The European Educational Researcher

http://www.eu-er.com

Integrating FoK and TPACK in Action Research: The impact of Video Creation Workshops on Pre-service Science Teachers in the Philippines

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Abstract: This mixed-methods study presents an Asian perspective on the impact of a science video creation workshop as an intervention on the technology adoption and utilization of pre-service science teachers. It aims to offer insights relevant to Initial Teacher Education programs in international contexts, including those in Europe and North America, where most of the literature referenced in this study was sourced. Integrating the Funds of Knowledge (FoK), Technological, Pedagogical, and Content Knowledge (TPACK), and action research frameworks, the intervention provided insights into pre-service teachers' professional development. Data collection included pre- and post-test surveys, individual interviews, and focus group discussions. Quantitative analysis using paired samples t-tests revealed statistically significant improvements in technology adoption and utilization across all levels of Morel's Matrix (2016). Triangulated with qualitative analysis, findings highlighted three key themes: enhancing science teaching through contextualized content, improving pedagogical practices via technology, and fostering inclusivity and cultural responsiveness. These results underscore the workshop's potential in gradually developing positive beliefs toward technology integration among pre-service teachers. The study's findings emphasize the value of integrating FoK and TPACK within action research to bridge theory and practice. It provides additional evidence for technology adoption in science education. This research contributes to the limited literature on pre-service teacher education in Asia, particularly in the Philippines, and offers insights into the potential of action research to foster meaningful and sustainable changes in teaching practices within broader science teacher preparation programs across international contexts.

Keywords: Action research; Funds of Knowledge; Pre-service teacher; Science video workshops; Technological Pedagogical Content Knowledge

DOI: https://doi.org/10.31757/euer.831

Introduction

The integration of educational research into classroom practice often encounters significant delays, leading to a slow trickle-down effect before research findings and recommendations impact teaching methods. This delay is influenced by various factors, including research evaluation systems within governments and universities that often prioritize metrics and incentives that do not directly inform best practices in education (Baccini, 2018). Consequently, these systems create a disconnect between research and practical application in educational settings. Additionally, the inherent uncertainties and perceived threats associated with change can cause teachers to revert to traditional methods, despite the intentions of reforms aimed at improving practices (Olsen & Sexton, 2009).

Broadly, the disconnect between research and practice in science, technology, engineering and mathematics (STEM) teacher education is a persistent challenge, often rooted in the differing perspectives, beliefs, and roles of students, teachers, and researchers (Taber, 2005, 2013, 2014). In the Philippines, this issue is evident in the coordination and management of large-scale STEM education technology initiatives from 1996 to 2016, which involved multiple public and private organizations at local and international levels. While these key players brought valuable expertise, the absence of a clear national curriculum benchmark led to overlapping and misaligned project implementations (Vergel de Dios, 2016).

A recent survey of 141 high school science teachers across 15 of 20 school districts in a Philippine region found that while over 90% had personal computers for classroom use, limited internet access, and a lack of grounding in learning sciences and educational technology frameworks hindered effective technology integration (Tembrevilla, 2020). This disconnects between research and practical application reflects broader challenges in Philippine education, where teachers often adopt technology without clear pedagogical strategies, leading to superficial implementation. Moreover, the uncertainty and perceived challenges of technology integration including added workload, administrative pressures, and concerns about digital competence often hinder meaningful engagement (Tembrevilla, 2020).

Addressing these gaps requires targeted professional development and systemic support to ensure that technology enhances, rather than burdens, teaching and learning (Tembrevilla, 2020; Tembrevilla et al., 2025). These knowledge gaps and differences create barriers to the effective translation of research findings into practical teaching strategies. To address these challenges, various tools and methodologies have been developed, with action research emerging as a particularly effective method for bridging the gap between educational research and classroom practice.

Action research has gained traction over the years as a valuable approach for professional development, particularly in the field of science education (Capobianco & Feldman, 2010; Gore & Zeichner, 1991; Lebak & Tinsley, 2010, Author et al., 2025). It promotes a cyclical process of inquiry and reflection among both pre-service and in-service teachers, fostering continuous improvement in teaching practices. This iterative process involves phases of planning, acting, observing, and reflecting, aimed at generating and implementing evidence-based innovations in teaching and learning (Laudonia et al., 2018). The ultimate goal of action research is to minimize the time and communication lag between the generation of relevant educational evidence and its application in the classroom.

Despite its growing popularity and effectiveness, action research in science education has predominantly been implemented in Western educational settings. For the past 30 years (see Feldman, 1996 as one of the earliest action research in science education in the 1990s), action research has been primarily concentrated among in-service and pre-service teachers in these regions, with only sporadic adoption in Southeast Asia (Faikhamta & Clarke, 2015), particularly among science pre-service teachers in the Philippines (Tembrevilla, 2020). For example, in a recent analytical review of action research (Laudonia et al., 2018), out of the 90 references in the review's bibliographies, 50 were specifically related to science education. These references included articles and books focusing on various aspects of science education, such as inquiry-based learning, curriculum development, and the professional development of science teachers. Of these 50 references, 42 were Western-based, while only eight were from Non-western sources. Further, 22 references addressed in-service teachers, and 20 focused on pre-service teachers in

Western contexts, whereas only six and two references, respectively, were Non-western. This gap underscores the need for broader application and adaptation of action research methodologies in diverse educational contexts, particularly in Southeast Asia.

Similar to other Asian regions, in the Southeast Asian educational landscape, there are unique challenges and opportunities related to technology integration. While there has been significant progress in investing in and integrating technology into education, the focus has predominantly been on in-service teachers (Gao et al., 2011; Jung et al., 2019). Various studies have explored factors such as educational beliefs about technology (Kim et al., 2013), confidence in using technology (Han et al., 2017), and the perceived value of technology (Kale & Akcaoglu, 2018). However, this focus leaves a critical gap in understanding how pre-service teachers, particularly those in science education, adopt and utilize technology in their teaching practices.

