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Abstract

The study assessed, designed, developed, validated, implemented, and evaluated the effects of the e-training package on TPACK. The study was conducted at Bukidnon State University from 2021-2022. Using Research and Development, an e-training package on TPACK involved Content Knowledge, Technological Knowledge, and Pedagogical Content Knowledge was developed. The level of TPACK knowledge of secondary pre-service teachers was measured using weighted mean and sd. Findings revealed that pre-service teachers' TPACK level of knowledge shows advancement across all levels of knowledge except for pedagogical knowledge, which is expert. From the needs analysis result, an e-training package on content knowledge, technological knowledge, and pedagogical knowledge was designed. With the development of e-training package, Integrating Resources in Science, feedback from the panel of experts was used as the basis for the revision of the lessons with the guidance of a systematic set of criteria. The e-training was implemented through an online platform for both 3rd year and 4th-year science pre-service teachers. From the evaluation result, pre-service teachers have a thorough initial comprehension and fundamental knowledge of TPACK.

Introduction

Technological Pedagogical Content Knowledge (TPACK) is an essential part of the education system today as it incorporates the growing demand for technology in the classroom. TPACK also focuses on the content and how to teach it. This advancement in technology and pedagogy opens up several new opportunities for pre-service teachers to use in their classrooms for various educational goals. However, using new technology in pedagogically effective ways presents obstacles for pre-service teachers and necessitates acquiring new skills and knowledge. The primary goal of TPACK is to train pre-service teachers to develop sufficient technological literacy. Such e-training enables them to achieve proficiency in delivering multiple learning approaches, such as face-to-face learning, blended learning, distance learning, and home-schooling (McGarr & McDonagh, 2019). Educational institutions struggle to help ECTs integrate digital technologies into their educational activities (König, Jäger-Biela, and Glutsch, 2020). A variety of strategies and approaches have been attempted to try and support and develop ECTs' professional digital competence (PDC), including reduced timetables and the provision of both formal support mechanisms and informal encouragement (Tondeur et al., 2017). Teo and Milutinovic (2015) have demonstrated that attitudes toward using ICT in education critically influence pre-service teachers' desire to utilize ICT.

In addition, there are two usual ideas of knowledge in teaching. The first is that teachers have content knowledge. This involves specific knowledge of the subject they are teaching. The second is pedagogical knowledge, which centers on how to teach, including specific teaching methods. Also, technology in the 21st century plays a significant role as a tool in helping teachers deliver lessons and learners in learning. This enhances the model of PCK into Technology, Pedagogy Content Knowledge (TPACK).

With the current instruction set up in the context of online, distance, or flexible learning due to the unprecedented and massive shift in education delivery during the pandemic, technology in education is now viewed as an indispensable vehicle toward student learning continuity. The concept of heutagogy offers certain principles and practices that respond to these developments within higher education. Heutagogy aims to incorporate the diverse experiences of each student into the learning process (Carpenter & Green, 2017). Furthermore, in the heutagogy method, students and teachers have the opportunity and freedom to choose, utilize, and gain from many resources of information regarding problems in the school (Halsall, Powell, & Snowden, 2016; Blaschke, 2016).

Education officials have implemented remote digital teaching to reduce the negative impact of prolonged school closures. It is a viable alternative to continuing education emphasizing synchronous and asynchronous teaching, distance education, and module-based learning through technology and other digital platforms. In most schools in the Philippines, teachers were caught in a dilemma when asked to deliver lessons from their classroom to an online environment. At the same time, the system for providing resources, training, and support is also being simultaneously established or simulated (Luz, 2020).

At present, teachers encounter several pedagogical challenges related to online learning. One challenge is teachers' lack of knowledge and skills in using technology. Similarly, students are also unfamiliar with online learning tools. Another one is the need for professional development training for teachers. Moreover, the lack of interactive multimedia teaching resources and difficulty in designing assessment and evaluation strategies to support learning are also among the pedagogical concerns (Ferri, Grifoni, & Guzzo, 2020).

