Research Paper

Mathematics Literacy, Fluency, and Creativity Among Senior High School Learners

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Abstract

This study examined the relationships between mathematical literacy and creativity, as well as between mathematical fluency and mathematical creativity, among senior high school learners. It used a quantitative approach and a descriptive-correlational design. The study's respondents were 200 senior high school students from Laguna State Polytechnic University - Los Baños Campus. The research instruments utilized were standardized scales that assessed the respondent's mathematical literacy, fluency, and creativity. The statistical tools used were the weighted mean, standard deviation, Pearson product-moment correlation, and linear regression. The findings revealed a strong and significant relationship among the respondents between mathematical literacy, fluency, and mathematical creativity. This indicates that the increase in their mathematical literacy is positively related to their ability to demonstrate originality, flexibility, and elaboration when solving higher mathematics problems. Their ability to make sense of numbers and apply that understanding flexibly and productively when solving problems greatly contributes to their producing ideas that are unique, valuable, appropriate, and meaningful in mathematics. Mathematical literacy and fluency significantly explain the creativity in mathematics among learners. The student's capability to create and justify a unique solution is greatly contributed to by their ability to construct, use, and interpret mathematics in a range of situations, as well as their ability to work swiftly and accurately under pressure while maintaining focus in solving higher mathematics problems.

Keywords: *Mathematics literacy, Mathematical fluency, Creativity*

INTRODUCTION

Mathematics is the language of modern society. It is used to solve real-world problems encountered in daily life. Mathematics is the science of shapes, structures, and numbers, dealing with abstractions, interrelations, and generalizations of space. Today, mathematics is applied across diverse disciplines, using data, scientific observations, inferences, deduction, and proofs, including mathematical models of natural phenomena, human behavior, and social systems. According to Yadav (2019), mathematics is the logical study of shape, numbers, arrangement, measure, quantity, and related concepts. Traditionally, mathematics is defined as the scientific study of quantities, their relationships, measurements, and operations, expressed through numbers and symbols. However, Yadav also describes mathematics today as a science that investigates abstract structures and creates patterns and properties.

Mathematical literacy (ML) is a concept that defines the competencies and knowledge essential to meet the mathematical demands of society in personal and social life. It enables individuals to use mathematical concepts, such as numeracy, to solve problems as reflective, informed, and contributing citizens. Rizki and Priatna (2019) describe mathematical literacy as a skill that applies mathematics to deal with daily challenges, allowing the development of skills and confidence to interpret and critically analyze problems numerically and spatially. Umbara & Suryadi's (2019) study states that mathematical literacy is not only the knowledge of complex mathematical concepts in fields such as differential equations, topology, calculus, linear algebra,

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analysis, or abstract algebra, but also the achievement of understanding and appreciating mathematics itself.

Mathematical fluency (MF) is the ability to carry out procedures flexibly, efficiently, accurately, and appropriately, using factual concepts and knowledge. It requires decision-making and choice (Cartwright, 2022). MF involves performing basic mathematical operations with speed and minimal effort across various mathematical disciplines. Fluency in mathematics enables individuals to communicate their knowledge, make connections, recognize patterns, and solve problems in social contexts. Hunter, Perger & Darragh (2018) highlight in their study that MF includes the ability of students to use multiple pathways, communicate their reasoning, make connections, take risks, and apply new learning in diverse disciplines.

