



Mathematical Proficiency and Achievement in Sequence of Students

Mary Rose B. Rios

Graduate Studies, Naga College Foundation Inc.
Naga City, Bicol Region, Philippines

Abstract: This study determined how the mathematical proficiency influence achievement in sequence of Grade 10 students and used the findings as basis in crafting worktext in Sequence, at Anib National High School, Anib Sipocot, Division of Camarines Sur for School year 2024-2025. Specifically, it answered (1) the level of mathematical proficiency of the students; (2) the students' achievement in sequence; (3) the relationship between mathematical proficiency of students and their achievement in sequence; (4) the influence of students' mathematical proficiency on their achievement in sequence; (5) the design of the worktext, and (6) the curricular validity of the worktext.

The research employed descriptive-correlational and research and development (R&D) methods, involving 80 Grade 10 students from Anib National High School in school year 2024-2025. Data collection tools included teacher made test and evaluation checklist. Statistical tools involved Mean, Standard Deviation, Proficiency Level, Pearson-product Moment Correlation Coefficient, Coefficient of Determination and Weighted Mean.

Key findings were (1) the level of mathematical proficiency of the students' has an overall proficiency level of 39.37; (2) the students' achievement in sequence have an overall proficiency level of 41.23; (3) the relationship between achievement of students in sequence and mathematical proficiency ranged from r-value of 0.009 to 0.770 and a p-value from 0.000 to 0.936; (4) the degree of influence of students' achievement in sequence on mathematical proficiency obtained an r^2 -values of 0.000 to 0.593; (5) the design of the worktext was divided into learning objectives, learning content, learning activities, and learning assessment; and (6) the curricular validity of the worktext obtained an overall average weighted mean of 4.83.

The major conclusion were (1) the mathematical proficiency skills of students were in the developing proficiency level; (2) the students demonstrated developing proficiency on achievement in sequence; (3) there was a significant relationship between the mathematical proficiency of students and achievement in sequence across parameters; (4) the mathematical proficiency influence ranged from negligible influence to high influence on the achievement of the grade 10 students in some areas; (5) the worksheet design enhanced the students mathematical proficiency and achievement in sequence, and (6) the overall validity of the worksheet was deemed very highly valid.

Keywords – Mathematical proficiency, Achievement in Sequence, Worktext

I. INTRODUCTION

Mathematical knowledge plays a very important role in understanding the other contents of other school subjects such as science, social studies, and even music and art. Many people believe that learning mathematics is an important thing to do and learning mathematics is a step-by-step process. Students' achievement in mathematics is a critical indicator of a student's abilities and problem-solving skills. Mathematics is a mere subject that goes beyond mere memorization of formulas and equations, requiring a deep understanding of concepts and the ability to apply them in a variety of contexts. Achieving success in mathematics not only demonstrates a students' proficiency in the subject but also their ability to think critically and analytically.

One of the factors that contribute to the academic achievement of students in mathematics is the strong foundation in basic mathematical concepts. At a very early stage of schooling students should master the basic concept of mathematics. Without a solid understanding of fundamental principles such as algebra, geometry, and calculus, students may struggle to

grasp more complex topics. It is essential for the students to master these foundational skills early in their academic careers in order to build a strong mathematical aptitude.

To have a strong solid foundation, achievement in mathematics also requires a regular practice and application of mathematical concepts. Regular practice not only helps students retain information but also allows them to develop problem solving skills and analytical thinking. Working through a variety of mathematical problems and scenarios, students can develop deeper understanding of the subject and improve their overall academic performance. According to Pandey (2017) Mathematical achievement refers to a student's competency in mathematics, typically measured through scores on achievement tests. It reflects the level of understanding, problem-solving skills, and knowledge of mathematical concepts attained by a student. Some factors causing students' error are ineffective learning, uncarefully solving questions, and student lack of understanding the material. To put it in a simple way, to learn math you must master the basic skills before solving problems that require higher order thinking skills. That is why teachers put effort into teaching mathematics for the student to learn the important skills they need to master.

The low performance of students in literacy and numeracy was evident across the globe which needed solutions. Programs and training were being implemented to solve this problem. Relative to this issue, the Sustainable Development Goal (SDGs), also known as the 2030 Agenda for Sustainable Development, were adopted by all United Nations members States in 2015, highlighted and discussed the 17 goals to target in 2030, and one of these was Sustainable Development Goal 4 or dubbed as 'Quality Education'.

“Sustainable Development Goal 4 aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. This goal supports the reduction of disparities and inequities in education, both in terms of access and quality. It recognizes the need to provide quality education for all, and most especially vulnerable populations, including poor children, children living in rural areas, persons with disabilities, indigenous people and refugee children.”

The effort to give quality education to all the children across the globe was evident because of the different programs and opportunities they keep on providing. Different tests were being conducted around the world to monitor the progress of the students in each country. Not just tests but in order to achieve these sustainable development goals effective strategies for achieving it include investing in teacher training programs, implementing instructional practices, and providing resources to support at-risk populations. They continue to set specific targets for improving math proficiency among students.

Despite the eagerness of the Department of education to provide students with appropriate education at an early age and provide the teacher with knowledge and skills to teach to enhance student's skills and knowledge, still there are a lot of students who struggle to learn mathematics. According to the 2022 Programmed for International Student Assessment (PISA) results, the Philippines ranked sixth from the bottom in mathematics with an average score of 356 which signifies that Filipino children's performance in mathematics is very poor. This could also be the result of the modular distance learning or the blended approach. Moreover, the result of 2018 Programmed for International Student Assessment (PISA) Filipino students achieved an average score of 353 points in Mathematical Literacy, which was significantly lower. Only 1 out of 5 Filipino students or 19.7% attained at least the minimum proficiency level (Level 2) in Mathematical Literacy. Among the participating Association of Southeast Asian Nations (ASEAN) countries, Filipino students performed closest to but significantly behind Indonesian students by 26 points in Mathematical Literacy. This result showed that even before the change in learning modalities the students are already struggling in mathematics which drastically decreased when the modular learning is being implemented

The Department of Education Order 24 series 2018 entitled “Guidelines for the Professional Development Component of the Early Language, Literacy, and Numeracy (ELLN)” program in the Philippines, aims to address the crucial need for quality education at an early age by focusing on developing children's foundational skills in language, literacy, and numeracy. The primary goal of this program is to ensure that all children have access to a strong educational foundation that will support their learning and development throughout their academic journey. The goal of this program is to strengthen the knowledge of the children in their early years of schooling. This program provides training to teachers to equip them with skills they need to use in teaching.