In the Philippines, as in other Asian countries, significant efforts have been made to integrate technology into Teacher Education curriculum, often drawing from national ICT policies such as Singapore's Ministry of Education master plans (Trucano, 2016). As one of the last in Asia to implement a K-12 system, the country introduced major reforms under the Enhanced Basic Education Act of 2013, including a shift from discipline-based science instruction to a spiral progression model for deeper conceptual learning. The curriculum also emphasizes contextualized teaching, encouraging the integration of local culture, history, and technology to enhance student engagement (UNESCO, 2023). Despite these efforts, disparities in technology access and adoption persist, particularly in public schools among in-service teachers and students, highlighting the need for targeted support for pre-service teachers in Teacher Education programmes.

Studies show that Filipino science in-service teachers frequently use videos from platforms like YouTube in science classes, but these often lack contextual relevance (Tembrevilla, 2020; Tembrevilla & Milner-Bolotin, 2025). Many teachers express interest in creating their own educational videos but face barriers such as limited access to technology and training. Addressing these challenges could enhance learning experiences, given Filipino students' strong engagement with video content on social media (Tembrevilla, 2020; Santisteban, 2017). Additionally, much of the research on technology integration in education relies on quantitative data collection, which, while efficient, often overlooks the nuanced challenges educators face—challenges better captured through qualitative methods (World Bank, 2017).

To address these challenges and fill the gaps in existing research, this study employs a mixed-methods approach, combining quantitative and qualitative data to provide a more comprehensive understanding of the impact of science video creation workshops on pre-service teachers. The study builds on the importance of implementing action research in technology integration using mixed methods, with a particular focus on the increased involvement of science pre-service teachers in the Asian context, especially in the Philippines. The overarching goal is to enhance the professional development of pre-service teachers in science education, preparing them for their teaching practicum and future careers as educators.

This study was a collaborative effort involving the first author from a Canadian university, who has comprehensive knowledge of and experience with teacher education programs in the Philippines, and three collaborators from universities in the Philippines specializing in Teacher Education. The research aimed to explore how science video creation workshops could influence pre-service teachers' beliefs about technology integration through the lens of action research. These workshops were carefully designed to incorporate the Funds of Knowledge (FoK) and Technological, Pedagogical, and Content Knowledge (TPACK) frameworks, offering a holistic approach to adopting technology in the classroom.

The central research question guiding this study was: How do science video creation workshops, integrating FoK, TPACK, and action research frameworks, impact the adoption and utilization of technology among Filipino pre-service science teachers?

Theoretical Framework

This study is grounded in two critical frameworks: FoK and TPACK, both of which are situated within the context of action research in science education. The integration of these frameworks provides a comprehensive approach to enhancing the professional development of pre-service science teachers, particularly in the use and adoption of technology in the classroom.

Funds of Knowledge (FoK) Framework

The seminal works of Moll et al. (1992) and González et al. (2005) on Funds of Knowledge form a critical part of the conceptual framework guiding this study. Their scholarship on recognizing and valuing the strengths and resources that learners, here, specifically preservice teachers, bring from their historical, cultural, social, and political contexts aligns closely with the central research question and the methodological approach employed in this study. These "funds" are valuable assets that can be leveraged to develop culturally responsive and relevant curricula. By incorporating the everyday experiences and knowledge that students gain from their home environments into classroom instruction, educators can bridge the gap between school and community. This approach leads to a more inclusive and effective learning experience, moving beyond traditional educational discourses focused on high-stakes testing and national assessments (Biesta, 2013; Pinar, 2012). Instead, it emphasizes meaningful discussions on a.) curriculum and pedagogy that connect with students' lives and local histories (Aikenhead, 2001; Gitari, 2003; Handa & Tippins, 2012) and b.) critical inisghts on studying preservice teachers' professional identity (Muhaji et al., 2023).

The earliest applications of FoK in education date back to the late 1980s (González, 1995; Llopart & Esteban-Guitart, 2018). These early studies demonstrated the effectiveness of FoK in creating educational environments that are not only more inclusive but also more engaging for students. However, while the concept of FoK has been widely accepted and implemented, its integration with technology remains limited. A recent review (Llopart & Esteban-Guitart, 2018) highlighted several innovative approaches to integrating FoK, but only two examples involved the use of technology, both focusing on in-service teachers. For example, a study explored how K-2 and K-

3 teachers guided their students in creating mini-maps, which were later compiled into books and used as navigation tools during a zoo visit (Hinde, 2012). Despite the successful use of technology to enhance students' FoK, these studies did not explicitly incorporate the TPACK framework, which could further enhance the integration of technology into educational practices.

Technological, Pedagogical, Content Knowledge (TPACK) Framework

The TPACK framework builds on Shulman's (1986) concept of pedagogical content knowledge (PCK), expanding it to include technology as a critical component of teachers' professional knowledge. TPACK consolidates the three forms of knowledge—technology, pedagogy, and content—into an integrated whole, which supports teachers in addressing the complex challenges of modern education (Koehler et al., 2013). By providing a structured approach to professional development, TPACK helps teachers effectively integrate technology into their teaching practices, thereby enhancing their ability to deliver content in ways that are both pedagogically sound and technologically appropriate.

TPACK has been particularly effective in STEM education, where the deliberate and innovative use of technology, grounded in this framework, has been shown to support significant professional development and knowledge growth among both pre-service and in-service teachers (Herring et al., 2016; Smith et al., 2016). However, while TPACK and FoK frameworks have been widely reviewed and adopted separately, there is a lack of studies that explore their integration, especially in the context of action research aimed at enhancing pre-service science teachers' use of technology.

Action Research in Science Education

Action research is a powerful tool for bridging the gap between educational research and classroom practice. In science education, action research projects can be categorized into three main modes based on the role teachers play: technically driven research, where external researchers lead and teachers provide feedback; teacher-centered research, where teachers drive the process with support from researchers; and participatory research, which involves close collaboration between teachers and researchers (Grundy, 1982; Fazio, 2009; Laudonia et al., 2018). These projects often evolve from technically driven beginnings to more teacher-driven initiatives, reflecting teachers' growing skills and ownership of the process.

