Original Article

The Use of Online Collaborative Learning in Teaching Operations on Functions in Synchronous Classes

Jonellyne R. Evangelista[1], Myra L. Mahinay[2], May Grace C. Princillo[3], Rosario Erika L. Quilang[4], Irene C. Gumiran[5]

[1,2,3,4]*Mathematics Department, College of Education, Rizal Technological University, Philippines*
[5]*Social Studies Department, College of Education, Rizal Technological University, Philippines*

Abstract - *Generally, this study intended to determine the effectiveness of using Online Collaborative Learning in teaching Operations on Functions in synchronous classes of Computer, Science, and System (CSS) Students at Rizal Experimental Station and Pilot School of Cottage Industries S.Y. 2020 - 2021, 4th quarter. It will also determine whether Online Collaborative Learning (OCL) helps in increasing the participation of students during synchronous learning. This study intended to determine the effectiveness of using Online Collaborative Learning in teaching Operations on Functions in synchronous classes of Computer, Science, and System (CSS) Students at Rizal Experimental Station and Pilot School of Cottage Industries S.Y. 2020 - 2021, 4th quarter. It will also determine whether Online Collaborative Learning (OCL) helps in increasing the participation of students during synchronous learning. It also looked into t1) What is the Math academic performance of the control and experimental group of student-respondents during the pre-test, (2) What is the Math academic performance of the control and experimental group of student-respondents during the post-test, (3) What is the perceived effectiveness of Online Collaborative Learning in increasing the students' involvement/participation in synchronous class, and (4) Is there a significant difference between the controlled and experimental group of student-respondents during the post-test.*

Keywords - *Collaborative learning, Mathematics Algebra, Online Class, Operations on Functions, Synchronous Class.*

1. Introduction

In the Philippines, slowing the risk to the academic community has been the primary concern, and due to the community quarantines, the traditional way of learning, which is the face-to-face class, is impossible. The Commission on Higher Education (CHED) adopts and promulgates CHED Memorandum Order (CMO) No. 4, series of 2020, also known as Guidelines on the implementation of Flexible Learning to be implemented by public and private Higher Education Institutions (HEIs). The development of Computer-Mediated Communication (CMC), also called Network Learning, is caused by both the constructivist approach to learning and the Internet progress. This has now been developed into Online Collaborative Learning (OCL), which Harasim (2012) described as a model of learning in which the students are encouraged to work together in creating knowledge and seeking concepts to solve problems and not just reciting the right answer that they think.

This study aims to determine the effectiveness of using Online Collaborative Learning in Teaching Operations on Functions in Synchronous Classes of Computer, Science, and System (CSS) Students of Rizal Experimental Station and Pilot School of Cottage Industries S.Y. 2020 - 2021, fourth quarter. It will focus on idea generation, organization and intellectual convergence, thus being reflected in the post-test as a result of the intervention. It will also determine whether Online Collaborative Learning helps in increasing the participation of students during synchronous learning. Online Collaborative Learning theory is not enough for learning or knowledge construction, even if it encourages the learners to be active and engaged. The teacher connects to the knowledge community or state of the art in a particular discipline rather than as a fellow learner. Learning is a conceptual change and a key to building knowledge. Learning activity needs to be guided by the norms and a discourse process that highlights conceptual learning and knowledge-building (Bates, 2015).

Synchronous virtual learning is a live interaction between teachers and students Racheva (2018). It is a new learning modality to which every student needs to adapt to keep pace with that change in educational learning. With these changes, more than half among of all the students are experiencing difficulties, especially those students who have a low internet connection which is a common problem among all. These difficulties faced by the students encourage the researcher to pursue this research study even though there would be a lot of circumstances to be faced with. This research study merely focuses on online collaborative learning in synchronous classes because we, the researchers, would like to know if online collaboration would be helpful for students to learn better and understand the lesson. Also, this study will help the researchers to have broad

ideas about online collaborative learning related to the researchers' specialization and in terms of the situation which is engaging students and teachers. It is practical to know it and better understand the situation involving this kind of online learning setup. It will give essence and knowledge to every student or researcher that will view and experience it.

