





Enhancing Teaching Practice Through ICT Integration: A Behavioral Evaluation of a Professional Development Program for Mathematics Educators

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ABSTRACT

This study evaluated the impact of the extension program implemented by the Department of Mathematics of Bukidnon State University. The program aimed to enhance ICT integration, math content knowledge, and teaching strategies among senior high school mathematics teachers in Malaybalay City, Bukidnon. Guided by the theory of change framework, the study employed a mixed-methods evaluation research design involving 22 teacher-participants. Quantitative data were gathered using a validated survey, while qualitative insights were obtained through semi-structured interviews with 12 participants. The survey results showed a very high impact of ICT integration in mathematics instruction, with an overall mean score of 4.65, indicating strong teacher agreement on improvements in lesson delivery, engagement, and effectiveness. The qualitative analysis revealed three major themes: initial gaps in content knowledge, improved conceptual understanding, and enhanced math relevance through technology and context. Teachers also reported increased use of interactive and contextualized strategies, stronger classroom confidence, and observable improvements in student engagement and performance. These findings highlight the value of sustained, context-specific professional development programs that integrate ICT and content mastery to support instructional improvement. The study underscores the importance of designing extension initiatives that are closely aligned with the actual teaching needs of mathematics educators in public schools.

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INTRODUCTION

In the rapidly evolving educational landscape, teachers are increasingly expected to adopt innovative strategies to meet the demands of 21st-century learning. However, many public senior high school mathematics teachers continue to face challenges in effectively integrating ICT, strengthening their content knowledge, and applying learner-centered teaching strategies. These gaps in professional capacity hinder their ability to deliver engaging and effective instruction. This study was conceived in response to these persistent challenges, recognizing the need to evaluate a specific professional development intervention aimed at addressing them.

ICT has long been considered a transformative force in education. Global studies suggest that it improves instructional delivery, fosters student engagement, and supports deeper learning (National Research Council, 2000; Chattopadhyay, 2025). In several regions, particularly in Asia and Africa, schools with

adequate infrastructure and training report improved math performance and stronger conceptual understanding due to ICT use (Mwaniki et al., 2024).

However, in countries like the Philippines, ICT adoption remains uneven. Many public schools face infrastructure deficits, and even when technology is available, teachers often lack the training to use it effectively (Navarro, 2019; Enorme et al., 2024). At the same time, Filipino teachers encounter persistent challenges in content mastery and instructional methods (Enriquez, 2025), especially in STEM education. The mismatch between global innovations and local classroom realities necessitates targeted, contextualized professional development efforts.

The focus on ICT, content knowledge, and teaching strategies stems from their combined importance in building effective mathematics instruction. ICT provides tools that enhance lesson delivery and student

engagement, while content knowledge ensures the teacher's mastery of key concepts. Teaching strategies, particularly those that are interactive and student-centered, bridge the gap between theory and application. Together, these three domains form the foundation for competent, confident, and future-ready educators. Without adequate support in these areas, even well-meaning interventions fail to improve classroom outcomes in a sustainable way.

Despite the implementation of numerous professional development initiatives that focus on ICT integration, content knowledge, and pedagogy, very few have been systematically evaluated for their actual impact, especially in localized contexts. One such initiative is the extension program conducted by the Mathematics Department of Bukidnon State University, which has yet to undergo a formal assessment. Currently, there is no evidence-based report confirming whether the program met its intended outcomes for participating mathematics teachers. This study aimed to address that gap by evaluating the program's effectiveness based on the perspectives of its participants.

Objectives of the Study

The primary objective of this study was to describe the perceived impact of the extension program conducted by the Department of Mathematics at Bukidnon State University on public STEM mathematics teachers within the Division of Malaybalay. Specifically, the study aimed to:

1. Assess the level of impact of ICT tools integration on mathematics teaching;
2. Explore the changes in the content knowledge among the mathematics teachers before and after the extension program; and
3. Determine the outcomes of the extension project for mathematics teachers on teaching strategies.

Framework of the Study

This study is anchored on the theory of change (ToC) by (Weiss, 1995), which provides a structured way to evaluate how and why an intervention produces specific outcomes.

The framework guided the assessment of the extension program's intended results, focusing on ICT integration, mathematics content knowledge, and teaching strategies, as aligned with the study's objectives.