Nevertheless, because they saw online learning to be a convenient, adaptable, and accessible form of instruction, researchers in other studies (Mukhtar et al., 2020; Paudel, 2021) reported high levels of satisfaction with the medium from both teachers and students. These studies indicate that, despite certain difficulties, online learning has significant educational benefits that should not be disregarded in the post-pandemic era (Fang et al., 2023). This is especially true given that both the number of students enrolled and the size of classes in higher education are steadily increasing (Shi, 2019). This makes it difficult for teachers to deliver timely, intelligent, and scaled-effective instruction in face-to-face (F2F) settings without taking into account intelligent online technologies (Banihashem, Farrokhnia, et al., 2022, 2022b; Banihashem & Macfadyen, 2021; Noroozi et al., 2019, 2020). The number of universities investing in online education has increased since it has demonstrated benefit for higher education (Er et al., 2021; Shi, 2019; Zhao & Watterston, 2021). There is a contention that while online learning will continue to exist in the post-pandemic era, face-to-face instruction will serve as the foundation (Lockee, 2021).

Consequently, these developments have put pressure on academic institutions to improve their curricula and make them more relevant to today's needs. There is an urgent and ongoing need to incorporate technology into the learning process. It has become a significant concern in improving student learning, particularly among learners aspiring to and training to become teachers soon.

Further, the Philippine government has been taking steps to ensure that digital literacy in the education department is fully realized and implemented even before the pandemic. The Philippines' technological integration network benefits from strong central government support for enhancing access to fundamental infrastructure, hardware, and software for teaching and learning for all students. Whether in schools or the informal, alternative learning system for out-of-school youth, even though the vision for ICT integration has yet to be fully articulated.

The university aims to produce innovative, ethical, and committed professionals who contribute to the nation's long-term growth and development. Pre-service teachers face high expectations because they are the field's newcomers. Thus, pre-service teachers' preparation must include technology integration to keep them up to date on educational technology innovations and to make their preparation relevant to the needs of the students they will be teaching. Hence, it is impartial to study and analyze their performance in terms of the application of TPACK and the use of educational technology in their respective cooperating schools.

Statement of the Problem

This study aims to develop a TPACK e-training package for secondary pre-service teachers in the teaching-learning process. Specifically, it sought to answer the following:

1. What is the level of knowledge of pre-service teachers in terms of:
   - 1.1. Content Knowledge (CK);
   - 1.2. Pedagogical Knowledge (PK);
   - 1.3. Technological Knowledge (TK);
   - 1.4. Pedagogical Content Knowledge (PCK);
   - 1.5. Technological Content Knowledge (TCK);
   - 1.6. Technological Pedagogical Knowledge (TPK); and
   - 1.7. Technological Pedagogical Content Knowledge (TPACK)?
2. What e-training package on TPACK can be designed based in the needs analysis?
3. How is e-training package on TPACK developed?
4. How is the e-training package on TPACK implemented?
5. What is the result of the evaluation of the e-training package on TPACK?

Framework of the Study

The increasing use of technology as an educational tool has changed the learning landscape. With it came gaps in traditional teaching ideas and the need for new methods to keep up. The theory of connectivism seeks to be the modern-day solution to those gaps. Connectivism (Siemens & Downes, 2009) is a relatively new learning theory that suggests students should helpfully combine thoughts, theories, and general information. It posits that technology is a significant part of the learning process and that constant connectedness gives opportunities to make choices about learning.

Online resources will be vital to post-pandemic education in order to deliver effective, flexible, and blended learning (Ratten, 2023). Online resources have been used extensively in education during the COVID-19 pandemic (Pozo et al., 2021). Numerous institutions have attempted to investigate the use of online resources and the degree to which they have aided in teaching and learning (e.g., Abdel-Rahim, 2021; Almusharraf & Khahro, 2020; Lei & So, 2021; Pozo et al., 2021).