Action research in science education covers a wide range of topics, including pedagogy, curriculum development, and understanding students' cognitive processes. It is applied across educational levels, from elementary to university, and includes special needs and inclusive settings. One significant focus of action research is the integration of socio-scientific issues into the curriculum, making learning more relevant to students' lives and thereby fostering higher engagement and interest (Gisewhite, et al., 2013; Marks & Eilks, 2009; Stolz et al., 2013). For example, interdisciplinary projects on climate change education have incorporated perspectives from biology, chemistry, physics, and politics, demonstrating the effectiveness of this approach (Feierabend & Eilks, 2011).

Integrating FoK and TPACK in Action Research

Integrating FoK and TPACK within action research strengthens the professional growth of pre-service teachers (Faikhamta & Clarke, 2015). In both Asian and Western Teacher Education programmes, this approach encourages teachers to design inquiry-based lessons that connect students' lived experiences with science concepts while leveraging digital tools. For instance, pre-service teachers can explore local farming and fishing practices in rural communities. They can document their inquiry using cameras, digital probes, and sensors. By weaving community narratives into lessons on general science, biology, chemistry, or physics, they can examine sustainability issues—such as harmful agricultural or fishing practices—and engage in action research cycles of planning, acting, observing, and reflecting to propose science-based solutions (Billaud et al., 2021; DiBattista et al., 2021). Similarly, rather than traditional map-making projects, pre-service teachers could design and create digital stories on household food preservation practices using Book Creator or Canva, linking these to discussions on food security, climate change, and climate anxiety in coastal and rural areas (Brown et al., 2019; Devine-Wright, 2013). By integrating FoK, TPACK, and action research, Teacher Education programmes can create learning environments that are culturally responsive, technologically enriched, and deeply connected to real-world challenges. This approach not only bridges research and practice but also fosters reflective teaching, collaboration, and meaningful community engagement.

Methods

Contexts and design of the study

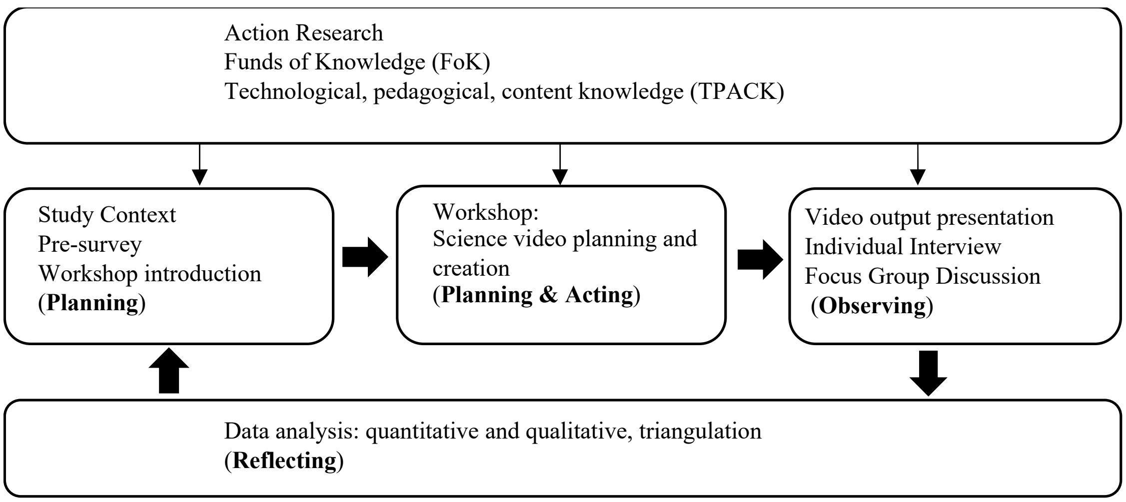
The study was conducted within a four-year Teacher Education Programme at a university in the Philippines, involving 14 fourth-year pre-service teachers majoring in one of the science areas (general science, biology, chemistry, and physics) for their Bachelor of Secondary Education (BSEd). The participants voluntarily joined the study after completing their course on Technology for Teaching and Learning, a 3-unit introductory course that covered the basic knowledge, skills, and values related to the use of technology in teaching and learning. This course was taught by one of the collaborators, and the participants had received their grades for the course before volunteering for the study. To facilitate participation, the study provided transportation allowances and lunches. Ethics clearance was obtained, and the study was approved by both the Canadian and Philippine institutions involved.

The workshops were conducted over two consecutive days, with participants consistently attending throughout. The participants were divided into five groups, with one group comprising two members and the remaining four groups comprising three members each. The first half-day of the workshop was dedicated to exploring and discussing the FoK and TPACK frameworks, action research in science education, and the basics of science video creation through group discussions and presentations. The remainder of the first day and the first half of the second day were spent on creating science videos. The final half-day involved presenting the video outputs, conducting peer critiques, and carrying out individual interviews and focus group discussions.

The study followed the cyclical process of an action research design, incorporating the FoK and TPACK frameworks (Fig. 1). It began with a pre-survey to collect initial data (planning stage), followed by the workshop on science video creation that involved both planning and acting stages. Participants created and presented their science videos, with subsequent individual interviews and focus group discussions serving as the observing and reflecting stages. Data analysis involved quantitative and qualitative methods, with triangulation used to enhance the reliability and validity of the findings. This cyclical process allowed for continuous improvement and refinement, bridging theory and practice effectively.

