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RICOSRE: A Basis for Developing Intervention Framework in Improving Problem-Solving Skills of Grade 10 Students

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A B S T R A C T

The study aims to probe the potential of the RICOSRE learning model using descriptive-comparative study. To address issues on problem-solving, a learning model called RICOSRE by Mahanal and Zubaidah (2018) was implemented for 26 grade 10 students. Using a RICOSRE-based worksheet, respondents answered one problem by providing their answers to each six stages. The level of performance of the respondents was described as emerging (n = 26, $\bar{x}$ = 16.34). After running the Kruskal-Wallis test, it revealed that there is no significant difference in the performance of students among academic groups (χ^2 = 0.411, df = 2, p = .814) implying that there is no difference among the mean ranks of these three academic groups. The study also provided the performance level of students in every stage of RICOSRE. Researchers suggested that the RICOSRE learning model can be used in guiding students every step of the way in solving problems.

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INTRODUCTION

One of the 7C's of the 21st Century Skills is critical thinking developed by applying its twin dexterity – problem-solving skills. According to Rahman and Mehadi (2019), problem-solving involves systematic observation and critical thinking to achieve the desired goal by identifying a solution to a certain problem. In the Philippines, enhancing students' problem-solving skills is a major concern in education (Mance-Avila & Guzon, 2020). As such, the Department of Education aligned its Mathematics curriculum to develop these 21st Century Skills. According to the K to 12 Mathematics Curriculum Guide (2016) of the Department of Education (DepEd), Mathematics, as defined, is a school subject that is vital in everyone's life at any age and under any circumstances making learning the said subject with an in-depth comprehension for students. In addition, to effectively and efficiently instill in the student such a mindset, the twin goals of the mathematics curriculum of DepEd are critical thinking and problem-solving.

Research suggests that a particular learning model may affect one's performance in solving problems. Applying such a problem-solving direction can enhance one's ability to solve a certain problem systematically and scientifically (Cheng, She, & Huang, 2018). There are various strategies to develop and improve the problem-solving skills of students. In a study conducted in 2018 by Özreçberoğlu and Çağanağa, the time or the duration of teaching Mathematics, especially with those teachers teaching in 9th grade give importance to problem-solving skills, problem-solving duration, problem-solving methods. Moreover, it emphasizes that the time given to each class is insufficient to implement the plan-program activities. Thus, it implies that problem-solving skills must be given sufficient time for students to learn how to solve problems with appropriate methods.

On the other hand, part of problem-solving skills is being creative. As such, one of the developments that education takes into consideration is enhancing the creative thinking skills of students as this has a direct relationship with problem-solving skills (Khalid et al., 2020). Further, the study highlighted that there is a statistically significant increase in scores for most categories of creativity and problem-solving through the use of teaching students through creative problem-solving. On that note, students can enhance their creative thinking and problem-solving skills which was evidenced in the introduction of *Kurikulum Standard Sekolah Menengah* emphasizing the goal to strengthen the quality of science, technology, engineering, and mathematics (STEM) education through which reformation of higher-order thinking skills (HOTS) are highlighted. Other forms of strategies are discovery learning (Yuliati & Munfaridah, 2018), problem-based learning through motivation (Almulla, 2019), and cooperative learning (Hanadi & Al Husseiny, 2017) which is sooner known as cooperative problem-based learning (CPBL).

The results confirmed that the learning above model improves the student's learning outcomes, especially on Virus materials. More so, the learning model helps to activate the uniqueness and interest of students in learning making it easier for them to solve existing problems. Thus, the use of this method

in class is highly recommended for teachers. This recommendation was supported by Mawaddah et al. (2021) as the learning model, RICOSRE, was seen to be effective in encouraging students' scientific literacy in terms of quality and quantity. The RICOSRE learning model has proved its potential for students' scientific reasoning and abilities in various academic skills (Putri, Mahanal, & Rohman, 2020).