TPACK is a technology integration framework introduced by Mishra and Koehler (2006) of Michigan State University. This framework identifies three types of knowledge instructors need to combine for successful edtech integration—technological, pedagogical, and content knowledge, also known as TPACK. Within this framework are the three primary forms of knowledge: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK).

In addition, the TPACK framework offers a productive approach to many of the dilemmas teachers face in implementing educational technology (edtech) in their classrooms. By differentiating among these three types of knowledge, the TPACK framework outlines how content (taught) and pedagogy (how the teacher imparts that content) must form the foundation for any effective edtech integration. This order is important because the technology implemented must communicate the content and support the pedagogy to enhance students' learning experience.

Method

The research and development approach was used in this study, specifically the ADDIE model. The aforementioned research was done at Bukidnon State University (BukSU), Malaybalay City, Bukidnon, Philippines. Five (5) males and 27 females who were science pre-service teachers with ages ranging from 18 to 23 were included through purposive sampling. The research tool employed was a Valtonen et al. (2017) survey questionnaire for evaluating the suitability of educational technology. The e-training package's development using the ADDIE approach was also followed in the study. Using these, the weighted mean and standard deviation were used to calculate the TPACK level of secondary pre-service teachers in the various elements. The development of the capacity building model involved the use of a thematic analysis in qualitative methodology. Data categorization was followed by explication using a streamlined version of thematic analysis. The study also followed a set of ethical guidelines and requirements.

Results and Discussion

TPACK Level of Knowledge of Pre-service Teachers

Table 1 presents the overall level of knowledge of science pre-service teachers. It shows that the science pre-service teachers have advanced knowledge of TPACK. It further displays that pre-service teachers were experts in pedagogical knowledge. On the other hand, they were advanced in content knowledge, the parameter with the lowest mean.

Table 1. Overall Level of Knowledge of Pre-service Teachers

Parameter	Mean	SD	Description	Qualifying Statement
Pedagogical Knowledge (PK)	4.21	0.52	Strong Knowledge	Expert
Technological Pedagogical Knowledge (TPK)	4.13	0.58	Moderate Knowledge	Advanced
Technological Pedagogical Content Knowledge (TPACK)	4.08	0.56	Moderate Knowledge	Advanced
Technological Content Knowledge (TCK)	4.03	0.54	Moderate Knowledge	Advanced
Pedagogical Content Knowledge (PCK)	4.01	0.62	Moderate Knowledge	Advanced
Technological Knowledge (TK)	3.99	0.56	Moderate Knowledge	Advanced
Content Knowledge (CK)	3.85	0.52	Moderate Knowledge	Advanced
Overall Mean	4.04	0.56	Moderate Knowledge	Advanced

Nowadays, technology cannot be taught as a separate and independent subject to assist pre-service teachers in integrating it into teaching in meaningful ways. Instead, pre-service teachers require assistance from teacher education programs in understanding how technology interacts with subject and pedagogy and connecting technology, content, and pedagogy.

This theoretical framework divides knowledge into content, pedagogy, and technology. A new body of knowledge known as technological pedagogical and content technology has been created by integrating all three bodies of knowledge (TPACK). Effective technology-assisted teaching is built on using the right tools, methodologies, and techniques to impart the lesson's content and the student's existing knowledge. TPACK aims to address the complex nature, form, and knowledge of teachers involving content knowledge, pedagogy, and technology, according to researchers like Aguinaldo (2012), Atasoy & Aygun (2016), Cherner & Smith (2017), Norhiza & Razana, (2016), and Papanikolaou, Makri, & Roussos (2017).

Furthermore, different pre-service teachers' TPACK has been found in other studies (Koh & Chai, 2014; Valtonen, Kukkonen, Kontkanen, Mäkitalo-Siegl, & Sointu, 2018). It suggests that rather than being viewed as a static entity, TPACK needs to be considered dynamic and evolving. This challenges studies documenting the nature and growth of pre-service teachers' TPACK areas. Hence, new and updated knowledge may be achieved by the pre-service teachers linking educational theories to actual teaching through learning, applying, and reflecting.

