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Analysis of the Alignment of Curriculum, Instruction, and Assessment in Higher Education Mathematics

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ABSTRACT

Using qualitative document analysis, this study determined the level of student performance in implementing the curriculum of Mathematics in the Modern World (MMW), the alignment of the syllabus, teaching-learning activities, and assessment, and proposed recommendations for alignment. Twenty-six (26) documents of two instructors from Kalinga State University during the School Year 2022-2023 and 2023-2024, and adapted alignment forms were utilized. The results revealed that the students had a satisfactory academic performance in MMW. All the intended learning objectives (ILOs) in the syllabus are aligned with the higher education general education objectives. All the teaching-learning activities and assessment tasks/materials employed and administered by the instructors aligned with the ILOs. Furthermore, findings proposed the following recommendations – develop a constructive alignment matrix, review and revise the syllabus, invest in high-quality aligned instructional materials, design professional development programs, and construct a mathematics college readiness test.

INTRODUCTION

To implement the education framework for the twenty-first century, alignment of academic endeavors—such as curriculum, instruction, and assessment—is an essential area of focus in higher education. Several studies mentioned that the harmony of these key elements ensures an effective teaching-learning process. Eventually, the concept of alignment was acknowledged as a significant contributor to the advancement of education. This causes countries to prioritize education on their national agendas. This prompts governments and educators throughout the world to place a high priority on how students learn and how to assess their success in areas like Mathematics and Science.

To improve student development, the Commission on Higher Education (CHED) works to ensure that curricula are relevant, instruction is efficient, and education is accessible and equitable (Abejuela *et al.*, , 2022). As a start, the curriculum in higher education was revised and included general education courses as per K–12 curriculum requirements. In line with this, one of the four missions of Philippine higher education, specifically the first mission is accurately described by the aim of general education. The CHED memorandum order for the General Education (GE) Curriculum (CHED, 2013a) highlighted that the holistic development of college students will be guided by the three primary learning competencies; 1) Intellectual Competencies; 2) Personal and Civic Competencies; and 3) Practical Responsibilities. Relatively, these competencies guided the Mathematics in the Modern World (MMW) learning objectives.

The following outcomes are highlighted in the course learning plan defined by the commission (CHED, 2013b); For the Knowledge component, debate and discuss the nature of mathematics, utilize various forms of reasoning to support claims about mathematics, and talk about the language and symbols used in mathematics; Develop students' Skills by utilizing a range of statistical techniques, deciphering codes and coding systems, and applying mathematics to various societal contexts; and To integrate Values, acknowledge the nature of mathematics and its applications in daily life, and affirm the use of mathematics with honesty and integrity. Correspondingly, this learning plan has included suggestions for classroom instruction and assessment plans. Some of the teaching methodologies are lectures/direct instruction, small group discussion, group or individual sharing/reporting, demo teaching, video watching, and interactive games. Meanwhile, some of the assessment plans discussed are essay/synthesis papers/writing exercises, quizzes, homework, problem sets, project proposals, and class exhibits.

The synergy of these components guarantees the attainment of the goal of the General Education course, specifically the MMW course subject.

Students' Performance in Mathematics in the Modern World

Over the years of implementation, MMW has strived to produce learners with mathematical literacy coupled with skill (data computation applied to real-life problems and technology skills), and values (appreciation, honesty, and integrity). Since the revision of the GE curriculum of higher education, several studies have assessed the academic performance of students in MMW subject. Many of these studies have underlying reasons related to

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developing interventions and looking into what actions are needed to sustain or improve students' mathematics performance.

According to the study of Morilla *et al.* (2020), the level of academic performance (based on grades) of the students towards the subject MMW is very good (mean grade of 2.01) considering that they acquired grades between 2.0 and 2.4 (grades in units). Similarly, Remo (2019) stated that students collectively have a good (mean grade of 2.00) performance in MMW. According to Labo (2022), freshmen students achieved a very good academic performance, falling within the grade range of 86-94. Yap *et al.* (2024) mentioned in their study that the 80–84 grade range is where most typical midterm and final grades of students fall. Roman and Villanueva (2019) found that first-year college students have a greater degree of proficiency in acquiring the learning competencies relating to knowledge, values, and skills outlined in the MMW. They also found that students had some minor challenges with the various MMW topics, but overall they performed satisfactorily in the subject. Also, in the study by Cornillez *et al.* (2020), results showed that in the MMW subject, while the non-mathematics major students showed good overall mathematical abilities, the mathematics major students showed extremely strong overall mathematical skills.

As splendid as the studies have shown, these successes are affected by some factors. Substantially which brought significant impact are the curriculum, classroom instruction, and proper utilization of assessment tools.

Alignment of Curriculum, Instruction, and Assessment in Mathematics in the Modern World

Bringing curriculum, instruction, and assessment in line with one another is the aim of alignment. The curriculum is usually the first thing educators work with, after which they define goals for instruction, provide guidance to meet those goals, and conduct assessments to gauge progress toward the curriculum's objectives (Baliber & Sañosa, 2022). To increase the likelihood that students will achieve the learning outcomes stipulated in the curriculum, it is crucial that the teaching be planned to include learning activities, and the assessment tasks be created to provide unambiguous evaluations of the extent to which those outcomes have been achieved.

According to Abragan *et al.*, (2022), the K–12 curriculum implementation in the Philippines is commendable and timely, yet it is plagued by socioeconomic and pedagogical issues. However, Dizon *et al.*, (2029) stated that despite all the issues that arose from the introduction of the new curriculum, many believed that the K–12 program would ultimately benefit every Filipino graduate in the long run. In realizing this belief, Balagtas (2021) advised that the program outcomes, performance indicators, and course descriptions be reviewed to represent the core competencies, new topic areas, applications of mathematics in less common situations, and soft areas of 21st-century abilities. Similarly, Urbano (2020) referenced Biggs' study concerning learning competency and teaching to assessment, which found that assessments can only improve learning when learning, instruction, and assessments are constructively aligned.

The alignment of instruction and assessment solidifies the learning of students. As Aquino and Gurat (2023) recommended in their study, when teaching MMW, teachers should take into account more creative approaches, especially when it comes to learner-centered (or student-focused) activities. Bangalan and Hipona (2020) also suggested that school administrators should offer teachers a wealth of materials and chances to improve and update their knowledge and abilities to facilitate successful teaching and learning of MMW. As Cabral (2022) recommended, a module is an effective instructional material for self-directed learning – self-paced that fosters metacognition. According to Taban *et al.* (2023), collaborative teaching—especially when there are many instructors in a class—can provide a blending of expertise, complementing personalities, and a fair grading system in MMW. Likewise, Tagalicud and Acosta (2024) proposed that design thinking-based lesson plans may be utilized in the classroom to help students develop their critical thinking, creativity, and problem-solving abilities.