Students' participation decreases in online class setups. It is unsettling for both the teachers and the students to have a lack of face-to-face interaction (Joaquin et al., 2020). Morin (2020) listed some possible barriers to students' engagement during online learning, and this includes: students' life circumstances have changed, they are dealing with stress and trauma, the content is not accessible, they need more structure and support, and the expectations for engagement have not changed.

2. Materials and Methods
2.1. Research Design
Quasi-experiments are commonly used in social sciences, public health, education, and policy analysis, especially when it is not practical or reasonable to randomize study participants to the treatment condition. The prefix quasi means "resembling." Thus, quasi-experimental research resembles experimental research but is not true experimental research. (Cook & Campbell, 1979). This quasi-experimental design is one that looks a bit like an experimental design but lacks the key ingredient – random assignment—often referred to them as "queasy" experiments because they give the experimental purists a queasy feeling (M.K., 2020). Instead, subjects are assigned to groups based on non-random criteria. However, a quasi-experimental design also aims to establish a cause-and-effect relationship between an independent and dependent variable. (Lauren, 2021). There are many different types of quasi-experimental design (i.e. nonequivalent groups design, regression discontinuity, natural experiments, pretest-posttest, interrupted time-series designs, Proxy Pre-test Design, Double Pre-test Design, Nonequivalent Dependent Variables Design, Pattern Matching Design, and the Regression Point Displacement design).

This study used a pre-test post-test quasi-experimental design in determining the effectiveness of Online Collaborative Learning in the synchronous class of Computer, Science, and System (CSS) Students of Rizal Experimental Station and Pilot School of Cottage Industries S.Y. 2020 - 2021, fourth quarter. It also determined whether Online Collaborative Learning helped in increasing the participation of students during synchronous learning. The researchers used two groups of respondents, namely the Control Group and the Experimental Group.

2.2. Statistical Treatment of Data
The specific data treatment that will be used in the study is the following:

2.2.1. Mean Percentage Score (MPS)
It indicates the ratio between the respondents' total correctly answered items and the total number of questions or the percentage of correctly answered items in a test.

2.2.2. Weighted Mean (WM)
The weighted average of observed data is the result of dividing the sum of the products of each observed value, the number of times it occurs, and this other factor by the total number of observations. The mean is a measure of central tendency. It points to where the majority of the respondents answer a question. It reveals what the reaction of the majority of the respondents is or what the common perception is of a phenomenon or issue (Garcia, Nuevo and Sapa, 2007).

2.2.3. T-test for Independent Groups/Samples
T-test for independent groups/samples is used to determine the significant difference between the post-tests of the control group and experimental groups' post-tests.

3. Results and Discussion
3.1. Pre-test Performance of the Control Group and Experimental Group in Operations on Functions

Topic	Control			Experimental		
	Mean Score	MPS	VI	Mean Score	MPS	VI
Identify the different operations on functions	5.50	36.67	Fair	8.75	58.33	Good
Perform addition, subtraction, multiplication, division, composition of functions, and solve problems involving functions	4.40	29.33	Fair	5.40	36.00	Fair
Enumerate the steps on how to perform the different operations on functions	3.00	20	Poor	2.33	15.56	Poor
Relate the essence of operation to functions in real-life situations	7.00	46.67	Good	8.33	55.56	Good
Overall	4.98	33.17	Fair	6.20	41.36	Good

Table shows the mean scores of the students gotten in the Pre-Test, 5.50 (36.67%) gained from Control Group with the verbal interpretation of fair, and 8.75 (58.33%) gained from Experimental Group with verbal interpretation of good from the topic Identify the different operations on functions, while 4.40 (29.33%) gained from Control Group, and 5.40 (36.00%) gained from Experimental Group with the same verbal interpretation of fair from the topic Perform addition, subtraction, multiplication, division, composition of functions, and solve problems involving functions, 3.00 (20.00%) gained from Control Group and 2.33 (15.56%) from Experimental Group with the same verbal interpretation which is poor from the topic Enumerate the steps on how to perform the different operations on functions and lastly, 7.00 (46.67%) gained from Control Group and 8.33 (55.56%) gained from Experimental Group with the same verbal interpretation which is good from the topic Relate the essence of operation on functions in real-life situations. The overall total gotten the respondents in the pre-test performance of the Control Group and Experimental Group in Operations on Functions has a frequency of 16 which is the number of respondents, and a mean score of 4.98 (33.17%) from the Control Group with the verbal interpretation of fair, while 6.20 (41.36%) from Experimental Group with the verbal interpretation which is Good.