Design of the e-Training Package

Based on the level of TPACK knowledge of science pre-service teachers, results show that Content Knowledge (CK), Technological Knowledge (TK), and Pedagogical Content Knowledge (PCK) garnered the lowest mean. Based on the results of the needs analysis, *Integrating Resources in Science e-training Package on TPACK* was then produced.

The e-training package was designed based on the needs of the pre-service teachers, as indicated in their statements. One of the participants expressed the "*Inadequacy ICT resources (e.g., computers), technical problems, lack of effective training, and lack of confidence in using various technologies*" as their concerns. This was confirmed by another participant who highlighted the lack of knowledge of fixing technical issues, saying, "*I only know how to use it, but I don't know how to fix technical issues while using ICT, which is a must to learn*" (Participant 15).

Three other participants expressed the same issue regarding the inadequate knowledge of addressing technical problems. According to a pre-service teacher, one problem is "*when students doesn't have enough idea to navigate such software*" (Participant 24). Another participant added, "*The challenges and issues can occur in the matter of application and skills, the ICT resources availability, and the netiquette in incorporating ICT*" (Participant 26). They also mentioned the "*limited accessibility and network connection, limited technical support*" (Participant 32) among the concerns. Such assessment may help improve the teacher education program in tertiary education institutions, particularly in terms of TPACK. This e-training package includes the different technological pedagogical content knowledge (TPACK) that science pre-service teachers (PSTs) would learn in the five-week capability training course. The PSTs would be guided through the course by a set of objectives and tasks for each topic.

A recent study explored an instructional intervention using an activity types approach for in-service teacher professional development. Its findings reveal that teachers' decisions regarding educational technology have become more deliberate and judicious. But change came suddenly and unplanned during the COVID-19 epidemic. For educators, there was no other option because online technology were the sole way to address very pressing issues (Cutri et al., 2020).

The result of the needs assessment served as the basis for creating the training's task analysis blueprint (TAB). It outlines the expected outcomes; the content; the tasks, activities, and strategies; the selected technology, media, and materials; and the timeframe. Moreover, the applications, websites, and other resources needed are also indicated in the blueprint. This study created a TAB for every type of knowledge in the TPACK. Hence, during this stage, five blueprints have been developed, serving as a guide in developing the lessons included in the e-package.

The e-training had a basic format of specific learning outcomes, materials, and the 4A strategy. The collaborative effort is necessary to make meaningful and creative learning. Also, the 4A strategy could be one of the most helpful gear for it. It focuses on four main categories: activate, acquire, apply, and assess. Each is essential to learners' success, and teachers can ensure they are front and center in deciding how to proceed with the instructional methods.

Development of the e-Training Package

Constant performance improvement should be the context for training. A setting that promotes productivity, applying the right technological learning resources, and upgrading pedagogical techniques are necessary for changing and enhancing practices. The foundation of training should be competencies or the skills needed to perform tasks to the standards expected. Training should therefore lead to adjustments in workplace behavior that result in a better, more productive individual.

The task analysis blueprint guided the development of the e-training package that includes the different Technological Pedagogical Content Knowledge (TPACK) areas. Specifically, it covered the following: *Content Knowledge* (CK), *Technological Knowledge* (TK), and *Pedagogical Content Knowledge* (PCK). These areas constitute the e-training package, which considers the relationships among all three areas and acknowledges that pre-service teachers are acting within this complex space.

Also, in developing the e-training package, titled Integrating Resources in Science, several technical aspects were evaluated by three (3) panels of experts. The researcher gave the experts an evaluation form individually, which contains the following criteria: Content and content accuracy, Clarity, and Appropriateness. The respective panel of experts assessed the developed e-training package and whether the features cited in the criteria are available using the following responses: Strongly Agree, Agree, Disagree, and Strongly Disagree. The comments gathered from the experts were used as a basis for refining the material.