These research articles clearly show that instruction and assessment are vital in the teaching-learning process, however, few and almost none covered assessing the alignment in the context of MMW subject. Consequently, there is no existing research (available on the Internet) that investigates the alignment of curriculum, instruction, and assessment in the MMW subject. Accordingly, the main objective of this study is to investigate if curriculum, instruction, and assessment are aligned in the subject of Mathematics in the Modern World. Specifically, this study aims to: 1) Determine students' performance in Mathematics in the Modern World for the school year 2023-2024; 2) Determine the alignment of curriculum and instruction in Mathematics in the Modern World; 3) Determine the alignment of instruction and assessment in Mathematics in the Modern World; 4) Determine the performance of the students in Mathematics in the Modern World during the last school year 2022-2023 (based on grade); 5) Propose recommendations to ensure alignment of Curriculum - Instruction and Assessment.

METHODOLOGY

Research Design

This study utilized the Qualitative research method, specifically, document analysis and descriptive statistics. Studies utilize document analysis, a qualitative research approach, to methodically study and assess documents—both printed and electronic. With this approach, a variety of materials are analyzed, such as books, newspaper articles, academic journal articles, institutional reports, and books (Morgan, 2022). Also, studies use descriptive statistics for arranging, compiling, and displaying data succinctly and intelligently.

Qualitative document analysis was appropriate for this

study since it is a systematic method of reviewing and assessing the essential documents related to curriculum, instruction, and assessment. The researcher collected and analyzed pre-existing documents such as syllabi, tests, written outputs, performance tasks, grade sheets, and students' evaluations. Consequently, descriptive statistics were used to generate frequency distribution, mean, and standard deviation.

Sources of Data

The documents needed in this study were collected from the researcher's accumulated record from the teaching experience of the subject, MMW (first semester of School Year 2023-2024). Some documents are also collected from previous instructors of the same subject matter (first semester of School Year 2022-2023). These documents include syllabi, tests, written outputs, performance tasks, grade sheets, and students' evaluations.

Consistently, these documents are products of the teaching-learning process of MMW subject in the College of Engineering and Information Technology (CEIT) of Kalinga State University (KSU). This college has six programs under it namely Bachelor of Science in Agricultural and Biosystem Engineering; Bachelor of Science in Civil Engineering; Bachelor of Science in Computer Engineering; Bachelor of Science in Electrical Engineering; Bachelor of Science in Information Technology; and Bachelor of Science in Mathematics. These documents will not exist without the outputs submitted and compiled by the students of these programs.

Table 1: Documents Retrieved

Documents	Frequency	Percent
Syllabus	1	4%
Table of Specifications	2	8%
Module	2	8%
Handouts	6	23%
Activity/Task/Problem Set	9	35%
Quiz	4	15%
Examination Paper	2	8%
Total	**26**	**100%**

Data Analysis

Given that this study's objectives are entirely qualitative, descriptive statistics will be applied to the collected data. To expound the first and fourth research objectives, data treatment used descriptive statistics such as mean grade, median, mode in the subject, or mean score in the recorded activities/quizzes/tests of students – with the Shapiro-Wilk test. The second and third objectives utilized binary ratings in the adopted criteria checklist (with Qualitative Description – evident and not evident, exist and non-existence, ✓ and ✗) and literature review. The adopted criteria checklist includes Webb's (1997) framework on alignment of assessment tools, Wiggins and McTighe's (2005) format of instructional design, and Smith's (2012) criteria for aligning curriculum materials. Finally, the fifth objective used a literature review of the different resources (Internet articles/studies) to propose recommendations.

RESULTS AND DISCUSSION

Students' Performance in Mathematics in the Modern World for the School Year 2023-2024

The academic achievement of CEIT students in Mathematics in the Modern World is shown in this part, which is relevant to explaining the study's first objective. The results of the test of normality and descriptive statistics are shown in the following tables.

Table 2: KSU Grading System

Numerical Grade	Percentage Equivalent
1.00	98-100
1.25	95-97
1.50	92-94
1.75	89-91
2.00	86-88
2.25	83-85
2.50	80-82
2.75	77-79
3.00	75-76
5.00	74 and below (Failed)
INC	Incomplete
OD	Officially Dropped

Source: Article 18, Section 2 of KSU Operational Manual (2017 Edition)

Using the grading system of KSU (KSU, 2017) presented in Table 2, it means that 1.00-1.25 is excellent;1.50-1.75 is very satisfactory; 2.00-2.25 is satisfactory; 2.50-2.75 is fairly satisfactory; 3.00 just passed; 5.00 is failed; INC could pass given that grade generated after submission of missing outputs cut to 3.00 and above; and OD is dropped.

Table 3: Students' Performance (based on Grades) in MMW

Statistical Measures	Values	Interpretation
Mean	2.768	Fairly Satisfactory
Median	2.500	Satisfactory
Mode	3.000	Passed
Skewness	1.476	Extremely High Positive Skewness
Standard Error of Skewness	0.145	
Shapiro-Wilk	0.780	Skewed Distribution
Shapiro-Wilk (P-value)	0.000 < 0.05	

Table 3 reveals the performance of first-year engineering college students in the subject MMW. This performance is based on their final grade (the grade that appears in their record).

The academic accomplishment of first-year college students in MMW spans from passing to satisfactory performance, as implied by the mean (2.768), median (2.50), and mode (3.00). With this sort of result, Shapiro-Wilk and Skewness were used to perform a normality test. The student performance is extremely positively skewed, as indicated by the quotient of 10.179 (a very long right tail), which was calculated using the ratio of skewness value of 1.476 and the standard error of skewness of 0.145. This indicates that the students' mean grade performance (2.768) is higher than the median grade (2.50). Using the Shapiro-Wilk test, a similar result was obtained, showing a skewed distribution of students' grades with a calculated value of 0.780 (p-value <0.05). A positive skewness score shown by the students' performance suggests that MMW academic performance (based on grades) is not normally distributed.

The same finding was found in the study of Roman and Villanueva (2019) on competency acquisition, difficulty, and performance of students in MMW. They reported a positively highly skewed and not normally distributed student performance (based on grades). On the contrary, Navida (2022) in his study on mathematics anxiety, conception, and performance of freshmen students indicated an approximately normal distribution of students' grades in MMW.