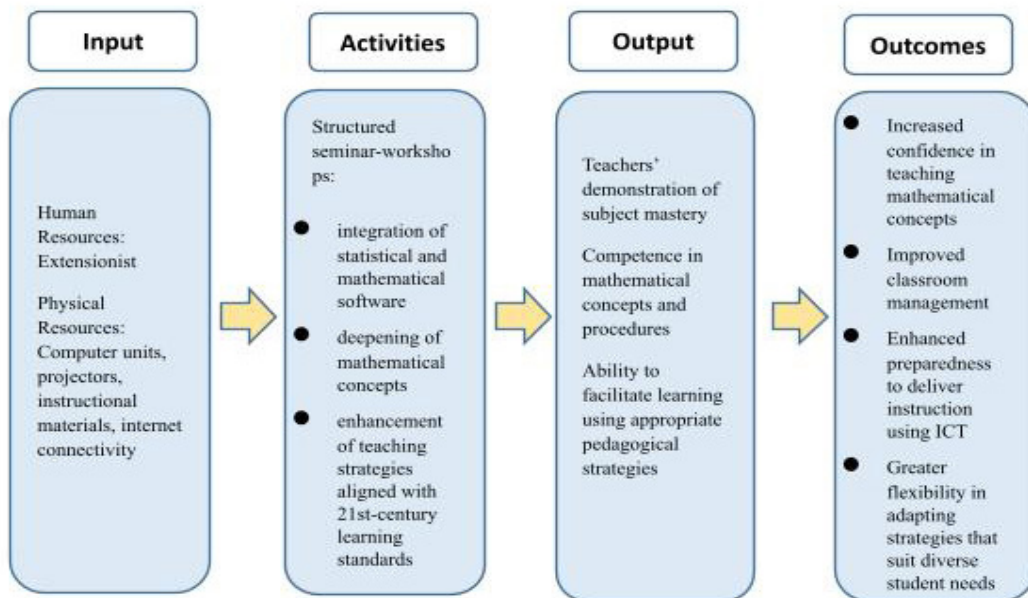
The framework is designed to reflect a continuum starting with resource allocation, through the planning and implementation of structured seminar workshops, to results in terms of changes in teaching practices and student learning environments. Inputs comprised human resources (extensionists) and physical resources (computers, projectors, instructional materials, internet access). These supported activities included the interfacing of mathematical and statistical software, deepening mathematical understanding, and improving teaching practices related to 21st-century learning goals. Ultimately, the framework allowed researchers to document the long-term effects of the program, revealing changes in classroom pedagogy, pedagogical flexibility, and the professional development of mathematics teachers. Therefore, the theory of change provided a rigorous and consistent framework for evaluating the impact of the extension approach.

The first research objective relates to inputs such as ICT resources and training materials, and activities such as structured workshops on digital tools. The expected outputs include increased familiarity and use of ICT in lesson delivery, while outcomes involve enhanced instructional pace, engagement, and relevance of math instruction. The second objective is addressed through activities like concept-deepening sessions and contextualization of mathematical topics. Outputs include strengthened understanding of key concepts, and outcomes point to more confident and accurate content delivery. The third objective is reflected in the development of context-based and learner-centered pedagogies during the seminar-workshops. Outputs include teacher demonstrations and instructional planning, while outcomes involve greater flexibility in adapting strategies and sustained use of effective approaches.

By directly linking inputs to outputs and outcomes through the lens of the ToC, this

framework enables a structured evaluation of the extension program’s effectiveness in strengthening mathematics instruction.

Figure 1
Theory of Change Framework



METHODS

Research Design

This study employed a mixed-methods evaluation research design, anchored in the theory of change (ToC) framework. The quantitative phase assessed the perceived impact of ICT integration, while the qualitative phase explored teachers’ experiences related to content knowledge and teaching strategies.

Quantitative Component

A validated survey questionnaire was administered to 22 senior high school mathematics teachers who completed the extension program. Descriptive statistics were used to analyze mean scores and standard deviations related to ICT integration.

Qualitative Component

Semi-structured interviews were

conducted with 12 participants, selected through purposive sampling. Thematic analysis was used to interpret patterns related to changes in content knowledge and instructional strategies.

Research Participant and Sampling

This study involved 22 public senior high school mathematics teachers from the Division of Malaybalay City, Bukidnon. All were STEM teachers who had completed the extension program conducted by the Department of Mathematics of Bukidnon State University in 2019. Participants were selected purposively, based on their full participation in the program, to ensure that feedback was informed by direct and complete exposure to the intervention.

Research Instruments

Two primary instruments were used in the study: a researcher-made survey questionnaire and a semi-structured interview guide. For the quantitative component, the survey instrument was carefully designed to

align with the research questions. The instrument underwent content validation by subject matter experts in education and ICT. It was pilot-tested with a small sample of teachers outside the Division of Malaybalay to establish its clarity and reliability. The reliability of the instrument was established with a Cronbach's alpha coefficient of 0.924, indicating that it is a reliable measure.

For the qualitative component, a semi-structured interview was conducted to explore participants' experiences related to enhancing mathematical content knowledge and teaching strategies. The interview guide was developed by the researchers and reviewed by a panel of experts. This guide allowed for open-ended responses and follow-up questions, enabling the researchers to gather rich and detailed narratives from the participants. All instruments were validated before deployment to ensure academic rigor.

Data Gathering Procedure

Before collecting the actual data, the researcher obtained formal approval from the relevant authorities. A letter of request, along with a copy of the research proposal and ethical clearance, was submitted to the Schools Division Superintendent of Malaybalay City. Once approved, the researcher coordinated with the school heads of the identified public senior high schools to inform them about the study and to seek their cooperation in facilitating the data gathering. Following institutional approval, the researcher distributed informed consent forms to the selected teacher-participants. These forms outlined the study's objectives, the voluntary nature of participation, assurance of confidentiality, and the right to withdraw at any time. Only those who signed and returned the consent forms were included in the study.

The quantitative phase focused on assessing the extent of ICT integration in mathematics teaching following the implementation of the extension program. A survey instrument was administered to gather teachers' perceptions regarding the influence of ICT tools on their classroom practices. This directly addressed the first objective of the study. In the second phase, qualitative data were

gathered through scheduled interviews with selected participants. Each interview session lasted approximately 30 to 45 minutes. Sessions were conducted in a quiet and neutral location within the school campus of Bukidnon National High School. Interviews and discussions were audio-recorded with participant consent, and detailed field notes were also taken. The researchers transcribed the recordings verbatim, and corresponded by member checking to ensure the accuracy and credibility of the data.