“...with the goal of the department to improve literacy and numeracy skills of learners from kindergarten to Grade 3 following the K to 12 Basic Education Curriculum by establishing a sustainable and cost-effective professional development system for teachers, the program aims to develop in Filipino children the literacy and numeracy skills, and attitudes, which will contribute to lifelong learning.”

The change in the learning strategies and environment has a great impact on the students especially in mathematics. According to the study of Dargo and Dimas (2021) there is 2.25% decrease in the general weighted average grade of the learners after the implementation of the modular distance learning and it 4 denotes a significant difference in their academic

performance. This can also imply that some students might not understand their topics or lessons in their module especially in mathematics and will find it very hard to encounter higher mathematics. One of the most important things that the students might not get in learning is also mastering their mathematical proficiency.

The poor performance of students in mathematics was being addressed by the Department of Education. According to the Department of Education Order no.14 series 2023, provides framework for the Implementation of the National Learning Camp. This policy guidelines aims to address learning gaps and challenges faced by students through an inclusive and learner-centered approach. The department of education continues to develop programs and strategy such as the Albay Numeracy Assessment Tool (ALNAT) which standardized tests used in the Philippines, specifically in the province of Albay, to assess the numeracy skills of students in grades 1-10. The test is designed to evaluate students' understanding of basic math concepts, including addition, subtraction, multiplication, division, and problem-solving in order to come up with a teaching strategy that will improve the performance of the students in math.

On the other hand, Mathematical Proficiency is about developing profound understanding in mathematics over several decades (Priya, 2017). According to him mathematically proficient people exhibit certain behavior and disposition as they are doing mathematics. To teach mathematical proficiency it requires a lot of effort, and concepts and connections develop over time, not in a day. Mathematical proficiency refers to an individual's ability to apply mathematical skills and knowledge effectively in a variety of contexts. It goes beyond simply being able to solve equations or perform calculations; it encompasses critical thinking, problem-solving, and reasoning skills. A mathematically proficient individual can analyze complex problems, identify patterns and relationships, and make connections between different mathematical concepts. They can communicate their findings clearly and concisely, using appropriate mathematical language. As students go from pre-kindergarten to eighth grade, all students should become increasingly proficient in mathematics which is not evident in students.

With this, the researcher was challenged to determine the influence of the students' mathematical proficiency to their achievement in a sequence of Grade 10 students at Anib National High School in Sipocot, district, school year 2024-2025. Furthermore, the researcher was challenged to develop a learning material that will enhance the students' mathematical proficiency skills, which are essential in learning mathematics. The research opted to develop learning materials specifically about sequences, which is a topic for grade 10 mathematics and is one of the important concepts used in higher-level math. It is in this light that the researcher necessitated conducting a study in this particular area of the curriculum.

II. RESEARCH METHODOLOGY

2.1 Method Used

This study employed the descriptive-correlational and Research and Development Methods. Descriptive method was applied to determine the mathematical proficiency skills of the students in terms of representation, comprehension, computation, and problem-solving. This was also applied to determine the achievement of the Grade 10 students in sequence. Furthermore, this was also used to determine the design of the worktext that enhanced the student's mathematical proficiency and achievement in sequence. Lastly, it was used to determine the curricular validity of the worktext in term of face, content, and construct.

The correlational method was used to determine the relationship between mathematical proficiency and achievement in sequence of the students. This was also used to determine the extent of influence of mathematical proficiency on achievement in sequence of the students. The research and development method on the other hand, was applied in crafting and producing the worktext, specifically focusing on Sequence.

2.2 Population and Sample

The respondents of the study were the grade 10 students of Anib National High School. The researcher used total enumeration hence no sampling technique was employed in identifying the number of respondents. The respondents of the study where all the grade 10 which was divided into two sections. The section A is composed of 42 students and the other section is composed of 38 students with a total of 80 respondents coming from the junior high school.

2.3 Data and Sources of Data

This study employed a researcher-made test and an evaluation checklist to validate its findings. The teacher-created test aimed at Grade 10 mathematics focused on essential learning competencies related to sequences and included 50 items. It utilized two tables of specification: one aligned with Bloom's Taxonomy and the other assessing mathematical proficiency in areas like representation and problem-solving. The test covered topics from the K-12 curriculum, including arithmetic and geometric sequences. After validation by a mathematics teacher, a dry run was conducted at an extension school. The test showed acceptable reliability (KR-20 score of 0.738) and item analysis revealed 18 difficult items and 21 items needing

revision or rejection before final administration. Additionally, an evaluation checklist was used with a 5-point Likert Scale to assess the curricular validity of the work text, covering face, content, and construct validity.

2.4 Theoretical framework

The present study was guided by the different theories supporting the use of instructional material in Mathematical Proficiency and students' achievement in sequence. This study was anchored mainly on Bruner's Constructivist Learning Theory cited by Abdolreza (2016). The supporting theories were Piaget's Cognitive Learning Theory cited Abdolreza (2016), Sticht's Functional Context Theory cited Cullata (2020). As illustrated in figure 1 shows the influence of the main theory and supporting theories.

Bruner's Constructivist Theory (2020) was utilized to guide the development and validation of instructional materials in a form of worksheet for Grade 10 – sequence, specifically targeting the competencies in Grade 10 mathematics.

According to Bruner's theory, a learner-centered approach emphasizes the importance of individuals actively constructing their knowledge and understanding through the guidance from the teacher. In the constructivist view, teachers should not attempt to simply pour information into children's minds. theory highlights the importance of considering the learner's existing knowledge and providing opportunities for meaningful interaction with the content. The application of Bruner's Constructivist Theory in this study informed the crafting, development, validation, and finalization of the Instructional material, material was designed to promote active learning and engagement. The worksheet was designed for the students to think critically and discover things on their own and understand mathematical concepts and develop their problem-solving skills.