The pre-test results show that the experimental group got the highest score compared to the control group. This relates to the study of Delucchi, M. (2014), wherein it explained the measuring of students' performance in terms of the pre-test. It is the evaluation wherein one can see the performance of an individual's learning from the previous lesson, based on the study showing every student's ability and how they performed according to the test given. It is equally distributed, and all lessons are already discussed.

3.2. Post-test Performance of the Control Group and Experimental Group in Operations on Functions

Topic	Control			Experimental		
	Mean Score	MPS	VI	Mean Score	MPS	VI
Identify the different operations on functions	8.25	55.00	Good	12	80	Very Good
Perform addition, subtraction, multiplication, division, composition of functions, and solve problems involving functions	5.60	37.33	Fair	9.80	65	Very Good
Enumerate the steps on how to perform the different operations on functions	5.00	33.33	Fair	9.00	60	Good
Relate the essence of operation to functions in real-life situations	7.00	46.67	Good	12	80	Very Good
Overall	6.46	43.08	Good	10.70	71.33	Very Good

Table shows the mean scores of the students gotten in the Post-test, 8.25 (55%) gained from Control Group with the verbal interpretation of Good, and 12 (80%) gained from Experimental Group with verbal interpretation of Very Good from the topic Identify the different operations on functions, while 5.60 (37.33%) gained from Control Group, and 9.80 (65%) gained from Experimental Group with the verbal interpretation of Fair and Very Good respectively, from the topic Perform addition, subtraction, multiplication, division, composition of functions, and solve problems involving functions, 5.00 (33.33%) gained from Control Group and 9.00 (60.00%) from Experimental Group with the verbal interpretation Fair and Good respectively, from the topic Enumerate the steps on how to perform the different operations on functions, and lastly, 7.00 (46.67%) gained from Control Group and 12.00 (80.00%) gained from Experimental Group with the verbal interpretation Good and Very Good respectively, from the topic Relate the essence of operation on functions in real-life situations. The overall total gotten the respondents in the pre-test performance of the Control Group and Experimental Group in Operations on Functions has a frequency of 16 which is the number of respondents, and a mean score of 6.46 (43.08%) from the Control Group with the verbal interpretation of Good, while 10.70 (71.33%) from Experimental Group with the verbal interpretation which is Very Good.

On the other hand, students who worked in smaller groups of five members scored definitely higher on perceived participation. Also, it is concluded that students were significantly more satisfied working on a smaller portion of the total assignment and learning from the group results from others (Kooloos J. et al., 2012)

3.3. Significant Difference Between the Performance of the Control and Experimental Group in Post-test

VARIABLES	MEANS (POST-TEST)	T-STAT	P-VALUE	DECISION
Control Group	6.06			
Experimental Group	10	2.22	0.05	SIGNIFICANT
Significance level = 0.10				

Table shows that the performance of the control group in the post-test has a mean of 6.06, and the experimental group has a mean score of 10. The p-value is 0.05, which means the null hypothesis is rejected since the p-value is higher than the significance level of 0.10.

Based on the result of the study by Ansari and Khan (2020) which is "Exploring the role of Social Media in Collaborative Learning the new domain of Learning", it is confirmed that the use of social media for collaborative learning purposes, interaction with peers, and teacher affects student's academic performance positively. Additionally, implementing such sophisticated communication technology would prove to be more useful to the students and bring revolutionary, drastic changes in higher education for international collaborative learning.

3.4. Perceived Effectiveness of Online Collaborative Learning According to the Experimental Group

CRITERIA	MEAN	DESCRIPTION
1. I was able to enjoy the Online Collaborative Learning strategy using other platform	3. 38	Highly Effective
2. I was able to answer the activity easier because of Online Collaborative Learning	3	Effective
3. I was able to answer the post-test easier after the Online Collaborative Learning Class	3	Effective
4. The use of the Online Collaborative Learning strategy gave me new learnings and ideas	3.38	Highly Effective
5. The use of an Online Collaborative Learning strategy was appropriate for the topic	2.94	Effective
6. I prefer the use of an Online Collaborative Learning strategy in learning Mathematics more than the traditional approach	2.38	Effective
7. It is important to use an Online Collaborative Learning strategy in every lesson	2.75	Effective
8. The use of the Online Collaborative Learning strategy helped me understand the lesson more	3.31	Highly Effective
9. I have the freedom to express and gain knew knowledge through Online Collaborative Learning	3.19	Effective
10. The overall use of the Online Collaborative Learning strategy was effective for my learning	3.19	Effective
Overall Mean	3.05	Effective