Data Analysis

The data were analyzed using both quantitative and qualitative techniques. For the quantitative data, descriptive statistics were employed to analyze the survey responses. These included the means and standard deviation, which described the extent to which ICT tools were integrated into mathematics teaching. On the other hand, for the qualitative data, the researcher employed thematic analysis (Braun & Clarke, 2006). This thematic analysis followed a sequential process in analyzing the data: first, familiarize the data; second, generate initial codes; third, search for themes; fourth, review themes; fifth, define and name themes; and finally, produce reports. The thematic analysis enabled the researchers to identify recurring patterns, unique experiences, and contextual factors that influenced teachers' knowledge and strategies following the extension program.

Ethical Consideration

This study complied with the ethical standards set by the Bukidnon State University Research Ethics Committee (BukSU-REC). The study protocol was reviewed and approved by the REC during its meeting on July 8, 2025, and was assigned REC Code: 2025-101-EEP-SECRETARIA.

All participants provided written informed consent before data collection. The consent process outlined the study's objectives, participants' rights, confidentiality measures, and their freedom to withdraw at any stage without penalty. Only those who signed the consent forms were included in the study. Confidentiality and data privacy were strictly

observed throughout. Identifiable information was anonymized in transcripts and reports. Digital files were stored securely with password protection, accessible only to the research team. The study also adhered to the provisions of the Data Privacy Act of 2012.

Furthermore, interviews and survey administration were scheduled during non-instructional hours to prevent any disruption to the teachers' professional duties. The study procedures aligned with the recommendations of the BukSU-REC and maintained sensitivity to school protocols and local norms.

RESULTS

The results present the evaluation of the extension program conducted by the Mathematics Department of Bukidnon State University. Using a mixed-methods approach, the study examined the impact of the program on three key areas: ICT integration in mathematics instruction, teachers' content knowledge, and classroom teaching strategies. Quantitative data described the extent of ICT use in teaching, while qualitative data explored changes in teachers' conceptual understanding and instructional practices. Findings were organized according to the research objectives, supported by descriptive statistics and thematic analysis.

Impact of ICT Tools Integration on Mathematics Teaching

The data presented in Table 1 presents the results of the impact of integrating ICT tools in mathematics teaching based on the statements rated by participants on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree). The mean scores for all items ranged from 4.22 to 4.95, indicating that the participants strongly agreed with all the statements. The mean score for all items combined was ($M = 4.65, SD = 0.44$), indicating a very high impact on the integration of ICT tools in mathematics teaching. The standard deviation for all items ranged from 0.22 to 0.79, indicating that the responses were consistent and not widely dispersed.

The very high impact attributed to

the integration of ICT tools implies several noteworthy implications for mathematics education. First, the positive influence on teacher-student interaction and the reduction of a traditional teacher-centered approach underscores the potential for technology to create more dynamic and engaging learning environments. Additionally, the emphasis on continuous professional development highlights the ongoing need for training to ensure teachers remain adept with the evolving ICT tools and teaching methodologies.

The results are consistent with previous studies highlighting the effectiveness of ICT tools in mathematics education. Higgins (2010) noted that interactive whiteboards increased student interest and comprehension. Mishra and Sahoo (2023) emphasized the importance of professional development for successful technology implementation. These findings align with this study's findings and confirm the overall advantages of using ICT tools in teaching various components of mathematics.

Changes in Mathematics Content Knowledge Before and After the Extension Program

The second objective explored the changes in the content knowledge among the mathematics teachers before and after the extension program. Based on the qualitative interviews, three major themes emerged from the narratives of the 12 participants. These themes are presented in Table 2. First, teachers expressed pre-existing gaps in mathematical content knowledge, particularly in areas such as proving, trigonometry, algebraic shifts, and investment mathematics. Several participants admitted to having limited understanding of abstract or applied concepts prior to the training.

Second, participants reported improved conceptual understanding in mathematics after the intervention. They described being able to break down complex concepts more clearly, link ideas to real-world examples, and apply more effective explanation techniques. Teachers also noted that they gained confidence in teaching topics they previously found intimidating.

Table 1
Level of Impact on the Integration of ICT Tools in Mathematics Teaching

		Mean	SD	Qualitative Description	Interpretation
1.	Integrating ICT tools has positively enhanced my effectiveness as a mathematics teacher.	4.95	0.22	Strongly Agree	Very High Impact
2.	The pace of mathematics instruction is enhanced when ICT tools are effectively used.	4.95	0.22	Strongly Agree	Very High Impact
3.	The use of ICT tools has increased teacher-student interaction during mathematics classes.	4.90	0.31	Strongly Agree	Very High Impact
4.	Access to a variety of ICT tools caters to different mathematical topics and enhances teaching flexibility.	4.85	0.37	Strongly Agree	Very High Impact
5.	The integration of ICT tools has led to a reduction in the traditional teacher-centered approach in mathematics classes.	4.65	0.49	Strongly Agree	Very High Impact
6.	Integration of ICT tools impact the effective delivery of mathematics instruction.	4.55	0.51	Strongly Agree	Very High Impact
7.	Training on ICT tools has positively impacted my confidence in using them for mathematics instruction.	4.55	0.51	Strongly Agree	Very High Impact
8.	Continuous professional development is necessary for staying updated on new ICT tools and teaching methods.	4.50	0.51	Strongly Agree	Very High Impact
9.	The use of ICT tools has led to increased relevance of mathematics to real-world applications.	4.40	0.50	Strongly Agree	Very High Impact
10.	The integration of ICT tools has positively impacted my overall teaching effectiveness in mathematics	4.22	0.79	Strongly Agree	Very High Impact
Overall Mean		4.65	0.44	Strongly Agree	Very High Impact