The Cognitive Learning Theory by Jean Piaget as cited by Abdolreza (2016), cognitive approach is another important theory. Piaget was the first psychologist to make a systematic study of cognitive development. Cognitive development is a progressive reorganization of mental processes because of biological maturation and environmental experience. Cognitive learning theory is that learning is based upon how people mentally process stimuli encountered. In reaction, Benjamin Bloom created a taxonomy for cognitive skill that included knowledge, comprehension, application, analysis, synthesis, and evaluation, which he believed teachers should help students, so that they use and develop. The six stages are further elaborated as remembering, understanding, applying, analyzing, evaluating, and creating. A cognitive perspective implies that a behavioral analysis of instruction is often inadequate to explain the effects of instruction on learning. The application of this theory in this study lies within the mathematical Proficiency in terms of representation, comprehension, computation, and problem solving which is similar to the cognitive skills in the bloom's taxonomy. This helped in creating the teacher-made-test which was anchored to the blooms' taxonomy and the mathematical proficiency. This theory also helps in creating the instructional materials as it patterns to the mathematical proficiency that serve as the basis for creating the content of the worktext.

The Functional Context theory introduced by Thomas Sticht as cited by Cullata (2020), stresses the importance of making learning relevant to the experience of learners in their work context. The learning of new information is facilitated by making it possible for the learner to relate into their knowledge. the theory is based on the following principles: instruction may be meaningful in terms of their learner prior knowledge, performance can be improved by improving content knowledge, information processing skills, or design of the learning materials, valid assessment of learning requires context/content specific measurement. That is why the developed instructional material was related to the learners' prior experiences for them to easily understand the materials. The instructional material was developed from students' experience in answering activities. Student's experience was the basis for making the material. This will help them to be more active in class and to give them opportunity to practice their skills at home by answering this worktext and understand mathematical concepts and develop their problem-solving skills.

2.5 Statistical tools

The study analyzed data collected from students using various statistical methods. Descriptive statistics, including mean and standard deviation, assessed student performance in teacher-made tests and measured variability in their mathematical proficiency. Proficiency levels were determined to evaluate students' achievements after learning. Inferential statistics included Pearson's Product Moment Correlation to explore the relationship between mathematical proficiency and student achievement, and the Coefficient of Determination to assess the strength of that correlation. A weighted mean was also used to prioritize certain data values in the analysis.

III. RESULTS AND DISCUSSION

Results of Descriptive Statics of Study Variables

This chapter presents the findings and discussion of the data gathered concerning students Mathematical Proficiency along with achievement in sequence of Grade 10 students of Anib National High School in Sipocot District. The study's specific questions were addressed, discussed, and interpreted, for a clear understanding data were displayed in tables.

Mathematical Proficiency

In the conduct of this study, the 50-item researcher-made test was used to assess students Mathematical Proficiency in terms of Representation, Comprehension, Computation, and Problem Solving. The result in table 1 was about the students' Mathematical proficiency skills. The scale and values on the performance level of the students and interpretation were based on the K-12 Mathematics Curriculum applied in the country.

Table 3.1: Mathematical Proficiency

Aspects	No. of Items	Mean Score	SD	PL	Int.	Rank
Representation	12	5.55	2.27	46.25	D	1
Comprehension	12	5.26	2.13	43.83	D	2
Computation	13	4.75	2.21	36.54	D	3
Problem Solving	13	4.01	2.22	30.85	D	4
Overall	50		2.19	39.37	Developing	

The result in table 3.1 was about the students' Mathematical proficiency skills. The scale and values on the performance level of the students and interpretation were based on the K-12 Mathematics Curriculum applied in the country. The report assesses four mathematical proficiency skills among students, revealing their performance levels: Representation: Students answered 12 questions with an average score of 5.55, indicating a developing proficiency level of 46.25. With a standard deviation (SD) of 2.27, the scores showed little variability, suggesting that most students performed similarly and struggled in this area. Comprehension: For another set of 12 questions, students achieved a mean score of 5.26 and a proficiency level of 43.83, along with an SD of 2.13. Again, the low variability indicated that most students were at a developing level, but they were slightly closer to proficiency compared to the first skill. Computation: In this area, consisting of 13 questions, students had a mean score of 4.75 with a developing proficiency level of 36.54 and an SD of 2.21. The low variability indicated similar, poor performance across students. Problem Solving: Students answered 13 questions with an average score of 4.01, leading to a developing proficiency level of 30.87 and an SD of 2.22. This reflects critical thinking skills but also indicates a consistent, low level of proficiency. Overall, students predominantly demonstrated developing proficiency across all skills, indicating a need for improvement.

Achievement of the Students in Sequence

Academic achievement in mathematics is a multifaceted concept that encompasses not only the ability to solve complex mathematical problems but also the capacity to think critically, reason logically, and apply mathematical principles to real-world situations. Achieving success in mathematics requires a deep understanding of foundational concepts, strong problem-solving skills, and a willingness to persist in the face of challenges. Ultimately, academic achievement in mathematics is a testament to one's dedication, perseverance, and ability to think critically and creatively in the realm of mathematics. In the conduct of this study, the 50-item researcher-made test was used to assess students Achievement in Sequence based on the K to 12 curriculum such as generating patterns, illustrating an arithmetic sequence, determining arithmetic means, determining nth term of an arithmetic sequence, determining sum of the terms of a given arithmetic's sequence, illustrating a geometric sequence, differentiating a geometric sequence from an arithmetic sequence, determining geometric means, determining the nth term of a geometric sequence, sum of the terms of a given finite or infinite geometric sequence, solves problems involving sequences, results of which is shown in table 3.2.

Table 3.2: Achievement of the Students in Sequence

Learning Competencies	No. of Items	Mean Score	SD	PL	Int	Rank
Differentiating a geometric sequence from an arithmetic sequence	2	1.13	0.70	56.5	Approaching Proficiency	1
Determining geometric means	4	2.11	1.06	52.75	Approaching Proficiency	2
Illustrating an arithmetic sequence	4	2.09	0.93	52.25	Developing	3

Generating patterns	4	1.84	1.26	46.00	Developing	4
Determining the sum of the terms of a given finite or infinite geometric sequence	4	1.69	1.04	42.25	Developing	5
Determining arithmetic means	4	1.60	0.89	40.00	Developing	6
Determining nth term of a geometric sequence	4	1.49	1.07	37.25	Developing	7
Illustrating a geometric sequence	6	2.20	1.22	36.67	Developing	8
Determining the sum of the terms of a given arithmetic's sequence	6	1.95	1.33	32.50	Developing	9
Solves problems involving sequences	6	1.86	1.23	31.00	Developing	10
Determining nth term of an arithmetic sequence	6	1.80	1.46	30.0	Developing	11
Overall	50		1.11	41.23	Developing	

