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INNOVATIVE STUDENT-CENTERED LEARNING: A CURRICULUM FRAMEWORK FOR MATHEMATICS IN THE MODERN WORLD

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Abstract:

This qualitative inquiry investigated the instructional content and structure of the Mathematics in the Modern World (MMW) course, with the objective of constructing a grounded instructional framework. Anchored in Creswell's grounded theory methodology, the study addressed three central questions: (1) What essential competencies are fostered in MMW? (2) What preliminary framework may be formulated for its delivery? and (3) What final framework can be advanced for course implementation? Data were elicited from five student participants through semi-structured interviews and analyzed using open, axial, and selective coding, guided by the constant comparative method.

The findings demonstrated strong congruence between the Commission on Higher Education's mandated outcomes (CMO No. 20, s. 2013) and students' lived experiences, particularly in the domains of mathematical literacy, critical thinking, logical reasoning, and interdisciplinary integration. Students affirmed the course's practical value in contexts such as budgeting, transportation analysis, data interpretation, and teaching. Nevertheless, participants articulated further competencies beyond CHED prescriptions, including mathematical communication, pedagogical readiness, digital fluency, and the need for affective support to mitigate mathematics anxiety. They also underscored the necessity of improved sequencing of topics (e.g., introducing sets before logic, and probability before statistics) and the integration of technological resources such as calculators, coding tools, and data visualization platforms.

These insights informed the development of the RAISE Framework—emphasizing Relevance, Application, Innovation, Student-centered learning, and Technology-based, Interdisciplinary instruction. This model unifies policy standards with student-derived needs, offering a comprehensive, adaptable approach to MMW instruction that advances academic competence, professional preparedness, and meaningful societal participation.

Keywords: Mathematics in the Modern World, grounded theory, instructional framework

INTRODUCTION

The Mathematics in the Modern World (MMW) course, established under CHED Memorandum Order No. 20, s. 2013, is a core subject in the General Education Curriculum (GEC) of the Philippines. It aims to show how mathematics connects to real-life contexts, developing students' critical thinking, quantitative literacy, and appreciation of mathematics' societal role. Unlike traditional math courses, MMW promotes understanding of logic, patterns, statistics, and problem-solving in everyday life.

However, despite its transformative goals, there are concerns about how MMW is implemented and perceived by students. The course's relevance and effectiveness vary across institutions, and limited research has explored how students actually experience and value it. This creates a gap between the curriculum's intent and students' real experiences, which is crucial in a general education system that aims to produce well-rounded and socially responsible citizens.

Previous studies on mathematics education in the Philippines often focus on achievement or anxiety, overlooking how students interpret the broader purpose of MMW (Novero & Bellen, 2019). Likewise,

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international research often centers on STEM perspectives, neglecting the social and philosophical aims of general education mathematics (Li & Schoenfeld, 2019).

To address these gaps, this study uses grounded theory (Charmaz, 2014), an inductive qualitative approach that builds theory from students' own insights and experiences. This allows a deeper understanding of how students view the relevance, application, and outcomes of MMW. The research also aligns with calls for learner-centered and context-sensitive reforms (Burton, 2020), especially as education adapts to digitalization and post-pandemic changes.

Through interviews and analysis, the study seeks to identify what students find meaningful or irrelevant in MMW and how they apply its lessons in real life. Ultimately, it aims to bridge the gap between policy and practice, offering a student-informed framework for improving the MMW curriculum, teaching strategies, and general education in the Philippines.

THEORETICAL FRAMEWORK

Review of Technical and Related Literature

Grounded Theory, as described by Creswell, is a qualitative research design aimed at developing theory directly from data provided by participants. It is especially valuable when existing theories fail to explain a process or when researchers seek to understand social phenomena from the perspectives of those involved (Creswell & Poth, 2018). Unlike deductive approaches, theory in grounded theory emerges inductively during analysis rather than being predetermined.The process typically begins with open-ended questions and data collection through interviews, observations, or documents. A central feature is constant comparative analysis, where new data are continuously compared with prior findings to refine categories and identify patterns. This is supported by multi-stage coding:Open coding breaks data into discrete parts,Axial coding connects categories, andSelective coding integrates them into a core category that explains the central phenomenon.

Grounded theory also uses theoretical sampling, where participant selection evolves based on the emerging theory, continuing until theoretical saturation is reached—when no new insights arise. Throughout, memo writing serves as an essential analytic tool, helping researchers reflect on codes, category relationships, and theory development (Birks & Mills, 2015).

Basic Principle of Grounded theory

The basic principles of grounded theory revolve around developing theory directly from data rather than starting with pre-existing assumptions. Below are its key principles explained in simple terms:

Open Coding

The researcher in this process closely examine data line by line to identify and label meaningful ideas, helping to break down people's experiences into clear parts for deeper analysis.

Axial Coding

The researcher link and organize initial codes, identifying relationships among categories to explain how concepts connect and interact.

Selective Coding

Selective coding is the last stage of grounded theory, where the researcher unifies all categories around a core idea to form a coherent theory.

Memo Writing

Researchers write memos throughout the process to record ideas, insights, and relationships among categories, helping shape the final theory.

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Theoretical Saturation

Data collection continues until no new ideas or categories emerge—meaning the theory is well-developed and comprehensive.

Research process

Grounded theory is a flexible, iterative research approach where data collection and analysis occur simultaneously, research questions evolve with emerging insights, and the ultimate goal is to build a theory grounded in data through constant comparison and theoretical saturation..

Data collection

Grounded theory employs diverse data collection methods and, in its full form, involves an iterative cycle of collecting and analyzing data to refine categories and guide further sampling until theoretical saturation is reached, whereas its abbreviated version applies the same coding techniques to a fixed dataset but lacks the flexibility, depth, and refinement of the full method.

Data analysis

In grounded theory, coding is the starting point of analysis, with line-by-line coding ensuring concepts emerge directly from data. Open coding generates initial categories, which may be refined through axial coding (Strauss & Corbin) or left to emerge naturally (Glaser). The approach explains social processes in context, blending realism with symbolic interactionism, where events are both real and interpreted. While traditional grounded theory emphasizes researcher neutrality, constructionist versions view the researcher as co-constructing meaning.

Framework Validation Through Grounded Theory

Validating a grounded theory framework is a qualitative process focused on credibility, resonance, and theoretical saturation rather than statistical tests. Strategies include constant comparison to ensure categories are grounded in data, reaching saturation to confirm completeness, and member checking to verify authenticity with participants. Memo writing documents analytic decisions, enhancing transparency, while criteria such as fit, relevance, and workability ensure the framework's rigor and applicability. Peer debriefing and triangulation further strengthen trustworthiness, making validation an iterative process that ensures the theory is both empirically grounded and meaningful to participants.

METHODOLOGY

This chapter presents the research methodology used to examine the Mathematics in the Modern World (MMW) course from students' perspectives. It employed a qualitative design using grounded theory to deeply understand how students experience, interpret, and respond to the MMW curriculum. Grounded theory was selected to generate a theory based on participants' lived experiences, particularly in areas lacking established explanations. The chapter discusses the research design, data sources, sampling, data collection, analysis procedures, and ethical considerations, all aimed at developing a conceptual framework that captures how MMW supports students' academic and personal growth.

Research Design

This study used a constructivist grounded theory approach to develop a theory based on students' views of the Mathematics in the Modern World (MMW) course. Data were gathered through semi-structured interviews with purposively chosen participants and analyzed using open, axial, and selective coding, supported by constant comparison and memo writing. Theoretical sampling continued until saturation was reached, while triangulation, peer debriefing, and member checking ensured credibility. This flexible, systematic process enabled the co-construction of meaning, producing a context-based framework that reflects students' experiences and informs curriculum and teaching improvements.

Locale of the Study

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This study was conducted at three institutions in Bukidnon: Central Mindanao University (CMU), San Agustin Institute of Technology (SAIT), and Bukidnon State University (BUKSU). CMU

PRESENTATION, ANALYSIS AND INTERPRETSTION OF DATA

This chapter presents the findings based on Creswell and Poth's (2018) grounded theory approach, using data from five purposively selected students interviewed in depth. The analysis involved open, axial, and selective coding, constant comparison, and theory generation to create a framework for instructional excellence in the Mathematics in the Modern World (MMW) course. Participants provided rich insights into the relevance of mathematics in academic and real-life contexts. Theoretical saturation was achieved after the fifth interview, ensuring that the developed framework was authentic, credible, and grounded in students' real experiences.

Essential Competencies of Mathematics in the Modern World

The first question in the statement of the problem is on the essential competencies on Mathematics in the Modern World. To address this statement of the problem a personal profile questionnaire was given to the participants and one on one interview was conducted to validate, verify and clarify what they have written. There were five (5) participants of the study give their pseudonym as Carla, Cavin, Christy, Reynand, and Gie. All of the respondents were undergraduate students from CMU, SAIT and BukSu.

Table 2. Open Coding of the Response of Participant 1

Transcript Excerpt	**Codes**
"Mathematics in a modern world is a course that helps students to see what is the role of mathematics in daily life…"	Role of mathematics in daily life
"Application of mathematics in the real world…"	Real-world application
"Development of critical thinking and analytical skills…"	Critical and analytical thinking
"Connection between mathematics, science, engineering, and technology…"	Interdisciplinary connection
"Group output where it is difficult to attain due to different level of understanding…"	Group learning challenges
"Introduce the real-world scenario… sequence… case study… Excel…"	Real-world scenarios, software integration
"Software should have been introduced earlier…"	Need for early tech integration
"Include a topic of financial mathematics like budgeting	Practical financial math

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and interest…”	
“Strong foundation in statistics…”	Foundation in statistics
“Collaborative projects…”	Collaborative learning
“Abstract nature of topics leads to disengagement…”	Student disengagement from abstract content

The table summarizes the open coding analysis of Participant 1, highlighting the key competencies developed through the Mathematics in the Modern World (MMW) course. Based on student narratives, the analysis revealed several interrelated themes:

Real-World Relevance and Application: Mathematics is viewed as a practical tool for solving everyday problems, consistent with CHED’s emphasis on contextual learning.

Critical and Analytical Thinking: Students recognize that logical reasoning and analysis are essential outcomes of mathematics education.

Interdisciplinary Integration: Mathematics is seen as connected to other fields like science, technology, and humanities.

Collaborative Learning and Social Competence: Group activities foster understanding, though some challenges in teamwork were noted.

Technological Competency: Students value integrating digital tools such as Excel and calculators for problem-solving.

Quantitative Literacy: Financial and statistical literacy are identified as vital skills for real-life decision-making.

Engagement through Contextualization: Students are less engaged when content is abstract, underscoring the importance of contextual, meaningful instruction.

Overall, Participant 1’s responses highlight that MMW develops holistic competencies—combining critical thinking, digital literacy, collaboration, and real-world application. These findings align with CHED outcomes and 21st-century educational standards, emphasizing relevance, interdisciplinarity, and student-centered learning.

Table 3 Open Coding of the Response of Participant 2

Transcript Excerpt	**Codes**
“Mathematics in the Modern World is a course that focuses on real-world applications of mathematics.”	Real-world application of mathematics
“...it encourages critical thinking and logical reasoning.”	Development of critical thinking and logical reasoning
“...there is an existing stigma about math that it	Misconception about math necessity; Math as

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is not needed... math is evident all around our universe... language of the universe."	universal language
"...it has introduced mathematics, its importance, a brief history."	Introduction to math and its importance
"It encourages critical thinking, logical reasoning, and overall understanding..."	Encouragement of logical and analytical skills
"MMW activities is not that hard for me... already have background in math concepts."	Easier learning due to math background
"It's like a basic level for a mathematician."	Perceived basic level of MMW
"...sequence of topics. First, introduce mathematics... relate to real-world applications... fractals, sequences..."	Sequence from concepts to application
"...better to dig deeper to relate functions to real life..."	Need for deeper understanding of functions in real life
"...challenges are memorization and recollection..."	Difficulty in memorizing and recalling
"...overcome challenges through practice, comprehension, and active recollection."	Coping strategies through practice and understanding
"...sets and logical statements should coexist... logical statements should follow the sets..."	Logical sequence of topics: Sets → Logic
"...logical statements so they can prove the set you made..."	Importance of logic in proofs
"...relation of functions should be discussed..."	Importance of connecting relations and functions

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"...MMW really helps my degree program."	MMW supports academic program
"Encourage instructors to do hands-on activities..."	Recommendation for active learning
"...hard for the student to answer if they are only absorbing materials..."	Limitation of passive learning
"...students should participate more..."	Call for student participation and engagement

The initial coding of Participant 2 emphasizes that the real-world application of mathematics is the core strength of the Mathematics in the Modern World (MMW) course. The participant views mathematics as a universal language that develops critical thinking and logical reasoning, aligning with CHED's General Education goals.

They appreciate the logical sequencing of topics, noting that starting with concrete ideas (e.g., fractals, sequences) before abstract ones (e.g., functions) supports conceptual understanding and scaffolding. The participant values comprehension and practice over memorization, advocating for differentiated instruction to meet learners' needs.