Table 2 shows the summary result of the evaluation of the panel of experts in terms of content and content accuracy, clarity, and appropriateness.

Table 2. Summary of Evaluation of the Panel of Experts in terms of Content and Content Accuracy, Clarity and Appropriateness

Criteria	Mean	SD	Description	Qualifying Statement
Content and content accuracy	4.60	0.58	Strongly Agree	Very Satisfied
Clarity	4.56	0.58	Strongly Agree	Very Satisfied
Appropriateness	4.67	0.58	Strongly Agree	Very Satisfied
Overall Mean	4.61	0.58	Strongly Agree	Very Satisfied

Table 2 displays that the criteria for evaluating the developed e-training package were very satisfied. The same is true regarding content and content accuracy, clarity, and appropriateness. The e-training package may enrich the technological pedagogical content knowledge of the science pre-service teachers. It also implies that the e-training package used educational technologies to develop its materials, instructional approaches, and professional development in a way that uses the technology. It further ensures that all pre-service teachers have access to high-quality training experiences.

All ages and backgrounds of instructors were required to plan and conduct remote lessons, frequently without sufficient organizational, educational, or technical assistance (Hodges et al., 2020; Scherer et al., 2020). Thus, teachers played a major role in the shift: their capacity to adapt and teach well online was crucial to the quality of online learning. Both teachers and students gain from using educational resources in the classroom. Using the e-training package may enhance the TPACK level of learning by making it more engaging, applicable, realistic, and appealing. Further, using instructional materials enables teachers and learners to engage in active and practical learning activities, create space for knowledge and skill acquisition, and foster assurance and self-actualization (Olayinka, 2016; Nura, 2016).

Implementation of the e-Training Package

With the approval of the university president, the e-training was conducted. The researcher sent the need analysis link to both 3rd year and 4th-year science pre-service teachers through Google Forms. Based on the responses, the participants of the e-training were then identified. A group chat was created, serving as the main platform for reaching the participants. Before conducting the proper e-training, an informed consent form was sent to the participant. With the agreement of the participants, the e-training then commenced following the developed modules of Integrating Resources in Science. After the short briefing: informing the respondents of the purpose of the study, source of data collection, participation risks and benefits, voluntary participation and withdrawal, and its confidentiality, the researcher agreed on a schedule with the respondents on where and when to conduct the training.

Given the full autonomy to choose their group members, the pre-service teachers choose the topic they are most comfortable with in making lesson plans. In this manner, they are encouraged to share their ideas with utmost confidence. With the active participation of the participants, the training proper lasted for five (5) weeks. After the presentation of topics, an evaluation was given to the participants to determine the effectiveness of the e-training. Assurance was also given to the confidentiality of their responses and their respective identification.

The instructional designer and the students both provided extensive input on this phase. When teachers and students actively participate in the implementation process, quick changes to the project is evident, increasing the program's effectiveness and success (Manichander, 2016). Williamson and Muckle (2018) discovered that attitudes regarding technology use directly impact the intention to use technology in their study on students' opinions of its use in education. Because they think it is practical and easy to use, poll respondents had a positive attitude about employing technology in the classroom.

According to possible benefits, innovations were meticulously planned and designed (Yadav et al., 2017). By creating new online learning environments and teaching tools with the goal of taking use of the potential presented by emerging technology, risks and failures were minimized (Shardlow et al., 2022; Yeo et al., 2006). Additionally, very few educators were experimenting with new ICT technologies. Thus, both inside and outside the classroom, technology tends to make learning more enjoyable. Instructional module design will likely increase learners' motivation by including multimedia elements. It incorporates offers the students context from the real world.

