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Research Article

Emergent Innovative Mathematics Pedagogies in Contemporary Education: Foundations Towards the Development of a Pedagogical Framework

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ABSTRACT

There is a growing need for more innovative approaches to teaching mathematics in classrooms worldwide. Teachers are expected to deliver pedagogies that cater to diverse learners, engage them in meaningful mathematical learning, and provide access to opportunities for all students to succeed in mathematics. This study sought to explore the lived experiences of teachers in implementing innovative mathematics pedagogies (IMP) and examine the foundations for the development of pedagogical framework that could guide other educators in teaching mathematics. This transcendental phenomenological study investigated senior high school mathematics teachers from public secondary schools in Region XI (Davao Region), Philippines, identified for their instructional innovations. Participants in the study were 10 purposively selected senior high school mathematics teachers. In-depth interviews were used as the research methodology to collect in-depth narratives of teachers' lived experiences with IMP. Findings from the study provided insight into IMP from the teachers' perspectives. Three main themes, Mathematical Engagement, Mathematical Representation, and Mathematical Action and Expression were found to characterize innovative teaching of mathematics. These themes included 14 subthemes, including game-based, contextualized, peer-based, project-based and experiential learning for mathematical engagement. Mathematical representation includes differentiated, technology-enhanced, use of SIMs, and asynchronous learning. Consequently, inquiry-based, assessment-based, problem-based, reflection-based, and remediation and enrichment math learning compose mathematical action and expression. These themes and subthemes collectively provide insight into teachers' instructional practices used to engage students in mathematical learning. The Innovative Mathematics Pedagogies Framework was developed based on themes which is consistent with

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Universal Design for Learning principles and emphasizes diverse learning needs, rigorous academic instruction, and personalization. Implications for future research include further validation and application of the Innovative Mathematics Pedagogies Framework in different educational settings. Educational stakeholders, such as school administrators, policymakers, and teacher educators, would benefit from an understanding of the Framework to develop innovative instructional practices and policy implementations.

Keywords: *Inclusive Mathematics Education, Innovative Mathematics Pedagogies, Mathematics Teaching Practices, Pedagogical Framework, Phenomenological Research*

Introduction

Improving students' cognitive abilities such as logical thinking, procedural fluency, and conceptual understanding has been a challenge in mathematics education. Although research has illustrated the importance of learner engagement with mathematical content, curriculum design that utilizes diverse mathematical representations to promote greater accessibility to learning opportunities for all students has remained a gap (Boaler, 2021). Notable educational research and policy documents also highlight teacher education and instructional practice as potential influences on student attainment (Darling-Hammond et al., 2019). Even with this shift in perspective, several aspects of mathematics education continue to operate within a transmission orientated instructional framework focused upon teacher delivered exposition and an emphasis on procedural skills.

The task addresses several challenges related to teaching mathematics in today's schools. Rapid technological developments and increasingly diverse learners require educators to use technology for visualization, modelling, and problem solving in mathematically driven situations (OECD, 2023). However, issues of unequal access to technology, teacher preparedness, and digital literacy in many settings restrict the full potential of digital resources. Furthermore, addressing diverse learner backgrounds and levels of readiness in mathematics through flexible, inclusive, and increasingly data-driven pedagogies is critical to avoiding learner disengagement, mathematics anxiety, and mathematics achievement gaps (UNESCO, 2021).

Studies on innovative mathematics pedagogies present mixed findings across settings. Innovative pedagogies have the potential to make mathematics learning more engaging and motivational. Studies that adopted contextualization and technology-integrated approaches reported positive student experiences and perceptions of learning in contextualised mathematics classrooms. Viberg et al. (2020) found that technology can support mathematical understanding provided the pedagogical practices utilized are collaborative and context-sensitive. However, findings with respect to improvements in academic attainment are less convincing. Innovative pedagogies have the potential to enhance teaching and learning mathematics, but their successful implementation largely hinges on several contextual factors including classroom resources, teachers' skills, knowledge and instructional design. A case in point is a study conducted in Ghana where a contextualized mathematics pedagogy was found to enhance students' engagement and enjoyment of mathematics but not their attainment (Aidoo et al., 2022).

Similar efforts to promote innovation in mathematics education are being pursued in other countries. While there are opportunities and challenges facing these endeavors in the Philippine context, research internationally has demonstrated both promise and barriers to effective reform. Andal and Hermosa (2024) reported positive results for problem-based learning on critical thinking, problem solving, communication, and learner adaptability, but less positive results regarding students' perception of real-world relevance of mathematical problems and situations. Cabasan (2024)

highlighted engagement and conceptual gains due to technology integration for some mathematics content but noted inequities in access to hardware and software which may hinder more widespread implementation.

Although there are challenges in teaching mathematics and some breakthroughs have been observed, there are still areas that need to be addressed particularly in areas far from the urban centers. In the Davao Region, for instance, performance of students in mathematics national assessments remained below the national average proficiency level (Oracion & Abina, 2021). Specifically, students in the region have problems in conceptual visualization and spatial reasoning that affect their mathematical performance, thus various context-based instructional strategies were developed by mathematics teachers. In some urban schools, there are alternative instructional techniques and materials that are being utilized to engage their students. In contrast, rural schools are just starting with the basics and are constrained by limited resources for effective mathematics instruction.

There are global educational imperatives for the teaching and learning of mathematics that are reflected in the Sustainable Development Goal (SDG) 4, 'Quality Education' (UNESCO, 2020). SDG 4 seeks to guarantee that all learners, particularly the most vulnerable, acquire inclusive and equitable quality education and full academic and professional competency. This is achieved through innovative pedagogies that are accessible and empower learners to apply mathematical knowledge appropriately in their different contexts. However, the goal faces a serious policy-practice gap due to lack of sufficient professional development and supporting infrastructure to foster the innovative teaching and learning of mathematics.

With these challenges facing mathematics education today, this study explores new approaches to mathematics teaching and learning from a phenomenological perspective, focusing on the lived experience of teachers and how they make sense of pedagogical innovation in their classrooms. It is through this that this study aimed to generate insights into innovative mathematics pedagogy and to inform the development of practical, contextual models of teaching and learning that are inclusive, equitable and of high quality.

Materials and Methods

Research Design

This study adopted a transcendental phenomenological approach to explore and describe teachers lived experiences in implementing innovations in mathematics pedagogy. A transcendental phenomenological approach to research according to Creswell (2013) seeks to uncover the essence or meaning of a phenomenon by examining how participants experience and give meaning to their perception of the phenomenon. The perspectives of several participants are examined, especially their personal experiences or first-hand accounts of the phenomenon (Moustakas, 1994).

To enhance the credibility of findings in this design, the researcher employed reflective bracketing. This involved making conscious awareness of personal theory and deliberate setting aside of personal assumptions, professional experience and prior knowledge about teaching and learning mathematics. A phenomenological approach was employed because this study purposefully chose to explore depth, complexity and the various contexts or living conditions that innovate mathematics teaching and learning practices from teachers' perspectives. Phenomenology provided a research methodology which enabled participants' individual experiences, perceptions and descriptions to be compiled, made patterns, and meanings generated from the "essences" of the data.

Research Locale

The study covered mathematics teachers from public secondary schools in Region XI, Philippines. The said region was purposively selected as it is comprised of urban and rural set up of schools hence the study focused on different experiences of teachers in terms of instructional strategies and practices in teaching mathematics. The region is also socio-economically and culturally diverse as most public schools have varying degree of access to resources for instruction, level of support from school administration, and opportunity for professional growth. Region XI is the right

place where innovative mathematics pedagogies are taught and its implementation in actual teaching situation is observed and analyzed. Figure 1 is the geographical map of Region XI.

