ITEACH IN ACTION: AN INTEGRATIVE PARTNERSHIP MODEL FOR EDUCATIONAL ADVANCEMENT AND HOLISTIC LEARNING AMONG HIGHER EDUCATION INSTITUTIONS

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Abstract
This study aimed to address critical professional development needs among educators in two partner schools, identified through a needs assessment that highlighted gaps in Research and Action Research, Technological Pedagogical Content Knowledge (TPACK), and Technology and Skills Assessment. A three-day training program was designed with objectives to: (a) enhance educators' competencies in conducting research and action research through data analysis, ethical practices, and classroom-based inquiry; (b) strengthen TPACK by integrating emerging technologies with pedagogical strategies; and (c) improve proficiency in digital tools for teaching and assessment via hands-on workshops on coding, data analysis software, and engagement platforms. Subject-specific innovations were incorporated across English, Filipino, Mathematics, Science, and Physical Education, tailoring strategies to disciplinary contexts. A one-group pretest–posttest design was employed with 85 faculty members and instructional staff participating in interactive lectures, collaborative workshops, and guided action research planning sessions. Sessions were facilitated by subject-matter experts and emphasized practical application, peer feedback, and reflective problem solving. Post-test results revealed significant improvements across all focus areas, with participants demonstrating enhanced research skills, increased confidence in technology integration, and greater proficiency with digital teaching tools. Limitations of the design, including potential maturation effects, testing effects, and uncontrolled confounders, were acknowledged. Nonetheless, the findings underscore the effectiveness of targeted, contextually relevant training in equipping educators with 21st-century teaching competencies. Practical implications highlight the value of discipline-specific interventions and the need for follow-up measures to sustain long-term transfer to classroom practice.

Keywords: *ITEACH, TPACK, research and action research, pre-test and post-test.*

INTRODUCTION

In the rapidly evolving landscape of education and community development, extension projects play a vital role in fostering progress and driving meaningful societal change. Community extension initiatives were established to respond to diverse social needs and community challenges (Corpuz et al., 2022). Through collaboration and capacity-building, extension programs bridge the gap between academic institutions and communities, translating knowledge into practical solutions that promote sustainable growth.

Central Mindanao University (CMU), as a premier higher education institution in Mindanao, remains steadfast in its mandate of instruction, research, and extension. Beyond providing quality education, CMU actively engages with partner schools, agencies, and communities to respond to their unique needs and foster mutual growth. One of its major research, development, and extension efforts focuses on extending expert services and technical assistance tailored to the specific requirements of its partner institutions. Through its extension programs, CMU seeks to improve educational practices, build institutional capacity, and promote sustainable community development (CMU Extension Office, 2025).

In line with this commitment, the Integrative Techniques for Educational Advancement, Collaboration, and Holistic Learning (ITEACH) Project was conceptualized. This initiative represents a collaborative partnership among the College of Education of Central Mindanao University, Mountain View College, and Don Carlos Polytechnic College. As reflected in its acronym, ITEACH embodies CMU's mission to go beyond classroom instruction by integrating technology, research, and innovative pedagogical approaches in teaching and learning. Moreover, it serves as a platform for professional collaboration, fostering shared expertise and continuous professional development among educators.

A needs assessment conducted in two partner schools revealed critical areas requiring development, particularly in Research and Action Research, Technological Pedagogical Content Knowledge (TPACK), and Technology and Skills Assessment. These findings underscored the urgency of strengthening educators' competencies to meet the evolving demands of 21st-century education (Mishra & Koehler, 2006). Consequently, the project formulated the following general objectives:

(a) to enhance educators' competencies in Research and Action Research through targeted training in data analysis, ethical research practices, and classroom-based inquiry; (b) to strengthen teachers' Technological Pedagogical Content Knowledge (TPACK) by providing practical experience with emerging technologies and integrated teaching strategies; and (c) to improve educators' proficiency in using digital tools and applications for teaching and assessment through hands-on workshops on coding, data analysis software, and engagement platforms.