This competency involves differentiating geometric and arithmetic sequences with a mean score: 1.13, standard deviation: 0.70 indicating low variability, and proficiency level of 56.5 interpreted as approaching proficiency, which was the highest among the competencies assessed. Next is determining geometric means with a mean score of 2.11, standard deviation: 1.06 indicating low variability, and proficiency level of 52.75 interpreted as approaching proficiency, ranked second in the study. Illustrating arithmetic sequences has mean score of 2.09 standard deviation of 0.93 indicating low variability, and a proficiency level of 52.25 interpreted as developing, indicating a need for improvement, ranked third. Next is generating patterns with a mean score of 1.84, and standard deviation of 1.26 indicating low variability, and a proficiency level of 46.00 interpreted as developing, ranked fourth among the competencies. Sum of geometric sequences focuses on calculating the sum of finite and infinite geometric sequences. Students scored a mean of 1.69 with a standard deviation of 1.04, indicating consistent performance. Arithmetic means involves determining arithmetic means, with a mean score of 1.60 and a standard deviation of 0.89, again showing low variability and consistent student scores. The nth term of a geometric sequence achieving a mean score of 1.49 and a standard deviation of 1.07, which reflects close clustering around the mean. This competency was rated as "developing" (d) with a proficiency level of 37.25. Illustrating a geometric sequence which obtained a mean score of 2.20 and a standard deviation of 1.22. This competency had a proficiency level of 36.67 and was also rated as "developing" (d). Problem-solving with sequences achieved a mean score of 1.86 and a standard deviation of 1.23, indicating scores were closely grouped around the mean, showing low variability and high consistency. The proficiency level is 31.00, categorized as developing, and ranked tenth among all competencies assessed. Lastly, determining the nth term of an arithmetic sequence similarly, students answered 6 questions on this topic, scoring a mean of 1.80 and a standard deviation of 1.46, suggesting a consistent performance with low variability. The proficiency level is 30.0, also classified as developing, which is the lowest among the assessed competencies. Overall, both competencies show that students are developing their skills, with slightly better performance in solving general sequence problems compared to finding the nth term of an arithmetic sequence.

Relationship between Achievement of Students in Sequence and Mathematical Proficiency

The relationship between achievement of students in sequence and Mathematical proficiency was measured using computed R-value and its significance was interpreted as using the p-value at 0.05 significant level. As shown in table of 3.3, the evaluated achievement of students in sequence includes the learning competencies under grade 10 mathematics under sequence such as Generating patterns, illustrating an arithmetic sequence, Determining arithmetic means, Determining nth term of an arithmetic sequence, Determining sum of the terms of a given arithmetic's sequence, Illustrating a geometric sequence, Differentiating a geometric sequence from an arithmetic sequence, determining geometric means, Determining the nth term of a geometric sequence, Sum of the terms of a given finite or infinite geometric sequence, solves problems involving sequences and mathematical proficiency include representation, comprehension, computation, and problem solving.

Table 3.3: Relationship between Achievement of Students in Sequence and Mathematical Proficiency

Learning Competencies	Mathematical Proficiency	r-value	Interpretation	p-value	Interpretation
Generating patterns	Representation	0.699	Moderate	0.000	S
	Comprehension	0.205	Low	0.068	NS
	Computation	0.235	Low	0.036	S
	Problem Solving	0.155	Negligible	0.171	NS
Illustrating an arithmetic sequence	Representation	0.452	Moderate	0.000	S
	Comprehension	0.365	Low	0.001	S
	Computation	0.459	Moderate	0.000	S
	Problem Solving	0.568	Moderate	0.000	S

Determining arithmetic means	Representation	0.144	Negligible	0.203	NS
	Comprehension	0.182	Negligible	0.107	NS
	Computation	0.166	Negligible	0.141	NS
	Problem Solving	0.193	Negligible	0.000	S
Determining nth term of an arithmetic sequence	Representation	0.231	Low	0.040	S
	Comprehension	0.549	Moderate	0.000	S
	Computation	0.583	Moderate	0.000	S
	Problem Solving	0.526	Moderate	0.000	S
Determining the sum of the terms of a given arithmetic's sequence	Representation	0.185	Moderate	0.100	NS
	Comprehension	0.611	Moderate	0.000	S
	Computation	0.770	High	0.000	S
	Problem Solving	0.449	Moderate	0.000	S
Illustrating a geometric sequence	Representation	0.467	Moderate	0.000	S
	Comprehension	0.248	Low	0.027	S
	Computation	0.480	Moderate	0.000	S
	Problem Solving	0.481	Moderate	0.000	S
Differentiating a geometric sequence from an arithmetic sequence	Representation	0.588	Moderate	0.000	S
	Comprehension	0.088	Negligible	0.438	NS
	Computation	0.069	Negligible	0.541	NS
	Problem Solving	0.291	Low	0.009	S
Determining geometric means	Representation	0.150	Negligible	0.184	NS
	Comprehension	0.369	Low	0.001	S
	Computation	0.251	Low	0.025	S
	Problem Solving	0.264	Low	0.018	S
Determining nth term of a geometric sequence	Representation	0.299	Low	0.007	S
	Comprehension	0.371	Low	0.001	S
	Computation	0.379	Low	0.001	S
	Problem Solving	0.509	Moderate	0.000	S
Determining the sum of the terms of a given finite or infinite geometric sequence	Representation	0.167	Negligible	0.139	NS
	Comprehension	0.249	Low	0.026	S
	Computation	0.329	Low	0.003	S
	Problem Solving	0.489	Moderate	0.000	S
Solves problems involving sequences	Representation	0.009	Moderate	0.936	NS
	Comprehension	0.535	Moderate	0.000	S
	Computation	0.592	Moderate	0.000	S
	Problem Solving	0.533	Moderate	0.000	S

Table 3.3 shows the Relationship Between Achievement of Students in Sequence and Mathematical Proficiency were findings revealed that most of the combination were found significant at the 5% level and a few were found not significant at the 5% significant level. The highest Pearson r-value yield was 0.699 under Generating patterns and the lowest was 0.009 in solves problem involving sequences. The p-value range from 0.000 to 0.936 getting most of the combination significant.

Influence of Students' Achievement in Sequence on Mathematical Proficiency

The study examined the impact of mathematical proficiency on students' achievements in sequence learning, with a focus on various competencies like generating patterns, illustrating an arithmetic sequence, determining arithmetic means, determining nth term of an arithmetic sequence, determining sum of the terms of a given geometric means, determining the nth term of a geometric sequence, sum of the terms of a given finite or infinite geometric sequence, solves problems involving sequences and mathematical proficiency such as representation, comprehension, computation, and problem solving were further evaluated through Pearson's Product Moment correlation (r) and the coefficient determination (r^2).