Meanwhile, by focusing on the academic grades of students, the mean grade of 2.768 falls between the percentage bracket 77-79 (Table 2). Several studies have close results, such as Morilla *et al.* (2020) with a mean grade of 2.01; Remo (2019) with a mean grade of 2.00; Labo (2022) with a grade range of 86-94; Yap *et al.* (2024) with 80–84 grade range; Bangalan and Hipona (2020) with most frequent grades 2.50. These imply that students perform at a satisfactory level in the MMW subject.

Moreover, Table 4 presents the mean scores of CEIT students in their different academic requirements.

Table 4: Students' Performance (based on Academic Requirements) in MMW

Statistical Measures	Activity	Quiz	Projects	Midterm Exam	Final Exam
Mean	65.49	68.03	82.71	47.37	47.85
Median	66.00	70.00	87.00	45.00	46.67
Mode	57.02	70.00	80.00	47.62	40.00
Skewness	-0.952	-1.276	-4.483	.661	.285
Standard Error of Skewness	.145	.145	.145	.145	.145
Shapiro-Wilk	0.955	0.909	0.485	0.969	---
Shapiro-Wilk (P-value)	0.000 < 0.05	0.000 < 0.05	0.000 < 0.05	0.000 < 0.05	---

Concerning mean scores, it can be noted that projects (82.71) have the highest mean, almost near 100, followed by the mean score in the quiz (68.03) then activity (65.49), and examinations midterm=47.37 and final=47.85) have the lowest. Considering these results, it can be concluded that students' performance in the different academic requirements is good except for poor examinations.

Comparing the values concerning scores in activity, quiz, project, and midterm exam, findings show not normally distributed scores except final exam scores since it is approximately normal. This conclusion is made by looking at the values of Shapiro-Wil and Shapiro-Wilk (P-value). Meanwhile, based on the mean, median, and mode, it can be noted that values are closed in the quiz (mean=68.03; median=70; mode=70) and midterm examination (mean=47.37; median=45; mode=47.62), however, the test of normality still implies scattered scores. On scores of the final examination, mean (47.85), median (46.67), and mode (40) seem to imply that scores are scattered but the ratio of skewness to its standard error is 1.97 which is still between -2 to +2 requirement. It is thus believed that this value is sufficient to demonstrate a normal univariate distribution (George & Mallery, 2010).

To attest to the normality and non-normality of the distribution, the following figures are presented.

