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COLLABORATIVE LEARNING AND ITS RELATIONSHIP TO GRADE PERFORMANCE IN CHEMISTRY OF GRADE 11 STEM STUDENTS

Angelika D. Diño, Claire D. Vico Ph.D
University of Perpetual Help System- DALTA, Las Piñas City

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ABSTRACT

This study explored how collaborative learning skills relate to academic performance among Grade 11 STEM students at Asian Christian Technological Schools & Colleges Inc. exhibited varying academic performance related somehow to their collaborative learning skills. Research focused on four collaborative strategies: problem-based learning, team-based learning, think-pair-share, and case studies examining how age and sex influenced students' performance markedly. Survey questionnaires were administered rather haphazardly to one hundred Grade 11 STEM students employing a fairly quantitative research approach. Research practices were conducted ethically by securing informed consent, and confidentiality of respondents was strictly maintained throughout the study proceedings. Experts validated the research instrument, and it was tested thoroughly for reliability using Cronbach's alpha in the Statistical Package for Social Sciences software. Data were analyzed using descriptive and inferential statistics to assess the extent of collaborative learning skills and their relation to academic performance. Findings revealed that students actively utilized collaborative skills in these learning approaches. However, statistical analysis indicated no significant relationship between collaborative skills and academic performance, suggesting that other factors, such as individual study habits and motivation, may have a greater influence on academic success. These results emphasize the value of collaboration in fostering teamwork and critical thinking but suggest that it is not directly determined by academic achievement. Interestingly, age did make a difference in how students engaged with problem-based learning, pointing to the importance of tailoring instructional methods to suit different developmental stages. To address this, a specially designed chemistry worksheet titled "Exploring Acid-Base Reactions and Solubility Equilibria: A Hands-On Investigation" was created as a learning tool and research instrument.

KEYWORDS: *Academic Performance, Case Study, Collaborative Learning, Problem-Based Learning, STEM Education, Team-Based Learning, Think-Pair-Share.*

1. INTRODUCTION

STEM education is drastically improving thanks to the widespread adoption of new collaborative learning approaches in schools around the world (Barakabitze et al., 2019; Baharin et al., 2018; and Zhu and Wang, 2023). Ariff et al. (2024) completed the most current study that compared national educational systems such as Malaysia, Finland, and Singapore, they asserted that among the three, the last two countries were known for their high-performing educational systems, while all these nations have integrated project-based learning into their curricula to promote teamwork and critical thinking.

Nationally, the Philippines has aligned with global standards through the K-12 curriculum, emphasizing collaborative learning. While some schools have adopted STEM-aligned approaches, there is limited research on their effectiveness—particularly in institutions like Asian Christian Technological School & Colleges Inc.–Main Branch.

Despite the global push for collaborative learning in STEM education, many students still face challenges such as poor communication, unequal participation, and difficulty in problem-solving during group projects (Karan & Brown, 2022). These issues highlight a gap in research—particularly at Asian Christian Technological School & Colleges Inc.–Main Branch—regarding how collaborative projects impact students' development of critical thinking and teamwork, emphasizing the need for targeted studies to ensure educational practices meet future STEM demands.

Regarding all those considerations in mind, this study seeks to investigate and evaluate through critical examination focused on the influence of collaborative learning skills and their relation to STEM academic performance of Asian Christian Technological School & Colleges Inc.-Main Branch. Specifically, this study will assess how engaging problem-solving learning, team-based learning, think-pair-share, and case study activities are enhancing their ability to analyze complex problems critically, communicate effectively, and cohesively work in groups or teams. In the end, this study aims to explore and identify what components or aspects of collaborative learning skills most significantly contribute to students' improvement of such skills, to achieve the goal of providing insightful recommendations for improving these instructional practices in classrooms across the nation.

2. OBJECTIVES

The purpose of this research was to examine the connection between collaborative learning and its relationship to grade performance in chemistry of grade 11 stem students.