The table shows the computed mean and its corresponding description of each item in the Likert Scale which was answered by the respondents in the Experimental group. Item numbers 1, 4, and 8 are all interpreted as "Highly Effective" as they got a mean of 3.38, 3.38, and 3.31, respectively. Items number 2 and 3 have both means of 3, which corresponds to "Effective". Meanwhile, items number 5, 6, 7, 9, and 10 have a description of "Effective" as they got a computed mean of 2.94, 2.38, 2.75, 3.19, and 3.19, respectively. Overall, the ten items in the Likert Scale got a computed mean of 3.05 which falls under the description "Effective". The results imply that Online Collaborative Learning was effective for the respondents in the Experimental Group.

Online collaborative learning is effective for the experimental group as students enjoy group work using an online platform. Racheva (2018) claimed that collaborative learning is a mutual engagement of learners to construct knowledge and solve problems together with a common goal. Successful collaborative learning requires a socio-emotional aspect of interaction wherein common understandings are developed through exploring the participants' various knowledge, skills, and positions. This approach uses the group as a source of information, motivation, and mutual support when applied to the synchronous virtual environment. The success of this approach requires task and group-related interaction where students have time and space for planning and discussions supported by a teacher.

Bates (2015) also stated that online learning environments add learning experiences for students where they can interact.

4. Conclusion

1. Students from the experimental group and the control who took the pre-test got the same highest possible score which is 15; however, the controlled group got a mean of 4.63 and a standard deviation of 2.86, while in the experimental group, the mean was 6.06 with a standard deviation of 1.67. This implies that the result of the student's exam during the pre-test shows that the experimental group got the highest score of students who got the correct answer rather than on control group.
2. The experimental group's performance was better than the performance of the control group based on the post-test result; the experimental group got the highest score of students who got the correct answer rather than the control.
3. Online collaborative learning effectively increases the students' involvement/participation in synchronous classes because it gives them new learning and ideas that help them understand the lesson easier. Through an online collaborative strategy, students' result in the post-test becomes higher, which means that students perform better when there is collaboration happened between them.
4. There is a significant difference between the control and experimental group of student-respondents during the post-test; this means that the online collaborative teaching strategy is effective in synchronous classes rather than the traditional way of teaching.

5. Recommendations

- Pre-test given to the respondents must be appropriate to their year level, accurate and valid as well. It is necessary to give them early as possible to your respondents before the actual teaching as it consumes a lot of time. The pre-test needs to be fit for them so that they are actually aware of the topic given.
- Post-test, as same in the pre-test, should also be valid, concise and accurate as well and the actual performance of both the control and experimental group are the same in the way of treating and answering.
- Choose an intervention that will catch the students' interest and attention to participate and enjoy the lesson while learning. Also, make an action and activity that is catchy and fit for the students and a short discussion with a short time of doing the activity more interesting.
- Pre-test and post-test questions must be parallel to each other so it can have a good comparison of the student's performance between the two tests the section should clearly explain the main findings and implications of the work, highlighting its importance and relevance.

References

[1] Mete Akcaoglu, and Eunbae Lee, "Increasing Social Presence in Online Learning through Small Group Discussions," *The International Review of Research in Open and Distributed Learning*, vol. 17, no. 3, pp. 1-17, 2016. [Google Scholar] [Publisher link]
[2] Jamal Abdul Nasir Ansari, and Nawab Ali Khan, "Exploring the Role of Social Media in Collaborative Learning the New Domain of Learning," *Smart Learning Environment*, vol. 7, 2020. [CrossRef] [Google Scholar] [Publisher link]

[3] Jane E. Brindley, Christine Walti, and Lisa M. Blaschke, "Creating Effective Collaborative Learning Groups in an Online Environment," *International Review of Research in Open and Distance Learning*, vol. 10, no. 3, 2009. [CrossRef] [Google Scholar] [Publisher link]