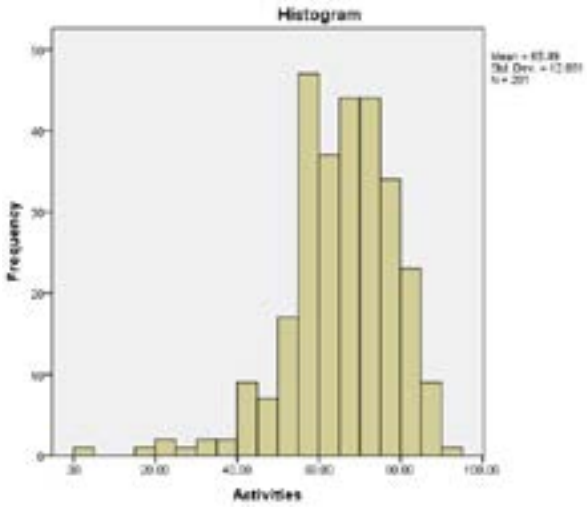

Figure 1: Distribution of Scores in Activities

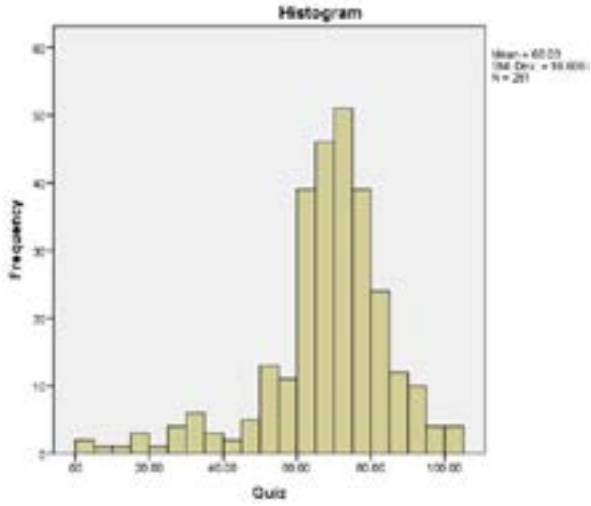

Figure 2: Distribution of Scores in Quizzes

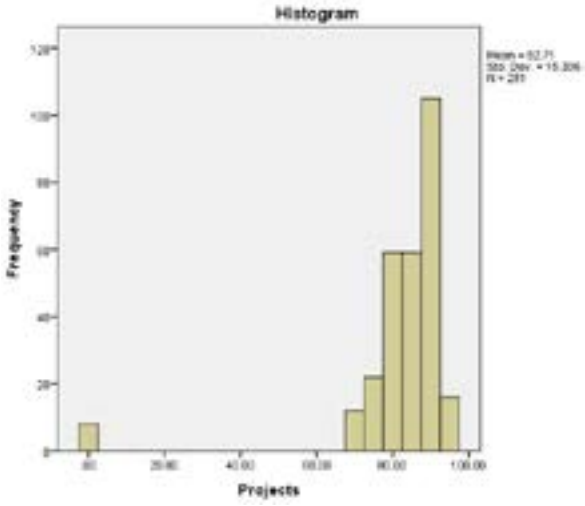

Figure 3: Distribution of Scores in Projects

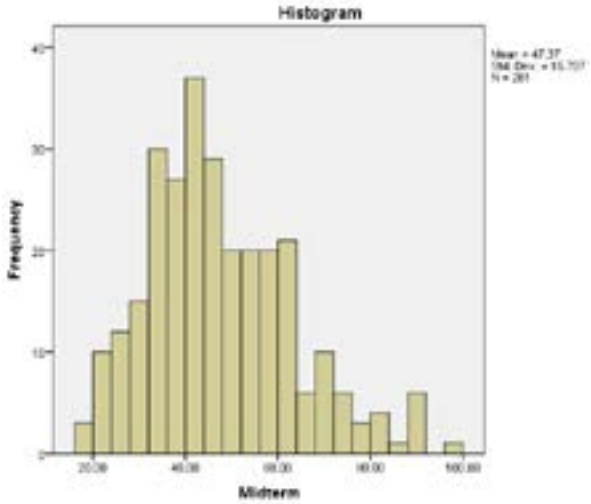

Figure 4: Distribution of Scores in Midterm Examination

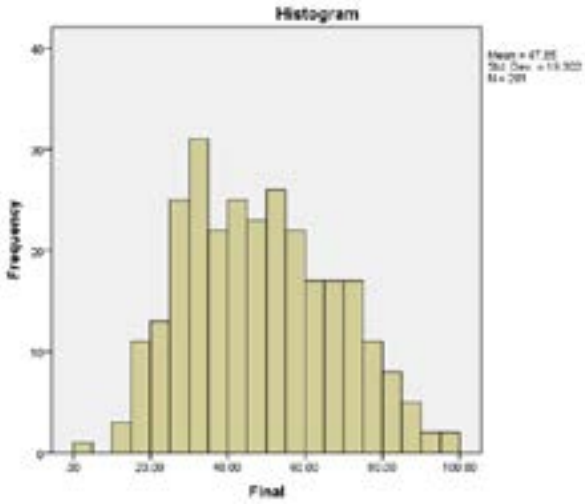

Figure 5: Distribution of Scores in Final Examination

Alignment of Curriculum and Instruction in Mathematics in the Modern World

An educational institution needs to demonstrate genuine care for the quality of service and education provided to its students and provide proof of its attempts to accomplish this goal. The curriculum must be organized to serve and actualize the school's philosophy, vision, mission, and objectives, in addition to meeting Department of Education regulations. The school should utilize modern teaching tools and resources sparingly. In addition to adapting to the subject matter, teaching styles and approaches should take into account the students' developmental requirements.

To assess the alignment of curriculum (in the form of syllabus) and instruction (in the form of teaching/learning activities), the following tables are organized. Table 5, in particular, presents the alignment of intended learning outcomes (ILOs) of the MMW syllabus to the general education outcomes stated in the CHED (2013b) memo for general education subjects.

Table 5: Syllabus ILOs Alignment to GE Outcomes

General Education Outcomes (CHED, 2013b)		**Evident or Not Evident**	**Syllabus Intended Learning Outcomes (ILO) for MMW**
Category	**Competencies**		
Intellectual Competencies	• Higher levels of comprehension (textual, visual, etc.)	Evident ILOs 6,8,9,12, 13,17,20	6. Argue about the nature of mathematics, what it is, how it is expressed, represented, and used
	• Proficient and effective communication (writing, speaking, and use of new technologies)		8. Discuss the language, symbols, and conventions of Mathematics

	• Understanding of basic concepts across the domains of knowledge		9. Explain the nature of Mathematics as a language.
	• Critical, analytical, and creative thinking		12. Use different types of reasoning to justify statements and arguments made about mathematics and mathematical processes
	• Application of different analytical modes (quantitative and qualitative, artistic and scientific, textual and visual, experimental, observation, etc.) in tackling problems methodically		13. Write clear and logical proofs.
			17. Use the method of linear regression and correlations to predict the value of a variable given certain conditions.
			20. Create the Euler path and Euler circuit.
Personal and civic responsibilities	• Appreciation of the human condition	Evident ILOs 6,8,9,12, 13,17,20	5. Articulate the importance of mathematics in one's life
	• Capacity to personally interpret the human experience		7. Express appreciation for mathematics as a human endeavor
	• Ability to view the contemporary world from both Philippine and global perspectives		11. Acknowledge that Mathematics is a useful language.
	• Self-assuredness in knowing and being Filipino		15. Respect one's method and approaches for proving and solving problems.
	• Capacity to reflect critically on shared concerns and think of innovative, creative solutions guided by ethical standards		18. Advocate the use of statistical data in making important decisions.
	• Ability to reflect on moral norms/ imperatives as they affect individuals and society		21. Support the use of mathematics in various aspects and endeavors in life.
	• Ability to appreciate and contribute to artistic beauty		
	• Understanding and respect for human rights		
	• Ability to contribute personally and meaningfully to the country's development		
Practical skills	• Working effectively in a group	Evident ILOs 4,10,14, 16,19	4. Identify patterns in nature and regularities
	• Application of computing and information technology to assist and facilitate research		10. Perform operations on Mathematical expressions correctly.
	• Ability to negotiate the world of technology responsibly		14. Solve real-life problems involving patterns and recreational problems following Polya's four steps.
	• Problem-solving (including real-world problems)		16. Use a variety of Statistical tools to process and manage numerical data.
	• Basic work-related skills and knowledge		19. Solve basic mathematics-related problems in finance.

As conveyed in Table 5, the three major GE outcomes – 1) Intellectual Competencies; 2) Personal and Civic Competencies; and 3) Practical Responsibilities are evident in the ILOs of the MMW syllabus. This infers that the GE outcomes are reflected in the ILOs of the MMW syllabus. Considering the 21 ILOs written in the syllabus except the first three since this relates to the university's orientation, they were mapped to present what particular GE outcomes they characterize. The remaining 18 ILOs are concerned with the subject matter and as revealed, ILOs 6,8,9,12,13,17, and 20 are aligned with intellectual competencies, ILOs 5,7,11, 15,18, and 21 are aligned with personal and civil responsibility competency, and ILOs 4,10,14, 16, and 19 are aligned with practical skills. This result implies that the syllabus's objectives seemed to have been crafted and arranged according to the course's subject requirements (GE outcomes), with a focus on themes that were ostensibly related to knowledge improvement, personal and national development, and real-world concerns.

Curriculum and instruction ensure that the teaching-learning process is focused on providing an education that is effective, relevant, and responsive. Wotring *et al.* (2021) cited that there are two types of syllabus orientations: process-oriented syllabuses that guide "the learning experiences themselves," and product-oriented

syllabuses that concentrate on "knowledge and skills." Hence, justification for the teaching-learning process is provided by the instructor's enactment of the syllabus. Additionally, Cipriano (2023) recommended that the subject matter must be thoroughly reviewed to develop worthwhile teaching strategies.

After it has been demonstrated that the ILOs in the syllabus are in line with the GE objectives provided by CHED, Table 6 shows the alignment of ILOs and classroom teaching/learning activities.