Pedagogically, the participant calls for hands-on and experiential learning to replace passive instruction, stressing that active participation enhances engagement and knowledge transfer. Lastly, they affirm MMW's academic value across disciplines, as it reinforces foundational mathematical ideas while making them relevant to real-life contexts.

Generally, Participant 2's responses highlight conceptual coherence, experiential learning, and critical reasoning as essential to meaningful mathematics education.Table 4 Open Coding of Response of Participant 3

Table 4 Open Coding of Response of Participant 3

Transcript Excerpt	Codes
"MMW... is very important in today's generation to learn and include in all curriculum because we can apply it in a real life situation."	Real-life application of mathematics; MMW as essential in all curricula
"...to break down those complex problems and to think logically using different mathematical methods or equations..."	Problem-solving skills; Logical thinking through mathematical methods
"...competencies in mathematics, we need to learn it in chronological order..."	Importance of proper sequencing in learning competencies
"...we can set the objectives when it comes to	Clear learning objectives aid in mathematical

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problem solving."	problem-solving
"...today's generation, we don't believe in numbers..."	Modern-day skepticism toward mathematics
"...important in general education subjects."	MMW as essential component of GE curriculum
"...we cannot predict the number of activities that are hard to attain because we cannot predict the situation."	Learning challenges depend on situational context
"As a student of MMW, what are the changes that you wish to implement in terms of the sequence of the topics?"	Student openness to curriculum improvement and topic reordering

The open coding results from Participant 3 highlight essential competencies that students believe should define the Mathematics in the Modern World (MMW) course. The analysis reveals that learners value real-life application, logical reasoning, and a well-sequenced curriculum as crucial for meaningful learning.

Students emphasized that mathematics should be applied to everyday situations, supporting CHED's goal of life-relevant education. They identified problem-solving and logical thinking as core skills, while stressing the importance of proper sequencing to ensure progressive understanding. The participant also valued clear learning objectives that guide performance and reflect purposeful instruction.

Affective factors emerged as well, with some expressing skepticism toward mathematics, indicating the need for confidence-building and contextualized learning. MMW was affirmed as an essential part of general education, while situational challenges underscored the necessity for flexible and adaptive teaching.

Finally, the participant showed openness to curriculum improvement, reflecting student agency in instructional design. Overall, Participant 3's insights support an MMW curriculum that is conceptually structured, contextually relevant, and learner-centered, aligning with CHED's educational vision.

Table 5 Open Coding of the Response of participant 4

Transcript Excerpt	Codes
"...its core purpose is to expose students to mathematical concepts, to reasoning, to appreciate the beauty and the application of mathematics..."	Appreciation of math's beauty and application
"...regardless of their major, it provides opportunity for all students to immerse in its beauty and practical applications."	Inclusivity across disciplines

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"So it is just beyond basic arithmetic..."	Beyond basic arithmetic
"...focused in mathematical concepts, logical reasoning, and statistics..."	Focus on concepts, reasoning, and statistics
"Math isn't just a subject, it's a universal language..."	Math as universal language
"I see applications in math, in time management, in budgeting, in my allowance... during exercise... geography... technology..."	Everyday application of mathematics
"...students reject math because they don't know how to use it..."	Math anxiety and student resistance
"...math is mystified... change the image of the subject..."	De-stigmatizing mathematics
"...I find the activities... very inclusive... manageable..."	Inclusive and manageable activities
"...add the basic fundamentals of probability before statistics..."	Restructuring content: probability before statistics
"...inclusion of AI and accessibility of materials..."	Improve access to technology-enhanced learning
"...no significant personal hurdles... challenge is systemic..."	Systemic challenges in math education
"...retain core structure... add technology-focused chapter..."	Maintain foundation, enhance with technology
"...important for me to see the application and relevance..."	Real-world relevance for math majors
"...refresher to see math from other perspectives..."	MMW as a bridge between theory and real-life application
"...clarity and creativity in teaching... storytelling..."	Creative and clear pedagogical methods
"...tools and curated materials should be accessible..."	Accessibility of curated instructional materials

Participant 4 offered a comprehensive and reflective view of the Mathematics in the Modern World (MMW) course, portraying it as a rigorous, meaningful, and practical discipline that nurtures both intellectual and aesthetic appreciation for mathematics. The participant emphasized that MMW goes beyond computation,

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cultivating logical reasoning, statistical literacy, and mathematical communication, consistent with Zaslavsky (2005) and NCTM (2014).

Mathematics was described as a universal language deeply embedded in daily life—seen in activities such as budgeting, travel, and health monitoring—aligning with Boaler (2016) and Lakoff & Núñez (2000). The participant also highlighted the course's interdisciplinary relevance, in line with CHED's (2013) goal of connecting mathematics across academic and social contexts.

A key recommendation was the integration of technology, including AI tools, digital platforms, and online resources, to modernize instruction and enhance flexibility, echoing UNESCO (2021) and CHED (2020). The participant also proposed sequencing improvements (e.g., teaching probability before statistics) and advocated learner-centered and engaging methods like storytelling and digital-enhanced strategies, consistent with Chickering & Gamson (1987).

Lastly, the participant emphasized the importance of accessible learning resources and an inclusive environment that reduces math anxiety and fosters equitable learning opportunities.

Overall, Participant 4 envisions MMW as a cognitively challenging, technologically advanced, and emotionally supportive course—one that blends foundational rigor with innovation to meet the diverse needs of 21st-century learners.

Table 6 Open Coding of the Response of Participant 5

Transcript Excerpt	Code
"Mathematics is like a secret ingredient that makes modern technology, science and innovation work."	Math as foundation of technology and innovation
"...it helps us develop problem solving skills, critical thinking and analytical reasoning."	Development of problem-solving, critical thinking, and analytical reasoning
"...it is a part of GE course..."	Justification for inclusion in General Education
"...existing competencies... are somewhat appropriate, but they need to evolve..."	Need for evolving competencies
"...to keep pace with emerging technologies and complex problems."	Math must align with modern technological and societal demands
"...a more integrated and applied approach to math education..."	Integration and application of math concepts
"...algebra, geometry, and calculus... interconnected and real-world relevant..."	Interconnected and contextualized math instruction
"...curriculum being too theoretical and disconnected from real-world applications..."	Disconnection between theory and real-life application
"...difficult... to see the relevance and importance of mathematical concepts."	Difficulty seeing math's real-life relevance
"...practical and relevant topics like data analysis, financial literacy, coding and mathematical modeling..."	Inclusion of practical topics and real-world content
"...with real-world applications and case studies."	Use of contextual and real-life examples
"...a more integrated and applied approach to math education..."	Integration and application of math concepts
"...arrange the topics from basic to advanced and from	Sequencing from foundational to applied knowledge

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theoretical up to applied...”	
“...develop strong mathematical knowledge and problem-solving skills...”	MMW builds strong math foundation for teaching
“...apply in teaching mathematics to secondary students...”	Use of MMW learnings in future teaching
“...enhance my understanding... create effective lesson plans...”	Support for lesson planning and pedagogy
“...engage students in meaningful learning experiences.”	Focus on student engagement through meaningful content
“...incorporate more real-world applications, project-based learning...”	Recommendation for real-world and project-based learning
“...technology tools like coding software and data analysis platforms.”	Integration of technology tools in math instruction

Participant 5 presented a forward-looking and reflective view of the Mathematics in the Modern World (MMW) course, emphasizing its vital role in developing 21st-century skills such as critical thinking, problem-solving, analytical reasoning, and digital literacy. They described mathematics as the “secret ingredient” behind technology and innovation, highlighting its real-world applications in budgeting, coding, data analysis, and financial literacy—consistent with Boaler (2016) and CHED (2013) on the importance of practical relevance.

The participant valued MMW’s role in preparing future teachers to design meaningful, outcomes-based lessons aligned with Biggs & Tang’s (2011) model of constructive alignment. However, they criticized its overly theoretical structure, suggesting a scaffolded and integrated curriculum that progresses from basic to applied concepts, reflecting Vygotsky’s (1978) learning principles. They also strongly advocated for technology integration through coding platforms, statistical software, and project-based learning to enhance engagement and digital competence, aligning with UNESCO (2021).

Overall, Participant 5 envisioned a modernized, technology-driven, and application-oriented MMW curriculum that bridges theory and practice, fosters creativity, and equips learners—particularly future educators—for success in a digital, knowledge-based society.

Comparative Analysis (SOP 1: Essential Competencies in MMW)

Real-World Application – All participants emphasized that MMW should focus on practical life contexts such as budgeting, interpreting data, and recognizing natural patterns. This supports CHED’s (2013) goal of fostering applicable mathematical literacy.

Critical and Analytical Thinking – Students consistently valued MMW’s role in promoting higher-order thinking through data analysis and real-world problem-solving, aligning with Brookhart (2010) on cognitive skill development.

Technological Competence – Participants recognized the importance of integrating digital tools (e.g., Excel, SPSS) to enhance data interpretation and visualization, reflecting OECD (2018) standards for digital literacy in education.

Interdisciplinary Awareness – MMW was seen as bridging mathematics with science, engineering, and social disciplines, reinforcing Boaler’s (2016) argument for interdisciplinary learning.

Implementation Challenges – Despite its strengths, participants noted issues such as disengagement from abstract lessons, group learning struggles, and delayed tech exposure—indicating the need for curricular refinement and pedagogical innovation.

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In summary, the analysis reveals that students view MMW as most effective when it is practical, technology-enhanced, interdisciplinary, and student-centered, underscoring the need to redesign the course for greater relevance and responsiveness to 21st-century demands.

Table 7 Summary of Essential Competencies

Competency Domain	Essential Competency	Source	Remarks/Insights
Mathematical Literacy	Apply mathematical tools and concepts in solving real-world problems	CHED, All Participants	Relevance in daily life, budgeting, decision-making, teaching
Critical Thinking & Reasoning	Engage in logical reasoning, analytical thinking, and structured problem-solving	CHED, P1–P5	Core cognitive goal affirmed by all participants
Interdisciplinary Relevance	Recognize math's connections to science, technology, health, and society	CHED, P1, P2, P4	Seen in examples involving coding, exercise, geography, etc.
Communication Skills	Convey mathematical ideas using appropriate language and representations	CHED, P4, P5	Emphasis on teaching skills, explaining math to non-majors
Appreciation of Mathematics	Appreciate math as a universal language and its aesthetic and functional aspects	CHED, P4	Math viewed as beautiful and foundational in progress and innovation
Technological Integration	Use technology (e.g., calculators, coding software, data tools) to support math learning	P4, P5	Suggested enhancement—tools and AI integration are highly recommended
Curriculum Sequencing	Learn concepts from basic to advanced, theoretical to applied	P2, P3, P4, P5	Emphasis on logical flow: e.g., sets → logic, probability → statistics
Pedagogical Development	Develop teaching skills and prepare to deliver meaningful math instruction	P4, P5	Important for future educators; not explicitly in CHED competencies
Affective Engagement	Reduce math anxiety; promote positive attitudes and confidence in learning mathematics	P4, P5	Emphasized emotional dimension and the need for inclusive, engaging instruction
Real-World Application	Apply math in practical contexts like finance, coding, data analysis, and teaching	CHED, All Participants	Strong call for project-based learning and real-life relevance

The consolidated analysis of essential competencies in Mathematics in the Modern World (MMW) reveals a strong alignment between CHED's prescribed learning outcomes and the lived experiences of students, while also surfacing additional learner-identified competencies. Core domains such as mathematical literacy, critical thinking, and interdisciplinary relevance were consistently affirmed by all five participants. Everyday applications—like budgeting, transportation decisions, and classroom teaching—were commonly cited, reflecting CHED's intent to foster life-relevant knowledge and skills. Participants also described how MMW

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enhanced their logical reasoning and analytical capabilities, aligning with cognitive goals outlined by CHED and supported by scholars like Facione (2015). Moreover, students appreciated mathematics as a universal and interdisciplinary language that intersects with science, technology, and society—an outcome emphasized by both CHED (2013) and theorists such as Lakoff and Núñez (2000).

Beyond CHED's framework, students identified additional competencies that reflect the evolving demands of modern education. These include the development of mathematical communication skills, especially among prospective teachers, and the integration of technological tools such as coding platforms, calculators, and AI-assisted applications. These findings suggest a pressing need to modernize the MMW curriculum to better align with 21st-century digital fluency, as advocated by UNESCO (2021). Furthermore, participants called for improved instructional sequencing—from basic to advanced and theoretical to applied—to support deeper learning. Emerging themes such as pedagogical preparedness and affective engagement also point to the role of MMW in addressing math anxiety and promoting inclusive, student-centered instruction. These insights extend the vision of mathematics education from foundational content mastery toward holistic learner development, advocating for a more adaptive, technologically responsive, and emotionally supportive MMW course.

Content Structure of the Mathematics in the Modern World Course

The Mathematics in the Modern World (MMW) course, as prescribed under the Commission on Higher Education (CHED) Memorandum Order No. 20, Series of 2013, is part of the General Education (GE) curriculum for tertiary education in the Philippines. It is designed to provide students—regardless of their academic program—with a deep understanding of mathematics as both a discipline and a tool for interpreting the world.

