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Online Collaborative Learning and the Enhancement of Most Essential Learning Competencies in General Mathematics among Grade Eleven Senior High School Students

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Abstract

Making collaborative learning happen during a pandemic raised concerns and doubts among educators, given that learning during these trying times emphasized the importance of cooperating, corroborating, and interacting, particularly on subjects that were thought to be difficult, such as mathematics. The uncertainty stems from the question of how collaborative learning affects competency learning. Teaching students to acquire mathematical competencies is difficult in and of itself in a face-to-face setting; thus, peer-teaching and collaborative learning are always on the list to help below-average learners cope easily. This study determined the effect of online collaborative learning on the enhancement of most essential learning competencies (MELC) in General Mathematics. The study focused on thirty-five (35) respondents who were enrolled in online classes in the aforementioned subject during the academic year 2020-2021. The results revealed a significant difference between the pre-test and post-test scores, indicating that the OCL aided the students in mastering General Mathematics competencies. It was suggested that Mathematics Supervisors, Coordinators, Master Teachers, and Teachers propose in-service training or a learning action cell (LAC) that covers teaching and training of ways and means for teachers to make collaborative learning possible through the use of various modern-day applications such as Google Breakout Rooms, Open Broadcaster Software (OBS), and other platforms to ensure learners can still interact and learn with peers amid tumultuous times.

Keywords: Online Collaborative Learning, Most Essential Learning Competency, Peer-teaching, Modern-day Applications, Online Class.

1. Introduction

In the context of obtaining competences in General Mathematics, Online Collaborative Learning (OCL) is novel, especially since everyone has been accustomed to the face-to-face form of learning in which teachers and students can engage and exchange discourses in person (Zambrano *et al*., 2019). OCL, like the collaborative approach in traditional education, is a constructivist teaching style that takes the form of instructor-led group learning, but online (Reyes & Aliazas, 2021). Instead of memorizing right answers, students are encouraged to address problems collectively and interactively through discourse and idea exchange. The teacher is both a facilitator and a member of the knowledge community under study (Chiong & Jovanovic, 2012). However, from the perspective of pupils learning Mathematics, when they are forced into a group and feel undesired, they may lose interest in the course before it ever begins. If the groups are chosen by the teacher or by a random selection, the teacher must still ensure that the groups are working well. If a student initiate taking over without and regardless of the input of others, the quieter students who may have known better will go by the wayside (Kumi-Yeboah, Dogbey, & Yuan, 2017). As time passes, these types of ineffective sessions can gradually erode a learner's belief, desire, and interest in studying in a group setting (Wilson, 2010). Currently, K-12 requires its graduates to be completely equipped with the competencies that correspond to the path they have chosen; nevertheless, this would be impossible if students were inhibited by numerous issues that waned their desire to learn as a result of what the pandemic has significantly taken (Muuro *et al*., 2014).

Everyone is learning in the new normal. Despite these unavoidable circumstances, teaching and learning continue to make their way to students via the virtual world, raising questions about how students might acquire competences in subjects that were previously taught in the face-to-face method of learning (Reyes & Aliazas, 2021). Questions about how learners can cooperate, peer-teach, and trade discourses in groups while lessons are in session are raised (Harasim, 2017).

Teaching students to gain Mathematics competency is tough in and of itself in a face-to-face setting; hence, peer-teaching and collaborative learning are constantly on the list to aid the below-average learners cope up smoothly (Chiong & Jovanovic, 2012). Many students have benefited from collaborative learning because it allows them to learn at their own pace, in their own way, and in their own language. It has greatly aided those who learn it is much easier to ask group mates than to raise it in class (Slof *et al.*, 2021). However, online collaborative learning makes mastering the General Mathematics competencies much more difficult for students because it necessitates greater student contact, collaboration, and cooperation.

