

# Enhancement of Mathematics Competency through Independent/Cooperative Learning (ICL)

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**Abstract** - *This study developed a Tutorial and Instructional Program (TIP) using the Independent/Cooperative Learning (ICL) Strategy in enhancing students' competencies in college and advanced algebra. The respondents of this study were forty (40) first-year Bachelor of Secondary Education major in Mathematics. Mixed research methods were utilized using developmental and survey approaches. The pre-test and post-test results were applied to evaluate the competencies developed, while the survey approach aimed to identify the acquired social skills, values, and attitudes. Results showed that the developed program using the ICL strategy effectively enhanced competencies and developed social skills, values, and attitudes. Subsequently, TIP using the ICL strategy enhanced students' competencies, social skills, and values and attitudes. Hence, additional session time is needed to provide sufficient time to deliver the lessons, and students need other activities on word problems to practice their problem-solving skills. As well, the implementation of more programs is necessary to enhance learning competencies.*

**Keywords** – *mathematics, learning competencies, tutorial, independent/cooperative learning.*

## INTRODUCTION

DepEd introduced a new curriculum through DepEd order no. 31 in the educational system. s. 2012 as K to 12 [1], where a new strategy, Independent/Cooperative Learning (ICL) [2], was implemented. It was being used regardless of the subject's handling among public school teachers in the country. ICL is of great benefit to the performance of the students in the classroom [3]. It enables its productivity in achieving desired results.

According to the National Achievement Test (NAT) results for 2013-2014 in one of the school divisions of DepEd, math had the lowest mean percentage score of 26.342% among the lowest five performing secondary schools [4]. The Philippines, as cited by King & Guerra [5], is significantly behind

other Asian countries in Mathematics and Science. Thus, this reflects that students had a poor performance in mathematics.

Numerous studies and experts have described some factors as leading to students' poor math results. Tshabalala et. al, as stated by Ojimba (2012), cite a shortage of well-trained teachers, inadequate teaching facilities, a lack of funds to purchase adequate equipment, low textbook material, large classes, and poorly motivated students as some of the factors [6]-[7]. Furthermore, a misunderstanding of the subject (mathematics) as complex, fear, and anxiety, according to Shiel and Kelly [8] in National Institute for Educational Development (NIED), may lead to poor results. Thus, the causes of poor mathematics performance among students are diverse and numerous, but they can be based on three groups: school-based causes, teacher-related causes, and student-related causes.

Teachers, students, and administrations all have suggestions for raising students' academic performance. According to Karue and Amukowa [9], providing instructional materials, a library, a laboratory, and other physical facilities are ways to enhance mathematics efficiency. Students' progress in mathematics can be enhanced by fostering a positive attitude toward mathematics, administering more assessments and quizzes, and providing sufficient teaching and learning materials.

Students' motivation, attention, retention, test scores, and social skills were all enhanced due to the ICL. However, no research has yet been performed in tertiary schools using the ICL strategy. As a result, the researcher used the ICL to develop students' competencies at the college-level and within a program.

## OBJECTIVES OF THE STUDY

This research aimed to develop a Tutorial and Instructional Program (TIP) using the Independent/Cooperative Learning (ICL) strategy.

Specifically, it looked at students' math competencies in college and advanced algebra before and after TIP was implemented. Furthermore, it also determined social skills, and values, and attitudes.

## **METHODS**

### **Research Design**

This research employed mixed quantitative and qualitative methods involving developmental and survey procedures. The pre-test and post-test were used to assess the competencies developed among college and advanced algebra students. Meanwhile, the TIP was established utilizing the developmental method. Moreover, the survey method was used to determine the competencies acquired in terms of social skills, and values and attitudes.

### **Respondents**

The respondents from this study were first-year college students taking a Bachelor of Secondary Education major in Mathematics (BSEd Math) in one of the tertiary schools in Camarines Sur, Philippines. The class was composed of forty (40) students, fourteen (14) males, and twenty-six (26) females. There was no sampling, and all of them were used as respondents. Furthermore, they were the first batch of K-12 graduates who took up senior high school with different tracks/strands and came from various municipalities in Camarines Sur, Naga City, and Masbate. Respondents' real names were replaced with A, B, C, and other letters to protect their identities in this study.

### **Research Instruments**

This study used a teacher-made test and a survey questionnaire to determine the developed competencies among college and advanced algebra students. It was validated by the experts composed of math professors and other related education courses. Five (5) jurors validated the test questions and table of specifications which are college mathematics instructors. The learning competencies were anchored to the course description of Math 101 – college and advanced algebra. It was made through the collaborative effort of a group of experts in math from the four (4) campuses of a university in Camarines Sur. Before it was administered to the respondents, pilot testing was given to another group of students, and item analysis was also considered to measure its validity and reliability. The test was pilot tested first to thirty-four (34) fourth year BSEd math major students. The findings found that only 30-item were retained along with item difficulty,

and the rest were revised/discarded. Only ten (10) items were qualified to be included in item discrimination. Furthermore, the survey questionnaire was constructed through an open-ended question, and it was modified and adapted from the existing instrument [10].

