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Enhanced Subject-Integrated Instruction and Mathematical Problem-Solving Skills among Grade 10 Learners

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Abstract. Enhanced subject-integrated instruction connects knowledge and skills across subject areas and may support learners' mathematical problem-solving abilities. However, limited studies have examined how different levels of integration relate to problem-solving skills. This study examined the relationship between enhanced subject-integrated instruction and the problem-solving skills of Grade 10 learners at Divine Word College of Calapan. Specifically, it determined the extent of multidisciplinary, interdisciplinary, and transdisciplinary integration; assessed learners' problem-solving skills based on Kolb's Experiential Learning stages; and examined their relationships and differences. Using a quantitative research design, data were gathered from 145 learners through a self-made questionnaire and a teacher-made assessment tool. Descriptive, inferential, and correlational analyses were employed. Findings showed that multidisciplinary, interdisciplinary, and transdisciplinary integration were implemented to a high extent, with mean scores of 3.29, 3.18, and 3.26, respectively. Learners demonstrated high to very high performance across the experiential learning stages, with mean percentage scores ranging from 90.29% to 91.71%, with Reflective Observation obtaining the highest score. Multiple regression revealed a strong positive association between subject-integrated instruction and problem-solving skills ($R = .73$), explaining 53% of the variance. All three integration dimensions significantly predicted problem-solving performance, with multidisciplinary integration having the largest standardized beta coefficient ($\beta = .39$). Repeated-measures ANOVA showed a significant difference among the three approaches, $F(2, 288) = 3.05$, $p = .0491$. Post-hoc analysis indicated a significant difference between multidisciplinary and interdisciplinary integration, while other pairwise comparisons were not significant. Based on these findings, a Mathematics Transitional Program is proposed to strengthen foundational mathematical and problem-solving skills and support Grade 10 learners' transition from Junior High School to Senior High School.

Keywords: Enhanced Subject-Integrated Instruction; Interdisciplinary; Multidisciplinary; Problem-Solving Skills; Transdisciplinary

Introduction

Mathematics plays a significant role in developing students' problem-solving skills through analytical thinking and logical reasoning, which are necessary for the achievement of 21st-century skills. With this, several educational systems across the world have shifted from traditional learning toward learner-centered and innovative teaching approaches that make Mathematics education more relevant and meaningful to real-life situations. For instance, educational reforms in European countries, as well as in Asia such as Indonesia, have increasingly highlighted integrated instruction, particularly in STEM education. This enables learners to relate mathematical concepts across different themes while developing the higher-order thinking skills needed in Education 4.0 (Perez & Montoya, 2022; Suherman et al., 2022; Hamad et al., 2022). In the Philippines, the Department of Education (DepEd) implementation of the MATATAG Curriculum likewise emphasizes strengthening foundational learning, contextualization, and meaningful application of knowledge. These directions provide opportunities for Mathematics instruction to connect concepts across learning areas and real-life contexts while developing learners' problem-solving abilities.

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However, despite these educational reforms, learners achievement in Mathematics continues to be a concern at international, national, and local levels. This is seen in international assessments such as the 2022 Programme for International Student Assessment (PISA), which revealed continous low performance of students in mathematical literacy and problem-solving abilities across participating education systems (OECD, 2023). The Philippines also performed low in Mathematics in PISA 2022, with Filipino learners demonstrating below the OECD average and facing substantial difficulty with items requiring the application of mathematical knowledge to real-life situations (OECD, 2023). Furthermore, findings from the Trends in International Mathematics and Science Study (TIMSS) have documented challenges in Mathematics achievement among Filipino learners (IEA, 2020). Similar concerns have been reported also in Region IV-B MIMAROPA, where learners' performance in areas involving information literacy, critical thinking, and problem solving remains a concern (Pacia, 2024). These educational problems are also mirrored in the local context of Divine Word College of Calapan, Inc., Basic Education Department. There is a noticeable decline in Mathematics academic competition, weak performance in Grade 11 admission assessment, classroom observation, and decreasing Grade 10 achievement in Mathematics, as many learners experience difficulties in solving problems and higher-order thinking skills.

Though several studies have shown positive effects of integrated instruction, including multidisciplinary, interdisciplinary, and transdisciplinary approaches, in developing academic achievement, learning engagement, collaboration, and critical thinking, much of the existing literature has examined these approaches as distinct instructional orientations rather than as complementary levels within a single instructional framework (Alibagon & Dilag, 2019; Takeuchi et al., 2020; Corbacho et al., 2021; Elliott Mokski et al., 2022; Honra & Monterola, 2024; Pathak, 2025). Multidisciplinary instruction generally connects concepts from different subjects around a common theme, interdisciplinary instruction establishes stronger conceptual and methodological connections across disciplines, while transdisciplinary instruction extends learning toward authentic problems and contexts beyond individual subject boundaries. Although these approaches share the goal of connecting learning across disciplines, their differing levels of integration suggest the possibility of using them progressively and complementarily rather than treating them as isolated strategies. However, limited research studies has examined the combined implementation of multidisciplinary, interdisciplinary, and transdisciplinary instruction as one enhanced subject-integrated framework for strengthening Mathematics problem-solving skills. This gap is particularly significant for Grade 10 learners from Junior High School who are preparing to transition to Senior High School, where they are expected to apply foundational mathematical knowledge to more complex and contextualized problems.

Given the continuing concerns regarding students' Mathematics performance and the identified research gap, there is a need to develop a transitional program as a preventive intervention that will help learners strengthen their foundational skills before encountering more advanced mathematical concepts in Senior High School. This direction is in line with the current thrust of the MATATAG Curriculum and the Department of Education's National Mathematics Program, which emphasize strengthening foundational mathematical knowledge, conceptual understanding, and problem-solving skills. The present study brings these levels of integration together within an enhanced subject-integrated framework rather than treating multidisciplinary, interdisciplinary, and transdisciplinary instruction as separate interventions. The proposed Mathematics Transitional Program is therefore grounded in the complementary use of multidisciplinary, interdisciplinary, and transdisciplinary instruction to provide structured academic support for Grade 10 learners and strengthen their readiness for Senior High School Mathematics.

Furthermore, in response to the above mentioned learning challenges, the study aims to determine the degree of implementation of enhanced subject-integrated instruction and examine its relationship with the problem-solving skills of Grade 10 learners in the Basic Education Department of Divine Word College of Calapan, Inc. Specifically, it will assess the implementation of different levels of integration, namely multidisciplinary, interdisciplinary, and transdisciplinary instruction, and examine their influence on students' levels of problem-solving skills based on the Experiential Learning Theory of Kolb. By examining these three levels collectively, the study seeks to provide empirical evidence on whether a combined integrated framework can serve as a meaningful foundation for a Mathematics transition intervention rather than relying on a single mode of subject integration. The results will also provide basis for formulating a Mathematics Transitional Program aligned with the goals of the MATATAG Curriculum and the Department of Education's National Mathematics Program. And lastly, the results are expected to provide evidence-based recommendations for curriculum developers, school administrators, and Mathematics teachers in designing instructional interventions responsive to learners' transitional needs.