Furthermore, it is an unavoidable fact that not all pupils will be able to simply understand a sample equation or problem with a solution. Not all of them can immediately respond to the line of activities with only a sample and themselves. Thus, the unaided debate is highly dubious, particularly for students who require so much attention and assistance from classmates and teachers, as well as those who lack the support to learn on their own.

2. Objectives of the Study

This study aimed to identify the effect of online collaborative learning technique to the enhancement of most essential learning competencies in General Mathematics of the grade eleven students of Tanauan City Integrated High School.

Specifically, this study sought to answer to the following questions:

2.1. What is the perception of the respondents on Online Collaborative Learning in terms of :
  2.1.1 idea generating;
  2.1.2 idea organizing; and
  2.1.3 intellectual convergence?

2.2. What are the pre-test and posttest scores of the respondents based on the Most Essential Learning Competencies (MELC) in terms of:
  2.2.1. illustrating and symbolizing propositions;
  2.2.2. distinguishing between simple and compound propositions; and

2.2.3. performing the different types of operations on propositions?

2.3. Is there a significant difference between the pretest and post test scores of the respondents?

2.4. Is there a significant relationship between Online Collaborative Learning and the Most Essential Learning Competencies (MELC)?

3. Methodology

The experimental approach was used in this study, with the use of a pretest and a posttest. The experimental approach is best suited for this study because it analyzes the potential cause-effect relationship of the variables. This strategy represents the most acceptable approach to the problem, both practically and theoretically (Robinson, 2014). The experimental technique is a set of processes that allows researchers to test the hypothesis by reaching a meaningful conclusion regarding the relationship between variables, both dependent and independent. Its goal is to make sense of the results, improve control, and evaluate and comprehend experiment data (Kumar, 2018).

The study included thirty-five participants who were exposed to online collaborative learning. They were given a pretest to determine learners' needs in the target competencies and to provide a foundation for students' progress during the study. The researcher used purposive sampling method, also known as judgment, selective, or subjective sampling, to produce reliable and accurate results (Kumar, 2018). Purposive sampling is a sampling approach in which the researcher selects members of the population to participate in the study based on his or her own judgment. It is a non-probability sampling method in which "components picked for the sample are chosen by the researcher's judgment. Researchers frequently feel that by using excellent judgment, they may acquire a representative sample while saving time and money (Hoy & Adams, 2015).

The researcher used thirty-five (35) students who were officially enrolled in online classes at Tanauan City Integrated High School for the school year 2020-2021. Respondents were given a pre- and post-test before and after the experiment. The researcher taught the respondents for eight hours, or four meetings, by exposing them to a learning technique, the online collaboration. Students in online collaborative learning were exposed to learning assignments that required engagement and discourse exchange with classmates, as well as opportunities to study cooperatively.

To assess the effectiveness of the OCL approach, the researcher devised a test that acted as both a pretest and a posttest. The exam was based on the acquisition of competencies outlined in the curriculum guide for the subject General Mathematics. The test was based on lessons on propositions that were discussed during the experiment, as represented in the most essential learning competency of the DepEd curriculum guide in General Mathematics. It was made up of forty-five (45) items that examined the three most important learning characteristics. The learners chose to illustrate and symbolize propositions in the first fifteen (15) items. Following that, fifteen (15) items asked students to discriminate between simple and complex propositions, which were followed by fifteen (15) items that required them to conduct various types of operations on propositions.

The researcher obtained permission from the principal of Tanauan City Integrated High School to perform the study in order to collect the essential data for this study. The respondents took the pretest when authorization was given. The test results were collated and computed to see whether there was a significant difference between the pretest and posttest. During the study, the researcher taught the respondents about online collaborative learning by using modern programs such as Open Broadcaster Software (OBS), Google Meet Breakout Rooms, and Google Meet. They were taught through exercises that required them to collaborate, exchange ideas, and interact. The researcher provided adequate time for each group to maximize each step of OCL – idea generation, idea organizing, and intellectual convergence. With supreme control and direction over all the groups that operate concurrently through OBS, the learners' learning and discovery process was clearly prioritized. While the online collaboration is ongoing, the teacher visits each breakout room on a regular basis to provide directions and reminders.