Creativity in mathematics involves understanding cause and effect in mathematical situations, leading to the formulation of hypotheses, testing and retesting them, making modifications, and communicating results. It is measured through exploration, experimentation, imagination, and originality, all stemming from curiosity. Yadav's (2016) study describes Mathematical Creativity (MC) as a construct that involves divergent and convergent thinking, problem-solving, self-expression, a questioning attitude, and self-confidence. Creativity in mathematics enables the generation of multiple solutions and approaches to mathematical problems, characterized by elaboration, originality, and flexibility. Furthermore, Vink, Willemsen, Lazonder & Kroesbergen (2022) state that mathematical creativity enables the connection of elements in mathematical problems and the exploration of various solution pathways. In the Philippine basic education system, this exploratory and flexible nature of mathematical creativity directly mirrors the core philosophy of the Strengthened Senior High School (SHS) Curriculum. By reducing the academic burden to five streamlined core subjects, with General Mathematics serving as a vital foundation, the curriculum deliberately creates structural space for deeper, innovation-driven learning rather than rote memorization. Consequently, nurturing mathematical creativity is vital to achieving the nation's expected learner outcomes: producing mathematically literate, autonomous, and analytical graduates who can fluidly apply divergent problem-solving across both Academic and Technical-Professional pathways.

The Policy Guidelines on the Implementation of Grades 1 to 10 of the K-12 Basic Education Curriculum (BEC), as stated in DepEd Order No. 31 s. 2012, aim to enhance learners' competencies. The curriculum follows a spiral progression, in which concepts are built upon and developed with increasing complexity and sophistication across subjects. Students are expected to build on previously learned concepts, gradually advancing from simple to complex presentations and gaining mastery of basic skills before tackling more complex ones. Orale & Uy's study (2018) found that the spiral progression approach encourages students to apply previously learned concepts to new situations, fostering an appreciation for the connections among content standards and reinforcing learning for all, including struggling learners.

The Philippines' new educational reform aims to foster the holistic development and global competence of Filipino learners. However, an assessment of its effectiveness found that Filipino high school students ranked second to last among 79 participating countries in the 2018 Program for International Student Assessment (PISA) mathematics examination (Balagtas et al., 2019). Furthermore, the study indicated that most students mastered fewer than 50% of the expected concepts.

In the same study, Balagtas et al. (2019) reported that the Philippines ranked last among 58 participating countries in the Trends in International Mathematics and Science Study (TIMSS), highlighting poor performance in mathematics among Filipino students. While they demonstrated basic computational skills, they struggled with questions requiring critical thinking. Therefore, there is a clear need to explicitly develop cognitive processes to enhance critical thinking and problem-solving skills among Filipino learners.

In the 21st century, daily problems are becoming increasingly complex and challenging. It is crucial for students to develop problem-solving skills at an early age, including decision-making, critical thinking, communication, collaboration, and literacy. These skills are essential for students to effectively solve real-world problems through diverse and creative solutions. Thus, this study aims to examine the relationship between mathematical literacy, fluency, and mathematical creativity among senior high school students. Specifically, it aims to determine the following:

Specifically, it sought to answer the following questions:

1. What are the students-respondents' level of mathematical literacy in terms of Competence, Confidence, Critical Thinking, and Task Value
2. What is the level of mathematical fluency among the respondents in terms of Strategic Competence, Conceptual Understanding, and Adaptive Reasoning
3. What is the level of mathematical creativity among the respondents in terms of Originality, Flexibility, and Elaboration
4. Is there a significant relationship between mathematical literacy and mathematical creativity among student-respondents?
5. Is there a significant relationship between mathematical fluency and mathematical creativity among student-respondents?
6. Do the mathematical literacy and fluency significantly explain the mathematical creativity of the students-respondents?

Hypotheses

The following hypotheses were treated at .05 level of significance:

1. There is no significant relationship between mathematical literacy and mathematical creativity among student-respondents.
2. There is no significant relationship between mathematical fluency and mathematical creativity among student-respondents.
3. Mathematical literacy and fluency do not significantly explain the mathematical creativity of the students-respondents.

LITERATURE REVIEW

The cited literature provides a framework for how the study was approached, and the discussion of results from various studies helps the researcher identify the gaps to be addressed in this study.

Literacy in Mathematics

Literacy skills are crucial to learning mathematics. In the Philippine educational context, mathematical literacy is especially important because students are expected to apply mathematical concepts to everyday situations, such as budgeting, measuring, interpreting data, and solving practical problems in school and in the community. Mathematical literacy enables students to recognize the practical benefits of mathematics in everyday life, solve real-world problems using mathematical concepts, and apply these skills in decision-making. The research findings indicated that students with high mathematical ability demonstrated a strong profile in mathematical literacy when solving PISA problems. These students were capable of advanced thinking and successfully completed all six levels of PISA problems by effectively engaging in each mathematical literacy process: formulating, employing, and interpreting (Rahmadhani et al., 2024).