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https://ijroms.com
Original Article

Research Questions

The study determined the enhanced subject -integrated instructions and problem-solving skills of Grade 10 learners in Divine Word College of Calapan, Inc., that served as the basis of the Mathematics Transitional Program. Specifically, the study will answer the following questions.

1. What is the extent of implementation of subject integrated instruction in terms of:
   1.1. Multidisciplinary Integration,
   1.2. Interdisciplinary Integration,
   1.3. and Transdisciplinary Integration?

2. What is the level of problem solving skills of Grade 10 students in mathematics in terms of:
   2.1. Concrete Learning,
   2.2. Reflective Observation,
   2.3. Abstract Conceptualization,
   2.4. and Active Experimentation?
3. What is the relationship between Enhanced Subject Integrated Teaching Approach to Problem Solving Skills of Grade 10 Learners?
4. Is there a significant difference in the problem-solving skills of Grade 10 learners across the three types of subject-integrated instruction?
5. What Mathematics transitional program can be proposed to enhance problems solving skills of Grade 10 learners through enhance subject integrated instruction?

Scope and Delimitation of the Study

The current study aims to identify the relationship between the Enhanced Subject-Integrated Instruction and the Problem-Solving Skills of Grade 10 Junior High School learners of Divine Word College of Calapan, Inc., for the Academic Year 2023 - 2024. The respondents were identified through stratified non-proportional random sampling, considering their grade level, and section. This specific group was chosen because this grade represents a critical transitioning stage from Junior to Senior High School, where stronger mathematical foundations are essential. Furthermore, it concentrates on the enhanced subject-integrated teaching approach by examining multidisciplinary, interdisciplinary, and transdisciplinary integration. A validated, self-made survey questionnaire was used to assess these approaches. These integration levels were chose because they represent a progressive way of connecting subject areas like multidisciplinary integration that links subjects while retaining distinct boundaries, interdisciplinary integration that blends concepts across subjects to highlight their relationships, and transdisciplinary integration transcends subject limits by engaging learners in real-world, holistic tasks. Using these approaches, it allows the study to determine how different types of instructional integration affect students' problem-solving skills in a structured and meaningful manner. Meanwhile, the study is within the assigned Most Essential Learning Competencies (MELCs) in Mathematics that define the scope of the content delivered and may influence the depth and breadth of integration applied by teachers. This study is limited to Grade 10 learners from a single setting institution which may restrict the generalizability of the findings to other schools or educational contexts. The research is conducted within only one institutional setting and culture, available resources, and existing instructional practices may affect the results. Teacher-related factors such as teaching style, experience, familiarity with integrated instruction, and personal interpretation of MELCs, may also introduce variations or potential biases in how integration is implemented. Furthermore, the findings rely solely on the integrated teaching approaches and survey instruments used, which may influence how results can be applied to broader populations.

Literature Review

Subject Integrated Instruction

Subject-integrated instruction is an innovative, learner-centered approach that connects Mathematics with technology, other disciplines, and real-life experiences. Technology integration and contextual learning help students develop mathematical thinking through problem solving (Darmayanti et al., 2025), while contextualization enables learners to apply prior knowledge to new situations (Zulkifli et al., 2022; Dinglasan et al., 2023). Integrated teaching may take the form of multidisciplinary, interdisciplinary, and transdisciplinary integration, providing opportunities for learners to apply Mathematics in varied contexts (Enorme et al., 2024; Pino & Mongas, 2025). Empirical studies in secondary Mathematics support these claims, with STEM-based interventions reporting improvements in mathematical proficiency and problem-solving compared with conventional instruction (Elsayed, Kong & Matore, 2022; Lailaturrosidah & Abadi, 2025). However, the findings also suggest that positive outcomes depend on how integration is implemented,

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Original Article

particularly through problem-based, inquiry-based, collaborative, and authentic learning activities. Thus, subject integration provides a relevant foundation for developing students' mathematical problem-solving skills.

Multidisciplinary Integration

Multidisciplinary integration links Mathematics with other disciplines through common themes while maintaining the independence of each subject. The use of coding, technology, and collaborative activities can develop analytical thinking, reasoning, creativity, and mathematical competence (Darmayanti et al., 2025; Granello et al., 2025; Ali & Yasmeen, 2023). Concept-first instructional sequencing may also strengthen conceptual and procedural understanding (Running et al., 2023). In addition further researches show that STEM-based Mathematics instruction can enhance students' mathematical proficiency and performance compared with conventional instruction, particularly when learners engage in activities requiring reasoning and application of mathematical concepts (Elsayed, 2022; Kong & Matore, 2022). These results implies that this integration can give meaningful learning experiences that support problem solving while maintaining disciplinary identities.

Interdisciplinary Integration

Integration through combining concepts and practices from other disciplines to deepen Mathematics understanding is the focus of the second level of integration which is the interdisciplinary approach. Studies revealed that the concept of programming and robotics through computational skills when integrated in teaching Mathematics help learners to transfer their reasoning and creativity in problem solving (Lv et al., 2022; Ye et al., 2023). In addition, as part of interdisciplinary integration the use of digital game-based and problem-based learning in STEM education provides more authentic opportunities for leaners to use Mathematics concept in different contexts (Pan et al., 2022). In this level of integration, when mathematical concepts are integrated with inquiry, problem-based learning, and technology-supported activities as intervention for secondary Mathematics, STEM-based instruction can significantly improve problem-solving ability (Kong & Matore, 2022; Lailaturrosidah & Abadi, 2025). Nevertheless, effective implementation may be affected by teacher preparation, technological resources, and available instructional time (Pellegrini et al., 2021). Thus, interdisciplinary integration can create richer mathematical learning experiences when integration is supported by appropriate instructional strategies and resources.

Transdisciplinary Integration

Transdisciplinary integration uses authentic real-life contexts as the basis for learning Mathematics. Realistic Mathematics Education, for example, allows students to connect mathematical concepts with everyday experiences and practical problems (Dinglasan et al., 2023). Authentic learning also promotes collaboration, hands-on experiences, and positive attitudes toward Mathematics (Antao & Morales, 2025). Similarly, studies in the context of STEM education indicate that real-world and problem-centered activities can improve mathematical literacy, reasoning, and problem-solving by requiring learners to formulate problems, apply concepts, and evaluate solutions. ICT and challenge-based learning can further increase engagement by connecting mathematical theories with practical situations (Enorme et al., 2024; Hernandez et al., 2024). Thus, transdisciplinary integration provides opportunities for learners to apply Mathematics beyond the classroom and develop skills for solving complex real-world problems.

