization of the goals and objectives of DepEd's "Sulong Edukalidad," an educational reform program aimed at achieving quality in basic education for young Filipinos. One of its four key reform areas is the upskilling and reskilling of the teachers. Thus, this professional development program is strongly proposed.

This proposed development program aims to provide fervent support to science teachers in enhancing instructional competence through the TPACK framework. It also seeks to capacitate science teachers towards quality instruction through effective ICT integration. Moreover, it also aims to recommend sound solutions that will improve instructional competence and will boost teachers' high morale in teaching science where content, pedagogy, and technology are given focus. It has three key areas of concern: technology, pedagogy, and content. It consists of four sub-areas: ICT integration in teaching the subject matter, responsive solutions to technical problems, assessment of learning, methods of teaching and learning, classroom management and subject matter, and teacher's learning resources.

This professional development program can be implemented after it receives approval from the school division office through the recommendation of the education program supervisor in science. The supervisor in-charge is tasked with disseminating the program's objectives to all elementary school principals. Then, these principals will implement this development program in their designated schools. Since each school is now conducting its own learning action cell (LAC) session, school principals will spearhead the activity through their Science Coordinators as the focal person. Only those training or activities that require specialist teachers or ICT instructors to assist colleagues will be undertaken by the school learning action cell.

At the school level, a monthly monitoring tool will be completed by the school principals and will be submitted to the supervisor in-charge. This monitoring tool focuses on the impact of a certain training or activity on science teachers.

To strengthen its implementation, a division-wide LAC will be conducted for all science teachers. This can be done in off-session episodes. All training or activities that need resource speakers will only be conducted through this mode—the division learning action cell (DLAC).

One finding that supports this claim was the study conducted by Angeli and Ioannou (2015), where teachers were taught how to think about the pedagogical affordances of different computer technologies and how to use them to make the computer science curriculum more understandable to learners during a 15-hour teacher professional development program. Teachers also learn how to think iteratively about technology, content, and pedagogy in order to create learning activities that are appropriate for the conceptual ecology of their students. The study shows instructors' real instructional artifacts as they developed from their involvement in the teacher professional development program, as well as their evaluations of the program, to provide good instances of TPACK in action.

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