In mathematics, literacy is the ability to construct, apply, and interpret mathematics across diverse contexts. This includes mathematical reasoning and the use of concepts to describe or predict phenomena. It is crucial to understand and apply mathematical literacy in daily life, particularly in the Philippines, where learners encounter mathematics not only in the classroom but also in real-life tasks that require numerical and spatial thinking. According to Rizki & Priatna (2019), mathematical literacy helps learners develop the skills to build confidence in numerical and spatial thinking and to critically analyze everyday situations and problems. It provides them with a deep understanding of the role of mathematics in the 21st century and the modern world.

However, mathematical literacy (ML) remains a significant challenge and a key issue in basic mathematics education. In the Philippine setting, this challenge is often seen in students' difficulty connecting mathematical ideas to real-life situations, especially when problems are presented as word problems or in unfamiliar contexts. According to Raj (2017), students truly understand mathematics when they actively build their own mathematical understanding. This process requires them to confidently represent, transform, solve, apply, demonstrate, and convey mathematical concepts. However, Raj (2017) also revealed that students face various obstacles to achieving mathematical literacy, such as a lack of prior knowledge, weak connections between new and previously learned mathematical concepts, negative attitudes toward mathematics, and mathematical anxiety. As a result, few or no students demonstrate a strong level of competence and confidence in the subject, and their skills and pre-existing knowledge often go unrecognized, leading to a poor appreciation of mathematics.

Fluency in Mathematics

Fluency is the ability to perform simple tasks quickly and accurately under pressure while maintaining concentration and focused attention. In the Philippine educational setting, this skill is especially important because learners are expected to apply basic mathematical operations not only in classroom exercises but also in practical situations such as budgeting, measuring, handling money, and solving everyday problems. Fluency involves selecting a response, assimilating alternative responses, and choosing the correct response among the activated alternatives. Fluency integrates "doing" and "knowing" in mathematics. This means that fluency involves understanding how numbers can be manipulated and applying that knowledge flexibly and effectively when solving problems. Foster (2018) considers fluency an essential mathematical skill that promotes students' development in mathematics. He found that mathematical fluency enables learners to engage in more complex problem-solving discussions, as automaticity in basic skills enhances their creativity.

Furthermore, Tikhomirova & Malykh (2017) define mathematics fluency (MF) as the ability to perform basic arithmetic operations quickly and accurately, which supports success across mathematical disciplines. In the Philippine context, this is highly relevant because many learners encounter mathematical tasks that demand speed and accuracy in real-life and academic settings, especially word problems and other applied exercises. They emphasize the need for mathematical education to prioritize fluency because of its link to students' success in daily life. Research also shows that when faced with more complex mathematical problems, students with low fluency rely heavily on their cognitive abilities to perform basic operations, which limits their ability to solve more advanced problems. In contrast, students who demonstrate high levels of fluency can perform basic calculations quickly and accurately, enabling them to solve a wider range of problems. Moreover, high fluency supports the mastery of higher-order mathematical skills by providing a foundation in basic operations and helping students stay focused on tasks for longer periods, avoiding distractions.

Fluency refers to the ability to perform tasks in a flexible, correct, efficient, and appropriate manner. It encompasses the application of factual knowledge and concepts, allowing individuals to readily execute mathematical procedures and understand the various aspects of concepts (Cartwright, 2022). In the Philippine classroom, developing this kind of fluency can help students become more confident in solving everyday numerical problems and improve their overall performance in mathematics.