Table 6: Classroom Instruction Alignment to Syllabus ILOs

Intended Learning Outcomes (ILO) **At the end of the lesson, the students are expected to…**	**Assessment Tasks**	**Evident or Not Evident**
Section 1- Nature of Mathematics		
• Identify patterns in nature and regularities	Lectures and class discussions on the different kinds of patterns and applications.	Evident
• Articulate the importance of mathematics in one's life	Recitation on patterns students encountered in their daily lives.	
• Argue about the nature of mathematics, what it is, how it is expressed, represented, and used	Unit quiz	
• Express appreciation for mathematics as a human endeavor		
Section 2- Speaking Mathematically		
• Discuss the language, symbols, and conventions of Mathematics	Lectures and class discussions on mathematical symbols, translating mathematical sentences/ phrases into symbols and vice versa.	Evident
• Explain the nature of Mathematics as a language.	Oral recitation on translating mathematical sentences/phrases into symbols and vice versa.	
• Perform operations on Mathematical expressions correctly.	Individual problem-solving on finding the value of the unknown using the property of equality.	
• Acknowledge that Mathematics is a useful language.		
Section 3. Problem Solving and Reasoning		
• Use different types of reasoning to justify statements and arguments made about mathematics and mathematical processes	Lectures and class discussions on deductive and inductive reasoning, proof, and Polya's problem-solving strategy.	Evident
• Write Clear and logical proofs.	Reporting (with small group problem-solving and peer teaching) on the different types of problem-solving strategies.	
• Solve real-life problems involving patterns and recreational problems following Polya's four steps.	Individual problem-solving using 4-step Polya's strategy and the different problem-solving strategies.	
• Respect one's method and approaches for proving and solving problems		
Section 4- Mathematics as a Tool (Part 1) Data Management		
• Use a variety of Statistical tools to process and manage numerical data.	Lectures and class discussions on the different measures (tendency, position, and dispersion)	Evident
• Use the method of linear regression and correlations to predict the value of a variable given certain conditions.	Interactive recitation in identifying what measure is applied or to be applied to data.	
• Advocate the use of statistical data in making important decisions.	Small group problem-solving and peer teaching using MS Excel for data processing.	
The Mathematics of Finance and The Mathematics of Graphs		
• Solve basic mathematics-related problems in finance.	Lectures and class discussions on simple, compound interest, stocks, bonds, graphs, and Euler circuits.	Evident
• Create the Euler path and Euler circuit.	Recitation on drawing the Euler path.	

Individual problem-solving on simple interest and compound interest.	Unit Quiz	
Small group problem-solving and peer teaching by exploring and using the Euler Formula		

As appeared in Table 6, the ILOs are evident in the classroom instruction planned by the instructor. Each section (major topics) has ILOs with their corresponding teaching/learning activities. The most commonly used instructions are direct instruction (lecture and class discussion), recitation, individual problem-solving, small group and peer teaching, reporting and sharing, and unit quiz activity. The instructor believed that these instructions were necessary for the attainment of the ILOs, hence these are included. For instance, Section 1 objectives, "Identify patterns in nature and regularities" and "Argue about the nature of mathematics, what it is, how it is expressed, represented, and used" will be achieved when lecture/class discussion and unit quiz activity are to be used. Similarly, objectives, "Articulate the importance of mathematics in one's life" and "Express appreciation for mathematics as a human endeavor" are acquired when oral recitation (sharing) is employed as a mode of classroom instruction.

When it comes to the structure and execution of courses in higher education, the curriculum is crucial and is frequently seen as directing or influencing classroom activities (Wotring *et al.*, 2021). Also, according to Kim *et al.* (2019), the secret to preserving a positive learning environment in the classroom is to offer students high-quality classroom instruction that is aligned with their individual ability levels. Relatively, when the teaching-learning process is supported by the appropriate classroom evaluation, student performance, and the actual learning process are effectively described (Abejuela *et al.*, 2022; Balagtas, 2021; Baliber & Sañosa, 2022).

Alignment of Instruction and Assessment in Mathematics in the Modern World

This section presents the alignment of instruction and assessment in MMW subject. It is important to assess the alignment of these two to conclude later if curriculum, instruction, and assessment are aligned. One great thing about assessment is that it gives teachers the information they need to adjust or enhance their instruction. Similarly, assessment data may be used for curriculum revision and updating. At its finest, effective assessment offers useful data to guide decisions about curriculum and teaching and permits real-time revisions to better serve the needs of students.

To get a picture of how assessment tasks/materials aligned with instruction, the following findings are presented. Particularly, Table 7 shows the affiliation of assessment tasks to the teaching/learning activities.

Table 7: Alignment of Instruction and Assessment Tasks

Intended Learning Outcomes (ILO) **At the end of the lesson, the students are expected to…**	**Instruction** **Teaching/ Learning Activities**	**Evident or Not Evident**
Section 1- Nature of Mathematics		
Lectures and class discussions on the different kinds of patterns and applications.	Activities/ Assignments Seatwork	Evident
Recitation on patterns students encountered in their daily lives.	Oral Recitation (Interactive small quizzes)	
Unit quiz	Unit Quiz	
Section 2- Speaking Mathematically		
Lectures and class discussions on mathematical symbols, translating mathematical sentences/phrases into symbols and vice versa.	Seatwork Homework	Evident
Oral recitation on translating mathematical sentences/phrases into symbols and vice versa.	Oral Recitation (Interactive - 4-pics one word)	
Individual problem-solving on finding the value of the unknown using the property of equality.	Unit Quiz	
Section 3. Problem Solving and Reasoning		
Lectures and class discussions on deductive and inductive reasoning, proof, and Polya's problem-solving strategy.	Exercises/Activities Seatwork	Evident
Reporting (with small group problem-solving and peer teaching) on the different types of problem-solving strategies.	Group Reporting with interactive small quizzes/ recitation	
Individual problem-solving using 4-step Polya's strategy and the different problem-solving strategies.	Unit Quiz (Problem set)	

Section 4- Mathematics as a Tool (Part 1) Data Management		
Lectures and class discussions on the different measures (tendency, position, and dispersion)	Activities Seatwork	Evident
Interactive recitation in identifying what measure is applied or to be applied to data.	Group Recitation (Mystery box)	
Small group problem-solving and peer teaching using MS Excel for data processing.	Unit Quiz (Data Processing in Excel)	
The Mathematics of Finance and The Mathematics of Graphs		
Lectures and class discussions on simple, compound interest, stocks, bonds, graphs, and Euler circuits.	Activities Seatwork	Evident
Recitation on drawing the Euler path.	Individual Recitation (Draw Path)	
Individual problem-solving on simple interest and compound interest.	Unit Quiz	
Small group problem-solving and peer teaching by exploring and using the Euler Formula		

As presented in Table 7 each of the MMW topics has corresponding teaching/learning activities and by the end or during the learning process there are assessment tasks that are expected to be completed by the students. The alignment of assessment tasks to classroom instruction is evident in every MMW topic. For example in sections 1, 2, and 5, the lecture has a corresponding task in the form of Activities/Assignments/Seatwork, and the interactive instruction is done through oral recitation and unit quiz. In sections 3 and 4, the same instruction and assessment were utilized but a modification in the interactive instruction since reporting and group recitation were utilized.

To encourage classroom discussions and subjects related to the students' real mathematics learning targets specified in the course objectives, course planners and instructors should carefully consider the choices they make about classroom instruction. To achieve this according to Roman and Villanueva (2019), it is advised to use technology-related tools to enhance the instruction. Classroom instruction and summative assessments must be appropriate in the realization of the learning competencies (Urbano, 2020).