After the experiment, the responders were given the same set of competencies and level of inquiry as in the pretest test as a posttest. The exam papers were examined, and the results were analyzed. The effectiveness of the aforementioned learning strategy was determined by the posttest performance of the respondents. The interpretation of the data acquired served as the foundation for the study's findings, conclusion, and recommendations.

To examine the effect of learning approaches on students' development of learning competencies in General Mathematics, the following statistical measures were employed. To display the respondents' pretest and posttest scores, Frequency and Percentage were used. The mean was used to calculate the average scores obtained from the group on the pretest and posttest. The T-test was used to evaluate whether there was a significant difference between the group's pretest and posttest results. Pearson Correlation was used to establish the significant link between the stages of OCL and the respondents' posttest scores.

4. Results and Discussions

Table 1: Online Collaborative Learning in terms of Idea Generating

In online collaborative learning I…	**Mean**	**Verbal Interpretation**
1. can share my knowledge with my groupmates with ease and confidence.	2.97	Agree
2. am able to discover new ideas from my groupmates.	3.63	Strongly Agree
3. am encourage to become more participative.	3.49	Agree
4. easily learn while brainstorming with my peers.	3.31	Agree
5. am given opportunity to speak and to share our thoughts, same with my groupmates.	3.46	Agree
6. can cope up with the lesson especially when my groupmates have shared more ideas	3.46	Agree
7. feel confident in sharing my knowledge to my groupmates.	2.94	Agree
8. have the opportunity to speak during group discussions.	3.06	Agree
9. am willing to accept criticism from my groupmates.	3.40	Agree
10. am motivated to interact with others	3.49	Agree
Overall	**3.32**	**Agree**

Legend: (1.00-1.49) Strongly Disagree; (1.50-2.49) Disagree; (2.50-3.49) Agree; (3.50-4.00) Strongly Agree

This section sought to ascertain students' perceptions on the stages of online collaborative learning (OCL). The researcher-created instrument was divided into three sections that corresponded to the three stages of OCL: idea generating, idea organizing, and intellectual convergence, each with 10 items, as indicated in the table above. According to table 1, respondents Strongly Agreed to indicator 2, "am able to discover new ideas from my groupmates," with the highest mean of 3.63, and Strongly Agreed to indicator 4, "feel confident in sharing my knowledge with my groupmates," with the lowest mean of 2.94 and a verbal interpretation of Agree. Meanwhile, the overall mean of 3.32 demonstrated that respondents agreed to OCL's aid in Phase I (Idea Generating), or the act of brainstorming and collecting divergent thoughts within a group. Furthermore, this finding was corroborated by Zhu's (2012) study, which demonstrated that computer-supported collaborative learning (CSCL) enhanced chances for brainstorming, exchanging ideas and viewpoints, sharing perspectives, and drawing on prior knowledge or experience. This venue encouraged learners to express their thoughts throughout the idea creation phase, which led to the discovery of fresh ideas from the material supplied by their groupmates.

Table 2: Online Collaborative Learning in terms of Idea Organizing

In online collaborative learning I…	Mean	Verbal Interpretation
1. understand the lesson easier from the similarities and differences of our generated ideas.	3.34	Agree
2. find it comfortable to visualize the underlying principles of the topic.	3.09	Agree
3. learn while having fun categorizing different point of views previously generated.	3.40	Agree
4. help and guide others in organizing ideas.	3.29	Agree
5. am given opportunity to intelligently discuss and argue on thoughts for better analysis	3.14	Agree
6. am able to handle and manage conflicts despite having contradicting ideas.	3.11	Agree
7. feel challenged analyzing the lesson.	3.49	Agree
8. am involve in making decisions.	3.40	Agree
9. find it easy organizing ideas with my groupmates.	3.20	Agree
10. am comfortable when someone compares his idea to mine.	3.20	Agree
Overall	**3.27**	**Agree**