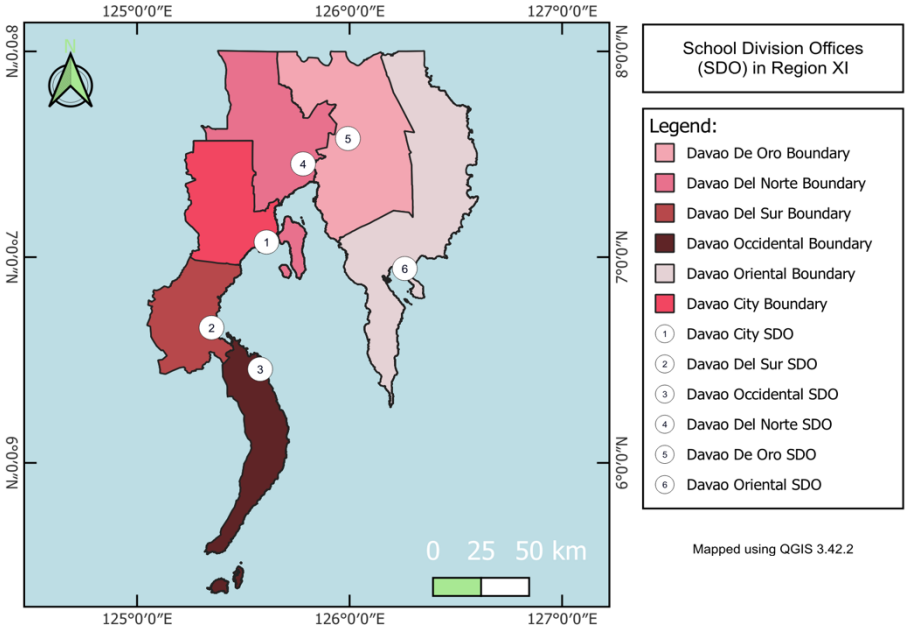

Figure 1. Geographical Map of Region XI (Davao Region), Philippines

The participants of this study consist of nine (9) senior high school mathematics teachers who are holding Master Teacher positions and assigned in different public secondary schools within the region. They are recipients of Achievement of Great Instructional Leadership Award (AGILA) given to great teachers who excel in instructional leadership and innovative practices in the classroom. As purposive sample, they have sufficient expertise and experience in implementing Innovative Mathematics Pedagogy (IMP) in their classrooms. Through their experiences, practices, and insights as teachers, they were able to provide qualitative data that describe how they apply IMP in their classrooms, the challenges and difficulties they encountered and the factors that help them succeed in implementing innovative pedagogy in mathematics education. Their diverse years of teaching experience, education, knowledge, skills, and awards earned in teaching mathematics make them rich sources of data that describe in depth the lived experiences of teachers who practice innovative mathematics pedagogy. Table 1 presents their demographic profile.

Table 1. *Demographic Profile of the Research Participants*

Participants	Teaching Position	Highest Degree	Teaching Experience	Award Received
A	Master Teacher II	PhD Candidate	12 years	Division AGILA Winner
B	Master Teacher I	PhD Candidate	10 years	Division AGILA Winner
C	Master Teacher III	EdD	21 years	Division AGILA Winner
D	Master Teacher II	EdD	19 years	Division AGILA Winner
E	Master Teacher III	PhD	14 years	Regional AGILA Winner
F	Master Teacher I	EdD	15 years	Division AGILA Winner
G	Master Teacher I	PhD	22 years	Division AGILA Winner
H	Master Teacher I	PhD Candidate	14 years	Division AGILA Winner
I	Master Teacher I	PhD Candidate	9 years	Division AGILA Winner

Data Analysis

The data collected in this qualitative study was organized and analyzed to identify patterns and meanings within the study. The data was analyzed using thematic analysis to identify trends and implications and to create an emergent framework for the study. This study utilized five stages of thematic analysis, similar to Ajjawi and Higgs (2007), in the analytical process of the data. The qualitative results were written and presented in a specific format identified in Weaver-Hightower's (2014) Setup–Quote–Comment (SQC) model. Using the SQC model, the "set-up" section included a conceptual and operational definition regarding the theme or subtheme under analysis. The "quote" section included direct citations from the participants with relevant analysis of each statement related to the emerging themes and subthemes. The "comment" section consisted of the researcher's brief description or interpretation of the quotes presented, and supported findings with relevant literature that informed the results.

Ethical Considerations

The ethical standards in conducting this research were adhered to ensure high standard of research quality. A formal permission from the Office of the Regional Director, Schools Division Superintendents, school administrators and/or heads from the participating schools where the teachers teach, and a clear informed consent from the respondents were secured prior to data gathering. The rights of the participants to confidentiality and anonymity were protected. Thus, their personal and significant data were treated as private information, and they were encoded with codes and printed transcripts that were safely stored. The participants were informed of their right to withdraw from the research at any point of time without giving any reasons for the withdrawal.

Additionally, the researcher adhered to principles of reflexivity and methodological rigor. To avoid bias, reflective bracketing was undertaken through ongoing reflection and analytic memoing to consciously set aside personal and professional assumptions in order to come close to the data. In addition, to remain objective and to ensure accurate findings, during data analysis, the researcher grounded the interpretations of the data back in the participants' words and narratives and utilized systematic coding techniques to identify patterns and themes that emerged from the data that accurately reflect the lived experiences of the participants.

Result and Discussion

Three themes and fourteen subthemes emerged that provided a detailed and grounded view of innovative teaching and learning approaches in mathematics classrooms. The themes emerged from the participants' narratives, providing a rigid empirical study of teachers experiences of and approaches to teaching and learning mathematics. The themes also demonstrate alignment with Universal Design for Learning (UDL) principles, particularly the addressing of learner variability through diversified approaches to engagement, representation and action or expression. However, the themes were not predetermined by the UDL framework, emerging from the data and thereby providing strong empirical underpinnings to innovative pedagogical practices that intentionally incorporate inclusive learning designs.

Theme 1: Mathematical Engagement

This theme includes pedagogies that engage students in meaningful mathematics learning, developing student interest, motivation, and a sense of purpose in mathematics. These approaches are designed to connect to students' lives, creating a personal relevance and emotional connection to mathematics, which in turn can improve students' persistence, enthusiasm and ownership for mathematics learning. By creating a purpose-driven learning environment, students can develop a more in-depth and enduring appreciation of mathematics.

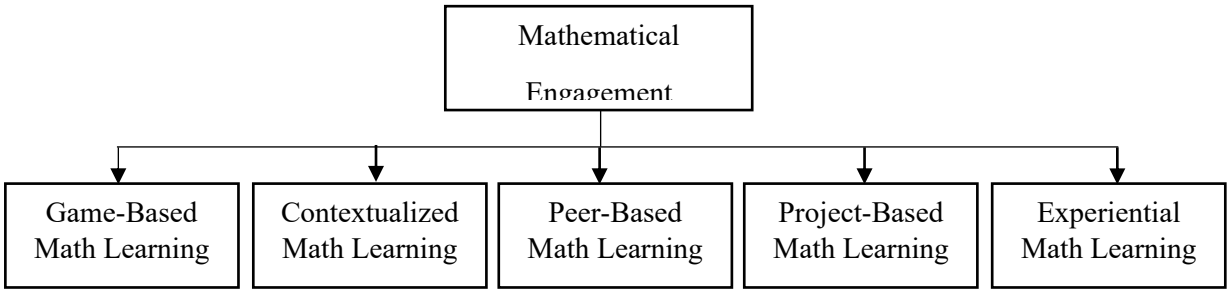

Figure 2. Innovative Pedagogies on Mathematical Engagement

Subtheme 1.1: Game-Based Math Learning

This subtheme highlights teachers' role in enhancing engagement in mathematics learning which involves creating spaces and activities that are active, and emotionally engaging. Participants explained how they employed various gamification strategies and platforms (Quizizz, Kahoot, Mentimeter, Socrative, Jeopardy Labs, Blooket, and more) to create a fun learning space, challenge, and to provide immediate feedback. These tools helped to bring variety to core routines in mathematics education while motivating students to learn and enjoy competition, collaboration, and learning.