The relevance of instruction and assessment to 21st-century learning competencies was assessed by how many times the competency skills (in terms of keywords) were mentioned in the teaching/learning activities in the syllabus and included (measured) in the analyzed documents. To present this assessment, Table 8 is constructed.

Table 8: Relevance of Teaching/ Learning Activities and Assessment to the 21st Century Learning Competencies

Key Competency Skills	**Teaching/ Learning Activities**			**Assessment**		
	Keywords	**f**	**%**	**Assessment Task**	**f**	**%**
Critical Thinking	Individual problem-solving, problem set	6	100%	Discuss ideas; Translating phrases to mathematical expressions; Problem-solving using strategies;	15	100%
Collaboration	Small interactive quizzes, peer teaching, group recitation	4	67%	Create a presentation of the problem-solving strategy you are assigned; Discuss the implication of the result among your groupmates; Discuss your answer with your seatmate/groupmate.	5	33%
Communication	Oral recitation, reporting, interactive recitation	4	67%	Communicate your idea; Discuss how you can apply graph theory in your field; Discuss the problem-solving strategy you choose.	5	33%
Creativity and Innovation	Drawing/ constructing, oral recitation	4	67%	Draw a road to a big city; Draw a path of a circuit; Make a photo essay on the things around you that represent Fibonacci; Construct an essay.	5	33%
Self-Direction	Unit quiz, individual problem-solving	5	83%	Explore different strategies in problem-solving; Complete all quizzes, activities, and tests.	15	100%

Global Connections	Group work	3	50%	Cite examples of patterns in nature; Calculate simple and compound interest using different currencies (dollar, peso, euro, yen, etc.); Cite examples/applications.	5	33%
Local Connections	Group work, peer teaching	3	50%	Document patterns you found in your locality; Cite examples/applications.	5	33%
Using Technology as a Tool for Learning	Data processing in Excel, reporting through PPT	2	33%	Watch and critique the given video; Perform data processing (mean, median, mode, standard deviation, variance, and range) using MS Excel; Present using PPT.	3	20%

The teaching/learning activities as revealed in Table 8 were analyzed by patterning the keywords about the 21st-century skills stated in the Ohio Department of Education (2016). The keywords were mentioned in the syllabus and were arranged concerning the skills they described. Of the six major topics of MMW, critical thinking (100%) is present in all the teaching/learning activities incorporated in every topic; self-direction is 83% present; collaboration, communication, creativity, and innovation are 67% present; global and local connections are 50% present; and using technology as a tool for learning is only 33% present. This means that students' use of ICT tools as a tool for learning is limited. The learning process provides a limited opportunity for ICT-student engagement and could also limit their technological skill. The same finding emerged in the study of Abejuela *et al.* (2022). They also found that competency skill related to technology has the lowest number of program outcomes.

Meanwhile, in the assessment task, the study analyzed all the assessment materials to generate frequency and percentage. The assessment tasks were organized according to the skills they measured and this was done with the help of the study of Mugot and Sumbalan (2019). A guide in determining what particular assessment task falls under the different key competency skills is included in their study. Considering that there are a total of 26 documents subjected to analysis, only 15 of them are assessment materials. Given the frequency of 15 (100%), critical thinking skills and self-direction skills were tested in all the assessment tools (activity/task/problem sets, quizzes, and examinations). The skills related to collaboration, communication, creativity, and innovation, global, and local connections were measured in 5 (33%) materials. The skill related to using technology as a tool for learning was tested in 3 (20%) documents.

When constructing an assessment, it's important to consider more than just choosing the right resources or having just items that are aligned, as these decisions don't reveal how effectively the assessment as a whole evaluates the student's achievement of all learning goals. Under the most severe circumstances, every assessment material may be linked to just one competency, leaving the other competencies untested. Technology-related skills, for instance (as presented in Table 8), included the fewest assessment resources. Therefore, it is and should be given greater emphasis when two components of an educational system are in alignment because alignment indicates, among other things, how well an assessment evaluates every standard.

In order to effectively chart students' progress over time, assessments need to be in line with the curriculum. To verify this, there are criteria that the assessment materials need to meet certain level of agreements for an acceptable standard of alignment according to Webb (1997). He explained that this phase was to ascertain which evaluation materials really measured student performance and whether they were in line with the stated assessment goals. This study, however, only presents the existence of alignment and not the levels of agreement. Also, several of the criteria that were initially included in the Webb analysis (Actual Instruction, Use of Technology, Equity and Fairness, and System Applicability) were eliminated since the evaluation was centered on the assessment materials and did not directly relate to the alignment of the documents. Table 9 presents the alignment of documents guided by Webb's criteria.

Table 9: Existence of Alignment for MMW Assessment Tools According to Webb Framework

Criteria		**Assessment Tools Used in MMW**			
		Activities	**Quizzes**	**Projects**	**Midterm/Final Exam with TOS**
1A	Categorical concurrence	E	E	E	E
1B	Depth of knowledge consistency	E	E	E	E
1C	Range of knowledge tested	E	E	E	E
1D	Balance of representation	E	E	E	E
2	Cumulative growth in procedural knowledge	E	E	E	E

Source: Criteria adapted from Webb (1997), Legend: E (Exist); NE (Non-Existent)

As revealed in Table 9, all criteria – categorical concurrence, depth of knowledge consistency, range of knowledge tested, balance of representation, and cumulative growth in procedural knowledge included in the Webb framework exist in all the assessment materials analyzed in this study. The first criteria mean that every skill is tested and Table 8 makes this clear by providing comparable testing materials for each skill. The second criterion refers to cognitive (knowledge) which exists and is evident in the assessment task (Table 8) for critical thinking skills. The third to fifth criteria involve showing knowledge of all assessment tasks, uniform importance of assessment tasks, and increasing difficulty of assessment activities. These are all evident in Table 8 – it shows that assessment tasks are after knowledge development, and it is balanced since all competency skills were mapped with tasks. Meanwhile, the growing complexity of the tasks is very evident in examinations since items are arranged from easiest to most difficult. This is usually transparent in the distribution of items according to test types and learning domains.

To give an example of these alignments, the distribution of items of the examinations which is apparent in the Table of Specifications (TOS) is displayed. Remember that instructors made their TOS to properly measure the domains of learning.