MMW is structured into three major content domains that emphasize both cognitive development and real-world relevance:

1. Understanding the Nature of Mathematics

This initial section introduces students to the nature and philosophy of mathematics, addressing questions such as:

What is mathematics?

How is mathematics used as an art and as a language?

What makes mathematics a powerful tool for abstraction and reasoning?

Topics include:

Definitions and misconceptions about mathematics

The aesthetic and logical structures of mathematics

Mathematical language and symbols

Mathematical proofs and reasoning

This part aims to dispel math anxiety and to shape a mindset that mathematics is not just about numbers, but about understanding and solving real-world problems (Schoenfeld, 2004).

2. Mathematics in the Modern World

The second component explores the applications of mathematics in various real-life contexts, demonstrating its relevance across different fields.

Topics often include:

Patterns and sequences in nature

Graph theory and networks (used in social media, transport systems)

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Voting and apportionment methods (used in political systems)

Linear and exponential growth (used in business and population modeling)

Mathematics of finance, including interest, annuities, and investments

This section aims to foster quantitative literacy, enabling students to critically interpret mathematical information and apply it in decision-making (Steen, 2001).

3. Tools and Technology in Mathematics

While not always emphasized in all implementations of MMW, CHED allows flexibility to include software tools that assist in understanding and visualizing data. The use of Microsoft Excel, SPSS, or graphing calculators is encouraged to:

Analyze data sets

Perform statistical analysis

Create visual representations like graphs and charts

This part addresses technological integration in mathematical instruction, aligning with the goals of 21st-century learning (Trilling & Fadel, 2009).

Pedagogical Approach and Interdisciplinary Emphasis

The course encourages active learning, problem-based instruction, and collaborative projects, which bridge mathematics with other disciplines such as:

Science (e.g., modeling biological growth)

Engineering (e.g., optimization problems)

Social Science (e.g., understanding surveys and statistics)

According to Boaler (2016), this interdisciplinary framing is crucial for developing mathematical mindsets and preparing students for complex, interconnected real-world problems.

Curricular Challenges

Despite its comprehensive structure, several studies and student feedback (including in this study) point to gaps in:

Sequencing of topics (too abstract early on)

Late or minimal integration of technology

Limited focus on financial literacy and statistical software

Variability in teaching strategies across institutions

These challenges suggest a need to restructure content delivery to prioritize real-world application first, followed by theory, and integrate tools and group work throughout the course (Niss & Højgaard, 2011).

The content structure of MMW reflects a balance between theory, application, and interdisciplinary relevance. Its success, however, hinges on effective curriculum delivery, integration of technology and real-life contexts, and responsiveness to student diversity and engagement levels.

Table 8 Integrated Structure of MMW

Competency Domain	CHED-Prescribed Competencies *(CMO No. 20, s. 2013)*	Perceived Competencies by Participants 1–5	Comparison and Interpretation

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1.Mathematical Literacy	Apply appropriate mathematical tools to solve real-life problems.	Seen in all participants—especially P1, P2, and P5—who emphasized real-world application, budgeting, decision-making, and relevance to life and work.	✅ Aligned: Both CHED and participants agree on real-life relevance of math.
2. Critical Thinking and Problem Solving	Use logic and quantitative reasoning in solving problems.	Strongly expressed by P1, P2, P4, and P5. MMW is credited with enhancing critical thinking, reasoning, and analytical skills.	✅ Aligned: Critical thinking is a shared core outcome.
3. Communication Using Mathematical Language	Communicate mathematically using symbols, graphs, tables, and words.	Participant 4 and 5 emphasized the need for communication skills in math—especially in teaching, conveying concepts to laymen, and explaining abstract ideas.	⚠️ Partial Alignment: While CHED includes it formally, participants request stronger emphasis and real classroom practice.
4.Appreciation of the Nature and Beauty of Mathematics	Recognize the nature of mathematics as a human endeavor and appreciate its aesthetic aspects.	Strongly emphasized by Participant 4 who described math as a universal language and a beautiful tool; others acknowledged math's value in everyday life.	✅ Aligned: Appreciation is present, though some students want deeper engagement.
5. Use of Modern Technology	Utilize appropriate technology in solving mathematical problems.	Expressed heavily by P4 and P5, calling for AI integration, calculators, graphing tools, coding software, and online platforms like YouTube and forums.	⚠️ Gap Identified: CHED mentions technology generally, but participants want explicit integration of modern tools and digital platforms.
6. Interdisciplinary Connections	Understand the interdisciplinary nature of mathematics.	Highlighted by P1 and P2 (math and science/social science), and P4 (math in coding, travel, exercise, geography).	✅ Aligned: Participants recognize math across disciplines.
7. Sequencing and Curriculum Flow	Not explicitly stated in CHED guidelines.	P2, P3, and P4 request better topic sequencing: sets → logic → functions; probability before statistics; foundational-to-applied arrangement.	❌ Gap: CHED lacks clear sequencing guidelines; participants perceive sequencing as essential.
8. Pedagogical Skills / Teaching Math	Not a formal CHED objective for MMW.	Strongly emphasized by P4 and P5, especially for future educators. They stress teaching math with clarity, creativity, and real-world connection.	❌ Gap: CHED does not account for future teachers; students seek pedagogical skill development.
9. Addressing Math Anxiety / Misconceptions	Not explicitly mentioned.	P4 and P5 observed math stigma, anxiety, and resistance in peers; suggested promoting math through communication and	❌ Gap: Participants desire emotional/psychological support components, which CHED omits.

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		inclusive instruction.	

The integrated structure of the Mathematics in the Modern World (MMW) course combines the CHED-prescribed framework, students' perspectives, and grounded theory insights. While CHED (CMO No. 20, s. 2013) aims to develop mathematical literacy, problem-solving, and real-world application, students affirmed these goals but identified key areas for improvement.

Participants observed that the current topic sequence feels disjointed and recommended reorganizing lessons from foundational to applied concepts (e.g., sets → logic → functions → probability → statistics), aligning with cognitive scaffolding principles (Bransford et al., 2000). They also emphasized stronger integration of technology—such as graphing tools, coding, and AI resources—to enhance engagement and relevance (UNESCO, 2021).

Student-centered teaching approaches like project-based learning, storytelling, and interdisciplinary activities were suggested to make MMW more meaningful and reduce math anxiety (Tobias, 1993; Boaler, 2002). Additionally, participants highlighted the importance of developing mathematical communication skills and fostering an emotionally supportive classroom environment.

Overall, the refined MMW structure proposed in this study maintains CHED's foundational goals but enhances them through improved topic sequencing, technology use, innovative pedagogy, and affective support—making the course more dynamic, inclusive, and aligned with 21st-century learning needs.

Table 9 Summary of Content Structure

Content Area	CHED-Prescribed Focus	Perceptions from Participants 1–5	Emergent Recommendation
Nature of Mathematics	Definition, scope, and appreciation of mathematics	Seen as important introduction (P1, P3, P4)	Retain as opening topic to establish appreciation and context
Mathematical Language and Symbols	Use of terms, notation, and operations	Understood as basic foundation (P2)	Emphasize application in proofs and logical expressions
Problem Solving and Reasoning	Heuristics, strategies, and critical thinking	Viewed as essential competency (all participants)	Integrate with real-life contexts and group-based problem-solving
Set Theory and Logic	Venn diagrams, truth tables, logical connectives	Requests for improved sequencing (P2, P4): sets before logic	Sequence: Sets → Logic → Functions
Functions and Graphs	Linear and non-linear functions, graphs, and applications	Seen as too abstract if taught before foundational logic (P2, P4)	Delay until students master basic reasoning and relational concepts
Sequences and Patterns	Arithmetic and geometric sequences;	Appreciated in real-world applications (P2, P4)	Reinforce with nature-based examples (e.g., fractals,

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	observed patterns in nature		Fibonacci)
Statistics and Probability	Data collection, analysis, and interpretation; basic probability	Suggested reordering: teach probability before statistics (P3, P4)	Adjust sequence to Probability → Statistics for conceptual flow
Mathematics in Nature and the Environment	Applications of math in art, nature, and social/environmental issues	Strongly supported as engaging and relatable (P1, P4)	Use interdisciplinary and project-based approaches (e.g., nature walks, art projects)
Real-World Applications	Integrated throughout topics	Emphasized by all participants—budgeting, decision-making, coding, teaching	Embed across all content areas; use case studies and project-based tasks
Emerging Topics (Technology)	Not explicitly included in CMO No. 20	Strongly advocated: coding, data analytics, AI tools (P4, P5)	Add data literacy, financial math, coding, and technology tools as elective/expansion

The content structure of the Mathematics in the Modern World (MMW) course demonstrates both strengths and areas for improvement when comparing CHED's (CMO No. 20, s. 2013) standards with students' perspectives. CHED's prescribed topics—such as the nature of mathematics, sets, logic, functions, sequences, statistics, probability, and real-world applications—effectively promote mathematical literacy and critical thinking.

Students affirmed the value of these topics, especially the focus on understanding mathematics as a practical and interdisciplinary tool for reasoning, decision-making, and technology use. They particularly appreciated lessons on mathematics in nature, which made abstract ideas more tangible and engaging.

However, participants noted that the current topic sequence needs reorganization to enhance conceptual flow. They recommended teaching sets before logic and probability before statistics, following the principle of cognitive scaffolding (Bransford et al., 2000). Some topics, like logic and functions, were viewed as overly abstract without adequate contextual grounding.

Students also suggested expanding the curriculum to include modern, applied areas such as data analysis, financial literacy, mathematical modeling, and coding—reflecting global trends emphasizing digital and applied mathematics (UNESCO, 2021; OECD, 2019).

In summary, while CHED's framework is comprehensive, the study recommends three key refinements: (1) reorganizing topics for logical progression, (2) emphasizing real-world applications, and (3) integrating technology-based and contemporary mathematical themes to make MMW more relevant and responsive to 21st-century learners.

Literature -based Comparison and Analysis

Participant 1's responses provide a holistic view of the key competencies essential to the Mathematics in the Modern World (MMW) course, emphasizing practical application, critical thinking, interdisciplinarity, technology integration, and collaboration.

The participant highlighted that MMW makes mathematics meaningful by connecting it to real-life contexts such as budgeting, surveys, and natural patterns—supporting Steen's (2001) and Boaler's (2016) advocacy for contextual and authentic learning. The course was seen as a venue for developing **critical and analytical**

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thinking, enabling students to make reasoned decisions based on data, consistent with Brookhart's (2010) view of mathematics as a tool for higher-order reasoning.

Participant 1 also valued **interdisciplinary awareness**, noting that mathematics links naturally to science, engineering, and technology, echoing OECD (2018) and Beers (2011) on integrated learning. The respondent further emphasized the need for **technological proficiency**, advocating for early use of tools like Excel and SPSS to enhance data analysis skills—aligning with Pierce and Stacey (2010) and Gal and Tout (2014), who stress the role of digital literacy in modern numeracy.

In addition, the participant supported collaborative learning, suggesting group projects to promote shared understanding, consistent with Vygotsky's (1978) social constructivism and Brame and Biel's (2015) findings on cooperative learning benefits. Finally, she expressed concern about disengagement with abstract content, recommending problem-based and experiential learning to sustain motivation, in line with Niss and Højgaard (2011).

Overall, Participant 1's insights affirm that MMW is most effective when it:

Begins with real-world contexts;

Promotes analytical and decision-making skills;

Integrates digital tools early;

Encourages structured collaboration; and

Connects mathematics across disciplines.

These themes align closely with contemporary educational research and point toward curriculum reforms that make MMW more relevant, engaging, and future-oriented.

Table 10 Comparison of CHED and Perceived Content

Content Area	CHED-Prescribed Content	Perceived Content by Participants 1–5	Interpretation / Suggested Revision
Nature of Mathematics	Introduces mathematics as a human endeavor with aesthetic and practical value	Valued as an appropriate starting point to build appreciation and context (P1, P3, P4)	✅ Retain as introductory topic; helps frame the course philosophically and contextually.
Mathematical Language and Symbols	Covers symbols, notation, and basic operations	Acknowledged as foundational, especially in logic and proofs (P2, P4)	✅ Reinforce its connection to real-world symbols and formal reasoning.
Problem-Solving and Reasoning	Teaches strategies and heuristics to solve problems logically and efficiently	Highly valued for real-life decision-making, teaching, and learning transfer (P1–P5)	✅ Integrate across all topics with real-life examples and project-based tasks.
Content Area	CHED-Prescribed Content	Perceived Content by Participants 1–5	Interpretation / Suggested Revision
Sequences and Patterns	Includes arithmetic/geometric sequences and patterns found in nature	Appreciated when connected to nature (fractals, Fibonacci) (P1, P4)	✅ Keep topic; expand interdisciplinary connections to biology, art, and nature.
Statistics and	Introduces data collection,	Suggest reversing order: teach	⚠ Revise topic flow:

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Probability	descriptive statistics, and basic probability	probability before statistics (P3, P4)	Probability → Statistics helps build intuitive understanding before analysis.
Mathematics in Nature and the Environment	Applies math to natural phenomena and environmental settings	Viewed as engaging, concrete, and cross-disciplinary (P1, P4)	✅ Emphasize this theme through nature-based or environmental projects.
Real-World Applications (Implied)	Implied across topics, especially through examples	Demanded strongly: include budgeting, coding, decision-making, travel, and teaching (P1–P5)	✅ Explicitly integrate real-life tasks into each topic.
Technology Integration (Not emphasized)	Briefly mentioned in general terms (e.g., calculators)	Strongly emphasized: use of coding, graphing calculators, data platforms, and AI tools (P4, P5)	❌ Add a dedicated module or integrated component on technology-enhanced mathematics.
Emerging Topics (Not included)	Not part of CHED's formal structure	Recommended additions: financial literacy, coding, mathematical modeling, data analysis (P4, P5)	❌ Expand the course to include 21st-century applied topics to make math more career-relevant.
Pedagogical Content (Not included)	No provision for teaching or explaining math to others	Future educators desire support in explaining math clearly, teaching techniques, and communication skills (P4, P5)	❌ Embed opportunities to develop math communication and teaching skills for education majors.