The program was designed to provide a comprehensive blend of technical, methodological, and pedagogical training. Each day focused on distinct yet interconnected aspects. Building Technical and Analytical Skills (Day 1) focused on data analysis using *Jamovi* and cross-disciplinary coding activities via *Code.org*. Strengthening Research Competence (Day 2) involved hands-on workshops on qualitative and experimental action research design. Applying Innovative Teaching Approaches (Day 3) emphasized integrating technology and pedagogy through engagement tools such as *Mentimeter*, *Slido*, and *Padlet*.

Subject-specific innovations were also explored across disciplines, including English (action research and instructional material development), Filipino (contextualized teaching strategies), Mathematics (flipped classroom models), Science (updated strategies for Physics and Chemistry), and Physical Education (training on pickleball officiating).

Preliminary outcomes demonstrated significant improvements across all focus areas. Post-test results showed enhanced competencies in conducting action research, greater confidence in integrating technology into instruction, and improved proficiency in digital teaching tools. These outcomes affirm the project's success in addressing the identified needs and equipping educators with essential 21st-century teaching competencies.

REVIEW OF RELATED LITERATURE

The succeeding review of related literature is organized based on the relevant disciplines and key components associated with the project.

Technology-Aided Instruction

Technology-Aided Instruction (TAI) has become a cross-cutting approach to teaching and learning, influencing classrooms from basic education to higher education and even lifelong learning programs. What the literature consistently emphasizes is that technology is most effective not by itself, but through the learning activities and pedagogical shifts it supports. Sailer et al. (2024), through a large-scale review of meta-analyses in higher education, observed that digital tools which enabled interactive and constructive engagement produced stronger outcomes compared to those that simply replicated lecture-style delivery. This reinforces the idea that in extension work, technology must be tied to redesigned teaching strategies that cultivate active knowledge-building rather than passive consumption.

In basic education, evidence demonstrates that technology-aided approaches can help improve literacy and foundational skills. Dahl-Leonard et al. (2024) found through a meta-analysis that technology-delivered instruction for elementary students yielded small but consistent positive effects across grade levels. However, their study also highlighted the need for careful attention to implementation supports, such as teacher facilitation and family involvement. This lesson extends to community and extension contexts: local partnerships and parental engagement are crucial to ensure that digital tools translate into real learning gains for young learners.

At the secondary level, digital integration is often framed around preparing students for 21st-century skills. Montero-Mesa et al. (2023) pointed out that while technology is frequently presented as an instrument of innovation in middle and high schools, the sustainability of such innovations depends on strong teacher professional development (TPD). In contexts where teachers lack sustained mentoring and collaborative opportunities, TAI risks being superficial or short-lived. This aligns with extension's focus on capacity building, highlighting the importance of designing professional learning opportunities that are iterative, practice-based, and responsive to teachers' real classroom needs.

In higher education, TAI supports advanced forms of learning, including problem-based tasks, collaborative knowledge building, and self-regulated learning. Wekerle et al. (2024) tested the ICAP framework (Interactive, Constructive, Active, Passive) in university settings and found that interactive and constructive learning activities facilitated by technology strongly enhanced both cognitive and motivational outcomes. Such findings underscore that extension programs engaging higher education faculty should encourage not only the adoption of tools but also the design of digital learning experiences that demand critical thinking and collaboration, with ripple effects on the wider community.

Equity and inclusivity cut across all educational levels. The OECD (2023) reported that digital divides are not limited to device access and connectivity but extend to digital skills, localized content, and meaningful participation. For extension practitioners, this calls for a holistic approach that combines infrastructure support with training, culturally relevant content creation, and strategies to reach digitally marginalized learners, from young pupils in rural schools to adult learners in continuing education.

Taken together, the literature suggests three critical insights that guide the implementation of TAI across educational levels and disciplines. First, technology must be embedded in purposeful, activity-rich pedagogy (Sailer et al., 2024; Wekerle et al., 2024). Second, teacher professional development should be continuous and community-anchored to sustain meaningful change (Montero-Mesa et al., 2023). Third, equity and local ownership should be at the heart of TAI design to ensure inclusivity and long-term impact (Dahl-Leonard et al., 2024; OECD, 2023). These insights resonate with the extension philosophy of co-creation, capacity building, and sustainability, ensuring that TAI becomes a shared community asset rather than a short-term intervention.