Problem Solving Skills

Problem-solving is the core of Mathematics education. This is recognized as its primary goal since it improves learners' abilities in reasoning, analytical thinking and decision-making. Effective problem solving doesn't only requires procedural knowledge but must require students to analyze situations, formulate solution and apply concepts to non-routine contexts. In this study, the level of problem solving skills will be based and anchored on levels of Experiential Learning Theory of David Kolb. This includes concrete experience, reflective observation, abstract conceptualization and active experimentation which explains learning as a connected and continuous process. This levels also let learners to create their everyday experiences into impactful knowledge using self-reflection, conceptual understanding and practical application. Thus, this makes Kolb's experiential learning framework a suitable theoretical basis for assessing skills of the students in solving problems and serves as the dependent variable framework of the present study.

Concrete Experiences

The first level of problem solving skills is the concrete experience. It refers to students direct involvement in real life activities that provide them the starting point of understanding mathematical concept. Some examples teaching strategies under the concrete learning are flipped classroom, problem-posing

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Original Article

instruction and game-based learning. This makes the learners to be actively involved in creating knowledge through authentic experiences. Study showed that the application of flipped classroom along with problem-based learning significantly enhance achievement in Mathematics (Pimdee et al., 2024). Furthermore, problem-posing activities let students independently to formulate and solve problems (Rahmah and Lubis, 2024) while game-based learning promotes experiential learning through exploration and trial-and-error activities (Liu and Israel, 2022). Lastly, STEM interventions commonly begin with authentic or practical problems that require learners to investigate situations before developing formal mathematical solutions. These findings suggest that concrete experiences can provide the starting point for mathematical problem solving by allowing learners to encounter, explore, and respond to meaningful problems.

Reflective Observation

When learners identify patterns, evaluate strategies and generate deeper understanding by examining their acquired experiences, they achieve the second level of problem solving skills known as the reflective observation. Through reflective thinking, learners can move from confusion and misconceptions toward organized problem-solving to clarify ideas and integrate personal experiences with new situations (Kholid et al., 2022). Furthermore, in this stage analytical thinking and self-efficacy is strengthen while collaborative reflection enhances learners critical thinking and performance in problem solving (Tasgin and Dilek, 2023; Xu et al., 2023). Several studies also suggest that effective mathematical reasoning in reflective observation is primarily contributed using metacognitive strategies, emotional intelligence, and technology-supported reflection (Winarti et al., 2022; Hernández & Namaziandost, 2022). This is also consistent with integrated STEM interventions in which students are required to explain solutions, evaluate strategies, communicate reasoning, and revise their approaches during problem-solving activities. Thus, reflection provides an important link between students' experiences and their developing mathematical understanding.

Abstract Conceptualization

In abstract conceptualization as the level of problem solving skills, learners can already construct concept, formulate justifications and devise solutions based on their prior experiences. Inquiry-based learning and collaborative STEM activities are some teaching approaches that develop this level while fostering creativity and problem-solving abilities (Karamustafaoğlu & Pektaş, 2022; Xu et al., 2023). In addition, the so-called design thinking as innovative teaching style allows learner to explore concepts from multiple perspectives while flexible and original thinking enhance creative approaches to mathematical problem solving (Guaman-Quintanilla et al., 2022; Alt et al., 2023). Aside from this, problem-based learning also reinforces conceptual development through collaborative investigation and practical application (Rehman et al., 2023). These findings suggest that integrated activities become more meaningful when learners move beyond performing tasks and are required to explain relationships, justify solutions, and construct mathematical concepts.

Active Experimentation

The highest level of problem solving skills is through active experimentation. This represents the application of acquired knowledge from concrete experiences to the investigation of real-life situations using testing, exploration and continuous improvement. With the use of different teaching approaches like collaborative teamwork, scaffolding, discovery-based activities and inquiry-based learning, it provides a learner a chance to examine mathematical ideas while formulating their strategy in solving problems. Specifically, in collaborative team work, peer collaboration strengthens problem solving in engineering education (Boelt et al., 2022), in scaffolding, instructional guidance is essential for developing experimental reasoning (Kranz et al., 2022), in discovery-based activities, learners self-determination will lead to application of mathematical concepts independently (Ong et al., 2022) and lastly in inquiry-based learning, promoting analytical thinking requires cultural context (Hariyanto et al. 2023). Likewise, integrated STEM interventions commonly require students to apply mathematical knowledge to authentic problems, test possible solutions, and revise their strategies based on results. This supports the experiential nature of active experimentation, where learners use mathematical concepts in practical situations and develop greater capacity to solve complex problems.

Mathematics Transitional Program

The proposed output of this study is the Mathematics Transitional Program (MTP). This highlights the use of experiential and problem-based learning materials to develop student's mathematical competence in understanding and solving problems. MTP will also include tutorial sessions with learning modules consisting of interactive worksheet. Studies revealed that experiential worksheets strengthen learning outcomes through active engagement and participation of students in different mathematical tasks (Halim et al., 2022; Melawati

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https://ijroms.com
Original Article

et al., 2022). Aside from this, the integration of real world problems using RICOSRE model also enhance higher-order thinking skills (Mahanal et al., 2022), while constructivist reflection and creative instructional design further enhance meaningful learning (Almulla, 2023; Setyosari et al., 2023). In terms of implementation of the transitional program, it will be incorporated with the Deped National Mathematics Program scheduled in every class program. In this study, these principles will guide the development of the MTP, which will be incorporated with the DepEd National Mathematics Program and designed to provide Grade 10 learners with structured opportunities to experience, reflect on, conceptualize, and apply mathematical ideas in solving problems.

Methodology

Research Design

The study used a quantitative research design. This approach primarily focuses on gathering, organizing, analysing and interpreting numerical data such as survey questionnaire responses and learners test raw score. Quantitative design also is use to identify patterns, to formulate assumptions and to investigate a wider range of population to generalize particular phenomenon (Bhandari, 2020 & Babbie, 2022). The appropriateness of this design allows the researcher to achieve objective measurement and quantification of integrated instruction level and learners' skills in solving problems. This study also utilized a descriptive-inferential method which helps researcher to make description and to analyze the pattern base on the data collected. The primary goal of a descriptive research design is to define a certain area or population of a study in a systematic and accurate way (Siedlecki, 2020). Meanwhile for the inferential side, formulating conclusion and generalization would be the focused. Data gathered from the procedure was used to describe trends and variations within the sample. And lastly, since the study aims to identify the impact of an innovative teaching approach to students' problem solving skills, correlational method was used. This inferential approach investigates the relationship between the independent and dependent variable of the study by determining the degree of directions and association among variables. With this, the researcher can ensure that the data result is valid, accurate and reliable.