During an informal observation, teachers observed that students were not organized when engaging with mathematical problems. In addition, most students fail to verify the result after it was obtained through computing. Verifying whether the obtained number satisfies the conditions of the problem is a crucial step as Polya, Father of Problem-solving, pointed out in his four steps in solving a problem. With the above claims, results of previous studies, and informal observation in the classroom, the present study would like to probe the potential of the RICOSRE learning model in enhancing the problem-solving skills of students in Mathematics. Specifically, the study develops a framework of how to integrate the said learning model in enhancing problem-solving skills of students in Mathematics, particularly, of Grade 10 students on the topic of *Sequences*.

THEORETICAL REVIEW

Problem-Solving as a Skill

By definition, problem-solving is a conversational term that often refers to courses of action to address a particular problem. Moreover, Reeve (2022) says it involves solving a problem by incorporating various skills such as analytical and critical thinking, creativity, reasoning, and experience. There is a systematic process involved in problem-solving and these are defining the problem, providing assessment, identifying relevant information, developing different solutions, evaluating the formulated alternative solutions, identifying the best course of action and answer, and generalizing the obtained results (Al-Hassawi, Al-Zaghul, & Al-Jassim, 2020). To sum up, problem-solving is a systematic process vital for everyone to understand to provide appropriate solutions. More so, it involves adequate knowledge and abilities to evaluate and choose the best solution among the alternative ones to be able to approach the problem systematically.

When one has these adequate abilities, this now forms a skill significant in one's life – problem-solving skills. These skills are critical for all individuals as this will help them develop a way of thinking to approach a problem effectively and efficiently. Mahanal et al., (2019) state that for students to solve a particular problem, they should understand the problem, identify the given information, seek possible solutions, determine the best solutions through evaluation, and propose solutions. In the present study, the process of problem-solving includes (1) reading, (2) identifying the problem, (3) constructing the solution, (4) solving the problem, (5) reviewing the solution, and (6) extending the solution.

The Intervention

Mahanal and Zubaidah developed the RICOSRE learning model in 2017 (Mahanal & Zubaidah, 2018). To address the problem of enhancing the problem-solving skills of students, various problem-solving-based learning models were developed. Some of these models were from experts namely Polya and Carson. More so, due to the several research and development attempts of researchers, such as Plomp, the learning model called RICOSRE was established. According to Mahanal et al. (2019), the said learning model is said to be feasible as it meets the required criteria such as validity, practicality, and effectivity. As mentioned earlier, RICOSRE involves six stages namely (1) reading, (2) identifying the problem, (3) constructing the solution, (4) solving the problem, (5) reviewing the solution, and (6) extending the solution. Many previously conducted studies proved the potential and effectiveness of the RICOSRE learning model in enhancing the problem-solving skills of students across different disciplines (Putri, Mahanal, Zubaidah, & Setiawan, 2023; Badriah et al., 2023; Azrai et al., 2022; Yuliskrniawati et al., 2021; Rizkiyah, 2021; Mawaddah et al., 2021; Putri, Mahanal, & Rofman, 2020).

The first stage of RICOSRE is reading which students are enable to utilize higher-order thinking skills such as critical and analytical thinking. Reading as a skill is a vital component in understanding the problem. Harangus (2019) suggests that there is a close relationship between the reading comprehension of students and their level of problem-solving performance. This implies that reading allows students to obtain important facts and/or information that will help them to practice distinguishing factual evidence which will later on be utilized in solving the problem.

RICOSRE Learning Model's second stage is identifying the problem. From the point that the student has gained key information from the problem, the second stage of the said learning model allows them to sort the information or causes of the problem systematically. This stage is considered to be the critical part of the learning model as this will be where the students must be cautious in identifying the root cause of the problem to find what needs to be solved. As cited in Mahanal et al. (2022), "*a well-defined problem significantly impacts the quantity, quality, inventiveness, and type of solutions presented.*"

The Conceptual Framework

Problem-solving skills are undeniably vital in enhancing students' 21st Century Skills. Figure 1 shows the conceptual framework of the present study. The study is anchored on the reality that students have their own pace of grasping and learning concepts or ideas. Students were categorized based on their Mathematics performance exhibited during the first quarter of the current school year into upper, moderate, and lower academic groups. These academic groups were introduced in RICOSRE learning model to investigate its potential to enhance problem-solving skills. Results of the study and reflections of the researchers formed as bases for developing the intervention framework towards problem-solving skills.