The comparison between CHED's prescribed Mathematics in the Modern World (MMW) curriculum and the views of Participants 1 to 5 shows that while both share the same educational goals, there are key areas needing enhancement for greater relevance and engagement.

CHED's framework (CMO No. 20, s. 2013) covers essential topics—such as the nature of mathematics, sets, logic, functions, probability, and statistics—aimed at promoting mathematical literacy, problem-solving, and real-world application. Participants affirmed these goals but pointed out gaps in topic sequencing, contextualization, and modernization.

They recommended a more logical topic flow (e.g., sets → logic → functions; probability → statistics) to strengthen conceptual understanding. They also called for explicit real-world applications like budgeting and data analysis to make lessons more meaningful and connected to daily life.

A significant concern was the limited use of technology; students suggested integrating digital tools such as graphing software, coding platforms, and AI-assisted applications to align with 21st-century learning standards. Participants further proposed including mathematical communication and pedagogical skills, especially for future teachers, and addressing the affective domain by creating supportive, engaging learning environments that reduce math anxiety.

Overall, while CHED's MMW framework provides a solid foundation, the participants advocate for a student-centered, technology-enhanced, and contextually grounded curriculum that better prepares learners for modern, real-world challenges.

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Table 11 Summary of Key emerging differences

Key Area	CHED Content/ Focus	Emerging Student Perspectives	Key Difference / Gap
Topic Sequencing	No explicit sequence required	Students want a logical flow: Sets → Logic → Functions	❌ Lack of structured sequencing causes conceptual confusion
Probability & Statistics	Statistics often taught before probability	Students suggest: Probability → Statistics for intuitive learning	⚠️ Misalignment in conceptual order
Technology Integration	General reference (e.g., calculators)	Strong demand for coding, data tools, AI, online platforms	❌ Inadequate emphasis on digital literacy and emerging tools
Real-World Application	Embedded but not consistently emphasized across topics	Students expect clear, practical, real-life connections	⚠️ Application needs to be explicit and embedded in all lessons
Pedagogical Development	Not part of CHED framework	Students (esp. future educators) request teaching and communication skills	❌ Missing support for math communication and pedagogy
Affective Domain	Not addressed	Students experience math anxiety and stigma	❌ Lack of emotional support and inclusive strategies
Emerging Topics	No provision for financial literacy, coding, or modeling	Students request financial math, data analysis, coding	❌ CHED framework lacks 21st-century applied topics
Instructional Strategies	Flexible delivery encouraged but not specified	Students prefer storytelling, project-based, hands-on learning	⚠️ Need for more engaging, student-centered methods
Communication in Math	Focus on symbols and representations	Students want to learn how to explain math to others	❌ Gap in developing math communication skills
Relevance to Degree Program	General knowledge for all programs	Students expect program-specific or interdisciplinary applications	⚠️ Mismatch in contextual relevance for various disciplines

The analysis of differences between CHED's prescribed Mathematics in the Modern World (MMW) content and students' perceived course structure reveals clear gaps in sequencing, technology integration, real-world relevance, affective support, and pedagogical focus.

First, topic sequencing emerged as a major concern. While CHED outlines key topics, it lacks a logical progression. Participants (notably P2, P3, and P4) suggested sequencing topics from foundational to abstract (e.g., sets → logic → functions and probability → statistics) to enhance conceptual understanding—echoing Bransford et al.'s (2000) principle of cognitive scaffolding.

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Second, technological integration is minimal in the CHED framework, which mainly mentions calculators. In contrast, students—especially P4 and P5—called for the use of modern digital tools such as coding platforms, data analysis software, and AI-based applications to strengthen engagement, digital literacy, and real-world readiness.

Third, participants noted insufficient real-world contextualization. While CHED promotes application-based learning, students found its implementation weak. They recommended embedding mathematical concepts in practical contexts like budgeting, teaching, health, and travel, aligning with Boaler's (2016) view that contextual learning increases motivation and meaning.

Fourth, there is a lack of attention to the affective domain. CHED does not address math anxiety or stigma, yet students reported that fear and low confidence affect learning. They advocated for inclusive, creative strategies such as storytelling, project-based learning, and peer discussions to build confidence and reduce anxiety (Tobias, 1993; Boaler, 2002).

Finally, students—especially education majors—emphasized the need for pedagogical preparation within MMW, including opportunities to practice explaining and teaching mathematical ideas, which CHED currently overlooks.

In summary, the study reveals that CHED's MMW framework, while comprehensive, remains static and traditional, whereas students envision a dynamic, technology-enriched, contextually grounded, and emotionally supportive curriculum. Addressing these gaps would make MMW more relevant, engaging, and aligned with 21st-century educational demands.

Curriculum Development of MMW

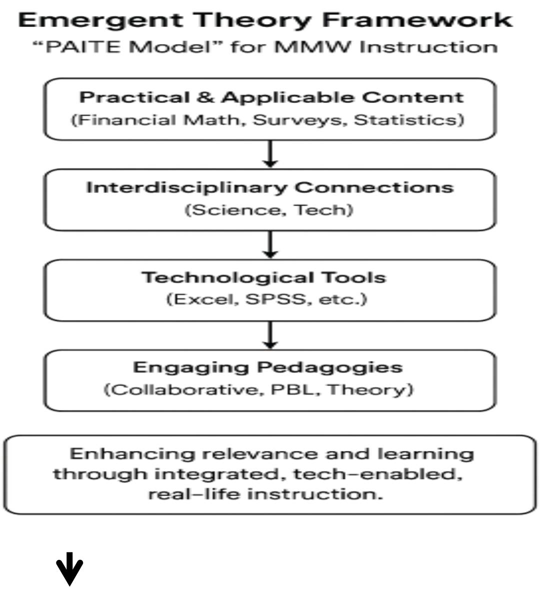

Figure 4 Emergent Competency-Based Instructional Model (PAITE) for Mathematics in the Modern World (MMW)

The PAITE Model is an emergent instructional framework grounded in participants experiences in the Mathematics in the Modern World (MMW) course. It encapsulates the interconnected instructional elements necessary to enhance the relevance and effectiveness of MMW as a General Education subject. PAITE is an acronym that stands for Practical & Applicable Content, Interdisciplinary Connections, Technological Tools, and Engaging Pedagogies, all of which contribute to a common goal: improving learning by grounding it in real-world contexts and making it more student-centered and future-ready.

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The model begins with Practical & Applicable Content, such as financial mathematics, statistical analysis, and surveys. These topics were repeatedly cited by students as highly relatable and essential in their academic and personal lives. They help demystify mathematics by showing its immediate relevance in areas like budgeting, interest computations, and data interpretation. Next, the model emphasizes Interdisciplinary Connections, reflecting students' recognition that mathematics does not exist in isolation but rather intersects with fields such as science, engineering, and technology. This integrative approach not only broadens students' understanding but also prepares them for future academic and professional demands.

A crucial component of the model is the inclusion of Technological Tools, particularly software like Excel and SPSS. Students expressed a strong preference for integrating these tools early in the course, stating that technology enhances their ability to visualize, analyze, and interpret mathematical data. This technological integration is also seen as a bridge to workplace relevance, preparing students to apply math skills in practical, industry-aligned contexts. Following this is Engaging Pedagogies, which include collaborative projects, problem-based learning (PBL), and transitioning from real-world problems to theoretical understanding. These strategies, according to participants, promote deeper learning, teamwork, and sustained interest in the subject.

The framework culminates in its core outcome: enhancing relevance and learning through integrated, tech-enabled, real-life instruction. The name PAITE was chosen to reflect the sequential and interconnected flow of the instructional elements identified by participants. It is not just an acronym, but also a representation of a transformative learning approach that makes mathematics accessible, meaningful, and engaging for all students, regardless of their program. By anchoring instruction in practicality, interdisciplinarity, and technological engagement, the PAITE model addresses the instructional gaps in the current MMW curriculum and offers a comprehensive guide for curriculum designers and educators seeking to reform the course in alignment with student needs and 21st-century competencies.

Designing a Initial framework of the Mathematics in the Modern World Course.

Based on on the incident, categories , Dimensions and constant Comparison the initial framework was generated.

Table 12 Incidents , Categories, and Dimensions of P1

Incidents	Categories	Dimensions
"Mathematics in the Modern World is a course that helps students to see what is the role of mathematics in daily life..."	Real-World Application of Math	From theoretical → to practical integration
"It gives the application of mathematics in the real world. It's not just more on numbers or formula..."	Relevance Beyond Computation	From formula-focused → to context-aware understanding
"We can use it like a sequence, it's already there in nature..."	Mathematics in Nature	From abstract → to naturally embedded patterns
"It is relevant in the real world because just like survey, the students can get results, and they can decide..."	Decision-Making and Quantitative Literacy	From passive use of data → to active, informed decision-making
"It helps in the development of critical thinking and analytical skills."	Cognitive Development through Math	From rote learning → to analytical and evaluative thinking
"There is an intersection or a connection between not just the mathematics..."	Interdisciplinary Connections	From isolated subject → to interconnected field
"Conducting a survey… based on the statistics… they need to focus…"	Applied Statistics and Focused Inquiry	From data gathering → to critical interpretation of results

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"They need critical thinking and analytical skills which is developed by the students."	Skill Acquisition through Activities	From activity completion → to skill internalization
"Then another part is the interdisciplinary connection…"	Interdisciplinary Insight	From disciplinary → to integration with science, social studies, etc.

The analysis of Participant 1's experiences with the Mathematics in the Modern World (MMW) course reveals eight key categories that describe how they perceive the course's purpose and impact. These categories—derived through open coding—highlight how MMW connects mathematical understanding to real-world meaning, interdisciplinary relevance, and cognitive growth.

Participant 1 emphasized that math gains value when applied to real-life contexts, leading to the category Real-World Application of Math, which ranges from theoretical learning to practical integration. Closely related is Relevance Beyond Computation, reflecting a shift from viewing math as formula-based to seeing it as a tool for interpreting everyday phenomena.

The participant also described Mathematics in Nature, recognizing patterns and sequences in the environment, showing how abstract math becomes meaningful when linked to natural experiences. Likewise, Decision-Making and Quantitative Literacy and Cognitive Development through Math reveal math's role in enhancing reasoning, critical thinking, and informed judgment—shifting students from rote learning to analytical engagement.

Further, the participant viewed MMW as interdisciplinary, connecting math with both science and social sciences. This led to the category Interdisciplinary Connections, reflecting math's integrative nature and its role in data-driven inquiry. Finally, Skill Acquisition through Activities highlights how MMW tasks build essential competencies such as focus, analysis, and problem-solving beyond mere compliance.

Overall, Participant 1's experience reflects a transformative understanding of mathematics—from abstract computation to an engaging, applied, and interdisciplinary discipline that fosters both cognitive and real-world growth, aligning with CHED's general education goals.

Table 13 Open coding and Memos of Participant 1

Open codes	Memos
"Mathematics in a modern world is a course that helps students to see what is the role of mathematics in daily life..."	Role of math in everyday life
"...it gives the application of mathematics in the real world."	Real-world application of math
"It's not just more on numbers, it's not just more on formula, but it's a real-world application of the nature."	Beyond numbers and formulas
"It is included as one of the GE courses because of its competencies..."	GE inclusion due to competencies
"...because it is relevant in the real-world application."	Real-world relevance
"Just like survey, the students can get results... they can also decide..."	Use of math for surveys and decision-making
"There is decision-making."	Decision-making skills
"They need critical thinking and analytical skills, which is developed by the students."	Development of critical and analytical thinking
"There is an intersection or a connection between not just the	Interdisciplinary connection

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mathematics..."	
"Statistics... they need to focus, so they need critical thinking."	Application of statistics to thinking skills

This open coding and memoing process reveals that Participant 1 views MMW as a course that is practical, competency-oriented, and transformative, particularly in its ability to develop real-life skills such as decision-making, critical thinking, and interdisciplinary understanding. These insights support the emerging core category:

"Mathematics in the Modern World as a Transformative and Contextualized Learning Experience."