Research Locale

The study was conducted at the Divine Word College of Calapan, Inc. (DWCC), Basic Education Department. It is a private Catholic educational institution in Oriental Mindoro offering a complete and continuous academic programs starting from Kindergarten to Graduate School. This academic organization provides an integrated vertical and horizontal alignment of learning competencies and course outcomes that makes DWCC an ideal setting for investigating programs that support students' learning progression like from Junior to Senior High School. DWCC Basic Education was selected by the researcher as the locale of the study due to a various institutional characteristics and identified academic challenges that is inline directly with the aims of this study. While the institution is recognized for maintaining quality standards in education as the only PAASCU-accredited Basic Education school in the province, there is an internal observations and performance records on the decline in learners' academic outcomes, particularly in mathematics proficiency and problem-solving performance. This recent concern presents a significant institutional need for innovative and evidence-based instructional approaches. In addition, DWCC's strategic commitment to continuous improvement in adoption of different research-driven teaching innovations make it a appropriate setting for implementing and evaluating the proposed Mathematics Transitional Program. Furthermore, the Grade 10 students, has shown frequent challenges in foundational mathematical skills as they transitioned to Senior High School. This highlights the relevance for structured support to prepare them in dealing with more advanced content in the SHS curriculum. Making DWCC as the locale of the study therefore justified not only through its capacity to provide systematic educational research but the alignment also between the institutional current needs and the intended outcomes of the Mathematics Transitional Program. The results of the study give evidenced-based recommendations that will help DWCC in recalibrating it institutional teaching practices, enhancing learners' mathematical readiness and assuring that the products of basic education most especially pursuing mathematics-related fields in higher education like Engineering, Accountancy and Medicines, are more equipped for future academic endeavor and career demands.

Research Participants

The participants of the study were Grade 10 students of Divine Word College of Calapan – Basic Education Department, Academic Year 2023-2024. In particular, 145 out of 154 grade 10 students is randomly chosen after applying the Slovins' Formula. As being mentioned in the previous chapters, this grade level was selected by the researcher since they are in the transitional period from Junior HS to Senior HS. Based on the gathered data, most of these students struggle a lot in problem solving skills from the fundamental concept

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https://ijroms.com
Original Article

they studied during junior year and complex application on their Senior Year. The researcher believes that this study on integration teaching approach will help these young adults to enhanced their ability to solve problems that they may use in their chosen career and field of specialization.

Research Instrument

The study employed two main research instruments: a self-made questionnaire intended to measure the learners' perceptions of the implementation of the subject-integrated teaching approach and a teacher-made assessment tool to quantify their problem-solving skills. The researcher-made questionnaire served as the primary tool for collecting data on the learners' perceptions of the implementation of the subject-integrated teaching approach (IV). It consists of two major parts. The first part contains the students' profile in terms of their section to identify their stratum, while the second part contains 30 statements about integrated instruction. The independent variable is divided into three levels: multidisciplinary, interdisciplinary, and transdisciplinary, with 10 statements for each level. It uses a 4-point Likert scale, where 1 means "strongly disagree" and 4 means "strongly agree." The questionnaire was subjected to expert validation, and its internal consistency was established using Cronbach's alpha to determine its reliability. Meanwhile, the researcher-made assessment tool served to measure the learners' problem-solving skills through their raw scores. The test items were based on the assigned Mathematics 10 learning competency from the MELCs in Quarter 4, which includes measures of position of grouped data, namely quartiles, deciles, and percentiles. The assessment tool is divided into four parts representing the levels of problem-solving skills associated with Kolb's Experiential Learning Theory. The items were reviewed for content validity and analyzed using item difficulty and discrimination indices to determine their suitability and effectiveness in measuring the intended skills. The obtained test scores were used to identify the level of problem-solving skills of the respondents. After analysis, these research instruments provided information on the learners' perceptions of the implementation of the subject-integrated teaching approach and their level of problem-solving skills, including the relationship between the two variables. These findings supported the primary goal of the study to determine the relationship between subject-integrated instruction and learners' problem-solving skills in Mathematics.

Data Gathering Procedure

Prior to the conduct of the study, a letter of request was submitted to the Graduate School Dean for endorsement. Upon signified, the letter was also sent to the Office of the Principal, Vice President for Academic Affairs and DWCC President for their consent and authorization. After securing the administrators approval, a notice of data collection permitted by the Academic Chairperson and Basic Education Department Principal was forwarded through class group chats. Right after the schedule was set, an orientation session is conducted with selected respondents from Grade 10 learners. This is the perfect opportunity to discuss the objective of the research and their participation in the conduct of the study. Distribution of students and parents' consent was also done to uphold ethical research standards. Following the consent process, the research questionnaire was administered to the grade 10 students facilitated by the researcher. Meanwhile, the assessment tool was distributed to their Math teacher as part of their learning activity. After the retrieval of research instruments, data gathered were organized, encoded and tabulated for statistical treatment. All computed, interpreted, and analyzed data were consulted with a qualified statistician before final presentation to ensure the accuracy, consistency, and objectivity of the results.

Results and Discussions

Research Question 1: What is the extent of implementation of subject integrated instruction in terms of multidisciplinary, interdisciplinary and transdisciplinary integration?

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https://ijroms.com
Original Article

Table 1. Extent of Implementation of Subject Integrated Instruction in terms of Multidisciplinary Integration

	Items	Mean	Standard Deviation	Description	Interpretation
1.	I have experienced integrated instructions during our class sessions.	3.22	0.52	Agree	High Extent
2.	During class discussion, our teacher uses multidisciplinary approach where he/she relates the topic to another concept.	3.33	0.55	Agree	High Extent
3.	In problem solving, I noticed that my teacher finds a way to integrate solution with the application of other related concepts.	3.36	0.60	Agree	High Extent
4.	I can answer the problem-based activity given by my teacher using the multidisciplinary approach he/she taught.	3.28	0.55	Agree	High Extent
5.	In written outputs, such as worksheet, I can solve the problems systematically and easily using integration.	3.12	0.59	Agree	High Extent
6.	During board work activities, our teacher encourage us to use any methods related to topic to solve the given problem	3.36	0.54	Agree	High Extent
7.	In some part of the quarterly examinations, there are choices that are related to one another that shared the same concept.	3.43	0.60	Agree	High Extent
8.	Our teacher assure us that problem solving during periodical exams can be solved by multidisciplinary approach.	3.32	0.59	Agree	High Extent
9.	I develop critical thinking skills in problem-solving through multidisciplinary approach.	3.23	0.65	Agree	High Extent
10.	I believe multidisciplinary approach develops my abilities in mathematics to solve problems.	3.30	0.61	Agree	High Extent
		3.29	**0.33**	**Agree**	**High Extent**

The results in Table 1 indicate a high extent of implementation of Subject-Integrated Instruction in terms of Multidisciplinary Integration, as shown by the overall mean of 3.29 (SD = 0.33), interpreted as “Agree” and described as “High Extent.” This suggests that learners generally perceived their Mathematics lessons as incorporating connections among related concepts through classroom discussions, problem-solving activities, written tasks, board work, and assessments. All indicators attained a mean of 3.00, showing a consistent positive perception of multidisciplinary integration. Meanwhile there is a relatively low variability and generally consistent responses among the learners as seen in the range of standard deviations from 0.52 to 0.65. Item 9, which focuses on the development of critical thinking skills through multidisciplinary problem-solving, had the highest variability (SD = 0.65), while Item 1 had the lowest (SD = 0.52). Overall, the findings indicate that Multidisciplinary Integration was implemented to a high extent, particularly in connecting mathematical concepts and applying them to problem-solving activities. The results suggest that learners generally recognized the approach as part of their classroom learning experiences.