Tutorial and Instructional Program (TIP) focused on the Independent/Cooperative Learning (ICL) Strategy, which experts verified to help students improve their skills. The developed program was adapted and modified based on the related programs [11] – [13], which offers tutoring, instructional assistance, and a supportive and secure learning atmosphere [14] – [17]. The program ran for ten (10) sessions or fifteen (15) hours, where each session is one and a half (1.5) hours. After the implementation, the post-test was administered.

### **Data Gathering Procedure**

The researcher asked the school administrators for approval of the proposed program for this study. The sessions were determined based on students' schedules and used their available time not to affect their classes. The topics included in the tests were aligned in the course description and only used the topics which cover the midterm.

Furthermore, this study developed a Tutorial and Instructional Program (TIP) using an Independent/Cooperative Learning (ICL) Strategy that ran for ten (10) sessions or fifteen (15) hours. After implementing the program, the post-test was given to the students to determine their mathematics skills. Meanwhile, the survey-questionnaire in a form of open-ended question was used to determine the social skills, and values and attitudes developed throughout the program's implementation.

### **Data Analysis**

The researcher used the statistical tools such as frequency counting and mean percentage score to assess the competencies developed among the students in college and advanced algebra both for the pre-test and post-test in the analysis and interpretation of the data collected. The number of students who got the correct response per competency was calculated using frequency counts, which were then converted into a percent.

In addition, to interpret the Mean Percentage Score (MPS) results in their pre-test and post-test, the guidelines of National Education Testing and Research Center (NETRC) was used: 96-100: Mastered (M); 86-95: Closely Approximating Mastery (CAM); 66-85: Moving

Towards Mastery (MTM); 35-65: Average Mastery (AM); 15-34: Low Mastery (LM); 5-14: Very Low Mastery (VLM); 0-4: Absolutely No Mastery (AVM)

**Ethical Considerations**

The ethical guidelines were put into place for the research period to protect the respondents' dignity and wellbeing. The researcher sought the students' consent to participate in conducting the research, and an approved letter from the school heads was sought before conducting the study. Furthermore, the respondents' test results and outputs were assured confidential.

**RESULTS AND DISCUSSION**

**Competencies of the students in College and Advanced Algebra**

Having a mathematical competency entails being equipped and able to act mathematically based on knowledge and insight. Students use and develop competencies when they encounter unfamiliar or challenging situations. Identifying specific competencies will enable learners to develop mastery of each skill at their own pace and with proper guidance. A valid evaluation of an individual's mathematical competencies is founded on the

identification of the presence and range of competencies in relation to mathematical activities in which the individual is involved, the study says. This study used the pre-test to determine the competencies of the students in college and advanced algebra along with the following competencies: properties of real numbers and exponents, radicals, complex numbers, linear and quadratic equations, and its applications.

One of the essential areas of investigation in this study is to determine the students' performance level in college and advanced algebra based on the pre-test results as shown in Table 1, and it was administered and interpreted using frequency counts and mean percentage score (MPS).

Table 1 displays the learning competencies where the top four (4) are the properties of real numbers (55.36%), roots of quadratic equations, completing the square, quadratic formula, and graphing (46.67%), solution of the system of equations (35.36%), and linear equations (39.17%). All of them were under Average Mastery (AM). This entails that the students have the usual understanding and have some experiences within the competency areas. Similarly, they understand key concepts, use their prior knowledge, and understand processes and their own techniques to solve math problems.

**Table 1. Competencies of the students in College and Advanced Algebra along Pre-test**

Learning Competencies	No. of Items	Pre-test		Interpretation
		Mean Score	Performance level	
1. Illustrate the properties of real numbers	7	3.875	55.36%	Average Mastery
2. Use the properties of exponents in simplifying algebraic expression	10	3.325	33.25%	Low Mastery
3. Simplify radicals	1	0.325	32.50%	Low Mastery
4. Perform operation on radicals	5	1.200	24.00%	Low Mastery
5. Rationalize the denominator of radical expression	1	0.225	22.50%	Low Mastery
6. Perform operation on complex numbers	4	1.075	26.88%	Low Mastery
7. Determine the complex roots of an equation	5	1.250	25.00%	Low Mastery
8. Solve linear equations	3	1.175	39.17%	Average Mastery
9. Use/apply the concepts of linear equation in solving real world problems	2	0.475	23.75%	Low Mastery
10. Find the roots of quadratic equations using the different methods such as, factoring, completing the square, quadratic formula and graphing	3	1.400	46.67%	Average Mastery
11. Use/apply the concepts of quadratic equation in solving real world problems	2	0.300	15.00%	Very Low Mastery
12. Determine the solution of system of equations using the different methods such as graphing, substitution, elimination by addition/subtraction, comparison, and determinants (Cramer's Rule)	7	2.475	35.36%	Average Mastery
Overall	50			

Likewise, students can draw the relational thinking strategies as a prerequisite skill between each property of a real number and solve linear equations and simplify math expressions. According to Demme Learning [18], we should learn basic math to use it to learn more advanced math. Much of the math we learn may only be functional but very important for learning more advanced math. Possessing the necessary elements for advanced learning gives more opportunities to solve math problems easily and quickly.