Figure 1

Study design incorporating FoK and TPACK frameworks in science video creation workshops



The workshop: Pre- to post-creation of science videos

The workshop was designed using the Workshop Project (Calkins, 1986) and reflected the cyclical nature of action research in science education (Laudonia et al., 2018). It included pre-production activities such as screenshot editing, recording, and editing audio/video clips; production activities such as the actual composition of the science videos; and post-production activities focused on evaluation and reflection. These phases were repeated cyclically, aligning with the action research framework. Participants used WeVideo (2023) and other resources for the video creation process, with the authors available throughout the workshop to provide support and guidance. The workshop-produced videos explored various scientific concepts, including heat transfer through dumpling preparation and cooking, scientific versus superstitious beliefs about meteors, energy conservation in sports, and light refraction affecting the apparent depth and position of objects in a pool.

Data collection and analysis

Pre- and post-questionnaire

A 12-item Likert scale questionnaire, developed a year before the study, was used to assess the impact of the science video creation workshops. The questionnaire, ranging from 1 (strongly disagree) to 5 (strongly agree), was based on Morel's Matrix (Trucano, 2016), a framework for integrating Information and Communication Technology (ICT) in education. The Matrix categorizes ICT integration into four levels: Emerging, Applying, Integrating, and Transforming. The "Emerging" level involves initial exposure to ICT tools; the "Applying" level uses ICT to support existing teaching practices; the "Integrating" level deeply incorporates ICT into the curriculum to enhance learning outcomes; and the "Transforming" level represents the highest integration, where ICT fundamentally changes teaching and learning, fostering innovation and dynamic experiences.

Sample questions from the questionnaire included items assessing the participants' awareness of applicable science content for ICT use, their ability to identify specific ICT tools for given science concepts, and their capability to outline strategies that align science content with ICT tools. The questions were classified according to the four levels of Morel's Matrix (Table 1).

Table 1

Categorization of questions by levels of ICT integration in science education

Morel's Matrix	Question Number	Theme
Emerging	Q1	Awareness of ICT in Science Content
	Q4	Familiarity with ICT Devices for Presentations and Visual Aids
	Q9	Knowledge of ICT to Improve Students' Learning
Applying	Q2	Identifying ICT Tools for Science Concepts
	Q5	Familiarity with ICT Devices' Strengths and Weaknesses
	Q6	Facilitating Student Collaboration using ICT
Integrating	Q7	Creating Multimedia Presentations using ICT
	Q8	Creating Inquiry-Based Activities using ICT
	Q10	Creating Digital Assessments using ICT
Transforming	Q3	Conviction in ICT Supporting Student Learning
	Q11	Encouraging Creation of ICT Applications and Solutions
	Q12	Communicating Science Concepts with ICT

The questionnaire underwent content validation through a thorough literature review and expert feedback and was piloted with separate groups of 24 pre-service science teachers at the same Philippine university. A pre-test was administered before the workshops, followed by two course meetings of 1.5 hours each, involving science video creation workshops as part of the course requirement. A post-survey was then conducted. The pre- and post-survey responses were analyzed for construct validity using exploratory factor analysis (EFA) (Kan & Fabrigar, 2018). The pre-survey showed an adequate model fit with three factors explaining 71.8% of the variance, although some items, like Q4_Pre, had high uniqueness. Low inter-factor correlations indicated good discriminant validity, suggesting the pre-survey was reasonably valid but might need item review. However, the post-survey revealed issues, with only one factor explaining 41.5% of the variance, poor model fit, and high item uniqueness. Consequently, two questions

(Q11_Post and Q12_Post) were modified to better capture the underlying constructs and were employed in this current study.

The current pre- and post-survey questionnaires used in this study were analyzed using descriptive statistical analysis and paired t-tests to measure the effect of the science video creation workshops as an intervention, using Jamovi (2023).

Interviews and Focus Group

Individual interviews and focus group discussions were conducted to explore pre-service teachers' experiences with integrating FoK into science teaching and enhancing their TPACK through video creation. The individual interviews, lasting 30–45 minutes each, involved ten of the 14 participants and focused on the benefits, challenges, and impact of video creation on FoK and TPACK development. Four focus group discussions, extending 40-45 minutes each with three to four participants, further examined strategies for incorporating FoK in science teaching and the role of video creation in this process. Interview and focus group responses were transcribed and anonymized by a graduate student familiar with Philippine pre-service teacher education contexts. Before data analysis, the first author briefed the student on the study's conceptual frameworks—FoK, TPACK, and action research. Member checking was conducted by the course instructor, and thematic coding followed Braun and Clarke's (2022) framework. Coding was carried out separately by the first author, an instructor, and graduate student using Excel, with themes grounded in discussions on FoK, TPACK, and technology integration.

Data Triangulation

More than 80% of the themes generated independently by the three coders aligned, while the remaining 20% were reconciled through online discussions over three consecutive weeks. Differences were resolved through collaborative deliberation, leading to a consensus on both initial and overarching themes. The finalized themes were refined through open, axial, and selective coding stages (Corbin & Strauss, 2008). The themes identified during selective coding (Appendix 1) were further triangulated with quantitative findings from pre- and post-survey questionnaires.