This analysis is vital for building the axial and selective coding stages, eventually leading to initial theoretical framework for restructuring the MMW course.

Table 14 Axial Coding of transcript of Participant 1

Phenomenon	When	What	How	Consequences
Real-world application enhances learning	When topics involve budgeting, surveys, or nature-based math	Students feel math is useful and understandable	By connecting lessons to daily life and societal functions	increased motivation, engagement, and
Abstract content leads to disengagement	When lessons include symbolic logic or set	Students feel confused or	By presenting concepts without relatable context	Improved comprehension and skill
Technology supports understanding	When tools like Excel or SPSS are introduced early	Students better visualize data and connect with content	By applying software in statistics and problem-solving tasks	Improved comprehension and skill application
Group work improves	When collaborative projects are assigned	All group members become active and contribute	By sharing responsibilities and explaining to peers	Enhanced collaboration and peer
Critical thinking is developed through data analysis	When students engage in interpreting survey data	Students learn to think beyond basic	By evaluating patterns and drawing conclusions from data	

The analysis identifies five major phenomena shaping students' experiences in the Mathematics in the Modern World (MMW) course, each illustrating how instructional design influences engagement, comprehension, and competency development.

Real-World Application Enhances Learning – Students found mathematics more meaningful when lessons related to real-life contexts such as budgeting, surveys, or patterns in nature. Practical applications increased motivation, participation, and retention, confirming that relevance drives learning effectiveness (Boaler, 2016; Trilling & Fadel, 2009).

Abstract Content Leads to Disengagement – Topics like symbolic logic and set theory, when taught without context, caused confusion and loss of interest. The absence of real-world connections limited understanding, underscoring the importance of scaffolding abstract ideas with examples and applications (Brookhart, 2020).

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Technology Supports Understanding – Integrating tools such as Excel and SPSS helped students visualize and apply mathematical concepts, strengthening both comprehension and digital literacy. Technology served as a bridge between theory and practice, demonstrating that it should be embedded in, not added to, instruction (Sawyer, 2014; Gholami et al., 2020).

Group Work Improves Participation – Collaborative projects encouraged active engagement and communication. Explaining concepts to peers deepened understanding and built accountability, aligning with constructivist principles that emphasize social learning (Vygotsky, as cited in Charmaz, 2017).

Critical Thinking Develops Through Data Analysis – Tasks involving survey interpretation and statistical reasoning promoted analytical thinking and logical decision-making. Students advanced from computation to reflection, enhancing their academic and real-world problem-solving abilities (Brookhart, 2020; Donnelly & Hernandez, 2023).

In summary, students' learning in MMW thrives when instruction is contextual, technology-enhanced, collaborative, and analytical, transforming mathematical understanding from abstract theory to applied, reflective practice.

Table 15 Selective Coding of Participant 1

Major Category	Axial Subcategories	How It Supports the Core Category
Relevance	Real-world application, everyday use	Demonstrates how MMW brings mathematics into real-life decision-making, making learning relevant.
Competency Development	Critical & analytical thinking, statistics	Highlights the transformational aspect of MMW — it develops higher-order thinking in learners.
Content (Interdisciplinary)	Cross-disciplinary links	Emphasizes how MMW is contextualized, blending math with other fields (science, technology, etc.).
Outcomes	Problem-solving, employment readiness	Reinforces that the competencies gained lead to real-world readiness, fulfilling the GE purpose.
Inclusion Justification	GE competency alignment	Justifies MMW's role in the GE curriculum due to its transformative impact on student development.

Selective coding, the final stage of grounded theory, identifies a core category that unifies all other categories into a coherent theory. For Participant 1, the core concept is:

"Mathematics in the Modern World as a Transformative and Contextualized Learning Experience."

This theme reflects the participant's view that MMW goes beyond formulas—it develops real-world competencies like decision-making, data interpretation, and analytical thinking, enhancing both intellectual growth and employability.

Supporting categories—Relevance, Competency Development, Application & Innovation, Interdisciplinary Content, Outcomes, and GE Inclusion—all connect to this central idea. They show how MMW links mathematics to everyday life, integrates technology and other disciplines, promotes higher-order thinking, and prepares students for real-world challenges.

In summary, selective coding reveals that MMW acts as a bridge between academic learning and practical life skills, demonstrating its transformative power when content and pedagogy are aligned with real-world contexts.

Constant Comparative Analysis of P1

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This is the process of continually comparing data with other data, codes, and emerging categories throughout the analysis to refine understanding, identify variations, and build a grounded theory.

Table 16 Constant Comparative from Participant 1

Incident / Statement	Open Code	Compared With	Emergent Insight / Theoretical Note
"Mathematics... helps students to see what is the role of mathematics in daily life."	Real-world role of mathematics	"It gives the application... in the real world."	Students value math when it is perceived as a life skill, not a school subject.
"It's not just more on numbers or formula…"	Mathematics beyond computation	"It helps in the development of critical thinking…"	Learners see relevance in math when it shifts from rote to reasoning.
"We can use it like a sequence... it's already there in nature."	Math in nature	"There is an intersection... between not just the mathematics..."	Math is best understood when linked to natural or interdisciplinary contexts.
"Just like survey, the students can get results, which is... decision-making."	Survey-based decision-making	"They need critical thinking and analytical skills..."	Applied math tasks (e.g., statistics) promote decision-making and analytical development.
"They need critical thinking... which is developed by the students."	Development of cognitive skills	"... based on the statistics… they need to focus."	Active engagement in data analysis helps internalize cognitive skills.
"There is a connection between not just mathematics..."	Interdisciplinary connection	"Application in survey… logic… statistics…"	Math becomes more relevant when it intersects with other subjects like science or social studies.
"They conduct surveys… based on statistics…"	Active learning through statistics	"Students decide based on data..."	Learners take ownership of decisions when involved in real-world data interpretation.
"We can use it like a sequence… it's already there in nature."	Pattern recognition in real-life contexts	"Not more on formula… it's a real-world application…"	Understanding emerges when mathematical ideas are grounded in observable or familiar contexts.

The constant comparative analysis of Participant 1's responses shows a clear transformation in understanding mathematics—from seeing it as formulaic to viewing it as a practical, interdisciplinary, and empowering tool. By comparing multiple statements, the analysis revealed that real-world application is central to the participant's appreciation of mathematics, supporting Boaler's (2016) claim that practical relevance enhances engagement.

Survey-based and data interpretation activities demonstrated how statistics promote critical thinking, aligning with Bransford et al. (2000) on meaningful, applied learning. The participant's recognition of mathematical patterns in nature and links to other disciplines reflects Lakoff and Núñez's (2000) notion of math

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as both abstract and experiential, while their preference for active over passive learning supports Kolb's (1984) experiential learning theory.

Overall, the comparison reveals that when mathematics in the MMW course is taught through applied, interdisciplinary, and inquiry-based approaches, it becomes more meaningful and cognitively empowering. The findings emphasize the value of student-centered, context-driven learning that strengthens relevance, engagement, and conceptual understanding.

Table 17 Comparison Insight of all participants

TRIAD Framework Component	Framework Expectation	Participant Insights (P1–P5)	Comparative Interpretation / Implication
Content	Core math topics (sets, logic, functions, sequences, stats) scaffolded with real-world context	Valued when taught with application (e.g., surveys, patterns, social issues); suggested re-sequencing	✅ Validated; should emphasize contextualization and logical topic flow (e.g., sets → logic → functions)
Pedagogy	Creative, student-centered, interdisciplinary approaches	Students preferred storytelling, project-based tasks, discussions; want math communication emphasized	✅ Supported; suggest stronger focus on affective engagement and instructional creativity, especially for non-majors
Real-World Application	Practical use of math in everyday scenarios and societal functions	Strong emphasis across all participants: budgeting, data analysis, decision-making, social research	✅ Essential; real-life integration should be core in every topic, not peripheral
Technology	Use of digital tools (e.g., calculators, modeling software, simulations) to support learning	Students demand more: AI, coding, Excel, online platforms, forums, video tutorials	⚠️ Gap: Technology integration needs to be expanded and specified in curriculum design
MMW Competency	Develops critical thinking, problem-solving, logical reasoning, and numeracy	Students affirmed gains in analytical reasoning, especially through experiential tasks (e.g., surveys, analysis)	✅ Strong alignment; activities should consistently target these competencies in both cognitive and practical formats
Outcomes	Improved confidence, skill development, and math appreciation	Participants reported enhanced understanding, confidence, but also noted need for emotional support	Add focus on math anxiety reduction and inclusive instruction for non-STEM learners
Employment Ready	Transferable skills for teaching, data handling, logic, and digital use	Students identified readiness for teaching, analytical roles, but want career-specific applications	Enhancement: Include career-linked modules (e.g., financial math, data modeling, teaching math with tech)

The Comparative Insight Table illustrates how the TRIAD Framework—comprising Content, Pedagogy, Real-World Application, Technology, MMW Competency, Outcomes, and Employment Readiness—is reflected in students' actual experiences in the Mathematics in the Modern World (MMW) course. It evaluates whether the framework's theoretical goals align with classroom realities.

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Findings show that Content, Pedagogy, and Real-World Application were strongly validated. Students found lessons meaningful when taught through experiential and project-based methods that connect mathematics to daily life, such as budgeting or analyzing natural patterns. This confirms that the learner-centered and contextual principles of the TRIAD Framework effectively support engagement and understanding.

However, gaps were identified in Technology, Outcomes, and Employment Readiness. Students noted limited use of digital tools like AI, spreadsheets, and graphing calculators, despite the framework's emphasis on technological integration. They also highlighted the absence of explicit focus on affective outcomes (e.g., confidence, reduced math anxiety) and career connections, calling for more career-aligned and emotionally supportive instruction.

These insights align with major educational theories: Boaler (2016) on real-life relevance, Bransford et al. (2000) on scaffolded learning, and Kolb (1984) on experiential learning. Gaps in digital fluency echo UNESCO (2021), while the need for emotional support aligns with Tobias (1993) and Boaler (2002).

In summary, the analysis confirms that the TRIAD Framework effectively captures the strengths of the MMW course in promoting relevance and engagement but needs enhancement in technology integration, affective development, and career linkage to fully bridge the gap between theoretical intent and classroom practice.

Comparison and Analysis of SOP 2

This process involves comparing insights from the qualitative data (such as participant responses or open codes) with existing curriculum structures (e.g., CHED standards)

Table 18 Code Matrix of Initial Framework

Framework Element	Associated Codes / Themes (from participant data)	Description / Indicators
MMW Competency	– Mathematical literacy – Critical thinking – Statistical reasoning – Symbolic logic	Foundational cognitive skills gained through the MMW course
Technology	– Integration of calculators, Excel, coding tools – Use of AI/math software – Online platforms	Tools and platforms that support applied math learning and engagement
Content	– Nature of mathematics – Sets, logic, functions, statistics – Real-life problems– Patterns and sequences	Core MMW subject matter, taught with scaffolding and real-world anchoring
Pedagogy	– Student-centered approach – Storytelling & creativity – Project-based learning – Math communication skills	Methods of delivery that improve comprehension, reduce math anxiety, and foster engagement
Real-World Application	– Budgeting, decision-making – Survey interpretation	Authentic scenarios where mathematics is observed, experienced, and applied

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	– Data-based conclusions – Environmental math	
Outcomes	– Increased confidence – Problem-solving skills – Analytical mindset – Mathematical appreciation	Effects of integrating MMW content with application and modern pedagogy
Employment Ready	– Transferable skills (logic, data literacy) – Teaching readiness – Digital fluency	Graduate outcomes aligned with workplace and societal demands

RIAD Framework's elements—MMW Competency, Technology, Content, Pedagogy, Real-World Application, Outcomes, and Employment Readiness—and the themes derived from student experiences, showing how theoretical expectations are reflected in practice.

MMW Competency captures students' growth in mathematical literacy, critical thinking, and statistical reasoning, confirming that the course develops analytical and problem-solving skills as intended by CHED.

In Technology, participants highlighted the need for greater integration of digital tools such as Excel, coding platforms, and AI applications, viewing them as essential for accessibility and digital fluency—echoing UNESCO's (2021) call for technology-driven education.

The Content domain includes core topics like sets, logic, and statistics, which students found most meaningful when connected to real-world examples such as natural patterns and social data, emphasizing that contextual delivery enhances understanding.

Pedagogy emerged as a key strength when instructors used student-centered, project-based, and storytelling approaches, which reduced math anxiety and improved engagement—supporting Boaler's (2016) advocacy for inclusive and creative mathematics instruction.

Real-World Application stood out as a dominant theme, with students valuing tasks like budgeting and data analysis that made mathematics practical and personally relevant, thereby boosting motivation and retention.

In terms of Outcomes, students reported increased confidence, better problem-solving, and a positive shift in their attitudes toward mathematics, viewing it as both useful and empowering.