Furthermore, the data showed that most of the learning competencies were under a Low Mastery (LM) along with properties of exponents (33.25%), simplifying radicals (32.50%), complex numbers (26.88%), complex roots (25.00%), operation on radicals (32.50), linear equation in solving real word problems (23.75%) and radical expression (22.50%). This result shows that the students have minimal knowledge and experience in the related competency domain. They did not use existing and defined procedures to solve the math problems. According to ISU [19] to facilitate learning, one of the fundamental principles that instructors should employ is to understand students' prior knowledge. It is well known that students build on what they already know and understand through formal and informal experiences. For the instructor, it is essential to assess such prior knowledge. The teacher should be aware of principles and strategies in teaching where it has a significant impact on students' learning.

On the other hand, only one (1) competency fell under the Very Low Mastery (VLM), which was quadratic equation in solving real-world problems (15%). This indicates that the students' learning in word problems was below the expectations and reasonable progress toward critical goals was not evident. Thus, significant improvement is needed. This may be attributed to proper interventions to improve their performance.

In the study of Tambychik et al. [20], it was stated that lack of mathematics skills caused difficulties in solving problems. Students are required to apply and integrate many mathematical concepts and skills while making decisions and problem-solving. Inadequacy of these skills could cause problems in mathematics skills among students. Furthermore, language and visual-spatial skills are also essential to interpret and manipulate information effectively.

As presented in Table 1, it shows in the pre-test that among the learning competencies in college and advanced algebra, the properties of real numbers (55.36%) got the highest percentage rating. It was

followed by quadratic equations (46.67%); linear equations (39.17%); solution of systems of equations (35.36%); properties of exponents (33.25%); simplify radicals (32.50%); complex numbers (26.88%); complex roots (25.00%); operation on radicals (24.00%); linear equation in solving real-world problems (23.75%); radical expression (22.50%) and lastly, quadratic equation in solving real-world problems (15.00%).

It further revealed that the students got low scores in the pre-test. According to Kuehn [21], students should not be expected to know some of the answers to the pre-test questions, however, they should be expected to use prior knowledge to interpret rational solutions. Another factor to be considered was their senior high school strands, where most of them belong to General Academic Strand (GAS) with thirteen (13) males (33.33%) and twenty-four (24) females (61.54%). In contrast, only one (1) female (2.56%) each belong to Accounting, Business and Management (ABM) and Science, Technology, Engineering and Mathematics (STEM). Moreover, based on the K-12 curriculum, students who graduated in ABM and STEM inculcate more in science and mathematics concepts than GAS. Thus, it is vital to develop a program and use a teaching strategy suited to diverse learners to bridge the gap in GAS graduates' lacking competencies. This would enrich students' ability to solve math problems.

### **Tutorial and Instructional Program (TIP) to enhance students' competencies in College and Advanced Algebra**

Having low academic performance in math is one of the most challenging problems that students, teachers, and especially the educational system face. This concern stems from various factors, including academic, social, cultural, and psychological characteristics. There have been many attempts to address low academic achievement. Lack of interest, learning enthusiasm, student and teacher factors, low vocabulary and reading comprehension, inadequate understanding of the fundamental mathematical foundation, and environmental influences have all been established to determine educational success. These factors are common issues to be recognized by the concerned people not to lead students' failure in tests, dropping the entire course, and disinterest in mathematics and enhancing mathematical competencies if proper steps are taken to mitigate the problems. One typical response to this challenge is group students with similar achievement levels into courses and study programs, Dumont [22]. Thus, this

study proposed a program that would help the students enhance their competencies so that mastery, appreciation, and understanding of every lesson concept would be manifested by them.

According to the research finding of Taylor [17] it was found that tutorial program was effective in improving students' academic performance. Hence, this study adapted the related programs [11] – [13] on Tutorial and Instructional Program and modified them. Furthermore, it was validated by the experts by giving comments and suggestions to improve the program further.

Teachers are looking for new ways to improve students' math skills to demonstrate mastery, appreciation, and comprehension of each lesson idea. The Independent/Cooperative Learning (ICL) strategy is one way to carry out the teacher's targets. Independent/Cooperative Learning (ICL) was first adopted as a K-12 program in 2012 by DepEd order no. 31, s. 2012 [1]. Thus, the Independent/Cooperative Learning (ICL) was applied as the main strategy in implementing the Tutorial and Instructional Program (TIP).