Pedagogical Content Knowledge in English

Advancing Pedagogical Content Knowledge (PCK) in English education is essential to enhance teaching quality and student learning outcomes. PCK, first introduced by Shulman (1986), integrates subject matter knowledge with pedagogy, enabling teachers to effectively convey content in ways that facilitate student understanding and engagement (Safitri et al., 2020). In English Language Teaching (ELT), PCK helps teachers to explore and transmit English language content through appropriate instructional strategies tailored to learners' needs (Kalsum, 2017; Faisal, 2015). Studies have revealed challenges in effectively applying PCK in diverse classroom settings, such as managing heterogeneous classes where students have varying abilities and needs (Safitri et al., 2020).

The development of PCK in English teachers requires reflective practice, pedagogical courses, collaboration with peers, and hands-on teaching experiences (Van Driel et al., 2015). Although much PCK research has focused on math and science, attention to English PCK is growing, aiming to capture its multidimensional nature, which includes knowledge of language, literature, and literacy strands in curriculum design and pedagogy (McCrory, 2021). Moreover, the effective measurement of English PCK remains complex due to its multifaceted construct involving content mastery and pedagogical skills (McCrory, 2021).

Pedagogical Content Knowledge in Filipino

According to the study conducted by Juancho (2021) on selected Filipino teachers, although teachers are proficient in technological knowledge, pedagogical knowledge, and content knowledge based on age, gender, and years of service, their competence in TK, PK, and CK continues to advance. They remain committed to striving for excellence in order to nurture and develop productive learners who can keep up with the global demands of education.

Mendoza (2024) demonstrated that cultural background exerts a significant influence on language comprehension in the Philippines, with considerable variations in reading proficiency among students from differing cultural contexts. These findings suggest that effective understanding of textual content is not solely dependent on linguistic ability but also requires consideration of the learners' cultural experiences and contextual frameworks, which shape the interpretation of meaning.

Moreover, in a study conducted, it was found that Audio-Visual, as one of the forms of technology in teaching, is not the only solution to improving the quality of learning; there are also other factors that help develop students' skills, such as language proficiency, analytical ability, and readiness to learn, which may affect students' understanding (Quitolbo & Pontemayor, 2024).

Pedagogical Content Knowledge in Mathematics

Shulman's seminal work positions PCK as the unique blend of content and pedagogy that enables teachers to transform subject matter for learner understanding, later elaborated as part of a broader "knowledge base for teaching." Empirical and conceptual syntheses in mathematics refine this into Mathematical Knowledge for Teaching (MKT), the specialized content and pedagogical understanding teachers use in practice. Effective professional development (PD) that strengthens

PCK/MKT typically features content focus, active learning, coherence with teachers' contexts, sufficient duration, and collective participation features your multi-session design exhibits.

Professional development programs grounded in subject-specific pedagogy have been shown to significantly improve teachers' instructional competence (Borko, 2004). Garet et al. (2001) emphasized that effective professional development is sustained, content-focused, and provides opportunities for active learning. In mathematics, PCK encompasses not only mastery of mathematical concepts but also the ability to anticipate student misconceptions, select appropriate representations, and facilitate problem-solving (Ball, Thames, & Phelps, 2008).

Action research complements PCK development by enabling teachers to identify contextual issues in their classrooms and implement evidence-based solutions (Ferrance, 2000). Studies by Zeichner (2003) and Burns (2010) have documented that teachers engaged in action research become more reflective, adaptive, and student-centered. Furthermore, pretest–posttest designs are widely used to evaluate the effectiveness of such interventions, as they provide direct measures of learning gains over time (Creswell & Creswell, 2018).

Pedagogical Content Knowledge in Science

Although existing studies have provided valuable insights into the PCK and TPACK competencies of science teachers in the Philippines, several important gaps remain. Most of the research has focused on describing teachers' current practices rather than exploring the deeper factors that influence their development of PCK. Many studies have also concentrated on specific subjects, such as chemistry, leaving limited information about how teachers in other science areas like biology or physics apply pedagogical strategies in real classrooms. Furthermore, while the integration of technology has often been mentioned as a challenge, there is still little understanding of how teachers adapt their PCK in response to the rapid shift toward digital and blended learning environments. These gaps highlight the need for further studies that investigate how science teachers' pedagogical and content knowledge evolve through experience, professional learning, and technological change. Addressing these areas could help improve science instruction and teacher training programs across the country.