Legend: (1.00-1.49) Strongly Disagree; (1.50-2.49) Disagree; (2.50-3.49) Agree; (3.50-4.00) Strongly Agree

It was clear from Table 2 above that respondent agreed with indicator 7, "feel challenged analyzing the lesson," with the highest mean of 3.49, but disagreed with indicator 2, "find it comfortable to visualize the underlying principles of the topic," with the lowest mean of 3.09 and a verbal interpretation of Agree. Similarly, the overall mean of 3.27 demonstrated that respondents agreed that OCL greatly aids the phase where they compare, examine, and sort out the various previously developed notions. Furthermore, Saqr *et al.* (2018) explained that in the process of organizing and classifying previously generated ideas, there will always be barriers to effective OCL classes in terms of understanding and analyzing ideas to be organized, which include social rambling, dysfunctional group dynamics, a lack of appreciation for values, and a lack of social skills, all of which add to the challenge that intragroup members may feel. Saqr *et al.* (2018) also stated that in order for a successful organization of different thoughts and opinions from each member during online collaboration to occur, there should be active coordination of group dynamics, respect and mutual engagement of the learners, discussion moderators, scaffolding by instructors, and a dynamic setting that encourages individuals to connect effectively, particularly during the idea organization phase (Wilson, 2010; Slof *et al.*, 2021). If the aforementioned traits were present, the member would find it easier to visualize the underlying ideas of the course as they interact.

Table 3: Online Collaborative Learning in terms of Intellectual Convergence

In online collaborative learning I…	**Mean**	**Verbal Interpretation**
1. can easily construct a piece of work cooperatively with my groupmates.	3.26	Agree
2. can finish the task right on time by joint effort of my groupmates.	3.17	Agree
3. learn better as we work together.	3.77	Strongly Agree
4. am able to reach a level of intellectual synthesis through every group members' participation.	3.26	Agree
5. become more motivated, interactive and friendly in accomplishing assigned tasks.	3.51	Strongly Agree
6. observe equal distribution of different tasks in the group.	3.40	Agree
7. work cooperatively with my groupmates.	3.69	Strongly Agree
8. have more opportunities to agree on the process of accomplishing the tasks.	3.49	Agree
9. am given the chance to contribute when tasks were assigned to us.	3.46	Agree
10. am confident to initiate help for the group's improvement.	3.34	Agree
Overall	**3.43**	**Agree**

Legend: (1.00-1.49) Strongly Disagree; (1.50-2.49) Disagree; (2.50-3.49) Agree; (3.50-4.00) Strongly Agree

Table 3 shows the respondents' perspectives on the third phase of OCL, Intellectual Convergence. This phase was about reaching the ultimate level of agreement among the group members. According to table 3, respondents Strongly Agreed to indicator 3, "learn better as we work together" with the highest mean of 3.77 and showed less agreement on indicator 2, "can finish the task right on time by joint effort of my groupmates" with the lowest mean of 3.17 and a verbal interpretation of Agree. As a result, the overall mean of 3.43 revealed that respondents Agreed to the assistance of OCL in terms of Phase III (Intellectual Convergence), or the moment of reaching a level of intellectual synthesis, understanding, and consensus (including agreeing to disagree), usually through the joint construction of some artefact or piece of work.

The aforementioned results were justified in the relative research conducted by Laal (2011), as his study led to the conclusion that in the process of having consensus or synthesis from what information was previously organized, collaborative learning has several benefits, and archetypally led to higher academic achievement and greater productivity caused by harmoniously working together (Dimaunahan & Panoy, 2021). This only helped to emphasize the reality that when students collaborate, they can achieve more and they tend to learn better and attain intellectual victory.