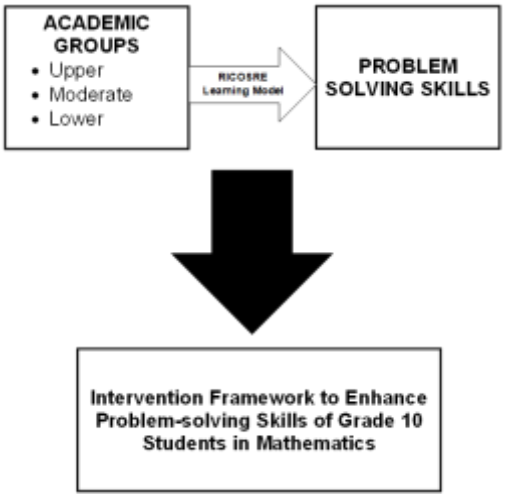

Figure 1. Conceptual Framework of the Study

In this study, the students, regardless of their academic discrepancies, are a lens to enhance their problem-solving skills after implementing the RICOSRE Learning Model. Hence, the collected data and results will be utilized to identify or develop an intervention framework to further implement the RICOSRE Learning Model in enhancing problem-solving skills – one of the twin goals of the Mathematics Curriculum Framework.

Theoretical Framework

The present study is anchored on the constructivism and problem-based learning theory. This is excerpted from the conceptual framework of the K-12 Mathematics Curriculum Guide. The mathematics framework of the Department of Education stands with its five theories as a foundation. One of these theories is constructivism. The constructivist learning theory, proposed by Jean Piaget, is a theory based on the idea that the learners are the active participants of learning through which knowledge is constructed based on their experiences. Undeniably, one's experience plays a vital role in facing the present reality; a person reflects on their experience and uses it to create new ideas out of their prior knowledge. This was rooted in the learning theories developed by Dewy, Piaget, Vygotsky, Gagne, and Bruner.

Most of the academies in the education sector implement this learning theory as the classroom or the learning environment facilitates a learner-centered atmosphere – where students are the active participants of learning and teachers serve as the facilitators of learning. Similarly, teachers are considered to be 'guides on the side' not 'sages on the stage'. In the present study, students' experience is a vital component in solving problems that may or may not be familiar to them, and use their formulated solution to further work with efficient and effective solutions established from a similar problem. This has become the foundation of other theories such as experiential learning (learning by doing), situated learning, reflective learning, inquiry-based learning and discovery learning, and cooperative learning. Thus, the implementation of this in the

curriculum leads to a general effect on the students to develop skills that are necessary for them to be equipped to face the challenging times of the world.

On the other hand, to specifically develop and hone students' problem-solving skills, there is a learning theory called problem-based learning theory (PBL). The said learning theory was coined by Howard Barrows in 1974. To briefly describe, the learning theory is a student-centered approach through which students work in groups to solve a particular open-ended problem. This theory underscores that the problem is the driver of motivation toward effective learning.

METHODOLOGY

The study is purely quantitative, specifically, a descriptive-comparative research design which was applied to determine relationships among variables (Cantrell, 2011). More so, this design has no manipulation of the independent variable. It also assesses the impact of certain factors within a given context. The said design was chosen as the researchers would like to describe and compare the potentials of the intervention across various academic groups. The study was conducted on a group of 26 Grade 10 students in a particular public school. Selected students are regular students of the identified school regardless of creed, status, gender, color, and race. The present study utilized full enumeration sampling which means all students enrolled in the identified section will be considered as participants of the study. Table 1 shows the performance level of the students. This shows that the level of performance ($\bar{x}$ = 87.5) of the students in Mathematics before the intervention is very satisfactory as described based on the descriptors of the DepEd Order No. 8, s. 2015.

Table 1. Performance Level of Grade 10 Students in Mathematics

	N	$\bar{x}$	**sd**
Academic Performance of Grade 10 Students in Mathematics	26	87.5	4.99

The present study divided the class into three academic groups namely lower academic group, moderate academic group, and upper academic group. The researchers used tertiles to divide the group into three. Tertile (pl. tertiles) is defined as either of the two points that divide an ordered distribution into three parts. Table 2 shows the description of each academic groups.