Legend:

Scale	Score Range	Qualitative Description	Interpretation
5	4.21-5.00	Strongly Agree	The ICT tools integration has a very high impact on mathematics teaching.
4	3.41-4.20	Agree	The ICT tools integration has a high impact on mathematics teaching.
3	2.61-3.40	Neutral	The ICT tools integration has a moderate impact on mathematics teaching.
2	1.81-2.60	Disagree	The ICT tools integration has a low impact on mathematics teaching.
1	1.00-1.80	Strongly Disagree	The ICT tools integration has a very low impact on mathematics teaching.

Table 2
Major Themes of the Changes in Content Knowledge among Mathematics Teachers Before and After the Community Engagement

No. of Frames	Themes	Description
1	Pre-Existing Gaps in Mathematical Content Knowledge	This theme refers to the teachers' limited understanding of advanced mathematical concepts such as proving, trigonometry, and investment mathematics before attending the extension program. It reflects the challenges they faced in delivering these topics effectively.
2	Improved Conceptual Understanding in Mathematics	This theme refers to the teachers' limited understanding of advanced mathematical concepts such as proving, trigonometry, and investment mathematics before attending the extension program. It reflects the challenges they faced in delivering these topics effectively.
3	Stronger Math Relevance via Tech and Context	This theme emphasizes how teachers began to internalize math content more effectively through the use of real-life examples and digital tools, making lessons more meaningful and engaging.

Third, the theme of stronger math relevance through technology and context emerged. Teachers appreciated the use of real-life problems and tech-supported instruction, which helped them internalize content more effectively. This shift made mathematics more meaningful not only for the students but for the teachers themselves.

Together, these themes highlight the program’s positive influence on deepening content mastery and equipping teachers with the ability to present mathematical ideas in more accessible and engaging ways.

Frame 1. Pre-Existing Gaps in Mathematical Content Knowledge

This theme captures the teachers’ difficulties in teaching specific mathematical topics due to limited training, low confidence, and insufficient mastery, particularly in abstract or applied areas like proving, investment math, trigonometry, and integration of technology in math instruction.

P1: *Proving*

P2: *The most challenging part to teach in math is the shifting of arithmetic to algebra. Students have difficulties in that area.*

P3: *Mathematics of Investment*

P4: *Trigonometry*

P5: *integration of appropriate technology in teaching math*

P6: *Before attending the seminar, I found the following areas in the math curriculum most challenging to teach: Problem Solving and Critical Thinking Tasks and Integration of Technology in Teaching Mathematics.*

The responses of the participants indicate a common concern about their ability to grasp higher-order mathematical concepts and applications. The reference to abstract topics, such as proving, rational functions, and algebra, points not only to a lack of knowledge of the content but also to an inability to apply it. The struggle between the infusion of technology and problem-solving exposes a lack of awareness of tele-instruction and active learning. These deficiencies suggest that teachers may have employ procedural or materials-oriented instructional techniques, thereby hindering the application of knowledge in real-life situations.

This theme reveals that without systematic and sustained training, mathematics educators are ill-equipped to teach beyond foundational concepts. The recurring mention of advanced and contextual topics, such as proof, investments, and technology integration, indicates that many teachers are not prepared to meet the cognitive and engagement needs of their students. This concern can reduce student motivation and achievement, especially when lessons fail to resonate with learners’ experiences or expectations. Strengthening teachers’ conceptual understanding and equipping them with relevant instructional strategies is, therefore, critical for modern mathematics education.

Recent studies have highlighted the challenges of mathematics teacher education in helping prospective teachers teach both advanced concepts and 21st-century skills. Teacher training does not equip prospective teachers with 4C skills due to a lack of knowledge, facilities, and support (Fitriati et al., 2023). Challenges related to TPACK for mathematics teachers include fear of designing technology-based lessons

and a lack of resources (Kholid et al., 2023). In that case, a teacher program involving both of them, aimed at improving their competence in teaching mathematics, is needed. The importance of organized Professional Development (PD) to support the movement of novice to expert teachers, through content-driven inquiry and reflective learning, is paramount (Brody & Hadar, 2015). Furthermore, Murray et al. (2024) found that a strong emphasis on dissecting content and student work resulted in directly measurable improvements in the instructional effectiveness of the teachers.

P1: Yes, I have noticed clear improvements in how I explain math topics to my students since the training. I've become more intentional in breaking down complex concepts into simpler, more understandable steps

P2: It helps improved my understanding of the mathematical concepts

P3: It had helped me how to use techniques in solving finance problems

P4: With the strategies and techniques they shared to us, we find a way how to easily teach the lessons to the learners

P6: The seminar significantly improved my understanding of the mathematical concepts I teach by providing clear explanations, practical applications...It deepened my content knowledge, especially in topics where I previously lacked confidence, such as higher-order problem solving, real-life integration of math concepts, and statistical reasoning.