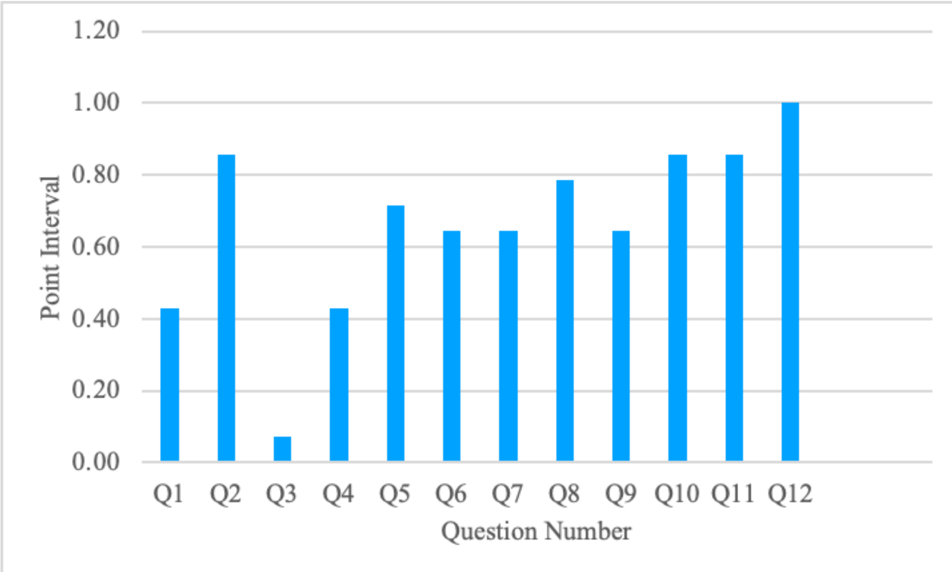
Results

Quantitative analysis: Pre- and post-intervention findings

The quantitative analysis of the pre- and post-survey data revealed significant improvements in pre-service teachers' technology adoption and utilization following the science video creation workshops. As illustrated in Figure 2, there was a positive overall improvement in mean scores across all survey questions. The most notable increase was observed in Q12, with a mean difference of 1.0, indicating a substantial enhancement in the participants' confidence and skills in integrating technology into their teaching practices. Significant improvements were also recorded for Q2, Q10, and Q11, each with a mean difference of 0.86, highlighting the workshops' effectiveness in fostering a deeper understanding of technology's role in education.

Figure 2

Pre-post mean difference for each question



Moderate improvements were noted in Q5, Q6, Q7, and Q9, with mean differences ranging from 0.64 to 0.71, suggesting that while the workshops were effective in these areas, there is still room for further development. The least improvement was seen in Q3, with a mean difference of only 0.07, indicating that this particular aspect of technology integration may require additional support or different instructional approaches.

Pre-intervention scores were highest for Q3, indicating that participants already had a strong foundation in this area, which could explain the minimal improvement post-intervention. Conversely, the lowest pre-intervention scores were recorded for Q6, Q7, Q8, and Q12, all of which showed considerable gains post-intervention, demonstrating the workshops' success in addressing initial gaps in knowledge and skills.

Table 2 presents the detailed statistical analysis, including standard deviations and p-values from paired t-tests, providing further insights into the variability and significance of the changes observed. The standard deviations before and after the intervention highlight the reduction in response variability, suggesting a more consistent understanding and application of technology among the participants. For instance, Q2's pre-intervention mean (SD) of 3.79 (0.89) and post-intervention mean (SD) of 4.64 (0.50) reflect a significant improvement in both mean score and consistency. Similarly, Q12's pre- and post-intervention mean scores of 3.79 (0.89) and 4.79 (0.43), respectively, demonstrate substantial progress and reduced variability.

The p-values from the paired t-tests indicate statistically significant improvements across most questions, with nine out of twelve questions showing p-values below the 0.05 threshold. For example, Q11, with a p-value of 0.003, reinforces the effectiveness of the intervention in enhancing pre-service teachers' technology integration skills. However, Q3, with a p-value of 0.336, did not show a statistically significant change, suggesting that this area was less impacted by the workshops.

Table 2

Standard deviation and paired t-test

Question number	Mean (SD) Pre	Mean (SD) Post	t-statistic	df	p-value
Q1	4.29 (0.61)	4.71 (0.47)	-3.12	13	0.008
Q2	3.79 (0.89)	4.64 (0.50)	-2.92	13	0.002
Q3	4.93 (0.27)	5.00 (0.00)	-1.00	13	0.336
Q4	4.43 (0.65)	4.86 (0.37)	-2.12	13	0.054
Q5	4.07 (0.73)	4.79 (0.43)	-2.92	13	0.012
Q6	3.79 (0.89)	4.43 (0.51)	-2.22	13	0.045
Q7	3.71 (0.83)	4.36 (0.50)	-1.98	13	0.069
Q8	3.64 (0.75)	4.43 (0.51)	-3.29	13	0.006
Q9	4.07 (0.83)	4.71 (0.47)	-2.59	13	0.022
Q10	3.86 (0.77)	4.71 (0.47)	-3.12	13	0.008
Q11	3.93 (0.73)	4.79 (0.43)	-3.71	13	0.003
Q12	3.79 (0.89)	4.79 (0.43)	-3.61	13	0.003

Overall, the quantitative findings underscore the science video creation workshops' effectiveness in enhancing pre-service teachers' positive attitudes toward technology use in education. These results provide clear evidence that the integration of FoK and TPACK frameworks within an action research context can significantly improve technology adoption among pre-service science teachers.

Qualitative analysis:

Themes from interviews and focus group discussions

The qualitative analysis of the individual interviews and focus group discussions provided additional insights into the pre-service teachers' experiences and perspectives on the science video creation workshops. The thematic analysis, represented in Table 3, identified several key themes that were consistent across both data collection methods.

Table 3

Selective coding: Counts and overall percentages of sub-themes mentioned in focus group discussions and individual interviews

Main Themes	Sub-Themes	Focus Group Mentions	Individual Interview Mentions	Overall Percentage
1. Enhancing Teaching and Learning through Contextual and Relatable Content				
	Contextual Learning	15	12	5
	Meaningful Integration	20	18	7
	Connecting Science Concepts to Real Life	10	11	4
	Enhancing Teaching and Learning	12	15	5
	Building Student Identity and Engagement	8	10	3
	Cultivating Curiosity	5	6	2
	Effective Teaching and Learning	18	14	6
2. Leveraging Technology to Improve Pedagogical Practices				
	Promoting Engagement and Accessibility	14	13	5
	Integration of Technology in Pedagogy	9	8	3
	Reflecting on Teaching Methods	11	10	4
	Catering to Diverse Learning Styles	13	11	4
	Technological Limitations	7	6	2
	Conceptual and Creative Difficulties	8	7	3
	Time Constraints	9	8	3
	Collaborative Efforts	6	7	2
	Environmental and Resource Challenges	5	6	2
	Expanding Knowledge through Observation and Reading	10	9	3
	Linking Learning to the Real World	11	10	4
	Activating Prior Knowledge	8	7	3
	Improving Teaching Pedagogies and Approaches	10	11	4
3. Fostering Inclusivity and Cultural Responsiveness				
	Inclusivity	9	8	3
	Building Emotional Connections	12	10	4
	Culturally Responsiveness Pedagogy	7	7	3
	Responsive Teaching	14	13	5
	Promoting Interactive Learning	8	7	3
	Differentiating Instruction	6	5	2
	Creative Learning in Authentic Contexts	5	6	2
	Making Science Relevant to Students	11	10	4