Table 2. Academic Performance of Each Academic Group in Mathematics

Academic Groups	N	$\bar{x}$	sd
Lower Academic Group	11	82.9	1.92
Moderate Academic Group	9	88.3	1.73
Upper Academic Group	6	94.7	1.75

Table 2 shows the academic differences of each group. The lower academic group shows that their general average lies on a satisfactory level (n=11, $\bar{x}$ = 82.9). On the other hand, moderate (n = 9, $\bar{x}$ = 88.3) and upper group (n=6, $\bar{x}$ = 94.7) show that their performance level is very satisfactory and outstanding, respectively.

Instructional Procedures

The action research strictly adheres to the ethical standards of research. The researchers secured important documents by submitting a permit letter to the selected school. Then, an informed consent letter was given to the parents and students to assure the respondents that the data they would give would be treated with utmost confidentiality and would not be disclosed unless authorized. An orientation to inform the respondents was given upon the conduct of the study. The research was conducted personally. The procedure followed the RICOSRE learning model's learning stages. Thus, the respondents were given activities in the form of student worksheets containing real-life problems to explore the topic of the Arithmetic Sequence of the study. The said student worksheets are configured following the RICOSRE learning stages, as seen in Table 3.

Table 3. RICOSRE learning stages for Sequences

RICOSRE Learning Stages	**Student Activities**
Reading	Students provide the condensed version of the real-life problem. The teacher should prepare the real-life problems in advance. The summarized problem should include the given facts and problem.
Identifying the problem	Students should be able to identify what is asked in the problem. This may come in the form of questions or statements.
Constructing the problem	Students provide at least two alternative solutions to solve the problem.
Solving the problem	Students should choose the best solution suited to solving the problem.
Reviewing the solution	Students should be able to review their answers. This will be reflected in the worksheet by checking the obtained result from the preceding stage.
Extending the solution	Students will compare the answers with other alternatives formulated in the third stage to establish more effective solutions for solving similar problems in the future.

Research Instrument and Analysis

The research instrument (see Annex A) was in the form of a worksheet and students should be able to accomplish these RICOSRE-integrated

worksheets. The data obtained from the said instrument was utilized as data on problem-solving skills. Moreover, the student's responses were graded based on the rubric adapted from the Association of American Colleges and Universities' problem-solving rubric (Association of American Colleges and Universities, 2017). The instrument will use the Rasch partial credit model (Fisher, 2007) to test the validity and reliability of the instrument. In addition, Table 4 shows the criteria that will be utilized to evaluate the participant's problem-solving skills.

Data Collection and Analysis

The collected data on the quantitative approach were used to measure the student's answers in the instrument following the problem-solving rubric (see Table 4). Moreover, the academic groups (i.e. upper, moderate, lower), were identified in each stage of the RICOSRE learning model. Hence, the study hypothesizes that the RICOSRE learning model improves the problem-solving skills of students regardless of their academic groups. To analyze the data and test the study's hypothesis, one-way ANOVA (non-parametric) using the Jamovi application with a 95% confidence level (see Table 5) was used.

Table 4. Problem-solving skills assessment rubric

Activity	**Exceptional (4)**	**Adequate (3)**	**Emerging (2)**	**Not Present (1)**
Reading	The summary is accurate, well-organized, coherent, and well-written. The summary contains the given facts of the problem and is written in the student's words.	The summary is quite accurate despite some minor errors in emphasizing the information needed. The summary may be written in the student's own words or may be copied directly from the given problem.	The summary is less accurate. It does not have the complete key information from the problem.	The summary is very limited. It does not contain any of the key information from the problem.
Identifying the problem	Students demonstrate the ability to write what is asked in the problem.	Students demonstrate the ability to construct what is asked of the problem but a	Students can identify what is asked in the problem but do not have the right details.	Students demonstrate limited ability to identify the problem related to the

		few details are quite missing.		given problem.
Constructing the solution	Students propose two or more solutions indicating a deep understanding of the problem.	Students propose one solution indicating an understanding of the problem.	Students propose one solution yet it is not appropriate in solving the problem.	Students propose one solution but difficult to assess as it exhibits irrelevance to the given problem.
Solving the problem	Students apply smart or innovative strategies to solve the problem.	Students use an efficient or effective strategy/ies to solve the problem.	Students apply an appropriate strategy or approach to solve the problem.	Students apply strategies or approaches to solve problems.
Reviewing and Extending the Solution	A review of the problem-solving results is defined with specific and thorough consideration of the need for future work.	A review of the problem-solving results is defined with some consideration of the need for future work.	A review of the problem-solving results is defined with little consideration of the need for further work.	A review of the problem-solving results is superficially defined without considering the need for further work.