Pedagogical Content Knowledge (PCK) has been considered as one of the most important foundations for effective teaching across field. In the Philippines alone, numerous studies have been conducted to assess how teachers utilize their understanding of the subject matter with appropriate teaching approach to delivering the content as way of helping students grasp complex scientific ideas. One of the studies was conducted by Lucenario, Yangco, Punzalan, and Espinosa (2016), who introduced a PCK-guided Lesson Study approach among chemistry teachers in the country (Philippines). It was emphasized in the findings that meaningful collaborative planning, observation, and reflection, the participating teachers improved both their classroom competence and their students' academic performance. The study also demonstrated how educators' capacity to link scientific context with appropriate teaching approach can be strengthened by organized professional learning opportunities.

According to the latest PISA 2022 results, Filipino learners gained 356 score in science which indicates significantly below the OECD average scores (OECD, 2023). While this result has been identified on the basis of the performance of the students, this can still be attributed by the ability of the teachers to deliver the content blend with appropriate approach that may significantly affect the performance of Filipino learners. The study conducted by Cordova and Linaugo (2022) found that even most teachers possessed expertise on subject-matter, many are still struggling how to deliver the content to the learners effectively creating a significant gap on digesting the knowledge taught by science teachers. Their results also imply that traditional, lecture-based methods continue to be the preferred method in schools, leaving less space for experiential and inquiry-based learning. Morales (2023) also find out similar trend among chemistry teachers, according to him, even those who are already expert on their subject-matter, still face difficulty in incorporating technology into their classes and thus call for relevant training for technology-driven instruction. However, it is worth noting that despite this difficulty experience by some experienced teachers in the field, they still use digital tools to improve learning in any way possible (Colao, 2023). This has been manifested by the work conducted Sapad and Caballes (2022) and Anud (2023) which shows that science public school teachers demonstrated higher pedagogical content knowledge (PCK) but less competent in pedagogical technological knowledge (PTK) based on the TPACK framework. This limitation is callback for a professional development training to capacitate teachers to effectively integrate technology in the instructional process.

Pedagogical Content Knowledge in Physical Education

Pedagogical Content Knowledge (PCK) is how teachers blend subject matter expertise with effective teaching strategies, while action research involves teachers in systematic inquiry to improve their practices (Bamufleh, Hussain, Sheikh, Khodary, 2020). This review examines the application of PCK and action research in physical education and music education across various educational levels. The integration of technology in the Music, Arts, Physical Education, and Health (MAPEH) subject in the Philippines offers numerous benefits, especially as it was found that teachers leverage various approaches like flipped classrooms and technology-enhanced collaboration to make learning more interactive (Ponsaran, 2024).

Action Research empowers physical education teachers to investigate their teaching practices and implement evidence-based strategies. By engaging in cycles of planning, acting, observing, and reflecting, teachers can refine their instructional methods and enhance student learning (Keegan, 2016).

Both PCK and action research are relevant across all educational levels, from elementary to higher education. At the elementary level, teachers focus on building foundational skills and fostering a love of learning. In secondary education, the emphasis shifts to developing more advanced skills and preparing students for college or careers. At the higher education level, instructors focus on promoting critical thinking and preparing future educators.

METHODOLOGY

This section pertains to the methodology used in the implementation of the Integrative Techniques for Educational Advancement, Collaboration, and Holistic Learning (ITEACH) Project. The methodology outlines the systematic processes undertaken to achieve the project's objectives, from needs assessment to training implementation and evaluation. It details how the activities were designed, organized, and delivered to address the identified gaps in educators' competencies in Research and Action Research, Technological Pedagogical Content Knowledge (TPACK), and Technology and Skills Assessment.

Study Purpose and Context

This extension study, Integrative Techniques for Education Advancement, Collaboration, and Holistic Learning (ITEACH): A Partnership Project Between the College of Education, Mountain View College, and Don Carlos Polytechnic College (Phase 1), aimed to enhance participants' knowledge and capabilities in Pedagogical Content Knowledge (PCK) and action research methodology through a structured, short-term training program. The program was guided by the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) as the overarching framework for training design and delivery, ensuring systematic needs assessment, instructional planning, material development, implementation, and evaluation.