P7: The seminar provided clearer and more in-depth explanations of key mathematical concepts, especially in the integration of real-life applications...It refreshed my content knowledge and introduced new strategies for teaching difficult topics, which allowed me to better connect abstract ideas to practical situations that my students could easily relate to.

P9: It helped me understand all the Key Concepts of the topics.

Frame 2. Improved Conceptual Understanding in Mathematics

This theme captures how the extension program improved teachers' understanding of math concepts, enabled better content delivery, and boosted their ability to explain lessons more clearly and confidently.

After the training, participants reported an enhanced clarity and depth of understanding of mathematical concepts. They also became more effective in simplifying and connecting lessons to students' levels of understanding. The statements reflect a shared recognition of the value the extension project brought to teachers' content knowledge. In particular, the integration of real-world contexts and ICT facilitated better understanding and teaching of previously abstract or confusing concepts. Teachers gained new pedagogical tools, enabling them to align instruction more closely with the curriculum. This improved clarity is likely to translate into better instructional delivery, increased student engagement, and improved learning outcomes. This theme highlights the importance of targeted, curriculum-aligned professional development in enhancing teachers' conceptual understanding. When teachers are provided with clear frameworks, hands-on strategies, and effective technological integration, they are better equipped to make mathematics accessible and relevant to students. The extension

project's success highlights the importance of continued, reflective professional growth that focuses on both content and pedagogy.

Professional Development programs had a significant impact on teacher epistemological beliefs and math content knowledge, particularly when professional reflectivity and curriculum maps were incorporated into the training format (Hernández-Martínez et al., 2025). Behera (2022) observed that adequate knowledge of mathematics teaching is crucial for understanding both the content of mathematics and the skills of teaching. Teachers are part of professional learning groups and tend to have a richer conceptual understanding, as well as more enhanced and engaging teaching, compared with less qualified providers. Additionally, Thirumalai and Sarangapani (2025) reported that engagement in professional learning communities was associated with teachers making significant progress in their conceptual understanding of mathematics through the inquiry-based, collaborative, contextual, and practical application of knowledge.

Frame 3. Stronger Math Relevance via Tech and Context

This theme reflects how contextualized instruction and technology enhanced the teachers' internalization and delivery of math content by making abstract concepts more

Understanding the lessons was easier because the topics were related to real-life problems.

I appreciated how the facilitators used technology to make the content more accessible.

Math made more sense to me when we used local examples.

The context-based examples helped me remember the topics better.

Linking topics to real-life situations was very helpful.

relatable and accessible.

Teachers shared that contextualized instruction and the use of technology significantly helped them understand and internalize math concepts more effectively. Many found it easier to grasp lessons when topics were linked to real-life problems, making abstract ideas more relatable. They appreciated how the facilitators used technology to simplify content and made it more accessible. Additionally, they discovered that math lessons incorporating local and practical examples helped them retain subjects more effectively. These reflections highlight how real-world applications and tech-based strategies contributed not only to student comprehension but also to the teachers' learning process. By experiencing how math can be taught through relevant and relatable contexts, teachers reported greater confidence and clarity in content delivery. This experience suggests that if teachers adopt methods based on constructivism and supported by technology, the future use and continuous utilization of these methods in their classrooms is more probable.

Teachers who attended Professional Development courses that focused on real-life contexts and technology reported better pedagogical efficacy and student-centered practices, as well as significantly increased classroom engagement (Hernández-Martínez et al., 2025). Chauraya and Brodie (2018) highlighted the fact that the use of technology as a link between theory and practical work enhances teacher capacity and student learning in complex areas such as this one. In addition, participation in professional learning communities focused on real-world applications had a significant positive impact on teachers' instruction and students' performance in early mathematics (Thirumalai & Sarangapani, 2025). Taken together, these results corroborate the change observed in Frame 3

and highlight the importance of relevance and interactivity in contemporary math education.

Outcomes of the Extension Program on Teaching Strategies

The third objective focused on determining the outcomes of the extension program for mathematics teachers in terms of teaching strategies. Interview data revealed five key outcome areas (Table 3).

First, teachers reported an increased integration of ICT and active learning strategies in their classrooms. They began using tools such as PowerPoint, online quizzes, videos, collaborative platforms like Jamboard, and digital simulations. These tools made instruction more interactive and engaging. Second, there was a shift toward contextualized and applied teaching approaches. Teachers noted that they were more intentional in relating math topics to real-life scenarios, community-based problems, and inquiry-based learning. This helped students find relevance in the content and boosted their interest. Third, teachers described a significant enhancement in their professional competence. They felt more confident, better prepared, and more capable of planning lessons with clear objectives and structured delivery. Many viewed the training as a turning point in their professional growth. Fourth, teachers observed enhanced student engagement and learning outcomes. Students reportedly became more participative, asked more questions, and performed better in tasks and assessments, particularly in topics that used to be challenging for them. Lastly, teachers expressed a commitment to the sustained utilization of the teaching strategies they had learned. They shared that these approaches had already become part of their regular classroom practice and were adaptable to different topics and student needs. These results indicate that the extension program

led to both immediate and lasting improvements in teaching strategies, reinforcing the value of professional development that is context-responsive and practically grounded.