Creativity in Mathematics

In the modern world, creativity, along with critical thinking and problem-solving skills, plays a crucial role across domains and is widely recognized as an essential 21st-century skill. In the Philippine educational context, creativity is equally important because students are expected to apply mathematical ideas not only in classroom tasks but also in everyday situations that require flexible thinking, adaptation, and practical problem-solving. The definition of creativity varies by culture, individual knowledge, and community. In mathematics, creativity is defined as an individual's capacity to generate new ideas and use them effectively to discover solutions that are novel, functional, appropriate, and valuable (Lehmkuhl et al., 2021).

Grégoire (2016) asserts that mathematical creativity (MC) is based on an individual's intellectual abilities and personality traits, enabling them to think creatively and apply their knowledge and calculations. In the Philippine setting, this is especially relevant because learners often encounter mathematics as more than a set of procedures; they are also expected to make sense of problems, explain their reasoning, and adapt strategies when standard methods are insufficient. A creative person produces ideas or products that are distinct from previous human activity and possess value, appropriateness, and significance. In mathematics, students demonstrate creativity when they actively engage with challenging problems, including ill-posed and open-ended tasks, to sustain independent problem-solving. While students may not necessarily construct new mathematical concepts like mathematicians do, they can still discover unique and insightful solutions to problems, allowing them to approach familiar problems from new perspectives and formulate new questions.

Creative thinking skills and communication abilities are essential capabilities that students should possess alongside affective skills. In Philippine classrooms, these skills are particularly important because students are often asked to explain their solutions clearly, work through unfamiliar problems, and communicate mathematical reasoning in ways that reflect both accuracy and understanding. The findings showed that problem-based learning is more effective than conventional teaching methods in enhancing students' creative thinking and mathematical communication skills (Umam et al., 2021). Overall, mathematical creativity encompasses the capacity to establish connections, engage in abstraction, and contribute to research, fostering innovative thinking and problem-solving in the realm of mathematics.

Theoretical Framework

This study is grounded in three theories: Dewey's Theory of Progressive Education, Kolb's Learning Cycle, and Werner's Theory of Cognition.

Dewey's Theory of Progressive Education, proposed by John Dewey in 1890, introduced a new perspective on classroom methods, the purpose of schools, and the nature of children. Dewey advocated for education that involves socially engaging learning experiences appropriate for the development of young learners. He believed in transforming traditional education to meet mature standards in terms of methodologies, subject matter, and the teaching of basic skills as formal subjects. According to William (2017), the foundation for achieving mastery in more complex problems lies in providing students with a solid foundation in basic skills.

Another theory relevant to this study is Kolb's Learning Cycle. This theory highlights that individuals can manage their own learning by reflecting on their experiences and taking control of their self-development. The learning cycle proposed by Kolb incorporates both deductive and inductive approaches to education, allowing students to move from concrete ideas to testing implications or using concrete experiences for reflective practice (Kuri, 2000), as illustrated in Figure 1. This transformation of experiences is based on the underlying principles that (1) learning is best developed as a process rather than an outcome, (2) learning is a continuous process rooted in experiences, and (3) learning is a comprehensive process that promotes adaptability in the world. Kolb's Learning Theory is highly relevant to this study, as the researcher believes in a clear connection between the process of attaining fluency from literacy to creativity, where students are able to effectively communicate their experiences and skills in formulating strategies and representations when solving abstract mathematical problems.

This study is grounded in Werner's Theory of Cognition, which holds that primitive forms of behavior persist even as more complex behaviors are acquired. However, these primitive behaviors become subordinated to more abstract activities in learners. Werner believed that human development begins with a global state and progresses to articulation, differentiation, and hierarchical integration. He viewed human growth as a systematic process, with each stage depending on the development of the preceding stages (Morgan, 1996; Nderu-Boddington, 2008).

Learners must demonstrate early numeracy skills, such as numerical identification and magnitude comparison, to understand the relationship between numbers and quantity. Their proficiency depends largely on their ability to apply their knowledge and understanding to develop more advanced skills based on the foundational skills they have acquired. Clarke further stated that learners become ready when they focus on basic concepts in the elementary grades and apply those skills in higher-level mathematics.