In addition, Table 3 presents a structured analysis of key themes derived from focus group discussions and individual interviews with pre-service teachers. It details the number of times these themes were mentioned in focus groups and individual interviews, providing a clear quantitative overview of the main areas of interest and concern among the pre-service teachers. Moreover, Table 3 allows for easy comparison and highlights the most significant themes discussed during the coding process.

Contextual learning and relatable content

A recurring theme in both the interviews and focus groups was the importance of contextual learning and the integration of relatable content, showing a combined 32% of the overall percentage among the three main themes under selective coding. The top three sub-themes evident from pre-service teachers' interviews and focus group discussions were meaningful integration (7%), effective teaching and learning (6%), and contextual learning (5%) and enhancing teaching and learning (5%). Pre-service teachers emphasized that incorporating real-world scenarios into their science videos made the science concepts more engaging and accessible to students. For example, one pre-service teacher remarked, "Integrating real-world scenarios like cooking dumplings and observing sports (there was a university-wide sports competition during the workshops) events made us more engaged in our video storyline creation and curious about heat transfer and energy conservation concepts," underscoring the value of contextual learning in enhancing student engagement and comprehension.

Leveraging technology to improve pedagogical practices

Another significant theme, the highest overall percentage among the three main themes at 42%, was the role of technology in improving pedagogical practices. The number of sub-themes was also at the highest count of 13 and included insights on promoting engagement and accessibility, catering to diverse learning styles, and improving pedagogies. Pre-service teachers reported that the workshops helped them understand how to effectively and creatively integrate technology into their teaching methods, leading to more interactive and inclusive learning experiences. One participant noted, "the WeVideo editing software was user friendly. It has allowed us to create more interactive video effects, transitions and media which can cater to diverse learning styles of our future students." While this feedback highlights how technology can create an engaging and inclusive learning environment, pre-service teachers noted challenges, including a steep learning curve and the significant instructional time required.

Fostering inclusivity and cultural responsiveness

The third major theme focused on fostering inclusivity and cultural responsiveness in the classroom with an overall 26% of rating in terms of insights of pre-service teachers regarding the importance of TPACK, FoK, and technology integration. Pre-service teachers started to recognize the importance of integrating students' cultural backgrounds and everyday experiences into the curriculum, a principle aligned with the FoK framework. One participant mentioned, "our learning experience creating a video on the scientific and superstitious perspectives of comets has provided me insights on building cultural and emotional connections with our future students," reflecting the significance of culturally responsive pedagogy in making science education relevant and relatable to diverse student populations.

Challenges and areas for improvement

Despite the positive outcomes, pre-service teachers also identified several challenges that need to be addressed to fully realize the potential of science video creation as a teaching tool. These included technological limitations, such as unstable internet connections on campus, availability and accessibility of video editing platforms and subscriptions, and time constraints during the planning and production of videos. The challenges highlighted the need for better support in terms of infrastructure, costs, and more time allocated to mastering the technical aspects of video creation, such as storyboarding, layering, and editing. While these challenges can guide future research, a key question also arises: how might the integration of FoK, TPACK, and action research in brief interventions like video workshops lead to meaningful and lasting shifts in pre-service science teachers' beliefs and practices across culturally diverse contexts?

Discussion

The integration of quantitative and qualitative findings offers a comprehensive understanding of the impact of the science video creation workshops on preservice teachers.

Science video creation workshops as a positive intervention

This study's findings suggest that science video creation workshops, when integrated with the FoK and TPACK frameworks, represent a positive intervention for enhancing technology adoption and utilization among preservice science teachers. The quantitative analysis indicated significant improvements across various metrics, highlighting the workshops' effectiveness in fostering positive beliefs toward technology integration. The statistical analysis, which included detailed p-values and mean difference scores, confirmed that the intervention led to substantial enhancements across all four levels of Morel's Matrix—emerging, applying, integrating, and transforming. This supports the argument that deliberate and well-structured interventions can effectively improve preservice teachers' readiness to integrate technology into their teaching practices (Ben-David Kolikant et al., 2020).

Despite the small sample size (n=14), the quantitative findings are encouraging, especially in the context of the Philippines' ongoing efforts to implement large-scale educational technology initiatives (Tembrevilla, 2020; Trucano & Dykes, 2017). As technology becomes increasingly embedded in Filipino classrooms, pre-service teachers might overcome barriers such as limited access to resources, insufficient TPACK development, and a lack of awareness of students' evolving needs. These workshops, grounded in action research, provided an opportunity for pre-service teachers to understand and navigate these challenges, gradually equipping them with the skills and confidence needed to integrate technology effectively in their future classrooms.

The study's findings that science video creation workshops as a positive intervention align with existing literature, which emphasizes that teachers' beliefs play a crucial role in their willingness to adopt new technologies in their teaching (Tembrevilla & Milner-Bolotin, 2019; Ben-David Kolikant et al., 2020; Ottenbreit-Leftwich et al., 2010). The significant statistical improvements observed indicate that science video creation workshops may have an impact on these beliefs. However, this finding should be interpreted with caution due to the extremely small sample size. Moreover, the study contributes to the relatively limited body of research on the use of teacher-created videos for professional development, highlighting the cyclical nature of action research as a valuable approach in this context (Tembrevilla & Milner-Bolotin, 2024).