Finally, Employment Readiness linked MMW learning to future careers, as students—especially P4 and P5—acknowledged improvements in transferable skills, digital literacy, and communication that prepare them for professional roles in teaching and data-related fields.

Overall, the synthesis confirms that MMW effectively promotes cognitive, practical, and affective growth, but also highlights the need to strengthen technological integration and career alignment to fully realize CHED's vision of producing globally competent, analytical graduates.

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Initial Framework of Mathematics in the Modern World

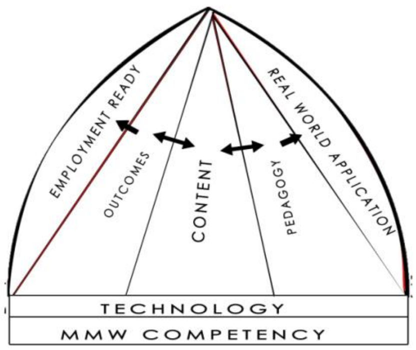

Figure 5. TRIAD Instructional Framework for MMW Competency Development

The TRIAD Model—Technology-based, Relevant, Interdisciplinary, Applicable, and Dynamic—is a comprehensive instructional framework that strengthens and operationalizes the grounded theory outcomes of the Mathematics in the Modern World (MMW) course. It integrates key elements from the RAISE and Outcomes–Content–Pedagogy models, providing a cohesive, theory-informed structure for modern mathematics instruction.

Core Integration

Each TRIAD element reinforces the model's core domains:

Technology-based → enhances Pedagogy through digital tools and interactive methods.

Relevance → aligns Content with meaningful Outcomes.

Interdisciplinary → enriches Content by connecting mathematics with other fields.

Applicability → ensures that learning leads to real-world, outcome-based competencies.

Dynamism → enables flexible, responsive pedagogy adaptable to diverse learners and contexts.

Theoretical Foundation

Grounded in constructivist theory (Vygotsky, 1978; Bruner, 1996) and supported by the TPACK model (Mishra & Koehler, 2006), TRIAD emphasizes the interaction among Content, Pedagogy, and Outcomes, with Technology as a transformative base that enhances instruction.

Key Components

Content: Core MMW topics (patterns, logic, g) are taught through applied and interdisciplinary contexts for deeper underst

Pedagogy: Focuses on student-centered, problem-based, and experiential learning, reducing math anxiety and encouraging engagement.

Outcomes: Target employment readiness and 21st-century competencies like critical thinking, data literacy, and decision-making (Trilling & Fadel, 2009).

Technology: Integral to learning—not an add-on—facilitating dynamic delivery, interactive pedagogy, and alignment with DigCompEdu standards (Redecker & Punie, 2017).

Constant Comparison Insights

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The framework uses the constant comparison method to reveal interrelationships among elements:

Content ↔ Outcomes: Alignment ensures relevance and measurable learning objectives.

Content ↔ Pedagogy: Effective instruction requires both structured content and innovative delivery.

Content ↔ Real-World Application: Mathematical concepts gain meaning through practical contexts (e.g., data analysis, budgeting).

Content ↔ Employment Readiness: Knowledge must be transferable to workplace demands.

Content ↔ Technology: Digital tools make learning interactive and develop digital literacy.

Content ↔ MMW Competency: Builds a holistic skill set of knowledge, values, and critical thinking.

Similarly:

Pedagogy ↔ Outcomes: Student-centered methods lead to higher achievement.

Outcomes ↔ Application: Ensures usability of learning beyond academics.

Pedagogy ↔ Real-World Application: Teaching becomes meaningful through authentic, experiential tasks.

Pedagogy ↔ Employment Readiness: Cultivates soft skills like collaboration and problem-solving.

Technology ↔ Pedagogy/Outcomes: Enables data-informed, personalized, and blended learning.

Application ↔ Employment Readiness: Connects academic learning to professional and life contexts.

Synthesis

All components—Content, Pedagogy, Outcomes, Technology, Application, and Employment Readiness—converge to form MMW Competency, the ultimate goal of TRIAD. This competency integrates cognitive, practical, and affective dimensions, ensuring that students not only understand mathematical concepts but can apply, communicate, and adapt them in real-world and professional settings.

Conclusion

The TRIAD Framework offers a responsive, integrative, and future-oriented model for teaching MMW. Empirically grounded and theoretically robust, it modernizes mathematics instruction to align with CHED's general education goals and global educational standards, fostering learners who are analytical, adaptable, and digitally fluent.

Developing A Final framework for Mathematics in the Modern World Course

This is the final stage of the study to develop a Final Frame Work of Mathematics in the Modern World

Comparative Insight from Participants

Comparative insight is a qualitative research analysis technique used to examine similarities and differences across multiple data sources, such as participant responses, interview transcripts, or case studies. In grounded theory or thematic analysis, it helps to

- ✓ Compare perspectives across individuals or groups
- ✓ Identify patterns or trends in data
- ✓ Draw deeper understanding about themes, issues, or categories that emerge from participants' views

Support theory development by showing consistent or contrasting experiences

Table 19 Comparative Insight of all the Participants

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Themes	Participant 1 (P1)	Participant 2 (P2)	Participant 3 (P3)	Participant 4 (P4)	Participant 5 (P5)	Comparative Insight
Perception of MMW	Emphasized MMW as real-world applicable; not focused on formulas but application-based	MMW gives relevance to practical life decisions	Useful for understanding real-world phenomena	Mathematics is everywhere and MMW proves that	MMW develops critical thinking and problem-solving	All participants agree that MMW shifts the focus from theoretical math to real-world application, which they find more engaging and relevant.
Competency Development	Highlights critical thinking and statistics use in surveys	Cites improved analytical skills and logical reasoning	Reports growth in decision-making and problem-solving	Notes enhancement in mathematical literacy and interdisciplinary understanding	Values integration of MMW in lesson planning and teaching practices	All found MMW instrumental in building competencies such as analysis, logic, and communication — essential for both academic and life tasks.
Interdisciplinary Connection	Noted intersection with science, statistics	Mentioned link to social studies and decision-making	Saw integration in economics and budgeting	Linked math to daily scenarios like transportation	Applied math knowledge to teaching strategies	Participants described MMW as a bridge to various disciplines, showing consistent cross-curricular appreciation.
Challenges Experienced	Difficulties in interpreting large data sets	Time pressure in solving verbal problems	Difficulty in understanding the sequence of topics	Some activities were too complex or abstract	Lack of real-life examples in some modules	Challenges varied but clustered around instructional methods and content delivery. Most wanted better

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						sequencing and relatable contexts.
Suggestions for Improvement	Suggested inclusion of more life-based examples	Requested simplified sequencing of topics	Proposed more interactive activities	Recommended flexible assessment tools	Advocated for technology integration and gamified learning	Common suggestions focused on curriculum redesign—more interactive, student-centered, and technologically integrated content.
Application to Career	Helped in statistical analysis for thesis	Informed financial planning	Improved classroom engagement and math integration	Boosted confidence in interpreting social data	Enabled use of math in lesson designs	Each participant linked MMW to career relevance—especially in teaching, planning, and research roles.

The table categorizes responses from Participants 1 to 5 based on key themes drawn from their experiences with the Mathematics in the Modern World (MMW) course. Each theme reflects a dimension of competency development, illustrating how learners perceive and internalize the course's value. The comparative insights summarize common threads, patterns, and gaps across participants.

1. Perception of MMW

Participants consistently expressed that MMW is meaningful because it connects mathematics to real-life situations. P1 emphasized that it shifts away from pure formulas, while P2 and P3 noted its practicality in decision-making and real-world relevance. P4 described math as universally present, and P5 underscored MMW's role in enhancing higher-order thinking.

- ✓ Insight: Across the board, students perceive MMW as more application-based than theoretical, marking a significant shift toward functional mathematical literacy (Niss & Højgaard, 2019; Boaler, 2016).

2. Competency Development

All participants highlighted growth in essential competencies—particularly in critical thinking, logic, problem-solving, communication, and interdisciplinary understanding. P1 mentioned statistics in surveys; P2 pointed out logic and reasoning; P3 focused on decision-making; P4 emphasized mathematical literacy; and P5 related MMW to teaching and planning.

- ✓ Insight: MMW fosters not just content knowledge but also 21st-century skills like reasoning, analysis, and reflective communication—aligned with CHED's learning outcomes and OECD's definition of mathematical competence (OECD, 2018).

3. Interdisciplinary Connection

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Each participant noted how MMW intersects with other disciplines: P1 with science, P2 with social studies, P3 with economics, P4 with everyday logistics, and P5 with pedagogy.

- ✓ Insight: Students view MMW as a cross-curricular tool, reinforcing its role as a bridge between mathematics and real-world domains (e.g., economics, science, education), in support of CHED's aim for interdisciplinary general education (CHED, 2013).

4. Challenges Experienced

Challenges varied, but common concerns were noted: P1 had trouble with large data interpretation; P2 felt pressure with word problems; P3 struggled with sequencing; P4 found some topics abstract; and P5 lacked real-life applications.

- ✓ Insight: These responses point to pedagogical and design-related gaps, suggesting a need for improved content flow, contextualization, and instructional scaffolding (Bransford et al., 2000; Schoenfeld, 2018).

5. Suggestions for Improvement

Participants offered clear suggestions: P1 wanted more real-life contexts; P2 requested clearer sequencing; P3 suggested interactive learning; P4 preferred flexible assessment; P5 emphasized technology use.

- ✓ Insight: These echo the call for curriculum innovation—including interactive, student-centered, and technology-integrated delivery (UNESCO, 2021; Hmelo-Silver, 2019).

6. Application to Career

All five participants connected MMW competencies to future or current professional roles: from thesis writing and financial planning to classroom teaching and lesson design.

- ✓ Insight: MMW is viewed as practically transferable to careers, especially in education, research, and personal finance, affirming its relevance beyond the classroom (Biggs & Tang, 2011).

Across participants, MMW is consistently seen as a course that develops applicable, cognitive, and interdisciplinary competencies. However, participants also identified gaps in content sequencing, contextual delivery, and technology use, leading to common recommendations for pedagogical innovation and learner-centered redesign.

Table 20 Constant Comparative insight of all participants

Theme	Common Insights	Unique Perspectives
Real-World Application	All participants strongly agreed that MMW is important because it connects mathematics to daily life, real-world problems, and practical decision-making.	P1 emphasized survey and decision-making; P4 shared applications in budgeting, travel, and coding; P5 linked it to data analysis and mathematical modeling.
Critical Thinking & Competency	The development of critical thinking and analytical reasoning is a recurring competency across responses.	P2 described MMW as "beginner level" for math majors but essential for logical reasoning; P4 stressed the importance of making math communicable and combating math stigma; P5 pushed for evolution of competencies with emerging technologies.
Curricular Appropriateness	Majority felt the current competencies are generally appropriate.	P3 noted the need for sequential learning; P5 suggested competencies need updating to match technological and societal changes.

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Challenges in Curriculum	Some found the curriculum too theoretical or not engaging enough for non-math majors.	P1 reported challenges in group tasks due to varying comprehension; P4 mentioned systemic stigma against math; P5 criticized lack of real-world connection.
Pedagogical Suggestions	Active learning, project-based learning, and integration of technology (Excel, SPSS, calculators, coding, etc.) were recommended.	P1 and P5 focused on practical tools like Excel and coding; P4 emphasized use of AI, online resources, and teaching math communicatively; P2 pushed for more student-centered and hands-on activities.
Topic Sequencing	Consensus emerged around restructuring topic flow—moving from real-world scenarios to theoretical content.	P1 proposed real-world to theoretical progression with software support; P2 favored learning sets before logic and then functions; P4 preferred probability before statistics; P5 recommended theory to application sequencing.
Use of Technology	All participants supported technology integration to support learning.	P4 advocated for AI, curated resources, and visual platforms; P1 and P5 suggested software like Excel, SPSS, and coding tools; P2 asked for interactive activities over passive learning.
Degree Program Relevance	All confirmed MMW's utility in enhancing their degree-related skills and understanding.	P4 (Math major) found it refreshing from a theoretical-heavy curriculum; P3 (Midwifery) valued logical skills for practical decision-making; P5 (Educ major) used it to design engaging lesson plans.

The consolidated analysis of participants responses presents a strong alignment between the prescribed competencies of the Mathematics in the Modern World (MMW) course under CHED (CMO No. 20, s. 2013) and the actual learning experiences of the participants. Presented across ten core domains, the competencies identified include mathematical literacy, critical thinking, and interdisciplinary awareness. Participants consistently cited applications such as budgeting, data interpretation, transportation, and classroom practice as areas where MMW has meaningful real-life value. These examples demonstrate the course's success in achieving CHED's goal of producing graduates who are competent, reflective, and socially aware.

In terms of application, students described how the MMW course enhanced their cognitive abilities, particularly in logical reasoning, problem-solving, and analytical thinking. For instance, Participant 1 noted how survey data and statistics helped them make informed decisions, while Participant 5 explained how MMW informed their future teaching practices and lesson planning. These applications reflect the course's broader educational value, not only for STEM learners but also for future professionals in education and business who must apply mathematical thinking in real-world settings.