Table 3.4. Influence of Students' Achievement in Sequence on Mathematical Proficiency

Learning Competencies	Mathematical Proficiency	r-value	r ² -value	Int.
Generating patterns	Representation	0.699	0.489	Moderate
	Comprehension	0.205	0.042	Very Low
	Computation	0.235	0.055	Very Low
	Problem Solving	0.155	0.024	Very Low
Illustrating an arithmetic sequence	Representation	0.452	0.204	Low
	Comprehension	0.365	0.133	Very Low
	Computation	0.459	0.211	Low
	Problem Solving	0.568	0.323	Low
Determining arithmetic means	Representation	0.144	0.021	Low
	Comprehension	0.182	0.033	Low
	Computation	0.166	0.028	Very Low
	Problem Solving	0.193	0.037	Very Low
Determining nth term of an arithmetic sequence	Representation	0.231	0.053	Very Low
	Comprehension	0.549	0.301	Low
	Computation	0.583	0.340	Low
	Problem Solving	0.526	0.277	Low
Determining the sum of the terms of a given arithmetic's sequence	Representation	0.185	0.034	Very Low
	Comprehension	0.611	0.373	Low
	Computation	0.770	0.593	Moderate
	Problem Solving	0.449	0.202	Low
Illustrating a geometric sequence	Representation	0.467	0.218	Low
	Comprehension	0.248	0.062	Very Low
	Computation	0.480	0.230	Low
	Problem Solving	0.481	0.231	Low
Differentiating a geometric sequence from an arithmetic sequence	Representation	0.588	0.346	Low
	Comprehension	0.088	0.008	Very Low
	Computation	0.069	0.005	Very Low
	Problem Solving	0.291	0.085	Very Low
Determining geometric means	Representation	0.150	0.023	Very Low
	Comprehension	0.369	0.136	Very Low
	Computation	0.251	0.063	Very Low
	Problem Solving	0.264	0.070	Very Low
Determining nth term of a geometric sequence	Representation	0.299	0.089	Very Low
	Comprehension	0.371	0.138	Very Low
	Computation	0.379	0.144	Very Low
	Problem Solving	0.509	0.259	Low
Determining the sum of the terms of a given finite or infinite geometric sequence	Representation	0.167	0.028	Very Low
	Comprehension	0.249	0.062	Very Low
	Computation	0.329	0.108	Very Low
	Problem Solving	0.489	0.239	Low
Solves problems involving sequences	Representation	0.009	0.000	No Influence
	Comprehension	0.535	0.286	Low
	Computation	0.592	0.350	Low
	Problem Solving	0.533	0.284	Low

Using Pearson's correlation analysis, it was found that the influence of mathematical proficiency on students' success in these areas was generally very low to moderate. The strongest correlation was observed for calculating the sum of terms in an arithmetic sequence, which indicated a moderate influence ($r^2 = 0.593$). However, many competencies, especially those related to problem-solving and representation, showed negligible influence (with r^2 values close to zero). Overall, while students performed satisfactorily in calculating sums, their overall mathematical skills appeared underdeveloped, indicating a need for improvement, particularly in problem-solving and conceptual understanding.

Design of the Developed Supplementary Material

The developed instructional material, a worktext in Sequences for Grade 10 Mathematics (First Quarter), was designed to enhance students' performance specifically in the topic of sequences. Grounded in the K to 12 Curriculum Guide, the worktext aimed to improve learners' mathematical proficiency by addressing the Most Essential Learning

Competencies (MELCs) prescribed by the Department of Education. It was systematically structured into eleven topics that comprehensively cover the first-quarter sequence content in Grade 10 Mathematics.

Learning Objectives. Each lesson in the worktext began with clearly defined learning objectives aligned with the MELCs. These objectives aimed to develop not only the students' conceptual understanding but also their procedural fluency and application skills. They were crafted to support students in acquiring the necessary knowledge, skills, and attitudes needed for academic and real-world mathematical tasks.

Learning Content. The content of the worktext was divided into four key parts. The introductory concept served as the first part of each topic, offering a clear overview, establishing the relevance of the lesson, and highlighting the key points to be addressed. This section was carefully written to engage students, build interest, and provide accessible information regardless of their current level of mathematical understanding. The second part presented the learning competencies, directly taken from the Grade 10 Curriculum Guide. These competencies provided a strong foundation for lesson design and ensured alignment with national standards. The worktext emphasized the Most Essential Learning Competencies (MELCs), ensuring its relevance and applicability in current educational settings. The structured division of the worktext into clearly defined parts demonstrates a thoughtful and systematic approach to instructional design. By beginning each topic with an introductory concept, the material intentionally aims to activate prior knowledge, establish context, and spark student interest. The effort to make content accessible to all levels of mathematical understanding implies a strong commitment to differentiated instruction, catering to both struggling and advanced learners. This inclusive approach enhances the usability of the worktext in diverse classroom settings.

Learning Activities. The third part, the learning activities, formed the core of the worktext. These activities were designed to reinforce understanding, support retention, and promote practical application of the concepts taught. Each topic included a variety of activities focused on enhancing mathematical proficiency across four key domains: representation, comprehension, computation, and problem-solving. The activities encouraged hands-on learning, allowing students to actively engage with content, apply their skills in realistic scenarios, and deepen their conceptual understanding through practice and exploration. This serves as the instructional backbone of the material. By centering the worktext around active, hands-on engagement, it emphasizes a constructivist approach to learning where students build knowledge through experience and exploration rather than passive reception. The targeted focus on the four domains of mathematical proficiency such as representation, comprehension, computation, and problem-solving suggests that the worktext was carefully designed to develop both foundational and higher-order thinking skills. This aligns with best practices in mathematics education, which stress the importance of deep understanding over rote memorization.