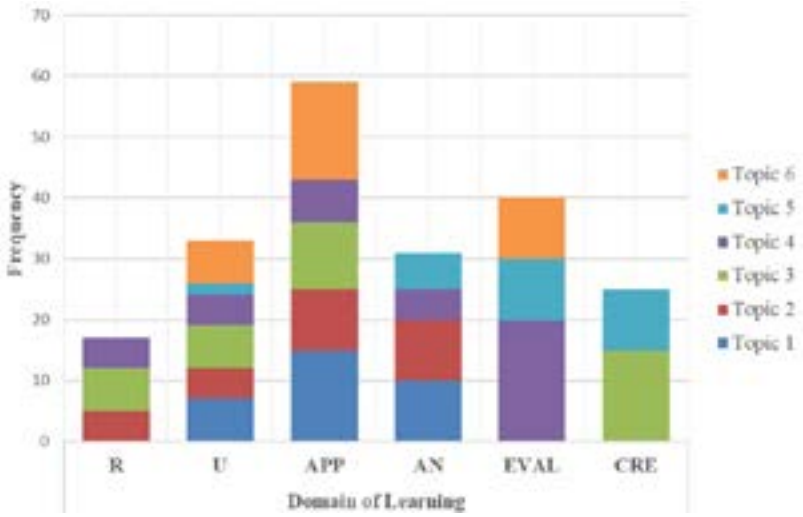

Figure 6: Distribution of Items in the Midterm and Final Exam

Figure 6 displays the careful distribution of test items in the six domains of learning. The midterm examination covers the first three topics and is composed of 105 items while the final examination deals with topics 4, 5, and 6, and is composed of 100 items. It can be noted that the distribution of test items per topic does not cover all the learning domains. This is because the topic has a certain domain that it measures and it is possible that not all domains can be tested by a single topic. For instance, topic 1 only has items mapped to understanding (R), application (APP), and Analysis (AN). Since the nature of the first topic is on patterns, numbers, Fibonacci, and applications to the real world, the distribution to these domains is deemed appropriate. Likewise, topics 3 to 6 have items mapped to evaluation (EVAL) and creating (CRE) domains since the nature of the topics requires evaluation and creation of the problem-solving process, reasoning, and interpretation,

One resource that educators may utilize to bolster their professional judgment when developing or choosing tests for their students is a TOS. To assist instructors in connecting planning, instruction, and assessment, the TOS can be utilized in conjunction with lesson and unit preparation. According to Fives and DiDonato-Barnes (2013), teacher alignment of objectives, teaching, and assessment is facilitated by the use of a TOS, often known as a test blueprint. As implied, TOS supports the completion of learning and acquisition of learning objectives.

In addition to this, Table 10 displays a sample of the mapping of assessment tools. To give a clearer view of what particular assessment tools/tasks (with the desired outcomes) in every topic were utilized in the teaching of MMW, the following findings are presented

Table 10: Sample of Mapping and Aligning Assessment Tools

Outputs/ Performance Task	**ILOs**	**Formative Assessment**	**Teaching/ Learning Activities**
Topic 1 Photo-Essay	• Identify patterns in nature and regularities	✓ Photo-Essay rubric	Lectures and class discussions on the different kinds of patterns and applications.

	• Articulate the importance of mathematics in one's life	✓ Reflection	Recitation on patterns students encountered in their daily lives.
	• Argue about the nature of mathematics, what it is, how it is expressed, represented, and used		Unit quiz
	• Express appreciation for mathematics as a human endeavor		
Topic 2 Problem Set	• Discuss the language, symbols, and conventions of Mathematics	✓ Oral Recitation ✓ Rubric for the solution	Lectures and class discussions on mathematical symbols, translating mathematical sentences/phrases into symbols and vice versa.
	• Explain the nature of Mathematics as a language.		Oral recitation on translating mathematical sentences/phrases into symbols and vice versa.
	• Perform operations on Mathematical expressions correctly.		Individual problem-solving on finding the value of the unknown using the property of equality.
	• Acknowledge that Mathematics is a useful language.		
Topic 3 Reporting	• Use different types of reasoning to justify statements and arguments made about mathematics and mathematical processes	✓ Reporting Rubric ✓ Use of technology-related materials ✓ Quiz	Lectures and class discussions on deductive and inductive reasoning, proof, and Polya's problem-solving strategy.
	• Write Clear and logical proofs.		Reporting (with small group problem-solving and peer teaching) on the different types of problem-solving strategies.
	• Solve real-life problems involving patterns and recreational problems following Polya's four steps.		Individual problem-solving using 4-step Polya's strategy and the different problem-solving strategies.
	• Respect one's method and approaches for proving and solving problems		
Topic 4 Completed Excel Data	• Use a variety of Statistical tools to process and manage numerical data.	✓ Rubric ✓ Quiz ✓ Excel file	Lectures and class discussions on the different measures (tendency, position, and dispersion)
	• Use the method of linear regression and correlations to predict the value of a variable given certain conditions.		Interactive recitation in identifying what measure is applied or to be applied to data.
	• Advocate the use of statistical data in making important decisions.		Small group problem-solving and peer teaching using MS Excel for data processing.
Topic 5 Problem Set	• Solve basic mathematics-related problems in finance.	Rubric for the solution Quiz	Lectures and class discussions on simple, compound interest, stocks, bonds, and graphs.
			Individual problem-solving on simple interest and compound interest.
Topic 6 Map/ Path Coloring	• Create the Euler path and Euler circuit.	Map coloring rubric Reflection	Recitation on drawing the Euler path.
	• Support the use of mathematics in various aspects and endeavors in life.		Small group problem-solving and peer teaching by exploring and using the Euler Formula

Format is adapted from the Instructional Design of Wiggins and McTighe (2005)

Table 10 is an example of instructional design (Wiggins and McTighe, 2005) which means that even before teaching-learning takes place, the teacher could map or align his/her desired outcome/performance tasks by the use of this tool (mapping backward). In the case of the MMW subject, the researcher organized the sample of expected outputs of the assessment materials according to the syllabus ILOs and classroom activities. Since the MMW syllabus already includes the teaching/learning activities and assessment tasks, it is not difficult to organize the sample of desired outputs. As presented, the assessment outcomes are aligned with instruction and curriculum. This illustrates how curriculum and teaching are driven by assessment.

To further understand the alignment of curriculum, instruction, and assessment, Table 11 presents not only the alignment of assessment materials but all curriculum materials subjected to analysis in this study.