Table 5. Scores after the implementation of RICOSRE

Academic Groups	**N**	$\bar{x}$	**Shapiro-Wilk *p***
Lower Academic Group	11	16.2	0.023
Moderate Academic Group	9	16.9	<.001
Upper Academic Group	6	15.8	0.079

Table 5 shows that the Shapiro-Wilk *p*-value of moderate and lower academic groups are lesser than 0.05 which means that the data set does not approximate a normal distribution. Moreover, since Figure 2 shows that there are three significant outliers, one-way ANOVA (parametric) cannot be used but rather a non-parametric test of one-way ANOVA which is the Kruskal-Wallis test was used.

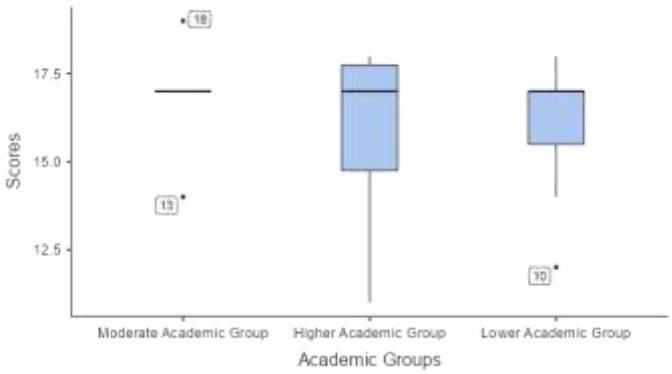

Figure 2. Box plot after the implementation of RICOSRE

RESULTS AND DISCUSSIONS

After implementing such strategy, the researchers have identified that there is an improvement happens between the student's problem solving skills. The following subsections shows the results of the study.

Performance Level of Students after implementing RICOSRE

The statistical analysis (Kruskal-Wallis test) shows a *p*-value is greater than α ($p < 0.05$), which means significant (see Table 6). This result indicates that there is a significant difference among the students after the implementation of RICOSRE. The scores seem to show improvement.

Table 6. Performance Level of Students after implementing RICOSRE

Kruskal-Wallis

	χ^2	df	p
Scores	0.411	2	0.814

As reflected from Table 7, the moderate academic group was reported to have the greatest mean among the scores of the three academic groups (n = 9, $\bar{x}$ = 16.9), followed by the lower academic group (n = 11, $\bar{x}$ = 16.2), and upper academic group (n = 6, $\bar{x}$ = 15.8). Moreover, the median of the three academic groups are equal with a value of 17. Lower and Upper academic groups are described as exceptional while upper academic group is said to be adequate. The results indicate that the implementation of the RICOSRE learning model has greatly enhanced the scores of students across the academic groups particularly those from moderate academic groups and lower academic groups.

Table 7. Scores of Students after implementing RICOSRE

Academic Groups	N	$\bar{x}$	$\tilde{x}$	SD	Description
Lower Academic Group	11	16.2	17	1.83	Exceptional
Moderate Academic Group	9	16.9	17	1.27	Exceptional
Upper Academic Group	6	15.8	17	2.79	Adequate

Performance Level of Students in every stage of RICOSRE

The following sections provide an in-depth details of students' problem-solving skills with upper, moderate, and lower academic groups at each stage of the RICOSRE learning model.

Reading Ability of Students

The data in Table 8 shows the reading ability of the students. The greatest mean was found at the moderate academic group (n = 9, $\bar{x}$ = 2.89), followed by lower academic group (n = 11, $\bar{x}$ = 2.73), and upper academic group (n = 6, $\bar{x}$ = 2.67). It was also revealed that the level of performance of students in terms of reading ability was described as adequate. Moreover, after running the Kruskal-

Wallis test, it has found that there is no significant difference found among the academic groups (χ^2(2) = 0.225, p = .893) as reflected to the p-value greater than 0.05.