The ICL is a one-hour weekly and open learning period that allows students to study topics, content, or processes they can handle independently or with others [2]. Many benefits have been observed to students when DepEd teachers implemented this, like (Hermosa 2012): first, it meets their learning styles by working in pairs or small groups, having discussions, and reporting; second, it is effective in increasing academic achievements; and third, it enables the teachers to work with a small group of students rather than big groups; fourth, it increases students' self-esteem; fifth, students can become real partners in the learning enterprise, and lastly, it encourages friendship among students of different abilities and social levels [13]. ICL is not intended to be used every day in every subject, and teachers can choose which lessons better suit their students' needs.

Since the Independent Cooperative Learning (ICL) is one of the DepEd teachers' strategies in intervening students' interests in various lessons, it was adopted in the developed Tutorial & Instructional Program (TIP). The TIP is a program that provides tutoring, coaching, and instructional support services for all students regardless of their abilities. It also provides an open and safe learning environment for them with the assistance of their teacher. In this program, students can learn independently by themselves, share their educational experiences with

more knowledgeable other, work as a team to achieve a specific task, gain positive relationship and interdependence and develop mathematics and social skills and values and attitude. This would provide an alternative way of strategy to the instructors in tertiary schools to enhance their students' skills and competencies. Furthermore, it would bring insights to the curriculum planners and CHED officials that adopting the DepEd's Independent/Cooperative Learning may optimize the students' performance in mathematics.

Tutorial & Instructional Program (TIP) stands out from other programs because it provides tutorial sessions with program proposals, ten (10) sessions or fifteen (15) hours of lessons and activities, a session guide, a class record, student attendance record, a completion certificate/recognition, and used an ICL strategy.

A tutorial is a formal process involving a supportive relationship with a more experienced and knowledgeable person. It can take many various forms, from simple task instructions to interactive problem-solving sessions. According to Oxford Learning Centres, Inc. [15], tutoring services have several advantages, including tutors who can tailor lessons and activities to the tutees' personalities. Furthermore, it provides students with the one-on-one attention they would not receive in a crowded classroom [15]. It also promotes independence, responsibility, and the ability to ask questions. It is a method of knowledge transfer that can be used as part of the learning process. It assists students in improving their cognitive, communication, and social abilities. Academic performance, attitude toward learning and school, self-esteem and confidence, work and study habits, and social and behavioral skills all improve due to this program.

TIP was also embedded by instructional support, which incorporates lessons, activities, evaluation, and intervention strategies (pairing by 2's and 3's, heterogeneous groupings, face-to-face interaction, individual learning, more knowledgeable others, think-pair-share, team-pair-solo, group brainstorming and sink or swim) to help all learners in the regular classroom address educational or behavioral stumbling blocks.

The objective, significance, rationale, scope, funding and expenditure, strategies/methodologies, and program plan are included in a proposal. It is also a first step toward coordinating more of the program's critical facets. This is the first phase in organizing all the activities, facilities, and other resources needed and

aligning them with a feasible schedule to meet the program's goal and motivate the participants. The college dean and campus administrator of the respondents' school were given a formal communication with the attached program proposal before implementing the TIP to clarify what ought to be done, how it could be done, and the implications of the process, SSWM [23].

The TIP is a free-of-charge service given to forty (40) students of I-BSEd math class. It ran for ten (10) sessions or fifteen (15) hours, each session has one and a half (1.5) hours where it has ten (10) lessons. The lecture method was used to deliver the instructions to the students and emphasize the content. The traditional lecture has many advantages, particularly in the large classroom, and can effectively meet instructional goals. It can be used in conjunction with active learning and teaching strategies, according to MSU [24].

The lessons discussed to students served as an instructional support to them. The activities were prepared, which is aligned to each lesson's learning objectives, and gave to the student after the discussion of the lesson. This will ensure student development and advancement through the unit of the program. It enables them to develop their skills, knowledge, and understandings in different ways. The teacher used effective instructional practices and diverse strategies to support student engagement, achievement, and success since each student has unique learning preferences, interests, strengths, needs, and potential. Group work can be an effective method to motivate students, encourage active learning, and develop key critical-thinking, communication, and decision-making skills. Similarly, Johnson [25] encourages students to work in groups and teams where their core aim is to achieve a specific task. The More Knowledgeable Others (MKO) in Vygotsky's Yen Social Development theory [26] can help children learn new concepts.

A session guide is a well-organized list of activities and resources that the teacher and students can use to achieve a particular learning goal. It integrates the content to be taught into a precise action sequence. It helps to ensure that the activities are consistent with being implemented for the program's entire duration. Session number, date, topics, objectives, number of hours, activities, resources needed, and learning activity strategy were all included in the session guide. According to Beasley [27], the session plan provides a clear guideline, organizes the sessions, and can foretell possible problems from the

session. The substitute teacher may also use the session guide if the teacher cannot attend the lesson.