Participant D commented positively on the heightened interest and engagement shown by the students when they used gamification approaches. It revealed the element of competition aspect of the pedagogy making it more engaging and easier to maintain students' attention.

> *"I use gamification through tools like Quizizz and Kahoot... There's active participation and healthy competition during these activities ... Students find the activity interesting and engaging." [Participant D]*

Participant I also drew upon a more developed system of gamification for mathematical practice, that incorporated an 'arc system' where points were awarded based on several criteria, including accuracy and speed of mathematical practice. This is an example of how game mechanics can be used to structure otherwise routine classroom activities into clear goals and exercises that need to be accomplished. As in the first example, there was a competitive element to this activity, but here there was a premium on not only getting answers correct, but also completing problems in the shortest possible time.

> *"I explore and experiment with different gamified platforms such as Mentimeter, Socrative, ... Jeopardy Labs, and Blooket. ... I created a point system. ... I created an arc system in which there are specific challenges. ... If they survive that specific challenge, they are going to earn a point which I'm going to tally on the board. ... They say, 'I have to really complete the task as fast as I can and also as correct as I can ... so that we will get that point.' ... They are sort of motivated." [Participant I]*

Game-based approaches to learning can engage students through more than just fun. They can draw students into interaction with mathematical content and develop sustained affective and cognitive engagement with that content. Challenge, feedback, and recognition can encourage students to interact more fully with learning activities, calm math anxiety, and develop not just surface-level participation in mathematical tasks, but also deep emotional investment in these tasks and steady persistence in completing them accurately and efficiently.

Additional interpretations of the findings concern the role of the teacher as a designer and catalyst of gamification and game play to develop student engagement and thinking mathematically. Participants described learning environments and activities in which gamification was not an afterthought but rather a component that served learning intentions, key mathematical concepts, and mathematical competencies. While this study does not offer new information regarding a teacher's role in

game-based learning, the findings demonstrate how carefully designed gamification can shape learning and is one of many approaches teachers and students use to increase engagement and mathematical thinking (Adipat et al. 2021; Bado 2019).

Subtheme 1.2: Contextualized Math Learning

The subtheme focuses on teachers' goals to teach mathematics in ways that are meaningful to their students' lives. Teachers in this study intentionally posed mathematics problems and projects within learners' real-world contexts, used content from a variety of culturally relevant mathematics sources, and conducted mathematics lessons and projects in community settings. By doing so, teachers tried to maintain positive mathematics-related emotions in their students by making mathematics relevant or familiar.

When describing the approach to teaching mathematical concepts, Participant F stressed the use of contextualized problem-solving worksheets in which story problems are set up as activity sheets that reflect genuine real-world scenarios that are readily recognizable and accessible to all students. These problems are more than simple, "cookie cutter" examples to which students are expected to apply abstract mathematical models. As pointed out, they serve as an important anchor to these concepts to make the learning meaningful and understandable for students.

> *"I implement contextualized problem-solving using worksheets. I design activity sheets that relate to real-life situations ... creating problems that students can relate to and connect with ..." [Participant F]*

Participant C further elaborated on how contextualization facilitated students' understanding of the project. It was stated that contextualization helped students see instruction in a more contextualized light and how instruction could be connected to students' lived realities. Furthermore, the materials and examples were framed in a way that made mathematics relevant, practical, and meaningful to students from the participant's community.

> *"Contextualization helps students easily relate to real-life situations. ... the examples and pedagogies used are relevant to their locality, which is what we call contextualization ... designing activities that are relevant to the students' community." [Participant C]*

Understanding mathematics is not the same as experiencing it as relevant and meaningful. From this perspective, the contextualization of teaching materials can help to facilitate learning in ways that foster both a deeper cognitive understanding of the mathematics and greater engagement with the subject matter.

Teaching mathematics in a contextualized manner opens pedagogical opportunities to facilitate deep engagement with mathematical concepts. Drawing on the perspectives of the participants, the findings illustrate that contextualized approaches to teaching and learning mathematics can facilitate students making mathematical connections. Furthermore, the study substantiates prior research that indicates academic achievement can be enhanced by incorporating contextualized approaches to teaching mathematics (Mahmuti et al., 2025). This study also builds on previous research that identified the need for teachers to address linguistic and representational issues that affect student understanding of mathematics, and the use of multimodal approaches to enhance mathematical understanding (Fernández and Galarza, 2023). Distinguishing this study from previous research is the finding that teachers intentionally incorporate contextual elements into lesson design to make mathematics meaningful in their teaching contexts.

Subtheme 1.3: Peer-Based Math Learning

This subtheme reports on pedagogical innovations that draw on social interaction and shared responsibility to promote meaningful participation and problem-solving in mathematics classrooms. The shared characteristics and outcomes of these approaches, reflected in participants' experiences, support the conclusion that these are crucial pedagogical innovations to enhance teaching and learning mathematics.

Structured participation within group tasks, such as the assigning of given roles to learners was often cited to ensure that all students had the opportunity to contribute evenly to a task. As Participant D exemplified, assigning roles in activities enhances discussion because everyone has something to do and therefore there is less inactivity and actually everyone gets involved. It allows for good interaction amongst peers and brings forth two significant concepts which are foundational to a peer-centered learning approach, namely, individual responsibility and group partnership.

> *"During the group activity, each student in a group has its own role to play ... so that they will collaborate ... there is a peer discussion so that nobody will be left behind in that certain group." [Participant D]*

Teachers also reported that having the flexibility to form groupings based on topics of interest or learning styles can increase motivation and student interaction. Several teachers shared that by allowing students to form their own groups, it helped students take ownership of learning and developed a sense of group, or relevance, to the task at hand. These types of peer-centered approaches to teaching and learning math can increase the affective and interpersonal dimensions of the classroom.

> *"I use collaborative problem-solving as a go-to strategy during classes ... I give them time to form their own groups based on shared interests or learning styles ... opportunities to interact and engage with their classmates." [Participant E]*

In addition, problem-solving activities that enable mathematical reasoning through peer-supported learning, and specifically within a dialogic framework, have been incorporated into lessons. Participant H illustrated how within these group-based activities, students could engage in sharing strategies, hypothesizing, and working collaboratively towards a solution. The dialogic, socially constructed nature of the mathematical discussions enabled students to reflect on and refine their mathematical thinking through engagement with their peers.