Table 8. Student's reading ability

Groups	**N**	$\bar{x}$	$\tilde{x}$	**SD**	**Description**
Lower Academic Group	11	2.73	3	1.01	Adequate
Moderate Academic Group	9	2.89	3	0.928	Adequate
Upper Academic Group	6	2.67	3	1.03	Adequate

On the topic of sequences, respondents can give the main thought of the problem. However, most participants did not give all the facts of the given problem as being summarized in the given situation. This implies that students' reading ability focuses on what was the condition given in the problem. Below are some of the responses of students from the moderate academic group.

"it focuses on computing Rey's total earnings and that eventually he receives a raise that costs P 1,500." – Student 1
"about the total amount of salary Rey earned within 15 years, with the added subsequent raise each year." – Student 2
"the problem is all about computing Rey's total earnings if he receives a raise of P 1,500.00 each subsequent year." – Student 5

Students' Ability to Identify the Problem

The data in Table 9 shows the ability of the students to identify the problem. The highest mean was found at the moderate academic group (n = 11, $\bar{x}$ = 3.33), followed by lower academic group (n = 9, $\bar{x}$ = 2.55), and upper academic group (n = 6, $\bar{x}$ = 2.50). In addition, the students' ability to identify the problem is adequate. Moreover, after running the Kruskal-Wallis test, it has found that there is no significant difference found among the academic groups ($\chi^2(2) = 5.29$, p = .071) as reflected to the *p*-value greater than 0.05.

Table 9. Students' Ability to Identify the Problem

Groups	N	$\bar{x}$	$\tilde{x}$	SD	Description
Lower Academic Group	11	2.55	3	0.688	Adequate
Moderate Academic Group	9	3.33	4	0.866	Adequate
Upper Academic Group	6	2.50	3	0.837	Adequate

The topic on sequence, respondents can provide the right question about the problem by rewriting the question stated in it using their own words. The results indicate that if they will be able to rewrite the questions in their own words, they will be able to understand more the problem making it easier for them to solve. Below are the responses of the students presented in verbatim.

"the problem is asking for the total amount of money Rey will earn over 15 years, considering his initial salary raise." – Student 23

"Rey's total earnings if he works for 15 years in the company." – Student 24

"Rey's total earnings for 15 years." – Student 26

Student's Ability to Construct the Solution

Table 10 revealed that the performance of students' ability in terms of constructing the solution is the same which is 4. This also categorizes the three academic groups to have an exceptional result. The Kruskal-Wallis test reveals that the *p*-value was NaN or non-a number means that it has no impact on the analyses. This has been the result because all of the students, regardless of the academic group, have the same score of 4. Moreover, the mean of each academic group is the same meaning all have the same way of constructing the solution. In addition, based on the comparison of student's ability to construct the problem among the three academic groups, the *p*-value is also NaN.

Table 10. Students' Ability to Construct the Solution

Groups	N	$\bar{x}$	$\tilde{x}$	SD	Description
Lower Academic Group	11	4	4	0	Exceptional
Moderate Academic Group	9	4	4	0	Exceptional
Upper Academic Group	6	4	4	0	Exceptional

Most of the students provided two strategies for solving the problem. Particularly, students give (1) multiplying and adding (manually solving) and (2) using a formula like notation or using arithmetic sequence. This indicates that students can construct more than one solution in a particular problem – beginning from traditional solving (adding the given facts manually) and use a formula they remember which they consider as suitable to use. The evidence below was presented verbatim to support the said claims.

"1. Multiply Php 1,500 to each subsequent raise, then add everything up. Multiply the yearly salary by 15 (years), then add the sum of the total subsequent raise.