Frame 4. Integration of ICT and Active Learning

have already put things they learned in the extension project into practice such as making problem solving environments contextual (using real-world type problems to teach math concepts). These approaches had a positive effect on students' engagement and comprehension. The overall reflections indicate that the utilization of ICT tools, if combined with an active and

Table 3

Emerging Themes from the Outcomes of the Extension Project on Teaching Strategies of Mathematics Teachers

No. of Frames	Themes	Description
4	Integration of ICT for Learning Strategy	This theme explains how teachers began incorporating ICT tools such as PowerPoint, videos, online quizzes, and other digital platforms into their teaching to enhance student engagement.
5	Contextualized and Applied Teaching Approaches	This theme captures how teachers used real-world and community-based problems to make math lessons more practical, relatable, and easier to understand.
6	Professional Competence in Teaching Mathematics	This theme reflects the enhanced sense of confidence, preparedness, and professional growth that teachers gained from the training.
7	Enhanced Student Engagement and Learning Outcomes	This theme describes the observed improvements in students' classroom behavior, interest, and academic performance as a result of the new strategies applied by teachers.
8	Sustained Utilization of Teaching Strategies	This theme illustrates how teachers are committed to continuing the use of newly acquired strategies in their teaching practice beyond the training.

The integration of Information and Communication Technology (ICT) tools and active learning strategies significantly enriched the teaching practices of mathematics teachers. It enabled them to establish more engaging, responsive, and student-centered instruction, fostering improved participation, conceptual visualization, and real-time feedback.

The participants had an advantage of the exposure to ICT integrated teaching strategies. Educators indicated improvement in their proficiency in educational technologies such as interactive quizzes, collaborative platforms and simulations that facilitated students' active learning. Many respondents agreed that the integration of ICT in the lesson presentation appealed to interested learners. Additionally, they identified specific improvements in their classrooms such as the use of PowerPoint presentations, videos, Google Forms, and Jamboard to promote content and student engagement. A number of them indicated they

context-oriented teaching approach, enhanced classroom practice and facilitated the switching to more interactive and learner-focused teaching.

The available literature is in favor of integration of ICT in mathematics teaching. For instance, Hernández-Martínez et al. (2025) reported that ICT-informative PD yielded better changes of teaching practices (i.e., more student-centered and more differentiated instruction). TPE based professional noticing and formative feedback also influenced the development of concepts and engagement of students in a positive manner (Makonye & Ngoepe, 2021). Moreover, as reported by Jupri et al. (2022), in the informal ICT mediated models of development raised the levels of teachers' problem solving and teaching competencies. These results confirm what we know that ICT integrated with active learning makes for classrooms that are more student responsive and are more powerful of mathematics classrooms.

The available literature is in favor of integration of ICT in mathematics teaching. teaching strategies in mathematics. These strategies include ICT tools, problem-

P3: I also enhanced my skills in integrating technology into instruction, particularly using tools that promote active learning such as interactive quizzes, collaborative platforms, and digital simulations.

P4: Integrating ICT in delivering the lesson makes it more engaging and interesting for the students.

P6: I have already implemented several of the strategies I learned from the seminar in my classes, and they've made a noticeable difference in student engagement and understanding. Specifically: Contextualized Problem Solving (I now regularly use real-life scenarios when presenting math problems, which helps students see the

P8: The training taught me how to use PowerPoint and videos effectively.

P10: Collaborative tools like Google Forms and Jamboard worked well.

For instance, Hernández-Martínez et al. (2025) reported that ICT-informative PD yielded better changes of teaching practices (i.e., more student-centered and more differentiated instruction). TPE based professional noticing and formative feedback also influenced the development of concepts and engagement of students in a positive manner (Makonye & Ngoepe, 2021). Moreover, as reported by Jupri et al. (2022), in the informal ICT mediated models of development raised the levels of teachers' problem solving and teaching competencies. These results confirm what we know that ICT integrated with active learning makes for classrooms that are more student responsive and are more powerful of mathematics classrooms.

based learning, formative assessment, and contextualized instruction

The extension project had a significant impact, causing teachers to make substantial changes in their teaching style after attending. Teachers shifted instruction from the traditional, lecture-based model to one that embraced more student-centered practices, seeking to make content more relevant and engaging through real-world contexts. Participants mentioned that context-based, problem-solving, inquiry-based learning, and ICT, were implemented. Many teachers mentioned that when they demonstrated how a lesson could be used in a real-life scenario, their students became more

P3: I also enhanced my skills in integrating technology into instruction, particularly using tools that promote active learning such as interactive quizzes, collaborative platforms, and digital simulations... helps create a more dynamic and student-centered classroom.

P6: During the seminar-workshop, I learned and enhanced several effective teaching strategies... Contextualized and Real-Life Problem Solving and Use of ICT Tools and Interactive Platforms.

P7: The seminar also emphasized the use of inquiry-based learning and contextualization to make mathematics more relatable to students' experiences.

We tackled how to apply lessons to actual situations, which made the students more engaged.

P9: I gained valuable insights on incorporating digital tools to enhance student engagement and collaboration.

Frame 5. Contextualized and Applied Teaching Approaches

This frame captures reflections on how professional development helped teachers implement real-world and contextualized

engaged and enthusiastic. They also learned how to implement digital tools, such as providing a practice of engagement and collaboration among students. These comments suggest a deliberate attempt to institute more contemporary and dynamic teaching and learning approaches.

Adding real-world content and technology to instruction made math experiential for students and facilitated higher-level cognitive processes. This shift reflects a broader movement towards a pedagogy of active learning, real-world applicability, and learner engagement.