> *"Another aspect is collaboration, where students learn with their peers, especially in mathematics. ... I let them work in groups or in pairs so everyone can contribute suggestions on how to solve the problem. That way, they can arrive at the correct answer together." [Participant H]*

Peer-based approaches can serve as pedagogical means to enhance cognitive and affective engagement in mathematics. Teachers' narratives present ways in which structured roles, flexible groupings, and dialogic interactions support learners to articulate, negotiate and refine their mathematical ideas. Consistent with prior research, collaboration strategies have been shown to enhance confidence, engagement, and problem-solving performance (Peñeda, 2023; Sugino, 2021). The study also reveals how teachers can on purpose design and orchestrate peer interactions to function as cognitive scaffolds for mathematical thinking and problem-solving.

Subtheme 1.4: Project-based Math Learning

This subtheme demonstrates a dynamic, instructional innovation where students are engaged in active and authentic mathematical tasks. Teacher's lived experiences had shown evidence of how mathematical concepts are connected and anchored through real life projects leading to better understanding and engagement.

In the narratives of Participant F, it was shown that real projects provide opportunities for Mathematics in action. For example, giving tasks that will enable students to calculate the height of a flagpole or to study the probability of different coin-tossing experiments through simulated events. Students are engaged in learning mathematical concepts in an informal and practical setting where they are able to 'do' and record data as they progress through actual projects designed to simulate real life situations. The intention is to carry learning beyond memorization of information to include applying mathematical reasoning skills in real-world project-based situations.

> *"I implement real-life task-based projects that connect math concepts to students' everyday experiences. ... assuming*

you are instructing your students to measure the height of the flagpole. ... I also applied this innovative strategy in a lesson on probability, where I instructed students to toss a coin to determine the sample space. In this activity, the students physically performed the coin toss and recorded their answers. ..." [Participant F]

Participant I also shared about a more extensive real-world modelling project they have done with their class. For that project, students were put into groups and assigned different types of conic sections. With those conic sections as inspiration, they had to design and build different architectural structures such as bridges, towers, and models of parks with mathematical features such as parabolas, hyperbolas, ellipses, or circles. In doing this modelling project, the students employed design thinking, conducted spatial visualization, and utilized mathematical abstraction, both of which are project-based learning skills.

"... I wanted them to see their application in the real world. ... I created an activity called CONIC-XHIBITS, where students were tasked to innovate. I assigned each group a specific type of conic section, and from that, they were to create a miniature model representing their assigned conic. ... They created miniatures that reflected real-world structures using their assigned conic section. Some students, or groups, created models like the Eiffel Tower and bridges to represent the parabola. Others designed parks that featured structures shaped like conics. ..." [Participant I]

This study revealed how teachers implement project-based mathematics learning to integrate mathematical concepts and real-world applications. Mathematics students engaged in prolonged, task-based mathematics learning experiences that were centered on planning, problem-solving, and publicly presenting their work. The findings not only indicated that the students had acquired important mathematical knowledge and problem-solving skills as also indicated in previous studies (Cruz et al., 2022; Ndiung and Menggo, 2024), but that they had also developed critical thinking, creativity, and collaboration skills. This shows how project-based learning facilitated problem-solving, critical thinking, creativity, and student-centered activities, and how teachers make mathematics meaningful and relevant for their students.

Subtheme 1.5: Experiential Math Learning

Tasks that promote learning through participation, tangible experience, and practical application of mathematical concepts and skills to real-world situations or to meaningful tasks are included under this subtheme. The term 'participation' connotes that the pedagogy places emphasis on learners' enactment of mathematics, through their construction of knowledge, ideas, and solutions while undertaking hands-on activities and concrete investigations into mathematical problems and situations. Such pedagogies tend to be more concrete, learner-centered and encourages a deeper sense of awareness and understanding, through students' experiences and perception of their learning.

Participant F referenced the experiential dimension of learning mathematics, in which students are presented with opportunities to be active in learning mathematics. Student learning occurs when they solve, and design problems related to lesson content through more than memorization and into deeper cognitive processing and internalization of mathematical ideas. This type of instruction develops higher-order thinking and teaches mathematics in a meaningful way.

"I always use experiential learning ... students enhance their learning through experiential methods. They take an active role on the topics and actually solving them themselves. ... in order for learning to become more meaningful and effective for our students." [Participant F]

The narrative revealed that hands-on mathematical tasks encouraged participants to be builders of their mathematical knowledge, fully engaging in conceptual understanding of various mathematical topics. Experiential learning has been shown in previous research to enhance students' motivation and understanding of different mathematical topics, support their

academic application of mathematical concepts, and promote meaningful classroom environments (e.g. Uyen et al., 2022; Sun & Xiao, 2023). The findings of this study demonstrate how experiential mathematics learning can heighten learning by supporting meaningful engagement and learning over a long period. Working with hands-on tasks and experience-based issues within experiential mathematics learning can enhance motivation and increase engagement through concrete experiences and meaningful connections to mathematics learning.

Theme 2: Mathematical Representation

This theme involves multiple representations of mathematical ideas in formats and modalities to meet the cognitive and perceptual needs of all learners. It provides a context to examine and showcase various teaching approaches that use multiple representations to facilitate a deeper understanding of mathematical concepts and enable access to mathematical experiences for all students. These approaches enable students to see and understand patterns within and across subject areas and develop and use a symbol system to represent and solve mathematical problems.

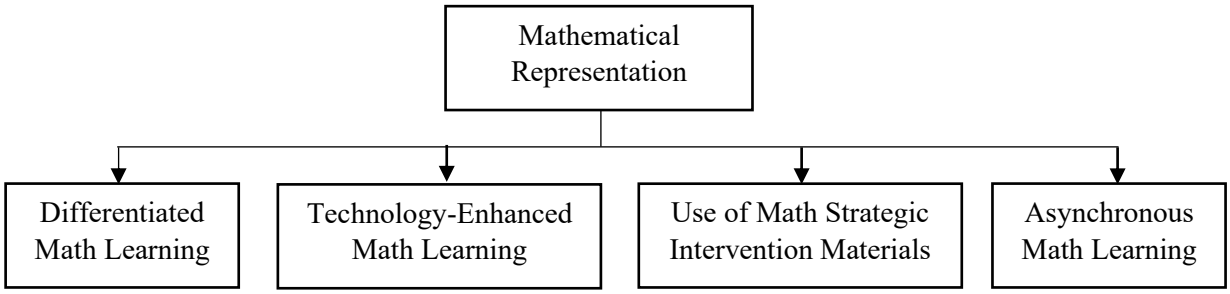

Figure 3. Innovative Pedagogies on Mathematical Representation

Subtheme 2.1: Differentiated Math Learning

This subtheme explores ways in which teachers vary the ways in which students learn, demonstrate, and master important mathematics concepts. This suggest that variation in the mathematics classroom should go beyond varying assignments. In a differentiated mathematics classroom, instruction and content are differentiated to reach the varied demographic of a classroom. Teaching styles, materials, methods of assessment, learning activities, and content can be varied in order to ensure that every student reaches their maximum potential in the classroom. Differentiated math instruction aims to create instructional diversity among the representations of mathematical concepts by matching methods of instruction to the needs of individual students.

Participant A stressed the importance of lessons containing materials that cater to different cognitive abilities in order to make the lesson more equitable. Recognizing that students will have different levels of readiness for certain concepts, means that there are multiple ways to present, facilitate and have students demonstrate their learning in the lesson. Mathematics lessons can include different levels of difficulty with problems, various representations of the same concept, and tasks of differing complexity that allow for the tiered instruction of a concept that is slowly built up throughout a unit. By using multiple different scaffolds, multiple different types of materials and various different types of learning products, each student can be challenged and succeed in the lesson.