Design, Participants, and Setting

A one-group pretest–posttest design was employed to evaluate learning gains resulting from the three-day training intervention. The study enrolled 85 participants drawn from faculty members and instructional staff across the partner institutions. All participants attended the entire training program, which consisted of interactive lectures, collaborative workshops, and guided action research planning sessions delivered in a combination of in-person sessions and integrated activities within designated training spaces on campus.

Intervention and Training Components

The three-day program comprised three core components: interactive lectures, collaborative workshops, and guided action research planning. Interactive lectures provided foundational and advanced concepts related to Pedagogical Content Knowledge and action research methodology. Collaborative workshops facilitated small-group discussions, peer feedback, and hands-on practice applying concepts to contextually relevant teaching scenarios. Guided action research planning sessions supported teams in articulating research questions, selecting appropriate data collection methods, and drafting an action research plan aligned with their disciplinary contexts. All sessions were facilitated by subject-matter experts and experienced educators from the partner institutions, with opportunities for structured reflection and collaborative problem solving.

Measurement Instruments and Procedures

A single instrument set was administered to participants as both the pretest and posttest. The instruments were designed to assess knowledge domains in Pedagogical Content Knowledge (PCK) and action research methodology. Items included a combination of multiple-choice questions, short-answer prompts, and scenario-based items intended to capture domain-specific knowledge and applied reasoning. To minimize measurement bias, the pretest and posttest used identical item sets, though item-level scoring was standardized to yield comparable knowledge scores across administrations. Prior to administration, instruments underwent expert review for content validity and underwent pilot testing to establish initial item clarity and scoring procedures. Reliability analyses conducted with pilot data indicated acceptable internal consistency for the overall instrument and satisfactory subscale reliability for PCK and action research components.

Data Collection and Ethical Considerations

Participants provided informed consent prior to participation, and the study adhered to ethical principles for educational research, including confidentiality of responses and voluntary participation. Data were collected in a controlled training environment, with assessments administered immediately before the first session (pretest) and after the final session (posttest). Missing data were minimized through administrative checks and participant reminders; any missing responses were examined, and cases with substantial missing data were excluded from the respective analysis as appropriate. The study protocol and instruments were approved by the relevant institutional review boards or ethics committees, with documentation available upon request. Additionally, the university granted an IERC permit for the implementation of the extension project, ensuring full compliance with institutional and regulatory standards.

Data Analysis Strategy

Statistical analyses focused on evaluating changes in knowledge from pretest to posttest. For each knowledge domain (PCK and action research), paired samples t-tests were conducted to assess mean differences between pretest and posttest scores. Where normality assumptions for the difference scores were not met, nonparametric alternatives (e.g., the Wilcoxon signed-rank test) were considered, and results were reported alongside the primary analyses. Effect sizes were computed as Cohen's d for paired samples, with Hedges' g reported if sample size considerations or deviation from normality warranted adjustment. Confidence intervals at 95% were calculated for mean differences and for effect sizes to provide precision estimates.

Reporting and Interpretation

Results are reported with transparency regarding data screening, assumption checks, and handling of missing data. A CONSORT-like flow diagram is provided to document participant enrollment, completion, and analysis inclusion. Limitations associated with the one-group design, such as potential maturation, testing effects due to identical pretest and posttest items, and any uncontrolled confounding factors, are acknowledged. Practical implications focus on contextualized learning gains within each discipline, with recommendations for strengthening future iterations, including the use of parallel forms to mitigate practice effects and follow-up measures to assess long-term transfer to classroom practice.

Ethical and Administrative Details

The study complies with applicable ethical standards for research involving human participants. Informed consent was obtained from all participants, and confidentiality of responses was maintained. Data security practices protected participant information, and findings are reported in aggregate form to prevent identification of individuals or specific teams.

Follow-Up and Future Work

Future studies should consider incorporating a control or comparison group to strengthen causal inferences, employing parallel forms of assessment to reduce testing effects, and including longitudinal follow-ups (e.g., classroom observations, implementation fidelity checks) to assess sustained transfer of learning into teaching practice. A detailed rubric and scoring conventions for both PCK and action research domains should be published to enhance replicability and comparability across sites.