Evaluation of the Effectiveness of the e-Training Package

The e-training evaluation followed the Kirkpatrick model's four levels of training evaluation. The Kirkpatrick model is an internationally recognized tool for evaluating and analyzing the results of educational, training, and learning programs. The model was created by Donald Kirkpatrick in 1959, with several revisions made since. It assesses formal and informal training methods and rates them against four levels of criteria: reaction, learning, behavior, and results.

Level 1 – Reaction

Level 1 Reaction measures how participants react to the training. *Level 2 Learning* analyzes if they genuinely understood the training. *Level 3 Behavior* verifies whether they are utilizing what they learned at work, and *Level 4 Results* determines if the material had a positive impact on the organization.

Table 3 presents the summary evaluation of *Level 1 – Reaction.* The table shows that the overall reaction of the pre-service teachers was excellent. It signifies that the e-training was favorable to the science pre-service teachers. It may also imply that they found the e-training engaging and relevant to their future careers.

Table 3. Summary Table of Evaluation of Level 1

Criteria/Statement	Mean	SD	Description	Qualifying Statement
The trainer was knowledgeable about the training topics.	4.88	0.72	Strongly Agree	Excellent
The trainer was well prepared.	4.88	0.70	Strongly Agree	Excellent
Participation and interaction were encouraged.	4.85	0.70	Strongly Agree	Excellent
The topics covered were relevant to me.	4.85	0.72	Strongly Agree	Excellent
This training experience will be useful in my internship.	4.85	0.73	Strongly Agree	Excellent
The objectives of the training were clearly defined.	4.82	0.70	Strongly Agree	Excellent
The content was organized and easy to follow.	4.82	0.69	Strongly Agree	Excellent
The training objectives were met.	4.82	0.69	Strongly Agree	Excellent
The time allotted for the training was sufficient.	4.82	0.72	Strongly Agree	Excellent
The materials used were helpful.	4.79	0.58	Strongly Agree	Excellent
Overall Mean	4.84	0.69	Strongly Agree	Excellent

Continuous evaluation of every training program is vital to determine its best elements (Rama & Vaishnavi, 2012). Punia and other researchers (2013), who emphasized employee qualities, stated that managers should first encourage their employees to learn new abilities and skills before supporting them as they put those skills into practice at work to increase the effectiveness of any training. Thus, pre-service teachers should be given various types of training as some undiscovered skills and talents may emerge through training.

Level 2- Learning of the Participants

This level measures whether the participants learned from the training. It assesses the extent learners have advanced in knowledge, skills, or attitude. This level evaluates the degree to which participants' attitudes, knowledge, and skill levels have improved due to participating in the program. Learning metrics are quantitative learning markers that have occurred after the training session and are evaluated by participants' self-assessments of their learning.

Table 4 shows the TPACK level of knowledge of science pre-service teachers before and after the e-training. From the table, it can be observed that pre-service teachers' TPACK level of knowledge before and after the e-training was from advanced to expert. It means that the science pre-service teachers increased their level of TPACK knowledge after the e-training was conducted. It also implies that learning has taken place and the pre-service teachers gained something from the e-training.

Table 4. TPACK Level of Knowledge of Science Pre-service Teachers Before and After the e-Training

Form of Knowledge	Before		After	
	Mean	Qualifying Statement	Mean	Qualifying Statement
Content Knowledge	3.85	Advanced	4.20	Advanced
Pedagogical Knowledge	4.21	Expert	4.30	Expert
Technological Knowledge	3.99	Advanced	4.24	Expert
Pedagogical Content Knowledge	4.01	Advanced	4.34	Expert
Technological Content Knowledge	4.03	Advanced	4.24	Expert
Technological Pedagogical Knowledge	4.13	Advanced	4.40	Expert
Technological Pedagogical Content Knowledge	4.08	Advanced	4.34	Expert
Overall Mean	4.04	Advanced	4.29	Expert

Table 5 displays the comparison of the TPACK level of knowledge of science pre-service teachers before and after the e-training. Results revealed that the p-value obtained by all forms of TPACK knowledge was less than the level of significance å= 0.05. Therefore, there is a significant difference before and after the e-training. It may imply that pre-service teachers learned and may apply the knowledge to innovate in their classes.