> *"I usually do differentiated instructions since they have different level of thinking ... We really need to base it with the level of the students, so we cannot make one instructional material for all the students, so we need to base it on their different level." [Participant A]*

This instructional pedagogy was further reinforced by Participant D, who stressed the importance of style-based instruction whereby the teacher utilizes instructional methods that are relevant to the students' learning style. The use of a VAK (visual, auditory, kinesthetic)

approach and multiple intelligences was mentioned as a method whereby students process and learn concepts differently. In order to help students achieve academic success, teachers must utilize a variety of approaches (e.g. diagrams, written/oral reports, manipulatives, activities, real life examples/mimics) and incorporate flexibility and responsiveness into their instructional approach. As students have different primary intelligences, the teacher must cater for these differences by drawing on various approaches for content delivery.

> *"… different learning style as well yung VAK. V stands for visual, A is Auditory and kinesthetics. First, you should know their VAK inclination. We know for the fact that each person has multiple intelligences. As a teacher we need really to be flexible. You have to make an activity that they are inclined to that particular learning style. There should be a what we so called differentiation of your different activity." [Participant D]*

Findings from these narratives show that using differentiated mathematics learning as a pedagogical approach can lead to greater representation and personalization in classrooms. Mathematical content, processes and products can be flexibly adapted to meet the diverse needs of students, while remaining true to mathematical goals. Research has long shown that teacher use of differentiation, specifically along the dimensions of content, process and product, can have positive outcomes for learning (Herner-Patnode and Lee, 2021; Rijal et al., 2025). This study presents ways in which teachers use differentiated approaches to mathematics learning, highlighting a range of strategies that can be used to make mathematics learning more meaningful, accessible and relevant for all students.

Subtheme 2.2: Technology-Enhanced Math Learning

This subtheme explores how mathematics educators use a variety of digital tools, platforms and applications to present mathematical content in innovative, interactive and visually engaging ways. Technology can be used to present mathematical concepts in a multitude of forms and to support a variety of learning styles. This presents how technology can support deeper mathematical understanding and how mathematics educators integrate technology into their teaching practices to support these learning goals.

Incorporating interactive materials like Excel Macros to automatically check responses and very quickly verify student input allows for automation of response checking which enables instant verification of students' work which enables Participant F's goal of enhancing practice, self-assessment, and metacognition through student's independent learning while instantly internalizing correct mathematical procedures.

> *"… I also use interactive digital materials like Excel Macros. An automated material that can generate responses and with that, the students can verify whether it is correct or not." [Participant F]*

Participant G described an application to creating interactive presentations using Office Remote technology for a formal lecture. Using mobile-enabled controls and Office apps on a Windows tablet created a level of support for learners in the class that Participant G found enabled a greater level of students' attentiveness. It increased the interactivity of the learning environment and supported multimodal representation.

> *"Yeah. So with Office Remote, we can control our slides. . . it becomes interactive. . . it really feels interactive because its's like they're pressing directly on the projection screen." [Participant G]*

Graphing with tools such as Desmos and GeoGebra was also frequently mentioned by Participant H, through which students can make precise and clear representations of mathematical relationships and, most importantly, vary independent variables to investigate how these changes affect the resulting graph. Using these tools allows students to enter a more visual, kinesthetic form of learning, which can lead to a deeper sense of mathematical behaviour and a more precise conceptual understanding of that behaviour.

> *"Another approach that I have just started looking into is using online platforms where you can actually do mathematical things. We have used Desmos, and I have just started to use GeoGebra. For example, with GeoGebra you can input given values and actually see the graph of the function, as well as see the behaviour as the given values change. Students do not have to imagine the shape of the graph, they can view it and see how it behaves." [Participant H]*

Technology can serve as a powerful tool for teaching mathematics, making it possible to pose and solve mathematical problems using multiple representations, to visualize and interact with complex mathematical concepts, and to cater to different learning styles. Technology can thus support teaching and learning of mathematics at many levels, and when used as a pedagogical tool, it can enhance the quality of teaching and learning experience. Several studies were conducted to identify the effectiveness of using technology in teaching mathematics. Technology-based instruction is seen as effective in enhancing students' comprehension and achievement (Rybak, 2021; Hidayat and Firmanti, 2024). This study goes further by depicting how teachers deliberately utilize technology in designing and delivering lesson to create an interactive learning process to enhance students' engagement and achievement in vocabulary and grammar learning.

Subtheme 2.3: Use of Math Strategic Intervention Materials

The use of Strategic Intervention Materials (SIMs) in mathematics instruction shows a responsive pedagogical approach that addresses the diverse learning needs of students, particularly those who struggle to master concepts through conventional methods. SIMs are purposefully designed to reteach least-mastered competencies by simplifying complex content, reinforcing foundational skills, and guiding learners through scaffolded tasks. Typically, these materials include guide cards, activity sheets, assessment tasks, and answer keys, enabling students to engage in independent or peer-assisted learning with minimal teacher supervision. To further sustain interest and motivation, teachers often present SIMs in creative formats, such as story-based scenarios, concept-driven activities, or comic-style lessons, which reframe abstract mathematical ideas in more engaging and accessible forms.

Participant A highlighted the crucial role of SIMs when standard teaching strategies do not adequately meet the needs of certain learners. This was especially evident in academic tracks such as the General Academic Strand (GAS) and Technical-Vocational-Livelihood (TVL), where students display varied levels of readiness and confidence. As the participant explained, SIMs offer an alternative pathway by closely matching instruction to the learner's level, thereby allowing them to revisit essential skills at a manageable pace and progress toward conceptual mastery:

> *"I used strategic intervention material as one of my interventions in teaching mathematics ... If the student really did not learn from any of those other strategies that I use I'll be making instructional materials or the SIM. ... students in the General Academic Strand or TVL ... usually require strategic intervention materials to support their learning." [Participant A]*

Building on this idea, Participant F emphasized the potential of contextualized automated interactive materials (AIMs), which serve as technology-enhanced SIMs. Unlike traditional print- based materials, AIMs employ automation to simplify complex concepts, provide immediate feedback, and promote self-paced learning. By embedding contextual elements drawn from students' lived experiences, these materials not only facilitate comprehension but also strengthen the relevance of mathematics to real-world situations:

> *"The most effective pedagogies that has been, that I've been using is the contextualized automated interactive materials or the AIM ... It simplify complex concepts and allow for self-paced learning. ..." [Participant F]*

The use of SIMs, together with their digital counterparts such as AIMs, illustrates how

teachers can diversify mathematical representation to promote equitable access to content. Through the integration of structured guidance and interactive features, these materials ensure not only improved academic performance but also greater learner motivation and self-regulation. In this way, SIMs emerge as vital components of inclusive and learner-centered mathematics pedagogy.

These interpretations are consistent with prior studies that demonstrate the effectiveness of SIMs in improving student performance and engagement (Segarino and Labisig, 2022; Saputri and Qohar, 2020; Lestari et al., 2020). However, the present findings extend this body of knowledge by illustrating how teachers operationalize these materials in practice, thereby positioning SIMs not only as remedial tools but also as strategic instruments for a meaningful mathematics learning.

Subtheme 2.4: Asynchronous Math Learning

This subtheme examines the variety of resources provided to students outside of the regular classroom for time-independent learning. These resources, used in addition to or in place of traditional instruction, enable students to view mathematical content in multiple formats for self-paced study at any time and from any location. As such, these learning objects offer an alternative means to traditional methods of representation and can be particularly valuable in inadequate learning environments.