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https://ijroms.com
Original Article

Table 2. Extent of Implementation of Subject Integrated Instruction in terms of Interdisciplinary Integration

	Items	Mean	Standard Deviation	Description	Interpretation
1.	I can see that my teachers effectively use other subjects through interdisciplinary approach when solving problems during mathematics classes.	3.14	0.74	Agree	High Extent
2.	My teachers give clear transition when problem-solving is integrated with the other subjects through interdisciplinary approach in mathematics classes.	3.22	0.63	Agree	High Extent
3.	During class discussion, our teacher asks us to use the concept from other subject matter to solve his/her given problem.	3.10	0.71	Agree	High Extent
4.	The teacher provides examples of word problems associated with other subject of discipline.	3.40	0.62	Agree	High Extent
5.	I noticed that some of the Math problems we tend to solve can be solved using related concept from other subjects.	3.14	0.74	Agree	High Extent
6.	When having quizzes, the teacher reminds us to use interdisciplinary approach in solving word problems.	3.18	0.69	Agree	High Extent
7.	As part of our performance task, the teacher collaborates with other subject teacher to create more meaningful outputs.	3.04	0.79	Agree	High Extent
8.	In quarterly outputs, the teacher makes sure that the problem can be solve using interdisciplinary approach.	3.17	0.64	Agree	High Extent
9.	I observed that some test questions in quarterly examination are integrated with other subjects.	3.06	0.75	Agree	High Extent
10.	I prefer interdisciplinary approach in solving Math problems since it makes the problem easier to solve.	3.22	0.58	Agree	High Extent
		3.18	**0.39**	**Agree**	**High Extent**

Table 2 shows that Interdisciplinary Integration was implemented to a high extent, with an overall mean of 3.18 (SD = 0.39), verbally interpreted as "Agree." This indicates that learners generally recognized the use of concepts from other subject areas in Mathematics, particularly in problem-solving, classroom discussions, performance tasks, and assessments. A mean of 3.18 as shown in each items also indicate consistent perception of interdisciplinary integration among different teaching and learning activities. Furthermore, a moderate variation in student's responses are reflected in the obtained standard deviation ranging from 0.58 to 0.79. The highest variability was observed in Item 7 (SD = 0.79), concerning teacher collaboration in developing meaningful performance tasks, while Item 10 had the lowest variability (SD = 0.58). Overall, the findings suggest that learners experienced Mathematics instruction as being connected with other disciplines through both learning activities and assessment tasks. The high overall rating indicates that Interdisciplinary Integration was a recognizable and consistently applied component of the instructional approach, particularly in helping learners relate mathematical problem-solving to concepts learned in other subject areas.

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https://ijroms.com
Original Article

Table 3. Extent of Implementation of Subject Integrated Instruction in terms of Transdisciplinary Integration

	Items	Mean	Standard Deviation	Description	Interpretation
1.	Based on my experience, transdisciplinary approach is a best way to appreciate problem solving in Mathematics.	3.26	0.72	Agree	High Extent
2.	Seeing the connection of the lesson in real life scenarios makes the subject more interesting.	3.53	0.60	Strongly Agree	Very High Extent
3.	Our teacher provides several word problems incorporated with real life application.	3.28	0.73	Agree	High Extent
4.	During our class discussion, I noticed that my teacher assure that she used transdisciplinary approach in teaching.	3.18	0.64	Agree	High Extent
5.	Our take home activities and assignments in problem solving are based on real life examples.	3.02	0.72	Agree	High Extent
6.	I observed that transdisciplinary approach can be used in problem-based worksheets in Mathematics.	3.33	0.62	Agree	High Extent
7.	In group activities, the teacher makes sure that the topic is relevant and uses integrated approach.	3.31	0.64	Agree	High Extent
8.	The teacher gives variety of activities that show transdisciplinary approach like survey, dice experiments and more.	3.26	0.66	Agree	High Extent
9.	During quarterly examinations, some items provide real life applications in problem solving.	3.25	0.72	Agree	High Extent
10.	Integration through transdisciplinary approach helps us to solve the Mathematical word problems.	3.38	0.59	Agree	High Extent
		3.26	**0.48**	**Agree**	**High Extent**

Table 3 shows that Transdisciplinary Integration was implemented to a high extent, with an overall mean of 3.26 (SD = 0.48), interpreted as “Agree.” This indicates that learners generally experienced Mathematics instruction connected with mathematical concepts in real-life situations and practical applications. In particular, item number 2 obtained a highest mean of 3.53 and a standard deviation of 0.60 which implies that students can recognized the value of integrating real life examples in learning Mathematics. However, other indicators showed a consistent implementation on average level (M = 3.26) across learning activities such as assignments, group work, examinations and worksheets. Also, in terms of student’s responses, the standard deviation shows relatively low in general. As a whole, the findings suggest that Transdisciplinary Integration was evident in Mathematics instruction, particularly through the use of real-life contexts to make problem solving more relevant and meaningful to learners.

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Volume 1, Issue 9, pp. 90-108, October 2026
https://ijroms.com
Original Article

Table 4. Summary of Extent of Implementation of Subject Integrated Instruction

	Items	Mean	Standard Deviation	Description	Interpretation
1.	Multidisciplinary Integration	3.29	0.33	Agree	High Extent
2.	Interdisciplinary Integration	3.18	0.39	Agree	High Extent
3.	Transdisciplinary Integration	3.26	0.48	Agree	High Extent

Table 4 presents the extent of implementation of Enhanced Subject-Integrated Instruction across its three dimensions: multidisciplinary, interdisciplinary, and transdisciplinary. The three dimensions obtained mean scores ranging from 3.18 to 3.26, all interpreted as High Extent. Multidisciplinary integration showed the lowest variability (SD = 0.33), indicating relatively consistent responses among the participants, whereas transdisciplinary integration had the highest variability (SD = 0.48), suggesting slightly greater differences in perceptions. This relatively consistent pattern may be attributed to shared curriculum frameworks, instructional guidelines, and institutional policies that support the implementation of integrated instruction across classrooms. Despite differences in variability, the mean scores indicate that the three dimensions were implemented at a comparable and consistently high level. Overall, the findings suggest that Enhanced Subject-Integrated Instruction is broadly implemented, providing a basis for examining its association with learners' mathematical problem-solving skills.

Research Question 2: What is the level of problem solving skills of Grade 10 students in mathematics in terms of concrete learning, reflective observation, abstract conceptualization and active experimentation?