Table 5. Comparison of the TPACK Level of Knowledge of Science Pre-service Teachers Before and after the e-Training

Form of Knowledge	t	df	p	Cohen's d
Content Knowledge	-10.233	9	< .001	3.236
Pedagogical Knowledge	-3.421	9	0.008	1.082
Technological Knowledge	-9.172	9	< .001	2.901
Pedagogical Content Knowledge	-11.855	9	< .001	3.749
Technological Content Knowledge	-6.007	9	< .001	1.900
Technological Pedagogical Knowledge	-13.615	9	< .001	4.305
Technological Pedagogical Content Knowledge	-7.796	9	< .001	2.465

**Significant at $p<0.05$ alpha level*

The result was supported by some of the answers of the participants. The statements below confirm that the pre-service learned from the training.

> *"I hope to change my practice on being contented of what I've already know. Because of this training it motivates to always seek for improvements because accordingly learning is a continuous process."* (Participant 3)
>
> *"I would apply the things I have learned in the training, and reflect on how our instructor have guided us in the training process to always give best results in the related field."* (Participant 8)
>
> *"I would like to apply all the things I have acquired throughout the duration of the training on areas where it is useful."* (Participant 13)
>
> *"… I learned to communicate properly and work cooperatively with my groupmates, which is critical in the workplace. Indeed, this training made me experience the reality of making lesson plans and demonstrating them to the students, even virtually."* (Participant 32)

Analyzing the training activities revealed that diverse views of developing pre-service teachers give rise to a wide range of training initiatives (Vu, 2018). Further, the more training given, the more advantages for the pre-service teachers, the more advanced skills and competencies, and the more benefits reflected in the institution (Terrana et al., 2016). Hence, results may serve as a guide for enhancing the impact of future training initiatives.

It can also be gleaned in Table 5 Cohen's D values. Cohen's D is one of the most common ways to measure effect size. An effect size is how large an effect is. From the data, it can be concluded that there was a large effect. Hence, the e-training package effectively improved the TPACK knowledge level of the science pre-service teachers.

Level 3 - Behavior of the Participants

It assesses behavioral change in the participants as a result of training. It assesses how well training participants have integrated their new knowledge and abilities into their current jobs and how this has affected their productivity. The most typical methods for assessing whether on-the-job performance has improved are reviewing performance data, directly monitoring people, and conducting performance reviews. A month after the e-training ended, the pre-service teachers were asked about their level of competence on different criteria. Table 6 presents the summary table of evaluation of Phase 2.

Table 6. Summary Table of Evaluation of Phase 2

Criteria/Statement	Mean	SD	Description	Qualifying Statement
Intentions	4.58	0.61	Strongly Agree	Excellent
Attitudes	4.39	0.61	Strongly Agree	Excellent
Behavior	4.39	0.66	Strongly Agree	Excellent
Knowledge	4.00	0.61	Strongly Agree	Excellent
Overall Mean	4.34	0.62	Strongly Agree	Excellent

Based on the results, science pre-service teachers' overall level of competence was *excellent*. It indicates that the e-training was pertinent to the pre-service teachers' profession and that they understood it. It may also imply that pre-service teachers used their learnings and recognized their behavior changes.

As observed from Table 6, intentions have the highest mean, while knowledge has the lowest. It means that pre-service teachers intend to carry out or use the learnings from the e-training. The result also suggests that the e-training assisted pre-service teachers in incorporating innovative approaches to instruction. Pre-service teachers felt more comfortable with modern teaching techniques utilizing numerous technological resources. Hence, pre-service teachers were more engaged in their studies and had better attitudes about learning, which led to increased and enhanced performance.