Participant E used printed modules to support independent study for students who required additional time to complete course material or who had conflicting scheduling. The study materials were used to extend learning beyond classroom delivery allowing for additional opportunities for students to review and reflect on course content. The teacher also provided opportunities to respond to student questions at any time.

> *"I really try to prepare modules to supplement my students' learning. I try to apply what I learned. Sometimes I send emails very late at night. They contact me in the early morning. I don't mind." [Participant E]*

Further narratives by Participant H cover the integration of asynchronous video, like TV Eskwela that was produced during the pandemic to deliver school television to students learning at home. These are additional resources that can be watched independently by the learner and can aid in ongoing learning even when the teacher is not around. This further transition to more student-centric learning that still has structured content, allows for a shift in the role of the teacher from sole communicator of information to facilitator of that information.

> *"…it gets to a point I'm not around as often as I wish I would be because of the sheer volume of responsibilities that are placed on me by DepEd. In that scenario, the videos can become one of the learning platforms that my students would use when I am not present. In the past, we had TV Eskwela and as part of the team I have accessed those videos in the past. In this current moment, those TV Eskwela videos would be a learning tool for them so that they could continue to learn even when I am not present." [Participant H]*

Participant C further reflected that having adequate internet access can be a challenge. However, the individual mentioned that providing the video content in an offline format is one way to support learning and instruction when live internet access is not possible and on-demand access to high-quality video is needed.

> *"Without internet access it is difficult to deliver ICT lessons effectively. Alternatively, teachers can provide learning resources in an offline format and students can view online videos at home as part of homework. [Participant C]*

In contrast to traditional approaches, the use of asynchronous communication in mathematics education can provide a more expansive and inclusive representation of mathematical concepts. Decentralized learning instruction and content delivery offer students numerous opportunities for accessing information and learning, maximizing their potential for inde-

pendent academic effort and adapting to individual student needs by sustaining, adapting, and personalizing instruction.

As evidence emerges demonstrating the effectiveness of using asynchronous learning methods in educational environments, this account can be supported and expanded on. For example, the use of asynchronous models supported by digital modules were seen to improve the math skills of students (Saputro et al., 2023). Their application resulted in greater learning than would have occurred with synchronous teaching approaches. Meanwhile, Cabrera (2023) observed that instructional designs that incorporate both synchronous and asynchronous methods can deliver greater learning outcomes than those utilizing a single method. Additionally, Crodua and Itaas (2025) revealed that reveal the potential of supplementary learning mathematics videos as an innovative pedagogical tool for improving student learning outcomes in mathematics. These findings align with the earlier accounts of teachers employing a range of printed and digital resources in attempting to maintain learners' engagement and promote learning within the asynchronous environment.

Theme 3: Mathematical Action and Expression

This theme reveals pedagogical innovations used for assessing understanding and evaluating the use of mathematical reasoning. It explores ways in which assessment and monitoring can facilitate learning, by encouraging children to describe and discuss their ideas, to tackle complex mathematical problems and evaluate their own performance. Through such learning strategies, students can develop greater independence, strategies for learning and an increased confidence in mathematics.

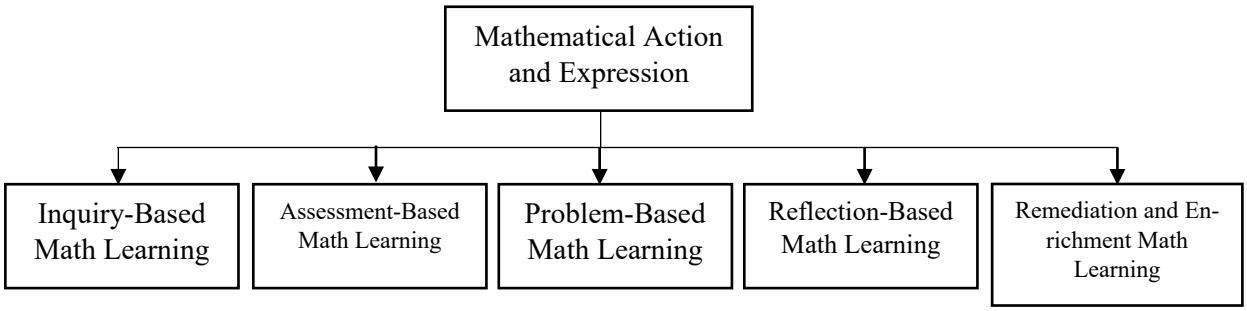

Figure 4. Innovative Pedagogies on Mathematical Action and Expression

Subtheme 3.1: Inquiry-Based Math Learning

This subtheme explores innovative pedagogies, such as teacher facilitation, inquiry learning, and student-centered approaches, which move teaching and learning from a traditional teacher-centered approach to a more student-focused approach. Students taking ownership of learning by developing, expressing and applying their understanding of mathematics through investigation and problem-solving. The pedagogy enables students to form their own understanding of mathematical concepts and ideas by formulating problems and questions, testing hypotheses, and generalizing from their own mathematical thinking and reasoning. The pedagogy enables students to take more of an action orientation in learning and expression.

It was particularly encouraging to see how Participant D integrated inquiry approaches into the teaching practices. Rather than starting with the direct delievry of procedures and then giving students the opportunity to practice them, inquiry-based approaches begin with mathematical problem scenarios that need to be explored and understood by students. By presenting mathematical situations, Participant D's lessons guided learners to recognize, to identify relationships and structures, and to make conjectures. As learning unfolded, the teacher acted as facilitator, posing questions, offering feedback, and gradually deepening, or refining, student understanding. This type of approach develops a rich understanding of mathematical concepts and creates learning

opportunities that students will find enduring and meaningful.

> *"Instead of starting with the concept, I give them an example, and then having them solve a similar problem using the concept, instead we explore first, maybe even the same problem or a similar scenario. They are going to explore first rather than giving all the steps or the solution by me. That is inquiry-based learning. So instead of giving the concept, they will be the one to discover the concept. Thus, they will develop the process of how to study math. That is IBL." [Participant D]*

Participant B utilized several research-focused approaches in teaching, incorporating real world exemplars and contexts to promote learner understanding of a range of mathematical techniques. Concrete examples of this approach included framing a number of research questions that allowed students to take on the roles of problem solvers/ investigators, using mathematical techniques to arrive at evidence-based conclusions. The approaches and practices incorporated within this teaching constructivist theories of learning, where learners construct meanings of new concepts, processes and procedures based upon prior experiences, understandings and social interactions.

> *"I implement a research-based approach, students will find a research problem, and we will apply the problems related to hypothesis testing."*

In these narratives, students move from being receivers of mathematical information to learners who develop mathematical knowledge in a collaborative setting through investigation, argumentation and articulation of their mathematical understanding. IBL methods are effective in reforming the learning environment and transforming learners from reluctant to enthusiastic mathematical participants. These learning activities promote the construction of mathematical concepts and procedures using explanation and solution of problems under the guidance of teachers or peers in exploratory learning environments. The narratives obtained highlight aspects of student behavior such as investigation of mathematical situations, critical thinking and sense-making that correlate with enhanced engagement (Khasawneh et al., 2023; Şen et al., 2021). Participants explicitly articulated how student discussions and the related argumentations helped improve their students' use of predictive, explanatory and justificatory reasoning, with particular emphasis on the development of conjectures. The teachers reported that classroom discussions within IBL activities stimulated the students' active use of their prior knowledge and aided in reaching robust mathematical understandings.