A class record is a type of form that can be used to keep assessment records about students' performance in class. Record keeping aims to ensure accurate and proper records of student achievement and growth, school activities [28]. Also, the class record is the teacher's actual data for the entire ICL implementation period. The researcher changed the actual name of the students for the sake of confidentiality. Some students did not complete the activity, for they were absent during the session. However, to cope with the missed activity, handouts and activity sheets were still distributed in the next session to work independently during their vacant time. More Knowledgeable Others (MKO) assisted them in relaying information towards the topic discussed. The rest of the students who accumulated absences for various reasons, such as practicing in preparation for their performance in other subjects, need to submit pertinent documents for their scholarship, experienced sickness, and other personal reasons. The whole activities have 185 items where the highest score was 151 (88.97%) while the lowest score was 32 (50.38%). Moreover, 30 of 40 students had passing scores in the activities. Thus, the instructional support delivered by the teacher was adequate.

Based on the class attendance record, there were only nine (9) students who completed the fifteen (15) hours needed time for the program's whole period. However, students who did not meet the expected number of hours were given a certificate of participation. It was signed by the proponent (researcher), college dean, and campus administrator. Moreover, the top five (5) students were awarded a certificate of recognition for their outstanding post-test achievement.

A certification is given to individuals after they meet specific requirements. Research has proven that recognizing one's efforts is more highly valued than money, APA [29]. A certificate of completion/participation and recognition was awarded to participants who have participated during the Tutorial and Instructional Program (TIP) implementation using Independent/Cooperative Learning (ICL). Giving certificates is most commonly essential for formal compliance requirements but can be leveraged to increase uptake and encourage training completion.

The Tutorial and Instructional Program (TIP) used primary strategies: independent learning and cooperative learning.

**Table 2. Comparison of competencies of the students in College and Advanced Algebra along Pre-test and Post-test**

Learning Competencies	No. of Items	Post-test		Interpretation	Pre-test		Performance level of Posttest minus Pre-test
		Mean Score	Performance level		Mean Score	Performance level	
1. Illustrate the properties of real numbers	7	5.250	75.00%	Moving Towards Mastery	3.875	55.36%	<b>19.64%</b>
2. Use the properties of exponents in simplifying algebraic expression	10	5.325	53.25%	Average Mastery	3.325	33.25%	<b>20.00%</b>
3. Simplify radicals	1	0.875	87.50%	Closely Approximating Mastery	0.325	32.50%	<b>55.00%</b>
4. Perform operation on radicals	5	3.625	72.50%	Moving Towards Mastery	1.200	24.00%	<b>48.50%</b>
5. Rationalize the denominator of radical expression	1	0.700	70.00%	Moving Towards Mastery	0.225	22.50%	<b>47.50%</b>
6. Perform operation on complex numbers	4	2.475	61.88%	Average Mastery	1.075	26.88%	<b>35.00%</b>
7. Determine the complex roots of an equation	5	2.350	47.00%	Average Mastery	1.250	25.00%	<b>22.00%</b>
8. Solve linear equations	3	2.200	73.33%	Moving Towards Mastery	1.175	39.17%	<b>34.17%</b>
9. Use/apply the concepts of linear equation in solving real world problems	2	1.475	73.75%	Moving Towards Mastery	0.475	23.75%	<b>50.00%</b>
10. Find the roots of quadratic equations using the different methods such as, factoring, completing the square, quadratic formula, and graphing	3	1.975	65.83%	Moving Towards Mastery	1.400	46.67%	<b>19.17%</b>
11. Use/apply the concepts of quadratic equation in solving real world problems	2	0.500	25.00%	Low Mastery	0.300	15.00%	<b>10.00%</b>
12. Determine the solution of system of equations using the different methods such as graphing, substitution, elimination by addition/subtraction, comparison, and determinants (Cramer's Rule)	7	4.975	71.07%	Moving Towards Mastery	2.475	35.36%	<b>35.71%</b>
<b>Overall</b>	<b>50</b>						

Independent learning is a type of learning strategy in which students' knowledge, abilities, and pace of learning were only used to answer the given activities independently. It is often linked with other learning approaches like personalization, student-centered learning, and learning ownership [30]. Teachers' critical role in assisting students to become independent learners is by ensuring that students were actively involved in education.

Cooperative Learning is a strategy that teachers use to increase students' motivation, attention, retention, and mean percentage score (MPS). In the ICL implementation, the teacher used different activity strategies such as pairing, heterogeneous groupings, face-to-face interaction.

More Knowledgeable Others, Think-Pair-Share, group brainstorming, and sink or swim. Cooperative Learning has many advantages that give benefits to the students and teachers. Hermosa 2012: It meets students learning styles, it is effective in increasing academic achievements of the students, it enables teachers to work with a small group of students rather than big groups, it increases students' self-esteem, and it encourages friendship among students of different abilities and social levels [13].

According to the study of Lazarus [31], it was revealed that students exposed to cooperative learning instructional strategy performed better than those exposed to peer tutoring and the control. Similarly, Altamira and Anowar [32]-[33] found that cooperative learning enhances students' interest and participation in the learning phase. It had a significant effect and great improvement in mathematics achievement and attitudes towards mathematics and can increase the motivation to achieve academically. Zakaria [34] concluded that cooperative learning is an effective approach that mathematics teachers need to incorporate.