Enhancing teaching through contextual and relatable content

One of the key themes that emerged from the qualitative analysis was the importance of contextual and relatable content in teaching. Pre-service teachers integrating FoK into their science videos during the workshops enable them to slowly reflect on designing lessons that resonate more deeply with their future students. As one pre-service teacher noted, "Integrating FoK in my future science classes requires time and thinking but is a better way to enhance my student's understanding of science and its relation to their daily lives." This sentiment reflects the broader literature on contemporary science teaching, which advocates for drawing on students' cultural knowledge and lived experiences to create more meaningful learning experiences (Bang, 2015; Gomez & Lee, 2015; González et al., 2005).

Embedding FoK into the curriculum also has a positive impact on pre-service teachers' TPACK development. By understanding their students' backgrounds and experiences, they can tailor their pedagogical strategies more effectively, slowly leading to a more integrated and holistic approach to teaching and integrating available technology. As another pre-service teacher highlighted, "Integrating FoK in our future science classes means knowing our students well and guides us to explore how to develop our TPACK." This statement underscores the interconnectedness of FoK and TPACK, suggesting that culturally responsive teaching practices can significantly enhance pre-service teachers' ability to leverage technology in their instruction.

Improving pedagogical practices through technological integration

The integration of technology in the creation of educational content, particularly FoK-based videos, emerged as another significant theme from the quantitative and qualitative data. This process was found to enhance pre-service science teachers' TPACK by providing them with hands-on experience in using various technological tools like video editing software. One pre-service teacher reflected, "Creating science videos during the workshop enhanced my understanding of technology integration through different multimedia while making concepts like refraction and heat transfer more relatable for my future students."

The role of multimedia in enhancing learning is well-documented in the literature. According to multimedia learning theories (Mayer, 1997), students learn more effectively when information is presented through multiple channels. The workshops' emphasis on digital tools allowed pre-service teachers to explore new ways of presenting complex scientific concepts visually, which not only fostered better comprehension but also prepared students for a world increasingly dominated by technology. The improvement in pre-service teachers' positive beliefs about technology integration can also be attributed to the collaborative and reflective nature of the workshops, which aligns with findings from other studies on TPACK and teacher education programs (Choe, 2017; Koumi, 2015). However, it should be emphasized that while these workshops with the used of friendly-user and accessible multimedia tools encouraged creative approaches to presenting scientific concepts and improved pedagogical practice among pre-service teacher-participants, their limited duration and one-time implementation constrain their long-term impact. Regular and sustained implementation is needed to generate more meaningful and reliable results.

Fostering inclusivity and cultural responsiveness

A third major theme identified was the role of FoK in fostering inclusivity and cultural responsiveness in the classroom. Incorporating students' cultural backgrounds into the curriculum ensures that all students feel valued and respected, which is essential for creating an equitable and a safe learning environment. Culturally responsive teaching practices have been shown to improve outcomes for diverse student populations by building stronger emotional connections and promoting a greater understanding of different perspectives (Bang, 2015; Gomez & Lee, 2015; González et al., 2005). As one pre-service teacher remarked, "Creating a video on the competing perspectives of the appearances of meteors and comets, scientifically and superstitiously, I am becoming more aware of my students' family and cultural identity."

Integrating Funds of Knowledge (FoK) in video workshops aligns with the Philippine K-12 curriculum's emphasis on contextualized teaching, enriching instruction by incorporating local culture and history (Tembrevilla, 2020). This approach not only enhances student engagement but also fosters a more inclusive classroom where students see their experiences reflected in the content. While the qualitative data are limited and self-reported, interviews and focus group discussions with pre-service science teachers highlight the value of recognizing students' household and family knowledge in making science instruction more meaningful and welcoming.

Conclusion

This study examined the impact of science video creation workshops, integrating FoK and TPACK frameworks, on the adoption and utilization of technology among Filipino preservice science teachers. The findings provide initial evidence that these workshops are forms of positive intervention for enhancing technology integration in science teaching. The quantitative analysis revealed significant improvements across all four levels of Morel's Matrix—emerging, applying, integrating, and transforming—demonstrating the workshops' effectiveness in positively influencing preservice teachers' attitudes and beliefs about technology use in education.

The study also highlighted critical barriers to effective technology integration, including access to resources, TPACK development, and appropriate beliefs about the benefits of technology. By addressing these barriers through targeted interventions like science video creation workshops, pre-service teachers can develop the necessary skills and knowledge to integrate technology more effectively into their teaching practices. These findings align with existing literature, which emphasizes the significant influence of teachers' beliefs on their use of technology in the classroom.

Moreover, the study underscores the importance of culturally responsive teaching and the inclusion of students' FoK in the curriculum. Recognizing and valuing students' cultural backgrounds allows teachers to create more inclusive and engaging learning environments. The triangulation of quantitative and qualitative data revealed positive growth in pre-service teachers' views on technology integration, focusing on three key themes: enhancing science teaching through contextual content, improving pedagogical practices with technology, and fostering inclusivity and cultural responsiveness.

The study also emphasizes the value of incorporating action research into the context of science education, particularly in Asian settings like the Philippines. Action research through collaborative workshops enables teachers to engage in a cyclical process of reflection, action, and evaluation, fostering gradual awareness on how to improve their teaching practices. This approach is especially relevant in the Philippine science education context, where there is a need among science teachers for quality and responsive educational strategies to address diverse student needs both in rural and urban contexts.

Finally, while short-term, interventions like video creation workshops can serve as powerful catalysts for change in preservice teachers’ technology integration practices by boosting confidence, sparking creativity, and encouraging contextualized use of digital tools. While the workshops alone may not guarantee long-term transformation, they provide a strong foundation for reflective practice and continued experimentation, especially when grounded in frameworks like FoK and TPACK. However, the impact of such interventions varies significantly depending on the level of digital infrastructure and prior exposure to technology. In well-resourced settings, preservice teachers tend to adopt and transfer these practices more readily, while in under-resourced or rural contexts, such as those in parts of the Philippines, barriers like limited access to devices, internet, and technical support may hinder implementation. Still, even in these contexts, the workshops offer a meaningful first step toward bridging gaps in digital readiness and fostering inclusive, culturally responsive science teaching.