Table 11: Alignment of MMW Curriculum Materials

Criteria	Syllabus	TOS	Module	Handouts	Activity/ Task/ Problem Set	Quiz	Exam Papers
Are the ILOs of the curriculum addressed?	✓	✓	✓	✓	✓	✓	✓
Do the curriculum materials support the ILOs?	✓	✓	✓	✓	✓	✓	✓
Is there an identification and maintenance of a sense of purpose toward the intended learning goals?	✓	✓	✓	✓	✓	✓	✓
Do the curriculum materials take into account student ideas on mathematics literacy?	✓	✓	✓	✓	✓	✓	✓
Does the material engage students with the ILOs?	✓	✓	✓	✓	✓	✓	✓
Does the intended curriculum develop and use mathematics literacy?	✓	✓	✓	✓	✓	✓	✓
Does the intended curriculum promote student thinking about mathematics literacy?	✓	✓	✓	✓	✓	✓	✓

Source: Criteria patterned from Smith (2012)

As revealed in Table 11, the seven criteria according to Smith (2012) ensure the alignment of the curriculum, instruction, and assessment. This criteria, according to Smith (2012) is an avenue to verify alignment with the intended outcomes of a course program. Findings show that all the curriculum materials analyzed in this study were aligned with the seven criteria. It should be noted from this result that a binary choice is used (✓ and ✗) with no distinct Likert scale. Since the materials undoubtedly answer the criteria then a check (✓) mark is put on the boxes.

The purpose of a curriculum may be to teach students the value of various problem-solving techniques, and it may include a variety of teaching methods (instruction). However, the way the curriculum is taught can be influenced by the variety of curriculum materials (syllabus, handouts, modules, etc.) that are used to support the learning objectives as a whole. Similarly, when assessment is used effectively, it may act as a strong catalyst to enhance curriculum and instruction, which in turn helps the teaching-learning process (Baliber & Sañosa, 2022; Cabral, 2022; Urbano 2020, Wotring *et al.*, 2021).

Performance of the Students in Mathematics in the Modern World During the Last School Year 2022-2023

After having found that the MMW curriculum, classroom instruction, and assessment are aligned, the following results are presented to make implications.

Table 12: Students' Performance in MMW for S.Y. 2022-2023

Statistical Measures	Values	Interpretation
Mean	3.290	Passed
Median	2.750	Fairly Satisfactory
Mode	5.000	Failed

Skewness	0.622	High Positive Skewness
Standard Error of Skewness	0.145	
Shapiro-Wilk	0.779	Skewed Distribution
Shapiro-Wilk (P-value)	0.000 < 0.05	

As presented in Table 12, the academic accomplishment of first-year college students in MMW (S.Y. 2022-2023) spans from failed to satisfactory performance, as implied by the mean (3.290), median (2.75), and mode (5.00). Given this result, Shapiro-Wilk and Skewness were used to perform a normality test. The student performance is positively highly skewed, as indicated by the quotient of 4.290 (a long right tail), which was calculated using the ratio of skewness value of 0.622 and the standard error of skewness of 0.145. This indicates that the students' mean grade performance (3.290) is higher (passing grade) than the most frequently occurring grade (5.00). Using the Shapiro-Wilk test, a similar result was obtained, showing a skewed distribution of students' grades with a calculated value of 0.779 (p-value <0.05). This positive skewness score shown by the students' performance suggests that MMW academic performance (based on grades) is not normally distributed.

Given this finding, it can be noted that the mathematics performance last school year was low despite having found from the previous discussions that the MMW syllabus, teaching/learning, and assessment tasks are aligned. Despite having covered all the topics in the syllabus, the performance is still low. This result may have been impacted by the mastery of students. According to Bangalan and Hipona (2020), students find the MMW subject challenging which affects their mastery and perception. They further mentioned some problems encountered such as difficulty in understanding the topics, difficulty in solving, and too many topics. This finding is seconded by Urbano (2020), when he mentioned that the educational system includes too many learning competencies to cover in the curriculum.

Additionally, according to the results, students may comprehend the subjects being covered, but there were unexpected difficulties when certain topics (especially the last parts) were covered quickly and the students needed assistance to fully understand the lessons. It can be inferred that despite having met the alignment requirements of curriculum, instruction, and assessment, the pace at which instructors discuss the topics is too fast for the students hence resulting in poor mastery. Labo (2022) and Ellvan and Edig (2022) also found in their study that despite having "very good" student performance in MMW, several challenges affected the students one of which was, that the instructor discussed the lessons too quickly.

Recommendations to Ensure Alignment of Curriculum - Instruction and Assessment

This section covers the recommendations for ensuring alignment in curriculum, instruction, and assessment in mathematics education, specifically for Mathematics in the Modern World. Based on the various research articles about MMW and aligning of curriculum, instruction, and assessment, the following recommendations are listed:

1. To make document analysis unbiased and for effective evaluation, educators should develop a constructive alignment matrix that includes a rubric and a checklist for assessing documents (Abejuela *et al.*, 2022; Baliber & Sañosa, 2022; Morgan, 2022; Smith 2012; Wotring *et al.*, 2021).

2. In light of the curriculum (syllabus), review and revise the approaches for managing various course programs. The MMW course is a GE subject and broad in scope, but it needs to be tailored to the individual student program, especially when it comes to providing exercises and example problems (Yap *et al.*, 2024).

3. Invest in high-quality aligned instructional materials (Abejuela *et al.*, 2022; Cabral, 2022; Remo, 2019; Roman, & Villanueva, 2019; Taban *et al.* 2023; Urbano, 2020; Yap *et al.*, 2024). There are many excellent alternative materials available that, if chosen, will influence education for many years to come in school systems.

4. Ensure that professional development is anchored in high-quality instruction and teaching resources (Balagtas 2021; Navida, 2022). Higher education institutions must design professional development programs in accordance with the curriculum to ensure that teachers are equipped to teach the subject matter in any kind of classroom.

5. Construct a College Readiness Test in line with Mathematics. Schools may ensure that their incoming college students are prepared to pursue advanced mathematics courses by creating exam questions that are in line with the general goals of higher education.

CONCLUSION

The following conclusions were made in light of the salient findings of this study:

1. The CEIT students achieved satisfactory academic achievement in MMW. Even though they had a not-so-good performance in the different academic requirements, it did not affect their final grade. This is because only the examinations have below half the passing scores and the accumulated performance still resulted in a satisfactory grade.

2. Alignment is evident in the syllabus ILOs and GE outcomes. Also, alignment exists in teaching-learning activities and ILOs.

3. There is alignment between teaching-learning activities and assessment tasks/materials employed and administered by the MMW instructors.

4. Performance of students in MMW subject during the school year 2022-2023 only achieved a passing mark.

This performance is lower than the school year 2022-2023 despite having found an alignment between curriculum, instruction, and assessment. Such a result was affected by several factors.

5. After a literature review regarding MMW and alignment of curriculum, instruction, and assessment, the study proposed some recommendations: 1) develop a constructive alignment matrix, 2) review and revise the syllabus, 3) invest in high-quality aligned instructional materials, 4) design professional development programs, and 5) construct a mathematics college readiness test.

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