### **Competencies developed among the students in the implementation of the Tutorial and Instructional Program using Independent/Cooperative Learning (ICL) in terms of Mathematics skills, Social skills and Values and Attitudes**

#### ***A. Mathematics skills***

The table 2 shows the competencies developed among the students in implementing the ICL in terms of mathematics skills. The post-test procedure was used to evaluate learner outcomes in college and advanced algebra. This procedure provides feedback to the instructor by measuring what knowledge the learner gained.

Only one competency, simplifying radicals (87.50%), was under Closely Approximating Mastery (CAM). Students knew how to factor the radicand with a perfect power number to facilitate the given radical expressions. According to Magoosh [35], sometimes radical terms can be simplified when the radicand is a perfect power. If the radicand is not perfect power, then they still might be able to factor it. The students were familiar with how to simplify radical expressions and how to use the table of perfect powers to factor radicands and variables.

Meanwhile, most of the competencies were under Moving Towards Mastery (MTM), such as properties of real numbers (75.00%), operation on radical (72.50%), radical expression (70.00%), linear equations (73.33%), linear equation in solving real-world problems (73.75%), quadratic equations (65.83%) and systems of equations (71.07%). This indicates that they are still working to the mastery level. However, most of the competencies had an improvement of their ratings from pre-test to post-test. Thus, their competencies were enhanced through the ICL implementation.

Three (3) of the twelve (12) competencies, however, got an Average Mastery (AM) rating: properties of exponents (53.25%), complex numbers (61.88%), and complex roots of an equation (47.00%). This indicates that students are still at the mastery phase and need further instruction and guidance.

Students had a poor foundation in the properties of integral and rational exponents. Exponents tell to multiply a number by itself using the superscript numeral to determine how many times to do this. Students got confused when all exponents' properties and combinations of numerical and literal coefficients were placed in one problem. Prior knowledge from previous courses significantly influenced student achievement, according to Hailikari et al. [36]. The properties of real numbers, factoring, and simplifying radicals were also realized, which are prerequisite knowledge in finding the complex roots of an equation. The students used the same concepts in radicals in dividing complex numbers, such as rationalization and getting its conjugate.

However, the same pre-test and post-test competency, quadratic equation in solving real-world problems, had the lowest performance rating (25%). This means they struggle with word problems and need guidance on how to solve it. According to the findings of Haghverdi's et al. [37] research, students' difficulties stemmed primarily from their difficulties in representing and capable of understanding word problems. The results found that text difficulties,



unfamiliar contexts of problems, and inadequate techniques were the underlying factors of the students' difficulties. Students are suggested to seek patterns, draw pictures, and rephrase questions. It is expected that teachers can develop a better understanding of how to teach students to think objectively to answer challenges logically and consistently.

Among the learning competencies in college and advanced algebra, the simplify radicals (87.50%) got the highest percentage rating than properties of real numbers (75.00%), linear equation in solving real-world problems (73.75%), linear equations (73.33%), operation on radicals (72.50%), solution of systems of equations (71.07%), radical expression (70.00%), roots of quadratic equations (65.83%), complex numbers (61.88%), properties of exponents (53.25%), determine the complex roots (47.00%) and lastly, quadratic equation in solving real-world problems (25.00%).

Only one (1) competency had low mastery learning accumulated, according to the results. This means that the Tutorial and Instructional Program through ICL strategy had a significant effect on the students' mathematical skills. According to Lazarus [31], students introduced to cooperative learning as a teaching technique performed well. Collaborative learning, on the other hand, boosts students' interest and participation in the learning process. This backs up the findings of Morillas et al. and Van Veggel et al. [38] – [39], who found that tutoring is an essential tool for optimizing students' academic performance. Thus, it had a positive impact and resulted in significant improvements in math performance and attitudes.

Thus, small-group tutorials are an effective mathematics support method to enhance student mathematics confidence and performance. They gained individual and unique learning experience, one-on-one attention, improving academic performance and attitude towards learning and school, encouraging self-paced, self-directed learning, improving self-esteem and confidence, and work-study habits.

### **B. Social skills**

Social skills are behaviors that encourage meaningful social interactions and with the environment. These skills include showing empathy, participation in group activities, generosity, and helpfulness. Displaying good manners, communicating effectively with others, being considerate of others' feelings are all important components of solid social skills. This study determines students' social skills

through the implementation of Tutorial and Instructional Program (TIP) using Independent/Cooperative Learning (ICL). A reflection paper was used with an open-ended question/statement. They are free to continue the given phrases/statements based on their experiences in the lessons and activities conducted. The students' responses were collected and use the Framework for Philippine Mathematics Teacher Education [40] to generalize their responses. Among the social skills developed are the following:

1. *Encourage friendship among co-students of different abilities and social levels.*

Teachers are vital in assisting students in forming friendships in the classroom. This is particularly true for students who may not have yet developed the necessary social skills to make friends on their own. It is essential to assist them in making friends in the classroom. It will help them in developing exceptional social and communication skills that they will apply throughout their lives.