Learning Assessment. The final part of each topic was the assessment, which aimed to evaluate students' overall understanding and mastery of the lesson. These assessments provided teachers with valuable data to measure instructional effectiveness and identify areas where students needed further support. For students, assessments served as checkpoints for self-evaluation and progress monitoring. Furthermore, the assessments were designed not only to test knowledge but also to inspire critical thinking, creativity, and independent learning. The inclusion of a well-defined assessment component at the end of each topic reflects a comprehensive approach to evaluating student learning. By positioning assessment as the final part of the instructional cycle, the worktext emphasizes its role not just as a tool for grading but as a diagnostic and formative measure benefiting both teachers and learners. For teachers, the assessments serve as a means to gather meaningful data on student performance, which can be used to evaluate the effectiveness of instruction and guide instructional adjustments. This underscores a data-informed teaching approach, where decisions are grounded in evidence of student learning. For students, the assessments function as formative checkpoints, encouraging self-assessment, reflection, and progress monitoring. This empowers students to take an active role in their own learning journey, which is a hallmark of learner-centered education.

Curricular Validity of the Worksheet

Instructional materials refer to the human and non-human materials and facilities that can be used to ease, encourage, improve and promote teaching and learning activities. They are whatever materials used in the process of instruction. They are a broad range of resources which can be used to facilitate effective instruction. They indicate a systematic way of designing, carrying out and employing the total process of learning and communication and employing human and non-human resources to bring out a more meaningful and effective instruction. The worktext was validated in term of three parts namely Face, Content, and Construct validity.

Presented in table 4.5 is the summary of validity of the Learning Materials in Sequence grade 10 using 5-point Likert. Each criterion indicator was interpreted as Very Highly Valid (VHV). The overall weighted mean was 4.835 which was interpreted as very highly valid. The highest obtained weighted mean was 4.85 at Construct validity, followed by Face

validity with a weighted mean of 4.84, and the lowest weighted mean obtained was 4.815 at Content Validity. The result of the study showed that the developed worksheet is valid to be used as the teaching and learning materials.

Table 3.5 Curricular Validity of Developed Worksheet of Sequence Grade 10

Indicators	Average Weighted Mean	Interpretation	Rank
Construct	4.85	Very Highly Valid	1
Face	4.84	Very Highly Valid	2
Content	4.815	Very Highly Valid	3
Overall Weighted Mean	4.835	Very Highly Valid	

IV. Conclusion

Based on the findings of this study, conclusions were drawn aligned with the objectives if this study:

- (1) The students are making significant progress in their mathematical proficiency, particularly in the areas of representation, comprehension, computation, and problem solving. While they are moving towards mastery, it is clear that they have not yet fully achieved proficiency in all of these skills.
- (2) The students' achievement in sequence, in terms of learning competencies, is at the developing level, indicating that they still need to improve their comprehensive understanding of the covered areas and assessed learning competencies.
- (3) There is a significant relationship between mathematical proficiency skills and the selected learning competencies in Sequence under the Mathematics 10 curriculum.
- (4) There is a significant influence between students' mathematical proficiency and achievement in sequence in selected combinations. The learning competency determining the sum of terms of the given arithmetic sequence demonstrates a comparatively lower degree of influence on the mathematical proficiency skills computation with an r^2 – value 0.593. This suggests that focusing more on instructional effort on developing the learning competency skills may have a more substantial impact on the mathematical proficiency skills of the students.
- (5) The worktext in Sequence Grade 10 demonstrated high overall validity, with good face validity criteria. It is suitable for teaching and learning activities, guiding students on expectations for the topic. The Construct aligns well with students' levels and subject discipline.

V. Recommendations

Based on the findings and conclusions of this study, the following recommendations were forwarded:

- (1) It is essential for teachers to evaluate students' mastery and performance in mathematical proficiency skills, including representation, comprehension, computation, and problem-solving. Additionally, teachers should offer activities aimed at enhancing these skills in mathematics. It is recommended to adapt the developed worksheet because it focuses on improving students' mathematical proficiency skills.
- (2) It is imperative for teachers to evaluate students' mastery and performance in specific learning competencies. Any competencies that fall under the developing level must be targeted for improvement through intervention, remediation, or innovative programs. The researcher suggests to use the develop worksheet because it will help improve the performance of the student in sequence.
- (3) It is recommended to include targeted interventions emphasizing representation, given its strong correlation, and tailored strategies to enhance mathematical Proficiency skills. These approaches aim to develop Mathematical proficiency skills, promoting comprehensive understanding of mathematical concepts among grade 10 students. Hence, the develop worksheet also aims to improve these mathematical proficiency skills as well as different activities that is align on the learning competencies.
- (4) The teacher should employ innovative strategies like enrichment and innovation programs to enhance the skills of the learner. Moreover, creating an instructional material will also help improve the mathematical proficiency skills of the students. The develop worksheet was developed to improve the performance of the students in sequence and to improve their mathematical proficiency skills. Hence, it is recommended to use the develop worksheet.
- (5) Consult with subject matter experts and educators to gather insights and perspectives on what should be included in the worktext. Focus on providing clear explanations, relevant examples, and engaging activities that will help students grasp key concepts effectively. Additionally, consider incorporating diverse perspectives and experiences to make the material more inclusive and reflective of the world we live in today.

VI. Acknowledgment

The realization of the research is indebted to the benevolence, guidance, and blessings bestowed by the almighty. The researcher expresses profound gratitude to GOD ALMIGHTY for providing strength and wisdom throughout this journey. Heartfelt thanks are extended to those whose unwavering support and assistance significantly contributed to the completion of this research. The following individuals deserve sincere acknowledgement: Dr. Josephine Francia R. Villanueva, the Dean of the Graduate Studies, for her continuous follow-up, words of wisdom, encouragement, and unwavering support in completing this study; Dr. Onward O. Ognita, for his professionalism and patient guidance as support in completing this study; The esteemed panelist, led by Dr. Fausto C. Romero, Jr., Chairman of the Thesis Committee, Dr. Juan O. Cruz, Jr., and Prof. Jesus L. Regacho, for their vivid suggestions, recommendations, and dedicated involvement in improving this study; and Miss Julie B. Doblón-Montana and Dr. Junabeth B. Panghulan, Secretary, for their invaluable time and effort in encoding and preparing the panelist recommendations during each defense.