RESEARCH METHOD

Research Design

This study employed a quantitative method and used a descriptive-correlational research design to investigate relationships among variables without manipulating them. The descriptive component was used to gain new insights, describe characteristics, and explore what exists within the group. This design provided the necessary information for hypothesis testing based on observations. Additionally, the correlational component was employed to examine and explain relationships among the variables, enabling the researcher to make predictions based on the established relationships in an objective manner (Seeram, 2019).

Respondents and Sampling

The respondents of this study were 200 senior high school students enrolled at Laguna State Polytechnic University - Los Baños Campus. Specifically, the participants were Grade 11 and Grade 12 students following the K-12 curriculum. These students had undergone the spiral progression approach in their education, which meant they had acquired the essential competencies and skills required for studying higher mathematics through progressively complex topics during their primary and lower secondary education.

This study employed a probability sampling method known as simple random sampling. This technique ensures that every unit in the population has an equal chance of being selected for the study. It is particularly suitable for studies with larger populations, as it allows for the selection of a subset of individuals that can provide a statistically representative response for the entire group. Given that this study focused on senior high school students at Laguna State Polytechnic University - Los Baños Campus, with a total population of 216 students, simple random sampling was advantageous. According to Sharma (2017), the simple random sampling technique is unbiased and enables researchers to generalize to the population from the results of the selected sample.

Instrument

The study employed an adapted survey questionnaire to gather primary data. Three instruments were used to assess the study's main variables: the Mathematical Literacy Checklist (MLC), the Mathematical Fluency Checklist (MFC), and the Mathematical Creativity Checklist (MCC). Secondary data collection included respondents' demographic profiles, capturing information such as name (optional), age, sex, and grade level.

The MLC, adapted from Zhi, Liu, & Lin (2017), consists of twenty (20) items divided into four parts: Competence, Confidence, Critical Thinking, and Task Value. It produced a good reliability index, with Cronbach's α = .884. The checklist used a five-point Likert scale ranging from Always – 5, Often – 4, Sometimes – 3, Rarely – 2, to Never – 1.

The MFC comprises fifteen (15) items that assess fluency characteristics among students, including Strategic Competence, Conceptual Understanding, and Adaptive Reasoning. It used a four-point Likert scale ranging from Strongly Agree – 4, Agree – 3, Disagree – 2, to Strongly Disagree – 1. The checklist was adapted from Zhang et al. (2021) and showed an excellent reliability index of α = .941.

The MCC consists of fifteen items anchored to a four-point Likert scale ranging from Strongly Agree – 4, Agree – 3, Disagree – 2, to Strongly Disagree – 1. The checklist for creativity was developed and adapted from Lehmkuhl et al. (2021), focusing on Originality, Flexibility, and Elaboration as factors in assessing mathematical creativity. Reliability analysis of the questionnaire showed a Cronbach's alpha coefficient of α = 0.961, indicating excellent internal consistency of the items.

Table 1. Reliability coefficient of the instrument measuring mathematics literacy, mathematics fluency, and mathematical creativity

Parameter (N = 30)	Cronbach Alpha Coefficient	Reliability Level
Mathematics Literacy (20 items)	.90	Good
Mathematics Fluency (15 items)	.83	Good
Mathematical Creativity (15 items)	.85	Good
Overall Instrument (50 items)	**.93**	**Very Good**

Legend: Excellent >.94, Very Good .91 - .94, Good .81 - .90, Fair .67 - .80, Poor < .67

Table 1 presents the results of the reliability testing conducted on the research instrument, which indicate a good reliability index for assessing respondents' mathematics literacy, mathematics fluency, and mathematical creativity.

Data Collection

Once the instrument was validated and approved by five (5) experts, and the request letter was approved and signed by the Associate Dean of the College of Teacher Education and the research adviser, the researcher promptly contacted the principal of the selected school to request permission to include the school's students as respondents in the study. Ethical guidelines were strictly followed to ensure the confidentiality of the data and the well-being of the respondents.