Table 5. Level of Problem Solving Skills of Grade 10 Students in Mathematics in terms of Concrete Learning

Percentage Score		Frequency	Percentage	Description	Interpretation
1.	90 – 100	98	67.59%	Outstanding	Very High Level
2.	85 – 89	26	17.93%	Very Satisfactory	High Level
3.	80 – 84	8	5.52%	Satisfactory	Moderate Level
4.	75 – 79	10	6.90%	Fairly Satisfactory	Low Level
5.	Below 75	3	2.07%	Did Not Meet Expectation	Very Low Level
Total		**145**	**100%**		
Mean		**90.43%**		**Very Satisfactory**	**High Level**

Table 5 shows the level of Grade 10 students' problem-solving skills in Mathematics in terms of Concrete Learning. The results reveal a generally strong level of performance, with an overall mean score of 90.43%, described as Very Satisfactory and interpreted as a High Level. A substantial majority of the students demonstrated excellent performance, with 98 out of 145 students (67.59%) obtaining scores within the 90–100% range, classified as Outstanding and indicating a Very High Level. Furthermore, 26 students (17.93%) achieved scores of 85–89%, showing Very Satisfactory performance and a High Level, 8 students (5.52%) obtained scores between 80–84%, with Moderate Level, 10 students (6.90%), interpreted as a Low Level. While only 3 students (2.07%) scored below 75%, representing a Very Low Level. Although a small proportion of learners may require additional instructional support, the overall distribution is strongly concentrated in the higher performance categories which indicate that Grade 10 learners exhibited a high level of problem-solving skills at the concrete learning stage. The high dominant scores in the outstanding and very satisfactory categories suggests that most learners were capable of engaging with mathematical problems through direct experiences and observable applications, providing a strong basis for progressing toward more reflective, abstract, and active forms of mathematical problem solving.

Table 6. Level of Problem Solving Skills of Grade 10 Students in Mathematics in terms of Reflective Observation

Percentage Score		Frequency	Percentage	Description	Interpretation
1.	90 – 100	102	70.34%	Outstanding	Very High Level
2.	85 – 89	22	15.17%	Very Satisfactory	High Level
3.	80 – 84	21	14.48%	Satisfactory	Moderate Level
4.	75 – 79	2	1.38%	Fairly Satisfactory	Low Level
5.	Below 75	0	0%	Did Not Meet Expectation	Very Low Level
Total		**145**	**100%**		
Mean		**91.71%**		**Outstanding**	**Very High Level**

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Volume 1, Issue 9, pp. 90-108, October 2026
https://ijroms.com
Original Article

Table 6 presents the performance of Grade 10 students in Mathematics with respect to Reflective Observation. The overall mean of 91.71%, indicates that the learners demonstrated strong capacity to examine, evaluate, and reflect on their mathematical problem-solving experiences. The distribution further reinforces when a large majority of 102 students (70.34%), achieved scores between 90–100%, reflecting students Outstanding performance. Meanwhile, 22 students (15.17%) obtained scores of 85–89%, classified as Very Satisfactory, and 21 students (14.48%) scored within the 80–84% range. Only 2 students (1.38%) obtained scores between 75–79%, while none scored below 75%. Notably, 85.51% of the learners achieved scores of 85% or higher, demonstrating consistently strong performance in reflective mathematical thinking. The absence of students in the lowest performance category suggests that all learners demonstrated at least an acceptable level of reflective observation. The concentration of scores in the upper ranges also indicates that students were generally able to review their approaches, recognize relationships among mathematical ideas, and learn from their problem-solving experiences. Overall, reflective observation emerged as a particularly strong component of the learners' problem-solving skills, as reflected by the highest mean among the reported learning dimensions. This finding suggests that opportunities for students to analyze and reflect on their mathematical experiences may contribute meaningfully to the development of effective problem-solving processes.

Table 7. Level of Problem Solving Skills of Grade 10 Students in Mathematics in terms of Abstract Conceptualization

Percentage Score		Frequency	Percentage	Description	Interpretation
1.	90 – 100	104	70.72%	Outstanding	Very High Level
2.	85 – 89	30	20.69%	Very Satisfactory	High Level
3.	80 – 84	9	6.21%	Satisfactory	Moderate Level
4.	75 – 79	3	2.07%	Fairly Satisfactory	Low Level
5.	Below 75	1	0.69%	Did Not Meet Expectation	Very Low Level
Total		**145**	**100%**		
Mean		**91.32%**		**Outstanding**	**Very High Level**

Table 7 presents the level of Grade 10 students' problem-solving skills in Mathematics in terms of Abstract Conceptualization. The learners obtained an overall mean score of 91.32%, described as Outstanding and interpreted as a Very High Level. Specifically, 104 students (70.72%) attained scores of 90–100%, classified as Outstanding. 30 students (20.69%) performed Very Satisfactory. Meanwhile, 9 students (6.21%) scored 80–84%, 3 students (2.07%) scored 75–79%, and only 1 student (0.69%) scored below 75%. The concentration of learners in the higher performance categories suggests that most students were able to move beyond specific mathematical experiences and develop broader conceptual understanding. It also indicates that abstract conceptualization is a well-developed component of the learners' problem-solving skills, reflecting their capacity to connect mathematical procedures with underlying concepts and apply these concepts to problem-solving situations.

Table 8. Level of Problem Solving Skills of Grade 10 Students in Mathematics in terms of Active Experimentation

Percentage Score		Frequency	Percentage	Description	Interpretation
1.	90 – 100	89	61.38%	Outstanding	Very High Level
2.	85 – 89	36	24.83%	Very Satisfactory	High Level
3.	80 – 84	11	7.59%	Satisfactory	Moderate Level
4.	75 – 79	1	0.60%	Fairly Satisfactory	Low Level
5.	Below 75	10	6.90%	Did Not Meet Expectation	Very Low Level
Total		**145**	**100%**		
Mean		**90.29%**		**Very Satisfactory**	**High Level**

Table 8 presents the level of Grade 10 students' problem-solving skills in Mathematics in terms of Active Experimentation. The overall mean score of 90.29%, described as Very Satisfactory and interpreted as a High Level, indicates that the learners generally demonstrated the ability to apply mathematical concepts and strategies in actual problem-solving situations. In particular, 89 out of 145 students (61.38%), achieved Outstanding performance, 36 students performed Very Satisfactory and 11 students (7.59%) scored 80–84%, as Satisfactory level. Meanwhile the remaining 7.50% consist of 1 student with low level in performance and 10 students at very low level. The strong concentration of students in the higher performance categories suggests that most learners were capable of testing strategies, applying mathematical concepts, and using their understanding to arrive at solutions. Nevertheless, the small group performing below 75% points to the need for targeted support and additional opportunities for guided practice and application.