VII. REFERENCES

- Afany Tawwab et al. (2023). Mathematical reasoning ability of junior high school students on the topic of arithmetic sequences and series viewed by gender. Available at <https://pubs.aip.org/aip/acp/article-abstract>. Retrieved October 21, 2024.
- Agus Sahendra et al. (2018). Students' representation in mathematical word problem-solving: exploring students' self-efficacy. Available at <https://iopscience.iop.org/article/10.1088>. Retrieved October 21, 2024.
- Andina Aulia Rachma et al. (2022) Students' mathematical obstacles in learning geometric sequences and series. Available at <https://doi.org/10.1063/5.0120129>. Retrieved November 11, 2024.
- Anupam Bansal (2024). Mathematical excellence: how arithmetic abilities drive achievement in secondary schools? Available at <https://www.researchgate.net/publication/390933317>. Retrieved October 21, 2024.
- Arselyn M. Bustoba et al. (2022). Development and validation of self-paced learning digital module in Mathematics 10. <https://pgjsrt.com/pgjsrt/index.php>. Retrieved October 21, 2024.
- Ayca Akın (2022). The effectiveness of web-based Mathematics instruction (WBMI) on K-16 students' mathematics learning: meta-analytic research. Available at <https://link.springer.com/article/10>. Retrieved October 21, 2024.
- Bhairab Datt Pandey (2017). A study of mathematical achievement of secondary school students. Available at <https://www.researchgate.net/publication>. Retrieved April 26, 2025.
- C.T.P. Utami (2019) "Profile of students' mathematical representation ability in solving geometry problems." Available at <https://iopscience.iop.org/article/10.1088/1755-1315/243/1/012123/meta>. Retrieved October 31, 2024.
- Edelyn A. Cadorna et al. (2023) "Development of worktext in Mathematics in the Modern World. Retrieved November 1, 2024.
- Edy Surya et al. (2017). Improving mathematical problem-solving ability and self-confidence of high school students through contextual learning model. Available at <https://eric.ed.gov/?id=EJ1173627>. Retrieved October 21, 2024.
- Eko Andy Purnomo et al. (2021) "Analysis of Problem Solving Process on HOTS Test for Integral Calculus." Available at <https://files.eric.ed.gov/fulltext/EJ1361643>. Retrieved November 11, 2024.
- Fardila Hayati et al. (2021). Development of Student Worksheet Based on Problem to Improve Student's Mathematics Communication Skills. Available at <https://www.edunesia.org/index.php/edu/article/view/135>. Retrieved October 21, 2024.
- Fitri Arfeti Rahmah et al. (2019). Mathematical representation analysis of students in solving mathematics problems. Available at <https://iopscience.iop.org/article/10>. Retrieved October 21, 2024.
- Garg Priya (2017) Mathematics Proficiency: Meaning and Importance. Available at <https://www.linkedin.com/pulse/mathematics-proficiency-priya-gar>. Retrieved October 31, 2024.
- Gina Qolbi et al. (2022). Analysis of Students' Mathematical Understanding on Arithmetic Sequences and Series in 12th Grade Senior High School. Available at <https://doi.org/10.56773/bj.v2i1.24>. Retrieved November 11, 2024.
- Hasnul Khatimah et al. (2019, February). The effect of problem-solving approach to mathematics problem solving ability in fifth grade. Available at <https://iopscience.iop.org/article/10.1088/1742-6596/1157/4/042104/meta>. Retrieved October 31, 2024.
- Hanifatul Rahmi (2023). Validity and Practicality of Online Learner Worksheets Based on Students' Mathematical Problem-Solving Ability. Available at <https://ejournal.iainkerinci.ac.id/index.php/jdime/article/view/2312>. Retrieved October 21, 2024.

- Ida E. Esquierdo et al. (2021). Worktext in Precalculus: Evaluation and Acceptability. Retrieved November 1, 2024.
- Linxia Zhu et al. (2024). An investigation and study of the mathematical computational skills of grade one junior students. *Academic Journal of Mathematical Sciences*. Available at <https://francis-press.com/papers/15941>. Retrieved November 11, 2024.
- Luluk Suryani (2023) "Analysis of creative mathematical thinking abilities of class viii junior high school students on arithmetic sequences and series." Retrieved October 21, 2024.
- Kevin Kertz Peñaflor (2017). Analysis of Reading Comprehension and Mathematical Ability and Its Relationship in Academic Performance in Mathematics. Retrieved October 21, 2024.
- Mae Joy Tan-Espinar et al. (2017). Content validity and acceptability of a developed worktext in Basic Mathematics. Available at www.apjmr.com. Retrieved November 1, 2024.
- Magda Frutas (2019). Reading comprehension and mathematics problem solving proficiency of Filipino ESL learners: An imperative for bridging the gap. Retrieved October 21, 2024.
- Mahnum Lailan Nasution et al. (2018). Students' mathematical problem-solving abilities through the application of learning models problem-based learning. Available at <https://iopscience.iop.org>. Retrieved October 21, 2024.
- Mega Suliani et al. (2023, June). Students' metacognitive processes to solve arithmetic sequence problems in terms of mathematical ability. Available at <https://pubs.aip.org/aip/acp/article-abstract>. Retrieved October 21, 2024.
- Meriam Villareal Dela Cruz (2019) A Proposed Supplementary Teaching Materials in Teaching Grade 7 Mathematics: Its Acceptability. Available at <https://pdfs.semanticscholar.org/da28/17986c1bee35675e160351010c36be07f964.pdf>. Retrieved October 21, 2024.
- Michelle Joy M. Notarte et al. (2024). Beyond Memorization: Building Problem-Solving Skills in Sequences for Future Math Teachers. Available at <https://doi.org/10.55927/eajmr.v3i9.9437>. Retrieved October 21, 2024.
- Mohammad Tohir et al. (2018) "Students creative thinking skills in solving two dimensional arithmetic series through research-based learning." Available at <https://iopscience.iop.org/article/10>. Retrieved October 21, 2024.
- Muhammad Yusup (2023) Students' errors in solving math problems in the form of stories on the topic of sequences and series. Available at <https://doi.org/10.31980/pme.v2i3.1764>. Retrieved October 21, 2024.
- Nadya Syifa Andzin et al. (2024). Arithmetic sequences and series learning using realistic mathematics education assisted by augmented reality. Available at <https://www.researchgate.net/publication>. Retrieved October 21, 2024.
- Nanang Priatna et al. (2019). Development of mathematics' teaching materials using project-based learning integrated STEM. Available at <https://iopscience.iop.org/article/10>. Retrieved October 21, 2024.
- Nguyen Van Hong et al. (2017). Teaching the Arithmetic Sequence through Guided Discovery Learning: A Pedagogical Experiment in Vietnam. Available at <http://dx.doi.org/10.21013/jems.v6.n3.p9>. Retrieved October 21, 2024.
- Paranad, Jill Ann R et al. (2023) "Development of A Worktext In Science, Technology, And Society. Available at <https://namibian-studies.com/>. Retrieved October 21, 2024.
- Resi Erni (2021). Analysis of Mathematical Problem-Solving Ability of Class XI Senior High School Students on Sequences and Series Materials. Available at <file:///C:/Users/Admin/Downloads/48-Article>. Retrieved October 21, 2024.
- Romel S. Panagdato et al. (2024) "Computational and Problem-Solving Skills in Mathematics of AIMS Students." Retrieved October 21, 2024.
- Singh Parmjit et al. (2020). An Analysis of Students' Mathematical Reasoning and Mental Computation Proficiencies. Available at UJER67_19517297-libre.pdf. Retrieved October 21, 2024.
- Usep Kosasih et al. (2024) "Student retention in arithmetic sequences and series learning through math maze." Available at <https://jurnal.unsil.ac.id/index>. Retrieved October 21, 2024.
- Violina Almaghfiroh et al. (2022). Analysis of the mathematical comprehension ability of grade xi students on story problems material on arithmetic sequences and series. Available at <http://repository.uin-malang.ac.id/12724/>. Retrieved November 1, 2024.
- Wisnu Siwi Satiti et al. (2023). Development of Occupational-based-Context Worksheets of Geometric Sequences and Series for Senior High School Students. Available at <https://doi.org/10.32764/application.v2i3.2849>. Retrieved October 21, 2024.