While inquiry activities are potent for increasing IBL students' conceptual understanding and problem-solving skills (Doz et al., 2025), only limited effects on procedural fluency were observed. Consequently, when adopting IBL, inquiry activities need to be complemented with opportunities for procedures to be applied in routine problem-solving situations, and therefore practice should not be used as the sole pedagogical method.

Subtheme 3.2: Assessment-Based Math Learning

This subtheme illustrates an innovative pedagogy for mathematics teaching and learning that involves the continuous collection and timely use of learning assessment to inform teaching and support learning. In this innovation, assessment is not treated as an end of unit test but as an instructional process that provides teachers and students with an ongoing measure of learning understanding. It is embedded in daily classroom routines and used to monitor students' progress towards achieving learning objectives and to identify any misconceptions that may be developing. Feedback is a two-way process which supports students to reflect on their learning and to plan future actions whilst enabling teachers to monitor and adjust their teaching so that it is more effective at meeting the needs of their students.

In the teacher's narratives, it revealed that activity sheets were used formatively by Participant F for initial diagnostic purposes as a first window into students' current levels of performance on specific mathematical content. The teacher would then use the resulting student

data to adjust the instructional pacing and design of subsequent paper-and-pencil tasks for the whole class.

> *"Some of the things I do to check for student understanding are things like and activity sheet and then I can look at that to see if I need to be rearranging my classroom instruction and/or projects." [Participant F]*

Participant G also highlighted the integration of digital assessment tools like ZipGrade, which helps digitize assessments. This digital tool also enables reach to students who may not be in school on a given day. Using ZipGrade, teachers can deliver formative assessments and provide feedback to their students immediately, even when they are not in school. This is an important practical innovation to make assessments more inclusive and efficient for teachers.

> *"...I also use ZipGrade because ZipGrade in my class actually is not only for assessment. Instead of the usual paper and pencil assessment, you can make use of that assessment online. Particularly for the students who will not be able to come to school." [Participant G]*

This formative aspect of assessment was further elucidated by Participant I who explained how she utilizes students' feedback to assess instructional effectiveness. Unlike the previously discussed assessment of student understanding of content material, the teacher uses the feedback of students in order to evaluate the tools and strategies employed on a formative basis. The feedback serves to continually revise pedagogical practices in order to more effectively meet the needs of students through the implementation of instructional approaches which are responsive to their present needs and preferences.

> *"I collect regular student feedback to understand whether tools and methods meet their learning needs. ... Their input helps me adjust strategies to improve effectiveness." [Participant I]*

The findings of this study have been supported and extended by a variety of research studies conducted with students in different educational settings. Assessments embedded into pedagogy can have positive effects on student learning by raising achievement and motivation when associated with quality feedback (Kültür & Kutlu, 2021). As noted by Participant F, the activity sheets 'give the students the opportunity to do more practical work that improves their performance and enhances their attitudes to learning mathematics. This way of incorporating assessment into teaching and learning can also enhance self-efficacy and interest through perceived usefulness of feedback (Rakoczy et al., 2019). Thus, assessment with feedback loops can encourage teachers and their students to become active participants in the learning and teaching process.

Subtheme 3.3: Problem-Based Math Learning

This pedagogy involves a method for teaching mathematics, based on active learning of mathematical problems and solutions. Generative problem posing and solving promotes moving from receiving and doing assignments toward learners formulating their own problems and applying procedures and methods already learned. This methodology develops critical thinking, creativity, and greater conceptual understanding of a topic.

Participant B reinforced the merits of the approach by explaining how students design problem sets aligned with specific mathematical competencies, prescribed by the Department of Education, and then solve those problems. Developing problem sets and solving them in this way enables students to engage in more hands-on learning in which they are actively constructing knowledge rather than being passive receivers of knowledge. The approach also advocates a sense of ownership and relevance in the learning process.

> *"... we make problem sets and it is them who make the problems from a topic. Problems they will study are problems they made themselves, the basis of which is the competencies set by the DepEd, and they will solve those problems. Hands-on learning of mathematics is achieved." [Participant B]*

This pedagogy also emphasized how students generate content for mathematics problems which entails for them to analyze, organize and contextualize mathematical concepts to create such problems. Hence, students are engaged in both problem-posing and problem-solving which are two distinct yet somewhat related mathematics skills that can be learned and developed at the same time.

Problem posing and solving are therefore essential elements of problem-based mathematics learning. Teacher's narrative demonstrates that enabling students to develop both analytic and creative competencies to pose problems is important for academic performance. The available evidence from studies demonstrated that there were medium to significant effects on students' performance in problem solving and problem posing as a result of active learning interventions (Zhang et al., 2024; Polat and Özkaya, 2023). These outcomes are in line with the finding that students develop essential skills such as reasoning, planning and monitoring while engaging in problem-solving activities (Dorimana et al., 2022). Overall, it confirms the inclusion of the process of problem posing within a broader inquiry process.

Subtheme 3.4: Reflection-Based Math Learning

This is an emerging pedagogy that positions an awareness of cognitive strategies as essential for mathematical performance and for self-regulation of learning. Teaching reflection is crucial and such approaches enable learners not only to monitor their thinking but also to describe the rationale underlying their actions. By doing so, critical thinking pedagogy develops more intentional mathematical problem solving.

Participant E described how students tackled a particular math problem and did a video log where they walked the viewer through their steps. The reflective video log serves several purposes, as a way for the individual student to solidify what they have learned, to revisit their own work over time, and to allow others to vicariously experience what a student does through watching the student work. In articulating their process and solution, students are engaging in metacognitive monitoring whereby they clarify their thinking by identifying what worked well, what didn't, and what improvements could be made. And they describe how their thinking and approach to the problem developed throughout the task.

> *"I provided them with a problem and asked them to make a video in which they explain how they solved it and how they go through their process. So that later on, they can view the video and will not forget how they did it. This reflective vlog or video log can then be shared with others that they can also benchmark." [Participant E]*

This video is not only useful to the original learner but can be used by other learners to benchmark against or learn from the different approaches, strategies and solutions that have been developed. In addition, others can learn from this process how to utilize metacognition. Also, once the original learner has reflected and published their outputs, they could discuss the outputs with their peers in academic dialogue modelling the reflective process as part of the learning journey.

Reflection is a crucial component of effective mathematics learning and performance. The field of research relating to mathematics learning reflects a diverse agenda relating to the development and teachability of some metacognitive skills across age ranges and contexts, and their role in problem solving and concept construction (Thi-Nga et al. 2024). In mathematics classrooms, research has shown that students' use of task analysis, planning, monitoring, checking, self-assessment, and self- and/or peer-monitoring supports mathematical problem solving (Tachie, 2019).

Subtheme 3.5: Mathematics Remediation and Enrichment

This subtheme details how an innovative mathematics pedagogy can engage students in meaningful mathematical action, while at the same time targeting specific learning gaps and providing opportunities for more advanced learners to extend and deepen their understanding of key mathematical concepts. It considers how to design remedial interventions

and more advanced lessons that provide an enriched learning experience and offer a range of learning pathways to support diverse learners.

Participant H described a locally developed initiative called MATHtuto, which is a peer-assisted learning program designed to provide remediation in mathematics for struggling students. The program, which is typically implemented towards the end of a grading period, matches high-performing students in mathematics with students who need assistance with mathematics. As participants learn to support their peers, both sets of learners are expected to strengthen their mastery of mathematical concepts. This form of remediation, therefore, is a collaborative learning approach that extends academic support outside of regular classroom hours and relies on peer assistance to support academic achievement.