2. Add the first salary raise total to the yearly salary (without the raise), then add the multiplied product (multiplied product from the yearly subsequent raise) to the sum." – Student 2

"make a notation and compute manually" – Student 26
"Arithmetic progress formula… and Iteration (step-by-step)" – Student 23

Student's Ability to Solve the Problem

The scores revealed the highest mean to be found in the lower academic group garnering an average score of 4.00, followed by the moderate and upper academic groups with a 3.67 mean score, respectively (see Table 11). In addition, the one-way ANOVA (Kruskal-Wallis test) revealed that the *p*-value was 0.294 ($p > 0.05$. This result indicates that there is no significant difference in the scores of students in measuring the ability to solve the problem. With this, it can be implied that regardless of the academic group where the students belong, it does not bring an impact to their score in solving the problem.

Table 11. Students' Ability to Solve the Problem

Groups	N	$\bar{x}$	$\tilde{x}$	SD	Description
Lower Academic Group	11	4	4	0	Exceptional
Moderate Academic Group	9	3.67	4	0.707	Exceptional
Upper Academic Group	6	3.67	4	0.632	Exceptional

Furthermore, students' responses chose the strategy that uses formula, particularly arithmetic sequence. This demonstrates that students find formulas to help solve problems.

Student's Ability to Review the Solution

The highest mean score was found in the moderate (n = 9, $\bar{x}$= 3.00) and upper (n = 6, $\bar{x}$= 3.00) academic groups (see Table 12). The performance of students in reviewing the solution is said to be exceptional. This was followed by the lower academic group with a mean score of 2.91. Moreover, the one-way ANOVA (Kruskal-Wallis test) shows that there is no significant difference among the three academic groups ($\chi^2(2) = 0.136$, p = 0.934). The result demonstrates that there is no significant difference between the scores of students regardless of their academic group.

Table 12. Students' Ability to Review and Extend the Solution

Groups	N	$\bar{x}$	$\tilde{x}$	SD	Description
Lower Academic Group	11	2.91	3	0.539	Exceptional
Moderate Academic Group	9	3	3	0.707	Exceptional
Upper Academic Group	6	3	3	0.632	Exceptional

In addition, most of the students responded with the final answer rather than showing how they checked the answer. Nevertheless, some use another strategy such as adding manually to check their answer. Below are the responses of the students presented verbatim.

"Therefore, Rey would receive a total of Php 6.3 Million, as his total earnings if he works now for 15 years" – Student 9
"[adds manually] Therefore, his total earnings is 6.3 million" – Student 10
"If Rey works now for 15 years, he will earn a total of P 6, 300, 000.00" – Student 12

Student's Ability to Extend the Solution

Table 12 shows the combined results and inference for the student's ability to extend the solution. Since the moderate group and upper group have the greater mean among the three identified academic groups, the result indicates that they can extend the solution by providing similar or related problems in real-life situations. This just implies that students can identify real-life scenarios that are closely related to them. Below are some of the responses of the students presented verbatim.

"Savings plan: You want to calculate the total amount you will save after a certain number of years considering a fixed monthly contribution and a potential interest rate." – Student 4
"total fare when you ride a multi-cab/jeepney" – Student 24
"For instance, calculating your yearly budget in your household, with this, you can predict your total earnings." – Student 8

Intervention Framework to Effectively Enhance Problem-solving Skills through RICOSRE Learning Model

Most, if not all, of the statistical analysis per stage of RICOSRE has no significant difference between and among the three academic groups – lower, moderate, and academic groups. From the results, it can be inferred that students have difficulty mostly in showing how they check their solutions and how to summarize well the problem. Thus, from the findings, the researchers suggested an intervention framework to effectively use the RICOSRE Learning Model in teaching Mathematics, particularly in problem-solving skills (see Figure 5). Figure 3 shows the intervention framework formulated from the findings of the study. It forms a house in the sense that a house has a firm foundation creating an effective and efficient way to enhance the problem-solving skills of students in Mathematics, particularly Grade 10. The foundation of the house lies on the five stages of the RICOSRE learning model namely (1) Reading, (2) Identify the problem, (3) Constructing the solution, (4) Solving the Problem, and (5) Reviewing the Solution.

In the first stage, students should be able to understand the problem well and it can be practiced and enhanced by summarizing the problem with their own words. Through this, it enables the student to fully grasp the thought of the problem. However, this also includes all the given facts in the problem so that he is guided along the way in solving it. This will give the students enough skill to move on to the next stage – identify the problem. The next stage tasks the students to identify the root cause of the problem enabling them to fully understand the problem. In this stage, students identify the relationships of the given facts to the problem making it easier for them to construct solutions using known strategies. With these underlying principles, students can extend the

solution in a similar real-life scenario leading to enhance the problem-solving skills of students in Mathematics.