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Online ISSN: 3116-4137 | Print ISSN: 3116-4145
Volume 1, Issue 9, pp. 90-108, October 2026
https://ijroms.com
Original Article

Table 9. Summary of the Level of Problem Solving Skills of Grade 10 Students in Mathematics

	Levels	Mean Raw Score	Total Score	Mean Percentage Score	Standard Deviation	Description	Interpretation
1.	Concrete Learning	18	20	90%	7.10	Outstanding	Very High Level
2.	Reflective Observation	23	25	92%	5.18	Outstanding	Very High Level
3.	Abstract Conceptualization	36	40	91%	4.59	Outstanding	Very High Level
4.	Active Experimentation	13	15	90%	6.34	Outstanding	Very High Level

Table 9 presents the overall performance of Grade 10 learners across the four dimensions of problem-solving skills based on the stages of Experiential Learning Theory (ELT): Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation. The results show outstanding performance across all four dimensions, indicating a very high level of mathematical problem-solving proficiency. This finding contrasts with reported difficulties in mathematics and problem-solving, suggesting that subject-integrated instruction may have supported improved learner performance.

Reflective Observation obtained the highest mean percentage score (92%), indicating learners' ability to analyze experiences, evaluate procedures, identify errors, and reflect on solutions. This supports Kholid et al. (2022), who emphasized the role of reflective thinking in developing meaningful understanding, and Taşgın and Dilek (2023), who highlighted its contribution to analytical reasoning and higher-order thinking.

Abstract Conceptualization recorded a mean percentage score of 91%, demonstrating learners' ability to generalize from concrete experiences and apply abstract mathematical concepts. Concrete Experience and Active Experimentation both obtained approximately 90%, reflecting learners' capacity to engage in mathematical tasks, apply concepts, evaluate strategies, and explore solutions. Despite the high performance, the need for guided practice, differentiated activities, and teacher scaffolding remains important, particularly in transferring concepts to real-life situations and exploring alternative strategies (Kapici, Akçay, & Cakir, 2022). The relatively low standard deviations (4.59–7.10) further indicate consistency in learner Mathematics performance in solving problems.

Overall, the findings indicate that subject-integrated instruction may contribute to the development of mathematical problem-solving skills across the experiential learning cycle. The results also support the study's theoretical foundations, particularly Experiential Learning Theory, Multiple Intelligences Theory, and Social Learning Theory, as learners demonstrated skills in concrete experience, reflection, abstract reasoning, and active application.

Research Question 3: What is the relationship between Enhanced Subject Integrated Teaching Approach to Problem Solving Skills of Grade 10 Learners?

Table 10. Multiple Regression Analysis on Enhanced Subject Integrated Teaching Approach and Problem-Solving Skills of Grade 10 Learners

Regression Statistics		
1.	Multiple R	0.73
2.	R Square	0.53
3.	Adjusted R Square	0.52
4.	Standard Error	3.13
5.	F-value	53.60
6.	Observations	145

	Predictor Variables	Coefficient	Standard Error	Standardized Beta	t-value	p-value	Interpretation
1.	Intercept	60.05	2.56	-	23.46	< .001	
2.	Multidisciplinary	4.69	0.72	0.39	6.53	< .001	Significant positive
3.	Interdisciplinary	2.62	0.63	0.30	4.38	< .001	Significant positive
4.	Transdisciplinary	2.22	0.51	0.28	4.15	< .001	Significant positive

Table 10 presents the multiple regression analysis of enhanced subject-integrated instruction and the problem-solving skills of Grade 10 learners. The regression model yielded a Multiple R of 0.73, indicating a strong positive association between the combined dimensions of multidisciplinary, interdisciplinary, and transdisciplinary instruction and learners' problem-solving skills. The R^2 value of 0.53 indicates that

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Volume 1, Issue 9, pp. 90-108, October 2026
https://ijroms.com
Original Article

approximately 53% of the variance in problem-solving skills was explained by the three dimensions included in the model, while the adjusted R^2 of 0.52 indicates that the model remained substantial after accounting for the number of predictors. The overall regression model was statistically significant, $F = 53.60$, $p < .001$.

Individually, multidisciplinary instruction showed a significant positive association with problem-solving skills ($\beta = 0.39$, $t = 6.53$, $p < .001$). Interdisciplinary instruction also showed a significant positive association ($\beta = 0.30$, $t = 4.38$, $p < .001$), as did transdisciplinary instruction ($\beta = 0.28$, $t = 4.15$, $p < .001$). These findings indicate that each dimension significantly contributed to the prediction of learners' problem-solving skills when the other dimensions were statistically controlled. Among the three predictors, multidisciplinary instruction had the largest standardized beta coefficient. Overall, the results indicate that the three dimensions of enhanced subject-integrated instruction are significantly associated with Grade 10 learners' problem-solving skills.

Research Question 4: Is there a significant difference in the problem-solving skills of Grade 10 learners across the three types of subject-integrated instruction?

Table 11. One-Way Repeated Measures ANOVA and Post-Hoc Analysis on Problem-Solving Skills Across Integrated Instructional Approaches (N = 145)

1. Approach	Mean	SD
Multidisciplinary (MD)	3.27	0.38
Interdisciplinary (ID)	3.15	0.48
Transdisciplinary (TD)	3.21	0.61

2. ANOVA Source	SS	df	MS	F	p-value	F - Critical	Decision ($\alpha = 0.05$)
Between Approaches (Columns)	0.99	2	0.49	3.05	0.0491	3.03	Reject H_0
Between Subjects (Rows)	61.72	144	0.43	2.64	< 0.001		
Error (Within Subjects)	46.78	288	0.16				
Total	**109.49**	**434**					

	Pairwise Comparison	Mean Difference	t-value	df	Unadjusted p	Bonferroni p_{adj}	Decision
1.	MD vs ID	0.12	2.60	144	0.0103	0.0310	Significant ($p < 0.05$)
2.	ID vs TD	-0.06	-1.41	144	0.1612	0.4836	Not Significant
3.	MD vs TD	0.05	1.02	144	0.3086	0.9258	Not Significant

Table 11 presents the results of the one-way repeated measures analysis of variance (RM-ANOVA) conducted to evaluate potential differences in the problem-solving performance of Grade 10 learners (N = 145) across three enhanced subject-integrated instructional approaches: Multidisciplinary (MD), Interdisciplinary (ID), and Transdisciplinary (TD). Descriptively, Multidisciplinary instruction obtained the highest mean score ($M = 3.27$, $SD = 0.38$), followed by Transdisciplinary ($M = 3.21$, $SD = 0.61$) and Interdisciplinary ($M = 3.15$, $SD = 0.48$).

Accounting for the dependent structure of the repeated evaluations across the same cohort of learners, the RM-ANOVA demonstrated a statistically significant difference among the three integrated approaches, $F(2, 288) = 3.05$, $p = 0.0491$, F-critical = 3.03. Consequently, the null hypothesis of equal performance across integration approaches was rejected. To determine specific pairwise differences, post-hoc analysis using paired-samples t-tests with Bonferroni adjustment was conducted. The results indicated that problem-solving performance was significantly higher under the Multidisciplinary approach compared to the Interdisciplinary approach $t(144) = 2.60$, Mean Diff = 0.12, $p_{adj} = 0.031$). No statistically significant differences were observed between Interdisciplinary and Transdisciplinary ($p_{adj} = 0.484$) or between Multidisciplinary and Transdisciplinary ($p_{adj} = 0.926$). These findings indicate that learners obtained significantly higher problem-solving scores under the multidisciplinary approach than under the interdisciplinary approach, although no significant differences were found between the multidisciplinary and transdisciplinary approaches or between the interdisciplinary and transdisciplinary approaches.