Yang Liu et al. (2023). A Practical Study on Developing Mathematical Computation Ability of Ninth-Grade Students. Available at <https://arxiv.org/abs/2303.02096>. Retrieved October 21, 2024.

Zulfaneti Sefna Rismen et al. (2016). Validity analysis of development lesson plan and student worksheet based realistic mathematics education. Available at <https://doi.org/10.1063/1.4940857>. Retrieved October 21, 2024.

B. JOURNAL/ ARTICLES

Aliakbar Montazer Haghighi et al. (2024). Sequences and Series. Available at <https://typeset.io/papers>. Retrieved October 31, 2024.

Azwani Masuwai et al. (2016). Evaluating the face and content validity of a Teaching and Learning Guiding Principles Instrument (TLGPI): A perspective study of Malaysian teacher educators. *Geografia*, 12(3). Retrieved October 31, 2024

Christian J.C Ballot et al. (2023). *The Lucas Sequences: Theory and Applications* (Vol. 8). Springer Nature. Retrieved October 31, 2024

Colin Foster (2023). Problem solving in the mathematics curriculum: From domain - general strategies to domain - specific tactics. Available at <https://bera-journals.onlinelibrary.wiley.com/doi/full/10.1002/curj.213>. Retrieved October 31, 2024

David Ebong et al. (2022). Geometric progression and relative strength index applied to FX hedging. Available at <https://typeset.io/papers/geometric-progression-and-relative-strength-index-applied-to-2cj2bi68>. Retrieved October 31, 2024

Department of Education (2018) DO 24, s. 2018 – Guidelines on the Utilization of the Early Language Literacy and Numeracy Program Funds: Professional Development Component. Retrieved October 31, 2024

Department of Education (2018) DO 14, s. 2023 – Policy Guidelines on the Implementation of National Learning Camp. Available at https://www.deped.gov.ph/wp-content/uploads/DO_s2023_014.pdf. Retrieved October 31, 2024

Fard Mohammad et al. (2021). The geometric mean is a superior frequency response averaging method for the human body. Available at <https://typeset.io/papers/the-geometric-mean-is-a-superior-frequency-response-zq9s4173in>. Retrieved October 31, 2024

Garg Priya (2017) Mathematics Proficiency: Meaning and Importance. Available at <https://www.linkedin.com/pulse/mathematics-proficiency-priya-garg>. Retrieved October 31, 2024

Gina Qolbi et al. (2022). Analysis of Students' Mathematical Understanding on Arithmetic Sequences and Series in 12th Grade Senior High School. Retrieved October 31, 2024

Janina Dargo et al. (2021). Modular Distance Learning: Its Effect in the Academic Performance of Learners in the New Normal. Available at <https://www.learntechlib.org/p/220456/>. Retrieved October 31, 2024

Jayne B. Miranda et al. (2022). Development and Evaluation of Task-Based Material in Business Mathematics for Senior High School. Available at <http://103.125.149.70/index.php/BRJ/article/view/315>. Retrieved October 31, 2024

John Woodward (2024) Arithmetic vs. Geometric Sequences: What's the Difference Available at <https://www.voyagersopris.com/>. Retrieved October 31, 2024

Julius Fergy Rabago (2015). On sequences of numbers in generalized arithmetic and geometric progressions. Available at <https://www.researchgate.net/publication/>. Retrieved October 31, 2024

LibreTexts (2025) Recognizing Patterns. Available at <https://math.libretexts.org/Courses>. Retrieved October 31, 2024

Luis Cohen et al. (2017). Validity and reliability. Retrieved October 31, 2024

Lynn Marecek (2017). Geometric Sequences and Series. Available at <https://typeset.io/papers/geometric-sequences-and-series-4rpyqk8ew>. Retrieved October 31, 2024

Mehdi Hage Hassan (2024) The Formulas of the sums of the n-product Of elements of arithmetic series." Retrieved October 31, 2024

Organization for Economic Cooperation and Development (2023) Programme for International Student Assessment 2022 Results (Volume I and II) - Country Notes: Philippines. Retrieved October 31, 2024

Programme for International Student Assessment 2018- National Report (2018). Available at [PISA-2018-Philippine-National-Report.pdf](https://pisa-2018-philippine-national-report.pdf). Retrieved October 31, 2024

Study.com (2023) Word Problems in Mathematics Education. Available at study.com/academy/lesson/word-problems-mathematics-education.html. Retrieved October 31, 2024

Suvarna, V. D. et al. (2016). A Study on Academic Achievement and Personality of Secondary School Students. Available at <https://eric.ed.gov/?id=EJ1149330>. Retrieved October 31, 2024

The Science of Math (2025) What is math proficiency? Available at <https://www.thescienceofmath.com/what-is-math-proficiency>. Retrieved October 31, 2024

Tri Atmojo Kusmayadi et al. (2017) Students' mathematical representations on secondary school in solving trigonometric problems. Available at <https://iopscience.iop.org/article/10>. Retrieved October 31, 2024

United Nation (2025) Sustainable development Goals: 4 Quality Education. Available at <https://unstats.un.org/sdgs/report/2017/goal-04/>. Retrieved October 31, 2024