Students formed friendships because of the introduction of ICL, as shown by their responses that ICL environment promotes... *“to have friendly environment not just in the classroom but in every aspect”* [A], *“more social closeness of classmates”* [B] and *“competitive yet friendly environment in the classroom”* [C]. Furthermore, the best part in the ICL implementation was... *“yong mag go group si sir para sa group activity kasi mas lalo kaming naging close ng mga kaklase ko”* (when our teacher groups the class for the activity and we became closer with my peers) [D]. On the other hand, I like about ICL was... *“kasi mas naenhanced ang aking pakikipagkapwa lalo na kapag may group activity at kung paano makisalamuha ng tama sa aking mga kaklase”* (it enhances my relationships to others most especially if there is a group activity and on how to socialize with my classmates) [E].

This entails that teacher structured lessons more cooperatively helped students to feel support and connection with their peers. Students had better success on academic tests and tasks and sustained higher levels of achievement. It was suggested that student-to-student friendships produced social contexts which facilitated conceptual understanding [41].

2. *Promote face-to-face interaction among co-students and teacher.*

Students support each other in learning with their teacher's assistance, resulting in cognitive processes and group interactions. Through face-to-face

promotional experiences, students become personally committed to each other and their common goals.

According to students' responses, through ICL, they developed on how to... "*na develop ko yung paano makisocialize sa ibang tao*" (I developed on how to socialize with other people) [A] and (confront things that requires mutual interaction between co-students and peers) [B]. Moreover, an ICL environment promotes... "*paano makisalamuha sa mga kaklase*" (on how to mingle with classmates) [C]. ICL trained me on how to... (be a true teacher that encourage students to learn in their comfortable environment which requires interaction among teachers and peers) [D].

Students boosted their collaboration and creativity through their ability to share ideas freely through face-to-face interaction. It allows them to have a voice in a more relaxed environment. This result supports the study of Adams [42], he concluded that teachers need to incorporate cooperative learning strategy like face-to-face interaction.

### 3. *Provide the opportunity to learn the importance of teamwork.*

One of the essential aspects of achievement is student cooperation. Great things can be accomplished by working together for a common goal rather than vying for personal advancement.

In the implementation of TIP, an ICL environment promotes... (cooperation in class), (teamwork, cooperation and have a good interaction with co-students), and (unity in the classroom) [A]-[C]. Furthermore, the best part in the ICL implementation was... "*meron kaming unity at sa paggugrupo nagtutulungan para mas tapos on time*" (we have unity especially during group activity, we help each other to finish task on time) [D].

The NDT [43] teamwork is vital to have teamwork skills when they enter the workforce. Findings tell that students learn best from tasks that involve doing tasks and involve social interactions. It also enhances communication and other development skills and creates more opportunities for critical thinking.

### 4. *Give confidence to recite in the class discussion.*

One of the essential step's teachers can take to ensure a learning environment is to instill confidence in their students.

Through ICL, it encourages me to... (talk in front and to express thoughts without any hesitations to answer) [A]. Likewise, with the ICL, it gives me confidence to... (recite/answer in front of the class because I admit that I am a shy person and gives me

confidence in sharing own ideas or opinions to others during group activity) [B].

Students' self-esteem, motivation, empathy, trust, and participation in the learning process all contribute to cooperative learning effectiveness. Mutai [44] discovered that a significant thing in secondary school mathematics learning habits was a lack of confidence and interest in learning and doing well in mathematics.

### 5. *Share information and opinions about different strategies in solving mathematical problems.*

Sharing various problem-solving strategies allows students to see a new, more effective strategy. Students will be able to solve problems clearly and efficiently due to this.

With the ICL, it gives me confidence to... (share ideas and opinions on how to solve problems and finish it on time) [A]. Likewise, I like about ICL was... (the opportunity to share the ideas on how to solve difficult and simple problem) [B].

Knowledge sharing plays a vital role in students' learning process. The primary motive is to improve understanding of the concepts discussed in the class. Leffler [45] shares the idea that the more minds that come together and from all different backgrounds, the better off we are.

### 6. *Exercise more communication skills.*

ICL encourages social interactions. As a result, students benefit in various ways from a social perspective, where it helps them improve communication skills by requiring them to justify their arguments and observations.

With the ICL, it gives me confidence to... (socialize with my classmate and improve my speaking or talking like I question my classmate) [A]. furthermore, though ICL, I developed on how to... (socialize with my classmate and develop communication with other and share my ideas or opinion) [B].

ICL develops students' interpersonal skills and their capacity to think at a higher stage. It may be claimed that it helps in the development of their communication skills. This validates Al-Tamimi's [46] findings that cooperative learning approaches resulted in a significant improvement in students' communication skills and attitudes.