> *"Once every month, around the grading period, we have this project called MATHtuto, where we have the achievers or students who are good in math teach the students whom we think might fail in math and then we conduct the remediation sessions. … Nearing the grading period, about twice every quarter we implement the said project in supporting struggling learners in math. In this, the achievers or the students who are good in math will teach those who are struggling students whom we think might fail in math. … we conduct the remediation sessions." [Participant H]*

In addition to individual section work Participant H also alluded to some form of "school wide" intervention in the form of a formal enrichment program that was delivered by a number of external facilitators working with groups of students under the guidance of some of the university's leading mathematicians/scientists. In addition to this, the program known as Problem-Solving Enrichment Training (PSET) was run on Saturdays with sessions of advanced mathematical problem-solving delivered in different sections. This was clearly an attempt to provide additional academic support that is future-oriented, which can optimize students' mathematical abilities.

> *"Another thing I should add is that we have an innovation or partnership with Ateneo de Manila University for three years now. ... It's called the Problem-Solving Enrichment Training. ... The teachers from Ateneo teach the students every Saturday, covering five sections. ... It's really a great program for the students." [Participant H]*

Classroom practices that develop mathematical action through equity and excellence in mathematics instruction can provide remediation and enrichment for students. Struggling learners must not be allowed to fall behind while advanced learners are often left wanting more challenging work. These strategies for mathematical action are innovative and learner-centered whether building a foundation or exploring a concept more in depth.

This innovative pedagogy receives strong support from the existing literature. Intentional and targeted intervention can improve mathematics achievement, including the affective deficits that interfere with students' ability to succeed academically (Shanaa & Hamada, 2020; Maruyama & Kurosaki, 2021; Ng et al., 2022). The intent behind pedagogy is thus to create targeted and diagnostic intervention and enrichment that can help students improve and expand their mathematics achievement over time.

Innovative Mathematics Pedagogies Framework

The Innovative Mathematics Pedagogies (IMP) Framework, depicted in Figure 5, presents a conceptual and structural synthesis of the phenomenological essences emergent from teachers' lived experiences of instructional innovation in mathematics education. The transcendental phenomenological design that informed this research process was employed to bracket individual experience in order to render experiences common to the lived world of instructional innovation. Analyzing the statements identified as significant moved progressively through extracting, coding and grouping the statements to generate meaning units, forming the basis of the resultant textural and

structural descriptions of experiences of instructional innovation in mathematics education. These invariant experiences of teaching mathematics innovatively gave rise to a set of pedagogical essences that form the essence of innovative mathematics teaching.

This framework identified three interconnected dimensions that are irreducible and fundamental for understanding innovation in teachers' pedagogical practice of teaching mathematics. These dimensions were identified and labelled in the order in which they appeared in the participants' narratives. The three dimensions are drawn from the variables Mathematical Engagement, Mathematical Representation and Mathematical Action and Expression. Importantly, these dimensions were not imposed a priori but inductively generated from the data to capture the fundamental ways in which teachers conceptualize and practice pedagogical innovation in mathematics classrooms.

Mathematical Engagement encapsulates the essence of sustained and meaningful learner involvement. Participants consistently emphasized instructional approaches that actively position learners at the center of the learning process, including game-based, contextualized, peer-assisted, project-based, and experiential mathematical pedagogies. In parallel, Mathematical Representation reflects the essence of conceptual accessibility, as teachers described the deliberate use of multiple modalities to make mathematical ideas comprehensible. These include differentiated instruction, technology-enhanced learning, use of strategic intervention materials, and asynchronous delivery modes that respond to diverse learner needs. Complementing these dimensions, Mathematical Action and Expression represents the essence of demonstrated understanding and meaningful application, encompassing inquiry-based, problem-based, assessment-driven, reflective, and remediation or enrichment practices that enable learners to construct, apply, and communicate mathematical knowledge.

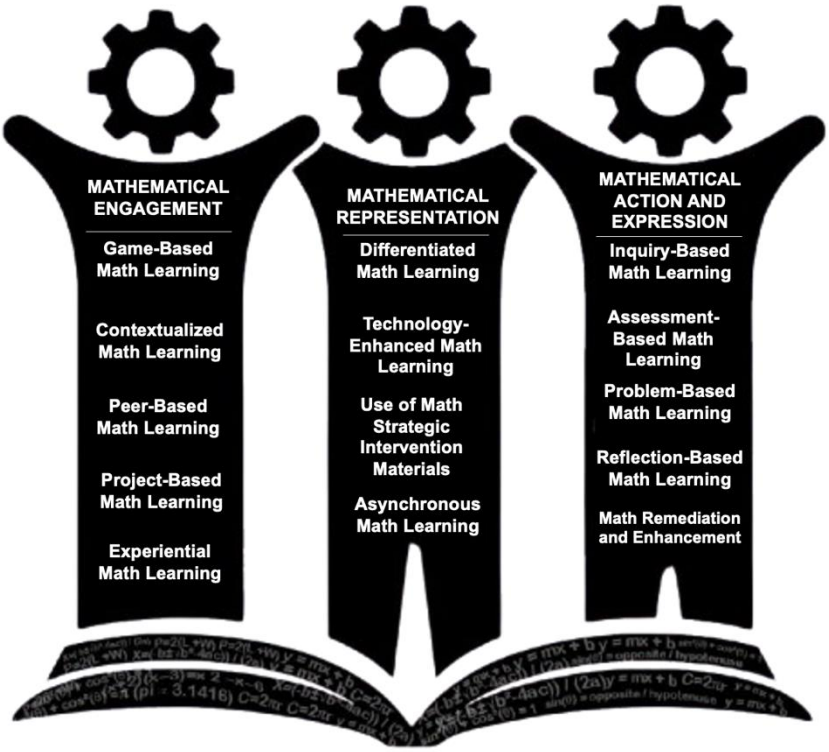

Figure 5. Innovative Mathematics Pedagogies (IMP) Framework

The framework is an open book to symbolize that the pedagogical approaches identified are grounded in the epistemology and procedures of mathematics, and that innovative

pedagogy is discipline-based. The three figures represent the three themes identified. Their linked posture signifies that all these approaches need to be enacted simultaneously and interdependently in teaching and learning mathematics. The gears representing the figures' heads signify the centrality of cognitive processes in mathematics teaching and learning. These include the processes of reasoning, problem solving, abstracting and constructing new knowledge in mathematics, and the figures' upward posture signifies progression and development in teaching and learning mathematics through these pedagogical approaches.

Overall, the transition from phenomenological essences to the IMP Framework is both analytic and interpretive. The three dimensions were organized to reflect the structural relationships evident across participants' accounts: engagement functions as the entry point that sustains participation, representation facilitates access to mathematical meaning, and action and expression enable the application and articulation of understanding. Accordingly, the emerging framework visually operationalizes these relationships, presenting it as a system of mutually reinforcing and dynamically interacting components.

Although the emergent dimensions reflect key principles of Universal Design for Learning (UDL), their emergence is not a result of imposing UDL principles onto teachers' classroom practices. Rather, their appearance is a natural consequence of attending to teachers' lived experiences of teaching and implementing innovative pedagogies that are inclusive and flexible by nature. The results strengthen the theoretical underpinnings and practical value of UDL.

In summary, the IMP Framework helps to make sense of the qualitative characteristics of mathematics teaching and learning and to connect this to established pedagogical theory in the form of a structured and transferable model. Moreover, it conveys a progressive view of innovative pedagogy as an integrated system of practice, rather than an additive collection of unrelated instructional tactics and techniques such as engagement and representation and action and expression.

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