This intervention framework was the result of the interconnectedness of critical and creative thinking in applying RICOSRE-based learning model to further enhance the problem solving skills of students. Moreover, the findings recommend that the teacher may use this framework in their class discussions, especially if it is anchored on problem-based learning theory.

Figure 3. RICOSRE-based Intervention to Enhance Problem-solving Skills of Grade 10 Students in Mathematics

Problem-solving skills are widely known to be a vital part of one's skills in facing the changing times of the future generation. Thus, enhancing these skills helps an individual to survive everyday life and make him an informed citizen of his community contributing to the betterment of his society and nation at large. As such, it has become part of the curriculum of Mathematics in the Philippines (as per the Department of Education) the achievement of the twin goals-problem-solving and critical thinking. This also supports the fact that problems are inevitable and unpredictable in any way (Kim et al., 2018). There are a lot of learning frameworks were developed to enhance the problem-solving skills of students and one of those is the RICOSRE learning model.

The findings of the study underscore that there is no significant difference found in the scores of students from lower, moderate, and upper academic groups. This means that there is a close level of performance of students in mathematics that exhibits in solving problems regardless of their academic groups.

This implies that through engagement and critically-minded, students can verify if they can answer the problem correctly and completely. Another way to review their answer is to try similar problems by using the same strategy – this now falls on the extending of solution. Celik et al., (2011) asserts that extending the solution by reviewing the strategy which has been used is one way to test the adequacy of the solution. This helps the students to relate more situational problems similar to the given problem.

The findings revealed a close performance level among the problem-solving skills of students regardless of the academic groups they are belong. This means that RICOSRE helps in enhancing problem-solving skills regardless of the student's academic group. Meanwhile, the intervention framework developed provides the concept that it sets direction for students towards obtaining correct answer in every stage of the way as guided by RICOSRE Learning model. From the findings of the study, the researchers recommend the integration of RICOSRE learning model using the intervention framework formulated from the initial phase. It is suggested for the future researchers to replicate the study with enough timeframe and closely create an experimental approach to the intervention assessing various topics in Grade 10 Mathematics or any other learning areas in the said subject.

Implications to Teaching and Learning

Problem-solving is one of the twin goals of the Mathematical framework of Department of Education. This classroom-based action research offers a lens to the education, especially to mathematics educators, to see the essence of problem solving as significant skill for students to develop. This has revealed that one particular intervention – RICOSRE Learning Model – can be used in enhancing the problem-solving skills of students. It contributes in addressing the problem that was commonly observed in the classroom which are the organization of students' thought in solving the problem and their mindset to stop solving once they had the answer already neglecting the last step of looking back or checking due to time constraint and other factors. Moreover, this intervention has provided the essence of creating connections in real-life situations providing a broader perspective for students to relate the newly gained skills in real-life scenarios by citing situations or problems which they can use the same strategy employed.

CONCLUSIONS AND RECOMMENDATIONS

The researchers concluded that RICOSRE is a helpful intervention in creating a critically and creative sound citizen. Moreover, the six stages of the RICOSRE learning model enables the students to fully use their cognitive abilities. The reading stage enables the students to use their literacy and reading comprehension to point out the thought of the given situation leading them trio identify the problem well. By relating it to real-life problems. They will be able to enhance their decision-making in the next run. Implementing RICOSRE learning model in teaching Mathematics and by providing them a hands-on problem solving will greatly help in achieving the twin goals of Mathematics education. With the findings, it has been concluded that experiences are vital part of solving a problem as student relates what they have experienced to the problem itself making it easier for them to solve the problems. More in-depth studies can be conducted to identify the potentials of RICOSRE in developing the problem-solving skills of students.

FURTHER STUDY

Future research may apply the RICOSRE approach to a larger and more diverse group of students to determine its effectiveness across different grade

levels and subject areas. Long-term studies are also recommended to assess the sustained impact of RICOSRE on students' problem-solving skills and to refine the intervention framework based on varying learning contexts.

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