Future research should consider increasing the sample size to further validate these findings and explore the sustainability and long-term impacts of science video creation workshops on pre-service teachers' technology integration. Additionally, assessing the effectiveness of similar interventions in various educational contexts and subjects could offer broader insights into the generalizability and scalability of this approach. A longitudinal study design would be particularly valuable in evaluating the sustained impact of these workshops on teachers' professional development and classroom practices.

Furthermore, integrating action research into future studies can provide a deeper understanding and more efficient application of theory and evidence in the teaching practices of pre-service science teachers. This approach will help bridge the gap between research and practice, ensuring that educational innovations are effectively implemented in the classroom, ultimately benefiting both teachers and students in diverse educational settings.

Acknowledgements

We would like to express our sincere thanks to the science pre-service teachers at West Visayas State University, College of Education in La Paz, Iloilo City, Philippines, whose participation was invaluable to this research. This work was supported by New Scholars Grant, Mount Saint Vincent University, Halifax, Nova Scotia, Canada.

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Appendix

Open-Axial-Selective Coding

Individual Interviews: Open Coding Stage	Descriptions	Focus Group Discussion: Open Coding Stage	Descriptions
Contextual Learning	Integrating FoK allows science lessons to be more relatable by connecting them to students' everyday lives and experiences. This contextual approach helps students see the relevance and application of scientific concepts in their own contexts.	Contextual Learning	
Building Student Identity and Engagement	FoK helps in building a sense of identity and connection among students. By incorporating their backgrounds and experiences into the curriculum, students are more likely to engage and participate actively in the learning process.	Meaningful Integration	
Meaningful Integration	FoK serves as a guide for teachers to prepare lessons that students can easily understand and relate to. This approach ensures that the content is not only educational but also meaningful and relevant to students' lives.	Responsive Teaching	Understanding students' FoK helps teachers ad their pedagogical strategies to meet the diverse of their students, making education more respo and effective.
Connecting Science Concepts to Real Life	FoK enhances student engagement and retention by presenting science concepts in a way that is interesting and relatable through real-life scenarios. This helps students see the practical applications of what they are learning.	Cultivating Curiosity	Leveraging students' FoK can help ignite their interest and curiosity in the subject matter, lead a more engaging and dynamic learning environ
Inclusivity and Cultural Responsiveness	By valuing and incorporating students' diverse cultures, beliefs, and traditions, FoK ensures that all students feel seen and included. This approach fosters a more inclusive and culturally responsive learning environment.	Effective Teaching and Learning	
Enhancing Teaching and Learning	Creating science videos helps pre-service teachers improve their TPACK by mastering scientific content, enhancing technological skills, and providing engaging and inclusive lessons.	Expanding Knowledge through Observation and Reading	Encouraging students to be observant and enga with different sources of knowledge, such as ta to elders or reading books, helps broaden their understanding and FoK.
Catering to Diverse Learning Styles	Science videos cater to visual learners and make lessons more engaging and enjoyable. This method helps accommodate different learning preferences and needs.	Linking Learning to the Real World	Integrating FoK helps students understand and connect lessons to their daily lives, making the learning process more relevant and practical.
Promoting Engagement and Accessibility	Science videos make learning materials more accessible and enjoyable, helping students grasp concepts more effectively. This approach combines lesson content with an engaging format.	Activating Prior Knowledge	Utilizing students' existing knowledge and experiences makes it easier for them to grasp n concepts, enhancing the interactive nature of le
Integration of Technology in Pedagogy	Creating videos challenges teachers to explore new technologies and software, which enhances their technological skills and helps them create compelling educational content.	Building Emotional Connections	Creating lessons based on students' daily lives build emotional connections between the teach students, fostering a more engaging learning environment.
Reflecting on Teaching Methods	The process of creating science videos allows teachers to assess and improve their teaching methods, ensuring that their pedagogical strategies are effective and aligned with technological advancements.	Improving Teaching Pedagogies and Approaches	Developing skills in creating FoK-based video teachers improve their teaching methods and a various pedagogical approaches to cater to dive learners.
Technological Limitations	Pre-service teachers face challenges such as low-performing devices, slow Internet on campus, lack of free video editing software, and limited storage, which hinder the video creation process.	Promoting Interactive Learning	Integrating FoK makes learning more interacti collaborative, as students feel more connected content and are more likely to participate activ
Conceptual and Creative Difficulties	Creating engaging and relatable science videos requires significant conceptual and creative effort to	Building Emotional Connections	Understanding and integrating students' FoK al teachers to connect with their students emotion building a strong foundation for effective teach

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Please Cite: Tembrevilla, G., Rosano, D., Magno, R & Manicio, M. T. (2025). Integrating FoK and TPACK in Action Research: The impact of Video Creation Workshops on Pre-service Science Teachers in the Philippines. *The European Educational Researcher, 8*(3), 1-24. DOI: https://doi.org/10.31757/euer.831

Conflict of Interest: The authors declare no conflicts of interest related to this study.

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Data Availability Statement: The data that support the findings of this study are available from the corresponding author.

Ethics Statement: This study received ethical approval from the Mount Saint Vincent University Research Ethics Board in Canada (File No. 2022-001) and the West Visayas State University Unified Research Ethics Review Committee in the Philippines (Protocol No. WVSU.URER-2022.PR_011).

Author Contributions: First author: Conceptualization, literature revuew, methodology, data collection, analysis, writing—original draft, ethics approvals. Second author: Data analysis support, ethics approvals, writing—review and editing. Third author: Validation, supervision, writing—review and editing. Fourth author: Project administration, ethics approvals, writing—review and editing.

Received: March 06, 2025 ▪ Accepted: July 20, 2025