RESULTS AND DISCUSSION

Generally, the results of the post-test conducted for Research and Action Research, TPACK (Technological Pedagogical Content Knowledge), and Skills Assessment/Technological Tools show significant improvement following the training. The table below presents the results of the pre-test and post-test on Research and Action Research. The findings reveal that there was a significant difference between the pre-test and post-test results, indicating a substantial improvement in the participants' knowledge and skills in conducting research and applying action research principles in their teaching practice.

Paired Samples T-Test

			Statistic	p
pretest	posttest	Wilcoxon W	532	< .001

The results suggest that the participants developed stronger competencies in several key areas of research, including data reduction and analysis**,** visual representation of findings**,** ethical research practices**,** and identifying actionable classroom problems. These improvements reflect the participants' growing ability to engage in systematic inquiry and evidence-based decision-making to enhance teaching and learning outcomes.

This improvement suggests that the training effectively enhanced participants' understanding, practical skills, and their ability to integrate technology into teaching practices. It highlights the positive impact of the training program in developing the essential competencies required for conducting research, applying pedagogical knowledge, and utilizing technological tools efficiently in educational settings. Below are the specific results and discussion for each area of study.

Technology-Aided Instruction

The study began with a needs analysis of teacher participants from partner institutions. Results indicated that while many teachers were eager to adopt technology in teaching, they lacked structured training in two priority areas: introducing computer science fundamentals and applying quantitative statistical tools in classroom and research contexts. Teachers reported that they were familiar with some digital platforms but needed more confidence in using structured programs such as *code.org* and Jamovi.

To address these gaps, a three-day training workshop was conducted. The first module focused on *Introduction to Computer Science Fundamentals* through *code.org*. Participants engaged in block-based coding activities designed to build computational thinking and problem-solving skills. The interactive and gamified design of the platform was well received, as teachers found it both accessible and directly applicable to their own instruction. This outcome is consistent with recent findings that block-based coding environments significantly improve teachers' confidence in introducing computational concepts while fostering problem-solving and logical reasoning (Grover & Pea, 2024).

The second module introduced Basic Quantitative Statistical Tools using Jamovi, with practical exercises on data entry, descriptive statistics, t-tests, and correlation. Teacher-participants emphasized that Jamovi's intuitive interface lowered the barriers often associated with statistical software, enabling them to apply data analysis in classroom assessments and action research. Similar conclusions were reached by Navarro et al. (2023), who highlighted Jamovi's value in democratizing access to statistical analysis for educators and non-specialists.

Paired Samples T-Test

			Statistic		p
pretest	posttest	Wilcoxon W	225	[a]	< .001

Pedagogical Content Knowledge in English

Following the workshop, monitoring and evaluation activities were conducted to assess the impact of the training. The table below presents the results of the pre-test and post-test on Pedagogical Content Knowledge (PCK) in English. The results reveal that there was a significant difference between the pre-test and post-test scores. This indicates that the training or intervention had a positive impact on the participants' PCK in English. Specifically, the findings suggest an increase in the participants' confidence in applying action research methods to their teaching practice, as well as notable improvements in their ability to design instructional materials that are well-aligned with pedagogical goals and learner needs.

Paired Samples T-Test

			Statistic	p
pretest	posttest	Wilcoxon W	0.00	< .001

The successful completion of the needs analysis demonstrates the critical importance of grounding professional development initiatives in actual educator needs. By tailoring the training flow around these identified needs, the program ensured relevance and practical value, which likely contributed to the active engagement and positive feedback observed during the workshop.

The three-day training model proved effective in delivering concentrated but comprehensive exposure to action research concepts and instructional material design. This aligns with the literature suggesting that focused, hands-on training can enhance teacher competence in applied research and curriculum development within relatively short time frames.

Monitoring and evaluation results underline the benefits of an iterative approach to capacity building, where continuous feedback informs both immediate training adjustments and future planning. The reported increases in participants' confidence and skills validate action research-based training as a viable strategy for advancing pedagogical content knowledge in English education across multiple levels.

Pedagogical Content Knowledge in Filipino

The table below presents the results of the pre-test and post-test on the Pedagogical Content Knowledge (PCK) in Filipino. The findings reveal that there was no significant difference between the pre-test and post-test results. This suggests that the intervention had a limited measurable effect on participants' overall PCK performance. One possible reason for this outcome is the limited number of participants involved in the study. With a small sample size, it is difficult to capture meaningful variations and establish statistical significance. Increasing the number of participants in future implementations may yield more reliable and representative results.