Upon receiving permission, the researcher personally delivered the questionnaire to the advisers of the selected respondents in each school, according to their grade level. Clear instructions were provided to the advisers to ensure that the students could comfortably complete the survey.

After collecting all the responses, the researcher used an Excel spreadsheet to tally and tabulate the data. The researcher then presented, analyzed, and interpreted the results based on the tabulated data. To address the research questions posed in the study, the researcher collaborated with a chosen statistician who applied appropriate statistical tools for data treatment.

FINDINGS AND DISCUSSION

The data were gathered through the administration of a survey questionnaire to the selected senior high school students at Laguna State Polytechnic University.

Table 2. Level of competencies in mathematics among students-respondents

Competency	Mean	SD	Descriptive Interpretation
Mathematical Literacy	3.81	0.58	Very High
Mathematical Fluency	3.15	0.48	High
Mathematical Creativity	3.18	0.43	High
Grand Mean	**3.38**	**0.47**	**High**

Legend: 1.00 – 1.74 = Very Low; 1.75 – 2.49 = Low; 2.50 – 3.74 = High; 3.75 – 4.0 = Very High

As shown in Table 2, senior high school students demonstrate a high level of mathematical competency after completing basic education, with an overall mean of 3.38 and a standard deviation of 0.47. This indicates that they have acquired the skills and knowledge needed to become proficient, fluent, and creative in mathematics. With the prerequisite knowledge and skills for higher-level mathematics, these students can perform tasks successfully. They can communicate ideas, formulate solutions to problems, solve challenging mathematical tasks accurately, and apply their knowledge to generate new solutions to the problems they encounter. Consequently, as highlighted by Mamolo (2019), students learn to value classroom discourse and take responsibility for their learning in mathematics.

Literacy, fluency, and creativity are crucial competencies for demonstrating mastery in higher-level mathematics. Although the study shows that senior high school students exhibit a high level of mathematical literacy, fluency, and creativity, they still face challenges that hinder them from demonstrating proficiency in the subject and realizing their full potential in solving higher-level mathematics. This finding is further supported by the study conducted by Nor et al. (2016), which shows that students at the secondary level, including senior high school, excel in mathematical communication, a component of mathematical literacy, but struggle to devise strategies, reason, and explain arguments to demonstrate mathematical creativity.

As a result, even if senior high school students' mean score (M = 3.38, SD = 0.47) indicates a respectable degree of mathematical literacy and fluency, it only partially satisfies curriculum objectives. The score shows that although the fundamental building blocks of mathematics education are well established, students still struggle to fully grasp the highest level of the curriculum's expected outputs, which include genuine mathematical creativity, strategic risk-taking, and robust algebraic reasoning.

Table 3 shows the relationship between the senior high school students' mathematical literacy and creativity.

Table 3. Test of significant relationship between mathematical literacy and creativity among student-respondents

Variables	r-value	Magnitude of Correlation
Competence	.396**	Low Positive
Confidence	.527**	Moderate Positive
Critical Thinking	.522**	Moderate Positive

Task Value	.509**	Moderate Positive
Mathematics Literacy	**.604****	**Moderate Positive**

**Correlation is significant at the .01 level (2 tailed)

As shown in Table 3, there is a strong and significant relationship between mathematical literacy and creativity among senior high school learners. This is evidenced by the computed p-value of .000, which is less than .05, indicating a statistically significant relationship. Students' competence, confidence, critical thinking, and task value are positively associated with their ability to generate meaningful strategies and solutions. Moreover, the computed r-value of .604 suggests a moderate positive relationship between creativity and literacy. This implies that as students develop mathematical literacy, their capacity to perceive different approaches to the diverse problems they encounter is enhanced.