Table 4: Pre-test and Posttest Scores of the Respondents in illustrating and symbolizing propositions

Score	Pre-test		Posttest		Remarks
	f	%	f	%	
96-100	0	0	30	86	Mastered
86-85	1	3	5	14	Closely approximating mastery
75-85	13	37	0	0	Moving towards mastery
50-74	21	60	0	0	Average mastery
15-49	0	0	0	0	Low mastery
5-14	0	0	0	0	Very low mastery
0-4	0	0	0	0	Absolutely no mastery

According to table 4, following the administration of the pretest, the learning competency "illustrates and symbolizes propositions" accumulated 60 percent or 21 learners achieving a score range of 50-74, 37 percent or 13 learners achieving a score range of 75-85, and 3 percent or 1 learner achieving a score range of 86-95, yielding an overall mean score of 73.97 with a verbal interpretation of Average Mastery. In comparison to the posttest result of the aforementioned competency, it received 14 percent or 5 learners from a score range of 86-95 and 86 percent or 30 learners from a score range of 96-100, with a mean score of 98.49 and a verbal interpretation of Mastered varying by a gap of 24.52. The pretest results indicated that the respondents were familiar with the issue. Propositions in terms of the first MELC, on the other hand, require further discussion and elaboration in order to pass through the levels of Moving towards Mastery (MtM) and Closely Approximately Mastery (CAM) and be declared Mastered. This elaboration and debate employed an online collaborative learning technique to assess its impact on the development of competences.

This was supported by Sanders & Lokey-Vega (2020), underlined that reteaching concepts and skills is what is meant in a carefully structured intervention materials and strategic technique in teaching unmastered competences. It also emphasized that it is a tool provided to students to help them master a competency-based ability that they were unable to improve during ordinary classroom teaching and learning (Panergayo & Aliazas, 2021). According to the posttest results, the additional discussion and elaboration provided by OCL was clearly beneficial, as the learners were able to master the given ability. The MELC distinguishes between simple and compound propositions received 77 percent or 27 learners from the score range of 50-74 and 23 percent or 8 learners from the score range of 75-85, with a mean score of 70.23 and a verbal interpretation of Average Mastery, as shown in the pretest results in Table 5. This competency received 3 percent or 1 learner from a score range of 75-85, 29 percent or 10 learners from a score range of 86-95, and 68 percent or 24 learners from a score range of 96-100, with a mean score of 96.66 and a verbal interpretation of Mastered.

Table 5: Pre-test and Posttest Scores of the Respondents in distinguishing between simple and compound propositions

Score	Pre-test		Posttest		Remarks
	f	**%**	**f**	**%**	
96-100	0	0	24	68	Mastered
86-85	0	0	10	29	Closely approximating mastery
75-85	8	23	1	3	Moving towards mastery
50-74	27	77	0	0	Average mastery
15-49	0	0	0	0	Low mastery
5-14	0	0	0	0	Very low mastery
0-4	0	0	0	0	Absolutely no mastery

The fact that the students mastered the said competency demonstrated the effectiveness of OCL, which is contradicted by the study of Nason and Woodruff (2014), which stated that computer supported collaborative learning (CSCL) or OCL environments had been unsuccessful in facilitating and developing knowledge building in Mathematics and suggested that these issues could be overcome by the inclusion of model-eliciting mathematical problems and comprehension modelling as well (Tan & Vicente, 2019).

Table 6: Pre-test and Posttest Scores of the Respondents in performing the different types of operations on propositions

Score	Pre-test		Posttest		Remarks
	f	**%**	**f**	**%**	
96-100	0	0	11	32	Mastered
86-85	0	0	20	57	Closely approximating mastery
75-85	4	11	4	11	Moving towards mastery
50-74	31	89	0	0	Average mastery
15-49	0	0	0	0	Low mastery
5-14	0	0	0	0	Very low mastery
0-4	0	0	0	0	Absolutely no mastery

Table 6 shows that the competency conducts various types of operations on propositions received 89 percent or 31 learners with a score range of 50-74 and 11 percent or 4 learners with a score range of 75-85 with a mean score of 66.23 all with the verbal interpretation of Average Mastery. However, the posttest result received 11 percent or 4 learners from the 75-85 range, 57 percent or 20 learners from the 86-95 range, and 32 percent or 11 learners from the 96-100 range, with a mean score of 91.83 and a verbal interpretation of Closely Approximating Mastery.