[4] Bo Chang, and Haijun Kang, "Challenges Facing Group Work Online," *Distance Education*, vol. 37, no. 1, pp. 73-88, 2016. [CrossRef] [Google Scholar] [Publisher link]

[5] Michael Delucchi, "Measuring Student Learning in Social Statistics: A Pretest-Posttest Study of Knowledge Gain," *Teaching Sociology*, vol. 42, no. 3, pp. 231-239, 2014. [CrossRef] [Google Scholar] [Publisher link]

[6] Educational Innovation, Collaborative Learning in Online Teacher Education: Challenges & Benefits, 2020. [Online]. Available: https://www.educationalinnovation360.com/blogs/collaborative-learning-in-online-teacher-education-challenges-amp-benefits

[7] Don Elger, Theory of Performance. Expectation of Faculty in Higher Education, pp. 11-14, 2021.

[8] Khalifa Elmusharaf, Qualitative Sampling Techniques, Training Course in Sexual and Reproductive Health Research Geneva 2015. [Google Scholar]

[9] Scott Freeman et al., "Likes Attract: Students Self-sort in a Classroom by Gender, Demography, and Academic Characteristics," *Active Learning in Higher Education*, vol. 18, no. 2, pp. 115-126, 2017. [CrossRef] [Google Scholar] [Publisher link]

[10] S. Iman, "Factors Affecting Students' Academic Achievement and Experiences," *Munich, GRIN Verlag*, pp. 1-18, 2017.

[11] Jeremiah Joven B. Joaquin, Hazel T. Biana, and Mark Anthony Dacela, "The Philippine Higher Education Sector in the Time of COVID-19," *Frontiers in Education*, vol. 5, 2020. [CrossRef] [Google Scholar] [Publisher link]

[12] Jan G.M. Koolos et al., "Collaborative Group Work: Effects of Group size and Assignment Structure on Learning Gain, Student Satisfaction and Perceived Participation," *Medical Teacher*, vol. 33, no. 12, pp. 983-988, 2011. [CrossRef] [Google Scholar] [Publisher link]

[13] C.-C Liu, S.-Y Tao, and J.-N Nee, "Bridging the Gap between Students and Computers: Supporting Activity Awareness for Network Collaborative Learning with GSM Network," *Behavior & Information Technology*, vol. 27, no. 2, pp. 127-137, 2008. [CrossRef] [Google Scholar] [Publisher link]

[14] O. Marjanovic, "Learning and Teaching in a Synchoronous Collaborative Environment," *Journal Computer Assistant Learning*, vol. 15, no. 2, pp. 129-138, 1999. [CrossRef] [Google Scholar] [Publisher link]

[15] Wan Maziah Wan Ab Razak et al., "Academic Performance of University Students: A Case in a Higher Learning Institution," *KnE Social Sciences*, vol. 3, no. 13, pp. 1294-1304, 2019. [CrossRef] [Google Scholar] [Publisher link]

[16] Veronica Racheva, "Social Aspects of Synchronous Virtual Learning Environments," *AIP Conference Proceedings*, 2018. [CrossRef] [Google Scholar] [Publisher link]

[17] ResourcEd, Collaborative Learning: How Can it Help Your Students?, 2019. [Online]. Available: https://resourced.prometheanworld.com/collaborative-learning-students/

[18] Stephen M. Rutherford, *Collaborative Learning: Theory, Strategies and Educational Benefits*, Nova, 2014. [Google Scholar] [Publisher link]

[19] James Herbert Shea, "Problems with Collaborative Learning," *Journal of Geological Education*, vol. 43, no. 4, pp. 306-308, 2018. [Google Scholar] [Publisher link]

[20] Anastasia Sofroniou, and Konstantinos Poutos, "Investigating the Effectiveness of Group Work in Mathematics," *Education Science*, vol. 6, no. 30, 2016. [Google Scholar] [Publisher link]

[21] Z. Sun et al., "Exploring Collaborative Learning Effect in Blended Learning Environments," *Journal of Computer Assisted Learning*, vol. 33, no. 6, pp. 575-587, 2017. [CrossRef] [Google Scholar] [Publisher link]