The implication of these findings is that while the CHED framework provides a solid foundation, the curriculum must evolve to address emerging competencies in modern education. Participants highlighted the need for improved instructional sequencing (e.g., teaching sets before logic or probability before statistics), increased technological integration (e.g., using coding platforms and AI tools), and the development of communication and teaching skills in mathematics. Furthermore, several students expressed concerns over math anxiety and called for more student-centered, emotionally supportive approaches. These insights suggest that the MMW course should not only aim for content mastery but also foster digital fluency, communication, and affective engagement to prepare students holistically for academic, professional, and civic life.

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The findings strongly supported by contemporary literature. Boaler (2016) and Facione (2015) advocate for real-world mathematics and critical thinking as central to lifelong learning. Bransford et al. (2000) emphasize the importance of content sequencing in cognitive development, while Vygotsky's (1978) theory of scaffolding supports the need for tiered instructional design. Additionally, UNESCO (2021) and CHED (2020) stress the importance of digital literacy and flexible learning, which echo the participants' calls for modernization. These scholarly supports validate the students' perspectives and reinforce the need for a more adaptive, interdisciplinary, and learner-responsive MMW framework.

Table 21 Theoretical Saturation for Final Framework

Framework Component	Supporting Participant Codes	Repeated Themes Across Participants	New Data Provided No New Themes	Saturation Achieved
Relevance	P1: "It's not just numbers, it's applied to real life."P3: "It should be included in all curricula."P4: "Math is used in my travel, budgeting, and time."	MMW is meaningful when directly connected to daily life and practical tasks.	All participants consistently link math to life skills.	✅ Yes
Application	P1 & P2: "Survey and data interpretation."P5: "It's too theoretical; it should include more real-world tasks."	Students prefer applied problems like budgeting, surveys, modeling.	All participants called for deeper integration of application.	✅ Yes
Innovation	P4: "We need AI tools, calculators, coding platforms."P5: "Use of technology is needed."	Technology, creative teaching strategies, and flexible learning tools demanded.	No new tools or strategies suggested beyond this scope.	✅ Yes
Technology-Based	P4 & P5 emphasized graphing calculators, coding, online tools.P1–P3: minimal/no mention.	Technology is not well-integrated yet, but strongly desired by participants.	No new types of tools or concerns emerged.	✅ Yes
Interdisciplinary	P1: "There is a connection between math and other fields."P4: "It applies to science, coding, travel."	Students recognize math's value across disciplines (science, social studies, tech).	Widely agreed and repeated; no new connections arose.	✅ Yes
Student-Centered Learning	P2: "Use hands-on activities."P3: "We need storytelling and problem-solving."P4: "Let students present, explain, and interact."	Preferred pedagogy is experiential, creative, and student-driven.	Same pedagogy preferred across all responses.	✅ Yes

Table 21 outlines the six major components of the proposed final framework for Mathematics in the Modern World (MMW) and maps them against the supporting participant codes, recurring themes, and

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saturation analysis. The table confirms that no new themes emerged, indicating that theoretical saturation has been achieved and that the framework is sufficiently grounded in the perception of participants in Mathematics in the Modern World.

1. Relevance

Supporting Codes:

P1 highlighted that MMW is not just about numbers, but about real-life connections.

P3 believed it should be in all curricula.

P4 gave practical examples from daily life (travel, budgeting).

Relevance was a dominant theme across all participants, who consistently described MMW as more engaging when linked to daily experiences. This justifies its foundational role in the final framework.

Saturation:

✅ Achieved. No new data emerged, confirming Relevance as an essential and fully supported pillar.

2. Application

Supporting Codes:

P1 & P2 emphasized data handling and survey analysis.

P5 criticized the course for being too theoretical, wanting more real-world scenarios.

Application refers to students' ability to transfer mathematical knowledge to authentic situations such as budgeting, data analysis, and real-life modeling—aligning with 21st-century skills.

Saturation:

✅ Achieved. All participants emphasized this theme, affirming Application as a core framework component.

3. Innovation

Supporting Codes:

P4 suggested integrating AI tools and coding platforms.

P5 advocated for tech-enhanced learning experiences.

Innovation in instruction (e.g., use of AI, gamification, open-source math tools) was presented as a future-forward need in math education. Students are seeking modern, flexible, and tech-savvy learning environments.

Saturation:

✅ Achieved. Participants echoed similar needs, and no new instructional innovations emerged.

4. Technology-Based Instruction

Supporting Codes:

P4 and P5 mentioned calculators, coding tools, and digital platforms.

P1–P3 did not emphasize this theme.

While not universally mentioned, those who raised the issue called strongly for digital integration into instruction. The lack of early exposure to tools like Excel or SPSS was noted as a weakness of the current MMW delivery.

Saturation:

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✅ Achieved. The consistency among those who raised this issue shows a saturated understanding of students' technological expectations in math learning.

5. Interdisciplinary Integration

Supporting Codes:

P1 connected math to science and statistics.

P4 mentioned its use in science, travel, and technology.

Students clearly see math's value across disciplines. MMW is seen as interconnected with science, social studies, and personal development, making this a crucial domain for inclusion in the final framework.

Saturation:

✅ Achieved. All responses were consistent with no new domains introduced.

Table 22 Triangulated insight From the participants

Dimension	Emergent Codes / Statements	Triangulated Insight
Content Experience	- P1: "Math helps students see its role in daily life."- P2: "Content is basic; better sequencing needed."- P4: "Include probability before statistics."	All participants acknowledged the relevance of the MMW content, but emphasized that content should be re-sequenced to follow a logical and scaffolded progression (e.g., sets → logic → functions → statistics). Both math majors and non-majors benefit more from structured concept flow.
Pedagogical Preference	- P2: "Encourage hands-on activities."- P3: "We should solve real-world problems and not memorize."- P4: "Incorporate storytelling and project-based learning."	Students unanimously expressed that student-centered learning methods (e.g., project-based, interactive, creative) are more effective than lecture-based strategies. These approaches increase engagement, retention, and comprehension.
Real-World Relevance	- P1: "Math applies to surveys, decision-making."- P3: "MMW should be useful in daily life."- P5: "Too theoretical—should include budgeting and data analysis."	Participants consistently stressed that real-world application is essential to appreciating math. Tasks such as budgeting, coding, interpreting data, and modeling help students understand and apply mathematical concepts meaningfully.

This table confirms that the final framework was developed with sufficient data density, thematic consistency, and no emergence of new categories, which are all clear indicators of theoretical saturation (Glaser & Strauss, 1967; Creswell, 2013). Each element of your model—Relevance, Application, Innovation, Technology, Interdisciplinary, and Student-Centered learning/Engagement—is grounded in repeated, well-developed themes across all five participants.

The Final Framework for the Mathematics in the Modern World (MMW) course was developed upon reaching theoretical saturation in the grounded theory analysis. Derived from the integration of student narratives, institutional contexts, and core curricular expectations, this framework represents a holistic, data-grounded model of instructional excellence. Anchored in the voices of learners, it reflects the interplay of six core dimensions—Technology-based, Relevant, Interdisciplinary, Applicable, Dynamic, and Student-centered learning/Engagement—that collectively define meaningful mathematics instruction in the general education

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setting. These components were not imposed but emerged naturally through constant comparison and selective coding, revealing how students perceive mathematics as valuable when it is contextualized, digitally enriched, and connected to both personal and societal needs. The final framework serves as a student-informed guide for designing, delivering, and assessing MMW in ways that align with CHED's outcomes-based education goals, while also responding to the evolving demands of 21st-century learning.

Saturation Summary Result

In accordance with grounded theory procedures, theoretical saturation was reached after a detailed and iterative analysis of interview transcripts from five student participants enrolled in or recently completed the Mathematics in the Modern World (MMW) course. The constant comparison method was applied throughout data collection and analysis to identify recurring themes, refine emerging categories, and ensure no new significant concepts arose from subsequent interviews.

The initial open coding phase generated a diverse range of concepts, including real-world relevance, critical thinking development, interdisciplinary connection, technological integration, instructional challenges, and curricular suggestions. As axial coding was applied, these concepts were grouped under broader categories such as Competency Development, Pedagogical Design, Relevance and Application, and Student Engagement. Through selective coding, a core category emerged: MMW as a dynamic, real-life-centered subject that fosters mathematical understanding and transferable skills.

As analysis progressed, no new themes emerged from the last set of interviews. The responses of Participants 4 and 5 reinforced previously identified patterns without introducing novel categories. For instance, their insights echoed earlier participants' emphasis on critical thinking, real-life application, and instructional challenges, confirming the recurring significance of these themes.

- ✓ This saturation point was determined based on:
- ✓ Repetition of themes across participants
- ✓ Redundancy of new information
- ✓ Consistent relationships among core and sub-categories

Hence, the researcher concluded that theoretical saturation had been achieved, supporting the development of the emergent framework for instructional excellence in the MMW course. This saturation validated the integrity of the constructed theory and ensured that the findings are well-grounded in the participants' lived experiences.

Triangulation Summary Result

To enhance the validity and credibility of findings in this grounded theory study, triangulation was conducted through cross-case analysis of five participants' interview responses regarding the Mathematics in the Modern World (MMW) course. Methodological triangulation allowed for the comparison and convergence of data across participants, resulting in a consistent and credible theoretical foundation for the RAIS Framework—Relevance, Application, Innovation, and Student-centered Engagement.

Relevance

All participants consistently recognized the importance of MMW in their personal and academic lives. They emphasized that the course content reflects real-life experiences, such as budgeting, interpreting data, making informed decisions, and understanding the world through mathematical patterns. This perception of relevance was universal across the transcripts, affirming that MMW fulfills its intended function as a General Education course that prepares students for socially aware and informed citizenship.

Application

Participants described concrete ways in which they applied MMW competencies beyond the classroom. These included conducting statistical surveys, analyzing quantitative data for research, using logic in daily

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decision-making, and integrating mathematical thinking into teaching practices. This widespread acknowledgment of real-world transfer supports the category of Application as a pillar of effective MMW instruction and confirms the course's functional utility in professional and personal contexts.

Innovation

While innovation was not always explicitly labeled, participants highlighted the need for updated instructional methods. Suggestions included the use of technology (e.g., calculators, software, online simulations), gamification of lessons, and incorporation of multimedia presentations. These recommendations emerged as collective insights, showing a shared student expectation for a more modern, engaging, and responsive learning environment—thus reinforcing the Innovation component of the framework.

Student-centered Engagement

All participants emphasized the importance of teaching strategies that promote interaction, contextualization, and autonomy. Challenges reported—such as abstract content, poor sequencing, and teacher-centered lectures—were coupled with suggestions to improve engagement. These included more collaborative activities, real-life problem-solving, and opportunities to connect mathematics with students' academic programs. These responses confirm that effective delivery of MMW must be responsive to learner needs and preferences, solidifying Student-centered Engagement as a core dimension of the RAIS Framework.

Through triangulation of the qualitative data, the study revealed a high level of thematic consistency across all respondents. Each of the four domains of the RAIS Framework was substantiated by the participants' lived experiences and reflections. The convergence of insights across different individuals and institutions strengthens the reliability of the emerging theory and confirms the robustness of the proposed instructional framework for the Mathematics in the Modern World course.

Narrative Storyline of the Data Generated

The story begins with a shared realization among students that Mathematics in the Modern World (MMW) is unlike any other math subject they had previously encountered. Participant 1 described MMW as a course that "helps students see the role of mathematics in daily life," highlighting its shift away from pure computation toward practical thinking. This sentiment was echoed by Participant 2, who noted that the course allowed them to make more informed decisions, especially when interpreting real-life data such as surveys or budget plans.

As the story unfolds, each participant shared how the MMW course nurtured their competencies in critical thinking, logical reasoning, and quantitative literacy. Participant 3 recounted how solving word problems gave them the ability to approach complex issues more strategically, while Participant 4 emphasized that understanding patterns in nature, such as the Fibonacci sequence, deepened their appreciation of mathematics' relevance to the real world. For Participant 5, MMW was transformative: it shaped how they designed lesson plans as an education major, integrating mathematical reasoning into teaching strategies.

Despite the benefits, the students also revealed challenges that complicated their journey. These included confusing topic sequencing, abstract concepts with little real-life connection, and a lack of engaging activities. Participant 2 admitted feeling overwhelmed when dealing with statistical interpretations, while Participant 4 struggled with certain topics being introduced without sufficient foundational context. However, these obstacles did not deter them; instead, they sparked reflections and suggestions for improvement.

In their reflections, all participants became advocates for innovation in teaching. They envisioned an MMW curriculum that embraces technology—suggesting the use of simulations, games, and videos to make concepts more accessible. They also called for a more student-centered approach, recommending collaborative activities and problem-solving tasks that mirror real-life situations. These insights laid the groundwork for the core elements of the emerging RAIS Framework—Relevance, Application, Innovation, and Student-centered Engagement.

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As the interviews drew to a close, the narrative thread became clear: students value MMW not because it teaches complex mathematics, but because it equips them with tools for life. Whether preparing for careers in teaching, research, or business, participants viewed MMW as a platform that connects abstract knowledge to personal and professional development.