Paired Samples T-Test

			statistic	df	p
pretest	posttest	Student's t	-0.839	8.00	0.426

However, despite the lack of significant difference in quantitative results**,** qualitative observations during the workshops indicate positive outcomes in terms of participant engagement and professional growth. Study 3 focused specifically on enhancing PCK in Filipino through workshops on contextualized teaching strategies, which included: *Paggawa ng kagamitang pampagtuturo* (teaching material development), *Paggawa ng poster* (poster-making), and *Paglikha ng awitin* (song creation).

These activities aimed to help teachers contextualize and localize instruction, allowing them to make learning more relevant and meaningful to their students. During the workshops, participants demonstrated high levels of enthusiasm, willingness to learn, and active participation. They collaborated effectively and showed creativity in developing instructional materials aligned with Filipino language teaching standards.

Furthermore, the evaluation results of the workshops were rated as *excellent*, reflecting participants' satisfaction with the content, strategies, and facilitation of the sessions. This implies that while the quantitative improvement in test scores was not significant, there was substantial growth in pedagogical awareness, motivation, and skill application**.**

In summary, the findings highlight the importance of considering both quantitative and qualitative indicators when assessing professional development outcomes. Future studies could strengthen the results by increasing the number of participants, extending the duration of training, and incorporating follow-up evaluations to measure long-term impact on classroom practice.

Pedagogical Content Knowledge in Mathematics

The pretest mean score for Pedagogical Content Knowledge (PCK) in Mathematics was 15.48 (SD=4.48), and the posttest mean increased to 17.19 (SD = 5.75), reflecting an average improvement of 1.71 points. The paired samples t-test confirmed this difference as statistically significant (t(84) = -2.889, p = 0.005), with a small-to-moderate effect size (Cohen's d = 0.313). This statistically significant gain indicates that the extension activity effectively enhanced participants' PCK and action research knowledge in mathematics.

Paired Samples T-Test

	Mean	**Std. Deviation**	**Std. Error Mean**	**t**	**df**	**Sig (2-tailed)**
Pretest-Posttest	-1.71	5.44	0.59	-2.889	0.426	0.005

Although the effect size is modest, it aligns with outcomes reported in comparable short-term professional development programs (Desimone, 2009), underscoring the realistic expectations from such interventions. The moderate correlation observed between pretest and posttest scores suggests that participants' initial knowledge influenced their post-intervention performance; however, the training benefitted all participants regardless of their baseline proficiency. This implies the program's design was sufficiently adaptive to engage educators across varying knowledge levels.

The results substantiate the importance of targeted, content-specific professional development within mathematics education. This is consistent with Loucks-Horsley et al. (2010), who emphasized that teacher learning is most effective when training is relevant to authentic classroom practice. The integration of action research principles likely fostered reflective thinking among participants, enhancing their ability to bridge theory and practical application in instructional settings.

These findings also support Shulman's (1986) foundational theory that the development of PCK requires both deep content mastery and the contextualization of teaching strategies to specific classroom environments. Further, Mertler (2019) highlights that action research encourages a cyclical process of inquiry and improvement, which can be initiated effectively even in brief professional development engagements.

Implications for practice include advocating for PCK-oriented training that integrates reflective action research components, enabling educators to continuously diagnose and adapt their teaching approaches. For future programs, follow-up studies measuring long-term classroom implementation and student learning impacts would strengthen evidence for sustained effectiveness.

Pedagogical Content Knowledge in Science

The Wilcoxon Signed-Rank Test was used to evaluate differences in teachers' pedagogical content knowledge (PCK) before and after the training program. Results showed a statistically significant improvement (W = 0.00, p = 0.0039). The computed effect size was large (r ≈ 0.89), indicating that the training intervention produced a substantial and meaningful improvement in teachers' PCK.

Paired Samples T-Test

			Statistic	**p**
pretest	posttest	Wilcoxon W	0.00	0.009

The findings demonstrate that the training significantly enhanced science teachers' PCK. The large effect size confirms not only statistical significance but also practical educational value, highlighting that targeted interventions can meaningfully strengthen teachers' professional expertise.