Research Question 5: Based on the analysis, what intense subject integrated instruction teaching approach for the improvement of the problem-solving skills upgrading through this in mathematics may be proposed?

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Volume 1, Issue 9, pp. 90-108, October 2026
https://ijroms.com
Original Article

Based on the findings, the Mathematics Transitional Program (MTP) titled A Foundational Bridge for Strengthening Mathematical and Problem-Solving Skills of Grade 10 Learners was developed as a proposed output of the study. This instructional program will support learners as they transition from Junior High School to Senior High School Mathematics. MTP is also designed in response to the significant contribution of Enhanced Subject Integrated Teaching Approach to Grade 10 Problem Solving Skills in Mathematics.

Furthermore, the MTP is also anchored on Schlossberg's 4S Transition Model: situation, self, strategies and support which address learner's transitional needs as they moved toward more advance learning in Mathematics. This program also consists of major components such as strengthening foundational competencies, developing skills in solving problems through integration, and providing continuous instructional support for learners to be prepared for more advanced mathematics courses such as General Mathematics, Statistics and Probability, and Pre-Calculus.

And lastly, this transitional program is also aligned with the goals of MATATAG curriculum and Department of Education (Deped) National Mathematics program which aims to highlights conceptual understanding, critical thinking, mathematical reasoning, and lifelong learning. This program may also be part of the teachers professional learning community that encourage to continuous enhancement of instructional practices through integrated teaching approaches.

Ethical Considerations

The conducted study strictly follows ethical and research standard to ensure its integrity through systematic process and providing safeguard to all participants involved. The researcher secured permission to conduct of the study prior to data collection. They also advocate the standard of informed consent by providing them clear and detailed orientation on research goals and possible risk and benefits on their participation. The respondents are given a freedom to refuse or withdraw in the research process without any penalty or consequence. In terms of data gathering proper, the researcher assured that respondents' confidentiality and anonymity would be maintained in full compliance with the Data Privacy Act of 2012 (RA No. 10173). Any personal or research information they will share were not disclosed in any form of publication or reporting. All participants were also protected on any harm by crafting non-threatening and non-offensive questions and applicable assessment based on their capability as a Grade 10 students. The principle of transparency and honesty were also maintained by collecting, analysing and presenting data in proper and systematic way as part of showing academic integrity in writing the research to avoid falsification and fabrication of incorrect information. All the data presented were based on trusted resources and references with proper acknowledgment on original authors to avoid plagiarism together with expert's validation in some part of the study. The above mentioned ethical measures collectively ensured that the study was conducted responsibly, respectfully, and in accordance with institutional and research ethics guidelines.

Conclusion

The study indicates that Enhanced Subject-Integrated Instruction is positively associated with the problem-solving skills of Grade 10 learners in Mathematics. The high extent of implementation in the integration levels such as multidisciplinary, interdisciplinary, and transdisciplinary assures that when Mathematics is integrated with other discipline and authentic context provides opportunities for learner-centered and meaningful learning experiences. Furthermore, the Grade 10 learners achieve very high performance in problem solving as measured by the levels of Kolb's Experiential Learning indicating that learners were able to engage in mathematical experiences involving reflection, conceptual understanding, and application beyond procedural knowledge. Furthermore, significant predictive relationship between subject-integrated instruction and problem-solving skills highlights the importance of designing learning experiences that connect mathematical concepts with other disciplines and authentic situations. However, since the study employed a correlational design, these findings should be interpreted as an association rather than evidence that subject-integrated instruction directly causes improvement in problem-solving skills. Although no significant difference was found across the three levels of integration, the findings suggest that multidisciplinary, interdisciplinary, and transdisciplinary approaches can all serve as viable instructional designs, with their value depending not only on the level of integration but also on the quality of instructional planning, implementation, and facilitation. Lastly, the study proposed the Mathematics Transitional Program as a research-based intervention for supporting Grade 10 learners' transition to advanced Mathematics courses in Senior High School. The program may be implemented as a structured transition support that reinforces foundational mathematical competencies, provides contextualized problem-solving activities, and monitors learners' readiness for General Mathematics, Statistics and Probability, and other

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https://ijroms.com
Original Article

advanced Mathematics courses. Its implementation may also be evaluated periodically to determine its usefulness in addressing learners' identified transition needs.

Recommendations

Anchored with the findings of the study, the school administrators may still strengthen the implementation of Enhanced Subject-Integrated Instruction by conducting sustained professional development programs, collaborative lesson planning, and professional learning community (PLC) activities focused on integrated curriculum design, contextualized teaching strategies, and innovative mathematics instruction. Mathematics teachers are encouraged to develop inquiry-based, interactive, and technology-supported learning experiences that connect mathematical concepts with interdisciplinary knowledge and real-world applications. These initiatives may be aligned with the principles and implementation provisions of the MATATAG Curriculum under DepEd Order No. 010, s. 2024, as amended by DepEd Order No. 012, s. 2024, particularly in promoting relevant learning experiences and allowing schools to consider their specific contexts in curriculum implementation.In addition, academic chairpersons and learning area leaders may establish continuous monitoring and evaluation mechanisms through classroom observations, lesson plan reviews, peer mentoring, and collaborative reflections to ensure the consistency and sustainability of integrated instructional practices. Since multidisciplinary, interdisciplinary, and transdisciplinary approaches demonstrated comparable effectiveness, teachers may apply these approaches flexibly, emphasizing the relevance, authenticity, and quality of learning activities rather than the exclusive use of a particular integration model. Furthermore, the Mathematics Transitional Program (MTP) may be considered for implementation as a structured intervention for Grade 10 learners to strengthen foundational mathematical skills and prepare them for higher-level mathematics courses in Senior High School. The school may further propose the integration of the MTP into its implementation of the MATATAG Curriculum, ensuring that its objectives, learning activities, assessment practices, and instructional time are aligned with the applicable provisions of DepEd Order No. 010, s. 2024 and its amendment, DepEd Order No. 012, s. 2024. Such integration may be undertaken within the flexibility provided to schools while remaining consistent with prescribed learning standards and subject to the appropriate school and DepEd approval processes. This may provide a policy-supported structure for strengthening Grade 10 learners' mathematical readiness before entering Senior High School. Future researchers may explore the long-term effects of subject-integrated instruction on other learner outcomes, including mathematical motivation, engagement, achievement, and learning attitudes. Replication studies across different grade levels, educational settings, and subject areas are also recommended to further validate the applicability and effectiveness of integrated instructional approaches..

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Volume 1, Issue 9, pp. 90-108, October 2026
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Original Article

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