Fernandes et al. (2020) highlight that contextualized learning results in meaningful mathematics learning, as mathematics is situated and more engaging and successful in understanding. Additionally, Reinke et al. (2022) observe that concept-based instruction, anchored in real-world scenarios, leads to a more profound understanding of concepts and stronger links between numerical meaning and meaning in daily life.

a professional jump-starter, which provided teachers with a range of tools and approaches that empowered them to take further charge of their practices. Consequently, because they delivered their instruction in a more engaging and focused manner, their instruction was more tailored to students and more responsive to their needs. Hence, they felt more competent and motivated.

Professional competence in teaching mathematics involves a complex interplay of knowledge, skills, and context. Studies have shown that competent math teachers possess a strong professional knowledge base and can effectively activate it in classroom situations (Ahuja, 2019). This competence encompasses

P1: *It helps me grow professionally and enhance my teaching skills.*

P2: *As a math teacher, I am confident, equipped, and competent...*

P3: *It boosted my confidence in teaching math and made me an efficient teacher for that subject*

P6: *The seminar has helped me become more confident and effective in both planning and delivering math lessons in several key ways: Clearer Lesson Objectives, Improved Lesson Structure, Enhanced Content Mastery, and Wider Range of Teaching Strategies.*

P9: *It strengthened my commitment to continuous improvement and collaboration, as I gained new perspectives and strategies from fellow educators and stakeholders.*

Frame 6. Professional Competence in Teaching Mathematics

Teachers expressed a notable increase in confidence and competence after participating in the extension project. They attributed these gains to better planning strategies, more precise instructional objectives, improved technology integration, and enhanced content mastery. The structured support made them to feel more capable and motivated in their teaching roles.

Both pedagogical ability and personal confidence were consistently reported by participants to have improved. These dimensions were associated with the organized nature of the extension project (lesson planning, ICT use, and student-centered teaching). Several respondents highlighted the transition from passive to active instruction and the opportunity to tailor lessons as key confidence builders. The seminar was

the ability to solve mathematical, teaching, and professional problems (Podkhodova et al., 2020). In addition, according to Zakaria (2020), teachers who embrace pedagogical innovations and reflective practice experience a renewed passion for teaching, which in turn enhances classroom environments and student outcomes.

Frame 7. Enhanced Student Engagement and Learning Outcomes

Math teachers observed a significant increase in student engagement and learning outcomes. The incorporation of interactive strategies and contextualized learning helped students understand lessons more clearly and participate more actively. This resulted in improved performance and enthusiasm, particularly in challenging mathematical topics.

The teachers observed a significant

- P1: *They are more engaged with the lesson.*
- P2: *They want to expand and explore more and solved problem*
- P3: *they were very active because they find it more engaging*
- P5: *the students showed a positive attitude towards learning math...The participation of students increased and the result of their test performance improved too.*
- P6: *I've also noticed that students complete tasks with greater accuracy and less hesitation, especially in topics that used to intimidate them, such as word problems and data analysis. They seem more motivated and interested...*
- P7: *Many students are now more open to asking questions and expressing their ideas during discussions, which I attribute to the more interactive and learner-centered strategies I adopted after the training.*
- P8: *More students actively volunteer to solve problems on the board.*
- P9: *Students were able to understand the topics, particularly on Math of Investment topic, they were able to relate to real life problems like how loan works. Students were very much engage during the activity and resulted to passing the subject with flying colors.*

increase in student interest, involvement, and participation after using interactive and real-life teaching methods. The analysis revealed that students demonstrated a clearer understanding of mathematical concepts and were more comfortable engaging in discussions and completing classroom assignments. These results provide evidence of the effectiveness of student-centered and contextual approaches to teaching in promoting student engagement. The findings of this study indicate that the use of a life-based approach by teachers helps students make sense of mathematics and perceive it as accessible. Enhanced student motivation, engagement, and performance have resulted from this change in pedagogy. The extension project allowed teachers to rework their practices to be more effective at engaging students in a range of cognitive, behavioral, and affective areas.

The notion is that active, learner-centered strategies and real-world applications enhance student engagement and comprehension in mathematics. For instance, Jansen et al. (2023) emphasized that when teachers view engagement as related to learning rather than just compliance, they tend to foster deeper cognitive and social involvement among students. Similarly, Alrajeh and Shindel (2020) found that interactive strategies and supportive classroom climates significantly improved students' engagement, particularly in math classes. Another study by Yang et al. (2024) demonstrated that teacher

emotional and competence support significantly enhances student engagement in mathematics, particularly when mediated by student academic self-efficacy. Lastly, Doño and Mangila (2021) found a strong correlation between teacher engagement and students' motivation to learn mathematics, affirming that teacher enthusiasm and commitment directly influence classroom dynamics and learning outcomes.

Frame 8. Sustained Utilization of Teaching Strategies

This theme captures teachers' perceptions of which instructional strategies are most feasible, effective, and long-lasting in their specific teaching contexts. The majority of teachers identified ICT integration, contextualized problem-solving, formative assessment, and differentiated instruction as the most sustainable practices.

The teachers observed a significant increase in student interest, involvement, and participation after using interactive and real-life teaching methods. The analysis revealed that students demonstrated a clearer understanding of mathematical concepts and were more comfortable engaging in discussions and completing classroom assignments. These results provide evidence of the effectiveness of student-centered and contextual approaches to teaching in promoting student engagement. The findings

ICT integration is something I will continue using.