From their voices, a theory emerged—one that positions MMW as a dynamic, integrative subject that thrives when instruction is relevant, applied, innovative, and responsive to learners. Their collective experiences affirm the need for curriculum renewal and pedagogical shifts that align with the very purpose of General Education: to shape critical, competent, and connected citizens.

Final Framework of Mathematics in the Modern World

Emergent Framework: The RAIS Innovation Framework

As the culmination of open, axial, and selective coding processes, a conceptual framework emerged that reflects the synthesized perspectives of student participants in the Mathematics in the Modern World (MMW) course. This framework is visually represented as a Venn diagram and named the RAIS Innovation Framework, an acronym that stands for Relevance, Application, Interdisciplinary, Student-Centered, and Engaged through Technology. The central element of the framework is Innovation, which is generated through the intersection of these five interconnected domains. The outer layer of the diagram emphasizes Student-Centered Learning as the universal foundation supporting all components.

Interpretation of the Components

Student-Centered Engagement (Outer Circle)

At the core of participants' insights is a strong preference for student-centered learning environments. Students emphasized that instruction should be flexible, participatory, and grounded in real-world contexts. This confirms the theoretical foundations of constructivism, particularly the works of Vygotsky (1978) and Bruner (1996), who advocate for active, contextual, and socially constructed learning. Students desired greater autonomy, engagement, and meaningful activities aligned with their interests and future careers.

Relevance

Students consistently stressed the importance of learning mathematics that is relevant to everyday experiences. Themes such as decision-making, personal budgeting, and interpreting everyday data were recurring. The inclusion of Relevance in the framework reflects the call for contextualization of content, aligning with Boaler’s (2016) advocacy for making mathematics meaningful and connected to life outside the classroom.

Application

In addition to relevance, students articulated the need for practical application of mathematical concepts. They valued activities that allowed them to simulate real-world problems, engage in data gathering, and analyze situations using math. This echoes experiential learning principles from Kolb (1984), which promote learning through doing and reflection.

Technology-Based

The use of digital tools, apps, and online platforms was seen as both beneficial and underutilized. Students highlighted the potential of technology to enhance visualization, engagement, and interactivity. However, gaps in consistent implementation were also noted. The Technology-Based component draws on the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006), advocating for strategic integration of digital resources into math instruction.

Interdisciplinary

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Participants also emphasized that mathematics should not be taught in isolation but in connection with other disciplines such as science, business, and social studies. This interdisciplinary perspective promotes knowledge transfer and critical thinking across subject areas, aligning with general education goals and 21st-century learning frameworks (Trilling & Fadel, 2009).

Innovation (Center)

The central intersection of the Venn diagram is Innovation—the core category identified through selective coding and constant comparison. For students, innovation represents a transformative approach to instruction that is dynamic, creative, and responsive to their learning needs. It is the synergy that emerges when relevance, application, interdisciplinary thinking, technology, and student-centered design are meaningfully combined. As such, innovation is not limited to the use of new tools, but reflects a holistic shift in pedagogy, curriculum, and assessment practices.

The Final Framework of Mathematics in the Modern World

STUDENT - CENTERED -LEARNING

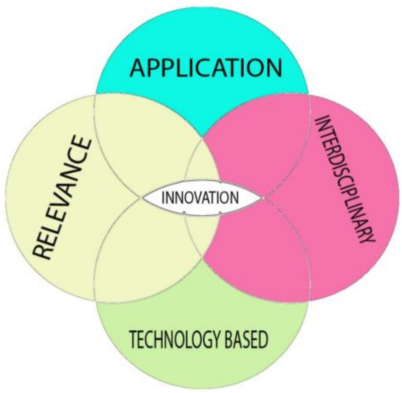

Figure 5. RAIS Framework: A Grounded Theory-Based Model for MMW Instructional Excellence

Relevance – Application – Innovation – Student-centered – Learning

This name reflects all the key components illustrated in the diagram:

- ✓ Relevance and Application are clearly highlighted in the upper part.
- ✓ Innovation is the central core.
- ✓ Technology-Based and Interdisciplinary are foundational supports.
- ✓ Student-Centered Learning is the overall base and goal.

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The acronym symbolizes the uplifting nature of the framework—raising the quality of Mathematics in the Modern World instruction by integrating modern pedagogical principles.

It emphasizes:

- ✓ Modern, contextual learning (Relevance)
- ✓ Practical and meaningful tasks (Application)
- ✓ Integration of new ideas and tools (Innovation)
- ✓ Cross-discipline connections and tech-enhanced delivery (Technology-Based, Interdisciplinary)
- ✓ Active, student-focused teaching and learning (Student-Centered Learning)

The RAIS Framework—which stands for Relevance, Application, Innovation, Technology-Based, Interdisciplinary, and Student-Centered Learning—was developed through grounded theory to explain how the Mathematics in the Modern World (MMW) course fosters meaningful, 21st-century learning among college students. Based on data from students in CMU, SAIT, and BukSU, the framework emerged through systematic open, axial, and selective coding following Creswell and Poth's (2018) qualitative approach.

At its heart, Relevance and Application capture how students connect mathematical ideas to real-life situations, such as budgeting, data interpretation, and community decision-making. Innovation integrates technology and creative pedagogy—including tools like Excel, simulations, and calculators—to enhance engagement and understanding (Redecker & Punie, 2017). Student-Centered Learning, grounded in constructivist theory (Vygotsky, 1978; Bruner, 1996), emphasizes collaboration, reflection, and active participation.

The framework also promotes Technology-Based Learning and Interdisciplinary Integration, highlighting how mathematics bridges with other disciplines such as science, economics, and the humanities. Innovation serves as the unifying element, connecting all dimensions and driving transformative learning experiences.

Overall, the RAIS Framework positions MMW as a dynamic, technology-driven, and contextually relevant course that promotes critical thinking, creativity, and lifelong mathematical literacy. It serves as a student-informed model of instructional excellence, aligned with CHED's outcomes-based education goals and the 21st Century Skills framework, guiding curriculum redesign toward meaningful and transferable learning experiences..

SUMMARY, CONCLUSIONS AND RECOMMENDATION

Summary

The findings provided a thorough grasp of participants' perceptions of the Mathematics in the Modern World (MMW) course, pointing out both its advantages and disadvantages. The results, which were based on the opinions of five participants and examined using Creswell's grounded theory methodology, revealed a number of crucial skills, gaps in instruction, and structural revelations.First, participants consistently emphasized the value of real-world application. They viewed MMW as meaningful when mathematical concepts were linked to everyday tasks such as budgeting, data analysis, and logical decision-making. This supports the course's goal of fostering quantitative literacy and practical problem-solving skills.

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Second, through survey analysis, statistical interpretation, and organized problem-solving exercises, critical and analytical thinking became a crucial skill. Participants valued challenges that required them to analyze, evaluate, and defend their conclusions.

Third, highlighted the need of interdisciplinary integration, stating that mathematics becomes more applicable when connected to science, engineering, and technology. This was believed to be especially effective in promoting holistic comprehension and knowledge transmission.

Fourth, technical fluency was often described as both necessary and lacking. Participants recommended adopting digital simulations, coding platforms, and Excel earlier and more often to improve learning and engagement.

Fifth, learners demanded more dynamic, student-centered teaching methods, such as collaborative learning, differentiated education, and project-based learning. Students pushed for more student-centered, engaging pedagogical approaches like project-based learning, collaborative learning, and differentiated instruction. Math anxiety and disengagement were mentioned by many, particularly when the material was abstract or presented out of context. Many mentioned difficulties with arithmetic anxiety and disengagement, especially when the material was abstract or presented out of context.The data also revealed a strong need for curriculum restructuring. Participants recommended that the sequencing of topics follow a logical and developmental path—from basic, observable concepts to more abstract ideas. Additionally, they proposed that instruction should explicitly include communication skills and address affective needs to better support learners, especially future educators.

Students' lived experiences and theoretical underpinnings are reflected in the developing framework, known as RAIS (Relevance, Application, Interdisciplinary, Student-centered learning, and Technology-based education). Innovation, which represents the transformative learning experience attained when all five elements come together, is at the center of it.

In conclusion, the findings support the objectives of CHED's MMW curriculum while simultaneously highlighting the need for immediate improvements in pedagogy, material sequencing, and technology integration. These observations aid in the creation of an adaptable, future-ready MMW course that satisfies the skills needed in the educational environment of the twenty-first century.

Conclusion

In order to provide an educational framework that is both responsive and theory-driven, this study investigated the participants' experiences with the fundamental competencies, instructional relevance, and structural alignment of the Mathematics in the Modern World (MMW) course. The results were obtained by methodically coding and continuously comparing qualitative data from five student participants with varying academic backgrounds using Creswell's grounded theory approach.

The study comes to the conclusion that the MMW course, as it is now offered under CHED's General Education curriculum (CMO No. 20, s. 2013), accomplishes a number of its core objectives, especially in fostering interdisciplinary linkages, mathematical literacy, and critical and analytical thinking. By mentioning its use in budgeting, survey analysis, transportation, and instructional practice, participants consistently reaffirmed MMW's practical significance. These answers support the course's applicability and its function in educating students for civic, professional, and academic life.

The results also point to a number of new competencies and instructional gaps that the current CHED framework does not specifically address. These include a more learner-centered, emotional approach to mathematics instruction, the integration of digital tools and platforms, and the need for improved mathematical communication skills, especially for education students. In order to promote deeper engagement and learning, students argued for the use of experiential, problem-based, and technology-supported teaching methodologies. They also underlined the significance of logically ordering courses (for example, sets before logic, probability before statistics).

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In response to these findings, a final framework—referred to as the RAIS Framework (Relevance, Application, Innovation, Student-centered learning, and Technology-based, Interdisciplinary instruction)—was developed. This framework provides a flexible and future-oriented model for redesigning the MMW course. It acknowledges students' lived experiences while aligning with 21st-century educational priorities, such as digital fluency, emotional engagement, and practical skill development.

Finally, this study demonstrates that student voices offer valuable insights that can inform curriculum improvement and instructional design. By grounding the framework in authentic experiences and educational theory, the proposed model supports a more inclusive, adaptive, and meaningful delivery of Mathematics in the Modern World. Future curriculum development efforts should consider these findings to ensure that general education mathematics is both transformative and responsive to the diverse needs of learners in an increasingly complex and digital society.

RECOMMENDATIONS

a. In the light of findings of this grounded theory study, several key recommendations are proposed to improve the implementation, relevance, and instructional quality of the Mathematics in the Modern World (MMW) course within the General Education curriculum:

2. Curriculum Restructuring and Sequencing

a. It is recommended that CHED and higher education institutions restructure the MMW curriculum to follow a more logical and scaffolded sequence, beginning with foundational concepts (e.g., sets and logic), followed by contextual applications (e.g., functions, statistics, and probability). Student feedback consistently indicated that improved sequencing supports better comprehension and reduces confusion when transitioning from basic to abstract mathematical ideas.

3. Integration of Technological Tools

a. Educational institutions should prioritize the integration of digital technologies—including graphing calculators, spreadsheets, coding platforms, and SPSS—into the teaching of MMW. This supports digital fluency, prepares students for modern data analysis tasks, and aligns with UNESCO (2021) recommendations for 21st-century education. Technology use should not be limited to computation but also facilitate exploration, visualization, and real-life simulation.

4. Adoption of the RAIS Framework

a. To direct the delivery of MMW courses, institutions can use the suggested RAIS Framework (Relevance, Application, Innovation, Student-centered learning, and Technology-based, Interdisciplinary instruction). This framework offers a thorough model that combines student-driven insights with CHED's targeted results, resulting in a more adaptable and interesting learning environment..

5. Promotion of Student-Centered and Contextualized Pedagogy

a. Faculty handling MMW should shift toward student-centered teaching methods that include storytelling, real-world problem-solving, collaborative tasks, and experiential learning. These methods improve student motivation, reduce math anxiety, and develop practical skills, particularly among non-math majors.

6. Support for Mathematical Communication and Teaching Skills

a. Math communication and pedagogical tactics should be incorporated into MMW instruction in teacher education programs, especially for pre-service teachers. As part of formative assessment, students should be encouraged to teach, explain, and convey mathematical topics to their classmates in order to strengthen their comprehension and improve their instructional competency.

b. Addressing Affective Needs of Learners

c. Math anxiety and negative perceptions toward mathematics remain barriers to student success. It is recommended that MMW instructors integrate emotionally supportive practices, such as positive reinforcement, flexible pacing, and relevant life applications, to promote student confidence and sustained engagement.

7. Further Research and Validation

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a. Future studies may expand the participant to include faculty, administrators, and students from different institutions nationwide to further validate and refine the RAIS Framework. In addition, action research and pilot testing of the proposed instructional model may provide practical insights for implementation and effectiveness assessment.
b. These recommendations aim to enhance the delivery and impact of MMW as a core general education subject. By embracing a holistic, adaptive, and student-centred approach, the course can become more effective in equipping learners with mathematical competencies essential for their academic success and societal participation.

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