Further, teachers are essential contributors to any educational institution, so they must have the necessary training (Carnoy, Khavenson, & Ivanova, 2015). Numerous studies have been conducted in the past on training and the effects of teacher preparation. However, there is still more work to be done in this field because training affects different areas differently (Chen, 2017). Every teacher training program is designed to attain a specific goal that improves organizational performance. Thus, providing pre-service teachers with the proper training may improve teacher education institution performance.

Level 4 - Results of the Training to the Participants

The final step measures and evaluates the result of the training program against the organization's or stakeholder's expectations. It reviews whether participants of the training have met their learning objectives. This level can only be measured by looking at business data relating to the training. Typically, the business captures this data, but it often needs to be compared to training data.

Furthermore, L&D departments may need access to it. Where data is captured, the challenge at this level is demonstrating the impact of the learning experience among the many other factors that can affect the business metric. Hence in this study, the science pre-service teachers were asked to create an action plan to ensure that the learning gained from the e-training will be applied in the field.

Recent years have seen a significant increase in the attention of researchers and educators to the efficient use of information and communication technology (ICT) to boost teaching and learning. If teachers are tech-savvy and know how to incorporate technology into the classroom, information and communication technology (ICT) can help boost learning. The technical, pedagogical, and content knowledge (TPACK) framework, developed by Mishra and Koehler (2006), is a method that can assist teachers in integrating technology into their instruction.

The TPACK framework is made to make it easier for instructors to comprehend how to effectively use ICT to teach particular material using the suitable methodology (Mishra & Koehler, 2006; Koehler et al., 2013; Rienties et al., 2013; Lee & Kim, 2014; Valtonen et al., 2017; Tondeur et al., 2020; Wang et al., 2020; Lachner et al., 2021). The framework, in short, proposes that teaching is the integration of what teachers know—namely, the content, pedagogy, and technology—and how the teachers may apply their knowledge in their classroom setting. In order to address any issues that may arise in the classroom, pre-service teachers with TPACK are required to be well-equipped to comprehend the link between CK, PK, and TK. Hence, a viable strategy to encourage their TPACK is to provide pre-service teachers the chance to create technology-enriched materials.

Conclusion

The results above and the findings of the study drew the following conclusions:

1. From the results, TPACK-level science pre-service teachers indicated strong agreement and that all the knowledge is necessary for their teaching-learning activities.
2. Designing an e-training package is essential in enhancing the TPACK level of Science pre-service teachers.
3. The developed e-training package functioned as effective teaching and learning tool that supports the collaborative learning of pre-service teachers.
4. The statistical analysis showed that when used in an online learning environment, then the ADDIE model can successfully teach Science.
5. Given the results of this study, teacher training institutions can incorporate technology into their curricula to boost pre-service teachers' acquisition of TPACK abilities.

Recommendations

The following statements are recommended based on the results of the study:

1. When developing a program or course, using the ADDIE model may help the creators implement a learner-centered approach instead of a teacher-centered one, making the program more applicable and meaningful for learners.
2. Exposing the pre-service teachers to varied training, symposia, or conferences may update them on their future roles as educators. This way, the pre-service teachers may increase their motivation and confidence when exposed to the field.
3. With the use of the capability building model for pre-service teachers, existing strategies and policies of the teacher education program of the Teacher Education Institutions may be reviewed and improved to make the curriculum more responsive to the needs of the profession and for its effective and efficient implementation.
4. Instructors are generally encouraged to incorporate and integrate TPACK into their lessons. To ensure that pre-service teachers are fully equipped and competitive in their teaching careers, extensive support may also be given to them throughout their tenure.
5. In order to effectively use technology and make the curriculum more responsive to the requirements of the students, cooperating schools may review and upgrade current facilities and equipment.
6. Future researchers may consider conducting another study to investigate the factors influencing pre-service teachers' teaching competence. Also, researchers may explore the same aspect with a broader scope of respondents, including the different fields of specialization.

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