I think these strategies will help me in the long run.

What I learned here is now part of my permanent lesson plans.

I plan to sustain the use of interactive activities.

I will keep on improving my approach using what I learned.

of this study indicate that the use of a life-based approach by teachers helps students make sense of mathematics and perceive it as accessible. Enhanced student motivation, engagement, and performance have resulted from this change in pedagogy. The extension project allowed teachers to rework their practices to be more effective at engaging students in a range of cognitive, behavioral, and affective areas.

Evidence suggests that using ICT tools in conjunction with formative assessment can lead to sustained teaching practices. For instance, Jeong et al. (2020) concluded that online formative assessment platforms led to significant improvements in student achievement and motivation, thus confirming their relevance in the flipped and sustainable learning approaches. Likewise, Barana and Conte (2023) found that automatic formative tests minimized socioeconomic gaps in learning and contributed to promoting equity in mathematical teaching. Therefore, ICT enhances the sustainability and efficiency of mathematics teaching by incorporating it correctly into the teaching-learning process (Zenki-Dalipi, 2019).

DISCUSSION

Based on the findings of this study, the extension program of the Mathematics Department at Bukidnon State University demonstrated a significant improvement in the teaching practices of mathematics teachers in Malaybalay City, Bukidnon. The findings confirm that the program successfully achieved its primary objectives, which are to integrate ICT tools into teaching mathematics and enhance mathematical content knowledge and teaching strategies.

The quantitative data showed a

significant impact of ICT tool integration on teaching mathematics, with an overall mean score of 4.65. Mathematics teachers strongly agreed that ICT tools enhanced instructional delivery, student engagement, and the relevance of math to real-world contexts. With that, technology fosters dynamic learning environments (Hafeez, 2021; Mwaniki et al., 2024; Hernández-Martínez et al., 2025; Makonye & Ngoepe, 2021; Jupri et al., 2022; Chattopadhyay, 2025). Notably, mathematics teachers reported an improved pace of instruction, a shift away from traditional teacher-centered approaches, and increased confidence in using digital tools.

In the qualitative phase, three major themes emerged in content knowledge: (1) Pre-existing Gaps in Content Knowledge, (2) Improved Conceptual Understanding, and (3) Stronger Math Relevance via Technology and Context. Before the program, many teachers struggled with advanced topics such as proving, investment mathematics, and trigonometry. After the extension project, they gained more profound conceptual clarity and were able to break down complex ideas into digestible, contextualized lessons. Mathematics teachers highlighted how real-life applications and digital simulations helped bridge the gap between concepts and practical understanding (Reinke et al., 2022; Behera, 2022).

In the aspect of teaching strategies, five major themes emerged: (4) Integration of ICT for Learning Strategy, (5) Contextualized and Applied Teaching Approaches, (6) Professional Competence in Teaching Mathematics, (7) Enhanced Student Engagement and Learning Outcomes, (8) Sustained Utilization of Teaching Strategies. Mathematics teachers implemented active and learner-centered strategies, shifting from passive instruction to interactive lessons that encouraged participation, collaboration, and inquiry. The continuous application of ICT tools and situation-based problem-solving suggested that the training effect was both practical and persistent. Math teachers reported a renewed love of teaching, increased confidence, and greater sensitivity to diverse learners. Additionally, these themes highlighted that sound ways of teaching with ICT integration are required to transform both content and technology into meaningful

learning experiences. As a result, the extension program became not only a technical but an emotional spur. It not only made a difference in the delivery of instruction but also refocused the teachers' zeal on teaching mathematics as an educationally significant, learner-relevant, and future-related subject.

The findings of this study affirm that the extension program significantly enhanced mathematics teachers' ICT use, content mastery, and pedagogical strategies. These results underscore the value of localized, practice-based professional development programs that are aligned with teachers' day-to-day instructional realities. For education practitioners and policymakers, this highlights the need to institutionalize regular in-service training that combines content deepening with practical applications of ICT tools. Schools and education departments may also use these insights to prioritize investments in digital infrastructure and teacher capacity-building as a strategy to improve STEM instruction.

As with any evaluation research, this study has a defined scope. It focused on a group of senior high school mathematics teachers within a single division, which reflects a specific context. While the findings are valuable for informing similar interventions, they are best interpreted within this setting. The study also relied on teacher self-reports, which provided rich insights into professional growth but may not capture all dimensions of change. Future research could explore broader applications by including multiple divisions or incorporating student-level data to support triangulation.

CONCLUSION

The evaluation of the extension program revealed that integrating ICT tools, strengthening content knowledge, and enhancing teaching strategies had a meaningful and lasting impact on participating mathematics teachers. The program was perceived to significantly improve instructional effectiveness, teacher confidence, and student engagement. Teachers also reported sustained use of strategies learned, particularly in contextualized and technology-supported

instruction. These findings confirm the value of localized, targeted professional development for public school educators.

RECOMMENDATION

These findings contribute to the university's ongoing efforts to deliver responsive and evidence-based extension services. The results may serve as a reference for scaling similar programs in other academic units and for developing institutional policies that promote sustained teacher development. It is recommended that follow-up programs be designed with a focus on mentoring, classroom-based application, and inclusion of student performance indicators to assess learning outcomes more comprehensively.

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