Furthermore, Laal (2011), stated that among all the benefits of collaborative learning, it has notable academic benefits such as promoting critical thinking skills, enhancing problem-solving and logical thinking skills, involving students actively in the learning process, improving classroom results, motivating students to learn a specific curriculum especially.

Table 7: Test of Difference between the Pretest and Posttest Scores

MELC	Pre-test		Post-test		*t(34)*	*p*	Cohen's *d*
	M	SD	M	SD			
Illustrate and symbolizes propositions	73.97	6.54	98.49	2.54	-21.614	.000	3.65
Distinguishes between simple and compound propositions	70.23	6.07	96.66	4.28	-21.979	.000	3.72
Performs the different types of operations on propositions	66.23	5.99	91.83	4.89	-21.607	.000	3.65

There was a significant difference between the pre-test and post-test, as shown in Table 7, because the p-value of 0.000 was smaller than the alpha when evaluated at the 0.05 level of significance. This meant that OCL significantly boosted the learning of competences in terms of the topic Propositions and contributed to the students' growth during the study, as evidenced by their posttest scores. This is supported by Delialioğlu (2012) study, which stated that in active learning methodologies, work that integrates cooperation, such as online collaborative learning to address assignments, is demanding yet gratifying, and considerably aids in enhancing learners' learning and academic accomplishment.

Table 8: Test of Relationship between Online Collaborative Learning and the Most Essential Learning Competencies (MELC)

OCL Phases	Illustrate and symbolizes propositions	Distinguishes between simple and compound propositions	Performs the different types of operations on propositions
Idea Generating	.098	-.047	-.109
Idea Organizing	.105	-.119	.032
Intellectual Convergence	.196	-.090	.060

Table 8 indicated that there was no significant association between OCL and the MELC. There was no statistically significant link between OCL and the Most Essential Learning Competencies (MELC), indicating that the relationship between the variables was most likely to have happened. This result was further explained by Zhou *et al.* (2020), who stated in his study that when perception is connected with academic achievement, the correlation is likely to be statistically insignificant because what was examined were merely perceptions, especially in the setting of experimental investigations. The experiment's outcome aids in determining the influence of the independent variable on the dependent variable, which may differ from what was previously perceived (Hoy & Adams, 2015). These findings advised that other latent and visible variables outside the scope of the current study be included to create a more comprehensive picture of the determinants influencing academic accomplishment (Kumar, 2018).

5. Conclusion

The findings demonstrated a substantial difference in pretest and posttest scores, demonstrating that the OCL benefited students in mastering General Mathematics competencies. However, there was no statistically significant link between OCL and the Most Essential Learning Competencies (MELC), indicating that the variables did not have a relationship. Following the study of the findings, the following recommendations were made. Supervisors may initiate the holding of seminar workshops for Mathematics instructors in order to recall and refresh them on various concepts and strategies in teaching General Mathematics, particularly in encouraging collaborative learning during this pandemic. Mathematics Coordinators may propose in-service training or a learning action cell (LAC) that focuses on teaching and training methods and means for teachers to enable collaborative learning through the use of modern-day applications such as Google Breakout Rooms, Open Broadcaster Software (OBS), and other platforms. Master Teachers can monitor and review each module, lesson plan, or activity sheet generated by each Mathematics teacher to see if they are aligned with the most important learning competencies issued by DepEd. Future researchers may choose to undertake similar investigations to confirm the study's findings. They may increase the sample size or improve the research instrument to see if the correlation test yields a different result.

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