Results of this training align with the studies conducted by Carlson and Daehler (2019) which emphasizes in the Refined Consensus Model of PCK that teacher learning is most effective when supported by professional development (training) and continuous self-evaluation. This reflective approach allows teachers to discern more on their ability and limitations. Bayram-Jacobs et al. (2019) also emphasize that integrating real-world issues into teacher training improves both content knowledge and pedagogy to keep them abreast on the current issues and trends in Science Education. In this way, teacher can built rapport and deliver meaningful and up-to-date content among learners. In the same way, Aydin and Boz (2021) stipulated that training-workshops are highly effective in developing preservice teachers' PCK.

This finding entails the need to continuously engage in mentoring sessions with the schools in the community to improve current practices through retooling to address the needs concerning the performance of the students through the pedagogical approach and content knowledge of teachers (Evens, Loughran, & Nilsson, 2016; Chan & Yung, 2018; Nilsson & Loughran, 2012). Furthermore, Kind (2015) emphasized that learnings in pedagogical content knowledge (PCK) matters are unlikely to last unless training is sustained though time and be supported by policy rooted in research conducted relevant to the training. Through this, the opportunity to sustain the meaningful goal of each partner vis-à-vis host institution become more adaptive according to the needs for both teachers and students to make it more essential for meaningful PCK development.

Pedagogical Content Knowledge in Physical Education

Based on the findings, the training design was established, tailored to Physical Education teaching. The training framework outlined clear objectives, content modules, and engagement activities that were conducive to various educational levels.

The workshop was conducted over a period of three days and was designed to enhance the professional competencies of the participants. Throughout the sessions, participants actively engaged in various learning activities that deepened their understanding of action research, promoted the integration of technology in teaching, and developed their practical skills in playing Pickleball as part of physical education innovation. Interactive discussions, hands-on exercises, and collaborative tasks encouraged active participation and reflection. Participants consistently provided positive feedback after each session, noting that the workshop was informative, relevant, and motivating. The table below presents the results of the pre-test and post-test, which revealed a significant difference and improvement in participants' knowledge, skills, and attitudes after the implementation of the workshop.

Paired Samples T-Test

			Statistic	p
pretest	posttest	Wilcoxon W	136*	0.029

Following the workshop, monitoring and evaluation were conducted to assess the training's impact. The participants showed confidence in performing basic skills in Pickleball.

These findings support that the extension studies of the university can play an important role in bridging research and practice, fostering continuous professional development among educators through targeted, evidence-based training interventions.

CONCLUSION

The three-day extension activity effectively enhanced participants' digital competencies, particularly through the introduction and practical use of Code.org for coding instruction and Jamovi for quantitative data analysis. Additionally, significant improvements were observed in participants' Pedagogical Content Knowledge (PCK) and action research skills, as reflected by the positive gains in posttest scores. These outcomes underscore the importance of professional development programs that integrate subject-specific pedagogy with reflective research practices and digital tool proficiency. Nonetheless, the small-to-moderate effect sizes observed suggest that while short-term training yields measurable benefits, sustained and progressive interventions are essential to deepen learning, foster lasting skill acquisition, and support meaningful instructional change.

RECOMMENDATIONS

To sustain and build upon the skills developed during the extension activity, it is recommended to implement regular follow-up workshops and mentoring sessions aimed at reinforcing teachers' proficiency with Code.org and Jamovi. Establishing peer-learning communities will also be valuable, providing educators with opportunities to exchange best practices, innovations, and to collaboratively address challenges related to technology-aided instruction and research-based pedagogy. Extending the training duration or introducing multi-phase programs can deepen participants' engagement, promote confidence, and enhance skill mastery. Additionally, integrating practical classroom implementation into the training design is crucial, encouraging participants to apply newly acquired strategies and tools within their teaching contexts and share their experiences in subsequent sessions. To assess the long-term effectiveness of the program, conducting longitudinal evaluations at multiple points after the training will help measure retention and practical application of skills. Furthermore, fostering peer mentoring structures will support ongoing reflective practice, collaborative problem solving, and continuous professional growth. Finally, regularly tailoring the training content to participants' evolving needs and emerging technological trends will ensure the program remains relevant and maximizes engagement and impact.

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