Mathematical literacy empowers students to apply, interpret, and construct mathematics across various concepts, including reasoning and describing phenomena (Montoya, 2018). In contrast, mathematical creativity enables students to independently formulate solutions that they can explain and justify. The study revealed a relationship between these two constructs, demonstrating that students become more creative as their mathematical literacy increases. Developing confidence in their knowledge, exercising critical thinking when faced with challenging problems, cultivating competence in problem-solving, and valuing mathematical tasks enable students to generate new techniques and employ them effectively to provide creative, useful, appropriate, and valuable solutions to a wide range of problems.

Table 4 presents the test of the significant relationship between mathematical fluency and creativity among senior high school learners.

Table 4. Test of significant relationship between mathematical fluency and creativity among student-respondents

Variables	r-value	Magnitude of Correlation
Strategic Competence	.626**	Moderate Correlation
Conceptual Understanding	.608**	Moderate Correlation
Adaptive Reasoning	.661**	Moderate Correlation
Mathematics Fluency	**.708****	**High Correlation**

**Correlation is significant at the .01 level (2 tailed)

As depicted in Table 4, there is a high correlation between mathematics fluency and creativity among senior high school learners, as evidenced by the computed r-value of .708. This indicates that higher fluency in mathematics corresponds to higher levels of creativity. The students' strategic competence, conceptual understanding, and adaptive reasoning significantly contribute to their ability to demonstrate originality, flexibility, and elaboration in various mathematical tasks. When students possess a strong foundation in manipulating and analyzing numbers and can apply this understanding flexibly and productively when solving problems, they are more likely to generate unique, valuable, appropriate, and meaningful ideas in higher-level mathematics. This finding aligns with the research conducted by Grégoire (2016), which suggests that creativity is nurtured when students demonstrate interest and independence in solving challenging problems, particularly through ill-posed and open-ended mathematics problems.

Furthermore, the study reveals a strong and significant relationship between fluency and creativity in mathematics, as indicated by the computed p-value of .000, which is less than .05. This implies that students exhibit higher levels of creativity in mathematics when they can focus their attention on the mathematical problem at hand and solve it quickly under pressure. While they may not construct and develop mathematical theories like professional mathematicians, they can generate unique solutions and explore questions that allow them to solve mathematical problems promptly and explicitly.

Table 5 shows the test of significant prediction of mathematical literacy and fluency on the mathematical creativity of senior high school learners.

Table 5. Test of significant prediction of mathematical literacy and fluency to the mathematical creativity of senior high school learners

		Unstandardized Coefficients		Standardized Coefficients		
	Model	B	Std. Error	Beta	t	Sig.
1	(Constant)	0.981	0.153		6.432	0.000
	Mathematics Literacy	0.163	0.050	0.220	3.242	0.001
	Mathematical Fluency	0.500	0.061	0.556	8.196	0.000

N = 200; R2 = .526; Adj. R2 = .521; F (2, 199) = 109.396; p < .01
Dependent Variable: Mathematical Creativity

As shown in Table 5, a multiple linear regression was conducted to predict senior high school students' mathematical creativity based on their mathematical literacy and fluency. A significant regression equation was found [F (2, 199) = 109. 109.396, p <. .01], with an Adjusted R 2 of. .521. This indicates that mathematical literacy and fluency contributed significantly to students' mathematical creativity. The respondent' s predicted creativity in mathematics (MC) is equal to. .981 +. .163 (Mathematical Literacy) +. .500 (Mathematical Fluency), where ML is coded or measured as never or always, while MF is coded or measured as strongly disagree or strongly agree.

The equation indicates that for every one (1) unit increase in the respondent' s creativity in mathematics, the model predicts a. .163- unit increase in mathematical literacy, holding other factors constant. Moreover, for everyone (1) unit increase in the respondent' s creativity in mathematics, the model predicts a. .500- unit increase in their mathematical fluency, keeping other factors fixed. The model also suggests 52. 1% of the variance in the respondent's mathematical creativity is significantly explained by their mathematical literacy in terms of competence, critical thinking, confidence, and task value, as well as their mathematical fluency in terms of strategic competence, conceptual understanding, and adaptive reasoning. Hence, students' ability to create and justify a unique solution is greatly supported by their ability to construct, use, and interpret mathematics in a range of situations, as well as their ability to work swiftly and accurately under pressure while maintaining focus and attention in solving higher mathematics problems.