This indicates that the ICL was successfully implemented and really helps develop social skills among the students. According to Vygotsky's social development theory, it suggests that social interaction is critical in cognition development [26]. When

children can interact with their peers, they exchange information and insights, correct one another, and adjust their understanding based on others' learning. This indicates that children value and learn from others and their surroundings.

### C. Values and Attitude

ICL has many academic and social advantages, as well as developing values and attitudes toward its application. Perseverance, confidence, respect, motivation, optimism, patience, responsibility, being active, pleasure, and being a good listener are a few of these qualities. An open-ended question/statement was used on a reflection paper. They are free to continue the phrases/statements given to them based on their experiences in the lessons and activities. Also, it employs the Framework for Philippine Mathematics Teacher Education [40] to synthesize their findings. The following are some of them:

#### 1. *Persevere to gain learnings and complete task given.*

Perseverance entails continuing to work despite difficulties until the task is completed. This is important for success in any endeavor. It involves continuing to practice and never giving up due to challenges in the classroom or other factors that distract students from studying.

Through ICL, it encourages me to... *"magpatuloy ng pag-aaral at para lumakas ang loob ko na labanan ang mga susunod pa na mga challenges sa pag-intindi ng mga problem"* (pursue my studies and have confidence to face every challenge in understanding problem) [A]. Additionally, *"kahit nahihirapan akong intindihin, pipupurso ko pa din at i-try ulit"* (even I find difficulty in understanding math problem; I still persevere and try once more) [B].

This shows that students keep their efforts despite difficulties in accomplishing their tasks. Perseverance is the ability to do their best toward a goal, even though it is a big challenge. According to Talking with Trees [47], a determination is self-control that pushes students to work through challenges.

#### 2. *Confidence to solve math problems and do some tasks.*

Students with low self-esteem may fail or make mistakes, then identify themselves due to that failure, deciding that they are illiterate. They must believe that they can understand and learn math to solve the problem.

By means of ICL, I motivated myself to... (improve my confidence by answering math problem especially in worded problem in front of my co-students and in front of my teacher and, I motivated myself to try solving math based on what I have learned during high school) [A]. Moreover, ICL trained me on how to... *"maging confidence sa sarili"* (to have self-confidence) [B].

It indicates that ICL implementation can improve students' self-confidence, self-esteem, and self-discipline. Nurhayati et al. [48] found that collaborative learning causes students to be more focused on sharing their classroom thoughts. They improve their ability to remain centered, hold an idea, form relationships with some students, and politely reject or accept others' opinions.

#### 3. *Motivate to progress academically.*

Students do better on tests when teachers use the ICL strategy in the teaching-learning process, particularly when it comes to reasoning and critical thinking skills than when they do not.

This supports the claim that, I value the most during the ICL implementation was... *"yong mga time na makataas ng score sa ICL activity"* (when he/she got high scores during every ICL activity) [A]. Moreover, by means of ICL, I motivated myself to... (it is good having an ICL because I have many learnings and knowledge gained, I motivated myself to learn more) [B].

It reveals that Independent/Cooperative Learning has a beneficial impact on academic performance and effective learning. This supports from Oxford Learning Centres, Inc [15] that tutoring can increase academic performance and attitude toward teaching and learning. Thus, teachers should have good strategies and methods to help students feel empowered and appreciate the lessons.

Students' values and attitudes were evident due to the Tutorial and Instructional Program using Independent/Cooperative Learning implementation. Thus, it is an essential technique that mathematics instructors could use in their classrooms. It gives students a substantial opportunity to develop, learn, and improve soft skills like leadership, communication, social, and conflict resolution, Adams [42].

## CONCLUSION AND RECOMMENDATIONS

According to the pre-test findings, the students had low learning competencies in College and Advanced Algebra. As a result, the developed Tutorial, and

Instructional Program (TIP) utilized Independent/Cooperative Learning (ICL) as a strategy. Students also developed social skills, beliefs, and behaviors in addition to their mathematical abilities.

It is essential to note the key elements to improve the study's results. Students who are having trouble understanding math concepts need extra assistance and instructional time. Learning Assistance Program (LAP), Mathematics Assistance Program (MAP), Math Lab Program (MLP), Greater University Tutoring Service (GUTS) and Mathematics Tutorial Program (MTP) [49] – [52] are only a few of the programs that can be adopted using Independent/Cooperative Learning (ICL) as a strategy to enhance students' competencies. Furthermore, extending ICL sessions to two (2) hours would benefit both the teacher and the students by providing them more opportunities to deliver lessons and interact with one another during activities. Learners should be given more word problem exercises to enhance their problem-solving skills. They should be exposed to more student groups and face-to-face interaction to develop their confidence and socialization skills.

When performing pilot testing and pre-testing for possible Independent/Cooperative Learning (ICL) studies, it is critical to consider the same respondents' profile. This would improve the test results' validity and reliability. Respondents from various SUCs will also represent their diverse cultures, backgrounds, and experiences. Furthermore, because students become tired as the school day progresses, conducting the proposed program in the morning rather than the afternoon may result in better student performance.

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