These findings align with the statement by Capone et al. (2020) that, although students showed difficulties in argumentation, they demonstrated development in their ability to communicate, which helps them improve their use of logical reasoning to explain their solutions to mathematical problems. This progressive communicative ability ultimately strengthens their capacity to utilize logical reasoning when explaining mathematical solutions. In the context of the Philippine Senior High School curriculum, this insight is highly significant. It suggests that the high communicative competence observed among Filipino learners, often nurtured through collaborative reporting, performance tasks, and contextualized learning, is not just an isolated soft skill. Rather, it is a potent, underutilized cognitive bridge. If instruction intentionally leverages students' willingness and ability to express themselves, their existing communicative fluency can be transformed into the very engine that drives deeper logical reasoning and mathematical argumentation.

CONCLUSIONS

Mathematics provides students with the opportunity to enhance their ability to utilize and interpret mathematical concepts, enabling them to respond accurately and swiftly to a variety of problems. This prepares them for real-world tasks that necessitate creativity. Students demonstrate their creativity in mathematics by exhibiting high levels of mathematics literacy and fluency. When they apply, interpret, and construct mathematical concepts and focus on problem-solving, they can develop their own techniques and apply them effectively to provide meaningful solutions to real-life situations.

The hypothesis that there is no significant relationship between mathematical literacy and creativity is rejected. This implies that students with high mathematical literacy also exhibit high levels of mathematical creativity. Students who are literate in the subject can also devise unique solutions based on the knowledge and skills they acquire. Additionally, the hypothesis that there is no significant relationship between mathematical fluency and creativity is rejected. This suggests that students who can solve problems proficiently and quickly also possess the ability to justify their processes and solutions for specific mathematical problems.

Moreover, the hypothesis that mathematical literacy and fluency do not significantly contribute to explaining creativity in mathematics among learners is also rejected. An increase in mathematical creativity corresponds to increases in both fluency and literacy among students in mathematics. This implies that as students become more literate and fluent in the subject, they become more capable of generating unconventional solutions that they can explain and justify. Because literacy and fluency collectively predict a learner's creative capacity, instructional frameworks must integrate them deliberately. By shifting classroom norms away from passive memorization and toward contextualized, multi-solution tasks, educators can leverage students' foundational skills to unlock original thinking. When students are routinely required not only to calculate accurately but also to verbally defend and justify their unique procedural pathways, they move beyond basic computational literacy and evolve into the innovative, flexible problem-solvers envisioned by the national curriculum.

In conclusion, the study demonstrates positive relationships among mathematical literacy, fluency, and creativity. Students with high literacy and fluency in mathematics are more likely to exhibit creative problem-solving skills, producing unique solutions that they can explain and justify.

LIMITATION & FURTHER RESEARCH

This study assessed the mathematical literacy, fluency, and creativity of 200 senior high school students from Laguna State Polytechnic University – Los Baños Campus during the second semester of Academic Year 2022–2023. The results cannot be widely extrapolated to the entire Philippine senior high school landscape due to the campus's localized physical and institutional boundaries, even though the straightforward random sampling technique guarantees statistical validity for this particular campus. These competencies may be affected differently by regional variations in K–12 implementation and school resources. Additionally, the scope was entirely correlational, treating respondents who received their education through the spiral progression approach as a homogeneous group and failing to distinguish the analysis by technical-vocational or specialized academic courses.

Further study should broaden both geographically and methodologically to build on these ideas. To attain genuine national generalizability, future research should use stratified random sampling across various areas and school typologies. To determine whether the favorable correlations between literacy, fluency, and creativity are consistent across various specialized learning routes, researchers are also urged to conduct strand-specific analyses. Last but not least, moving beyond correlational data through quasi-experimental treatments and longitudinal tracking from Grades 11 through 12 would offer profound, causal insights into how to actively foster mathematical creativity in Filipino students.

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