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Specifically, the research set out to address the following inquiries:

1. What is the demographic profile of the respondents in terms of;
   1.1 Age,
   1.2 Sex, and
   1.3 Section
2. What is the extent of the utilization of the collaborative learning as evaluated
by the respondent by respect to?
   2.1. Problem Based Learning
   2.2. Team Based Learning
   2.3. Think-Pair-Share
   2.4. Case Study
3. What is the academic performance of the respondent in third quarter?
4. Is there significant difference on the extent of the utilization of the collaborative learning as evaluated by the respondent with respect to cited variables when grouped according to profile?
5. Is there a significant relationship between the extent of the utilization of the collaborative learning and the academic performance of the respondent?
6. Based on the study's findings, what instructional materials may be proposed?

3. METHODOLOGY

A quantitative descriptive-correlational research strategy was utilized in this study. This is to quantify behaviors or occurrences using data collection methods and analysis of numerical data described by Siedlecki (2020). This research approach does not include manipulating variables in any way, and its primary goal is to describe people, events, or situations.

4. SAMPLING DESIGN

The researcher used a basic random sampling technique to determine the sample size and relied on Slovin's technique to get credible and statistically significant findings. Participants in the present investigation were two hundred fifty-six (256) students enrolled in Science, Technology, Engineering, or Mathematics (STEM) and had practical experience working on group projects as part of a STEM program. From this, a sample of about one hundred (100) was considered as the respondents of this study. The population had an equal opportunity to be chosen. Concluding a population from statistical data is its primary use. Its use of randomization, the most effective strategy for mitigating the influence of any confounding variables, contributed to its high internal validity.

5. STATISTICAL DESIGN

Frequencies and Percentages Distribution were used to assess the demographic profiles of the respondents based on their age, gender, and section. The weighted mean and standard deviation were used to describe the extent of collaborative learning skills and their relation to STEM academic performance. Lastly, Anova was utilized to determine if there were significant differences in how the respondents utilized collaborative skills based on profile variables, including age and sex, as well as to examine between collaborative skills utilization to academic performance. All analyses were conducted using the Statistical Package for Social Sciences (SPSS).

6. GEOGRAPHICAL AREA

This study was conducted in the geographical area of Barangay Pinagsama Taguig City. The area was selected because of its accessibility and the presence of the target population, which includes students enrolled in Science, Technology, Engineering, or Mathematics (STEM) at Asian Christian Technological School & Colleges Inc. - Main Branch. Data collection took place within this locality to ensure the relevance and applicability of the findings to the study.

7. RESULTS

Problem number 1. What is the demographic profile of the respondents in terms of Age, Sex and Section?

Regarding age, the majority of those who participated are more than 17 years old, comprising 68% of the population. This shows that older students approaching legal age were the respondents of this study, signifying maturity and depth in their responses. In terms of sex, an even distribution was observed. This shows that there is a balance in the responses gathered, as neither of the two categories surpasses the other in terms of numbers.

Problem 2. What is the extent of the utilization of the collaborative learning as evaluated by the respondent by respect to: problem-based learning, team-based learning, think-pair-share, and case study?

The extremely high level of collaboration abilities in accordance with problem-based learning is indicated by the overall mean of 3.42 and standard deviation of 0.49. This shows that students are working together to improve their critical thinking and problem-solving abilities.

Table 1 Extent of the utilization of the collaborative learning as evaluated by the respondent by respect to Problem-Based Learning

	Mean	SD	Interpretation
Problem-Based Learning	3.42	0.49	Highly utilized
Team Based Learning	3.39	0.49	Highly utilized
Think-Pair-Share	3.45	0.50	Highly utilized
Case Study	3.40	0.49	Highly utilized

The incredibly high extent of utilization of collaborative skills enables learners to effectively solve problems and apply them in real-world situations. , The findings suggest that while collaborative skills were highly utilized, it should be

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emphasized that there is room for development in problem-based learning. Baran (2021) studied how STEM students' project-based learning affected their performance through collaboration, which mainly involved waste materials that have improved students 21st-century skills through fostering communication while brainstorming and implementing solutions.

Also, the study discussed the level of proficiency in teamwork as it relates to learning in groups. The aspect is heavily used, having a mean of 3.41 and a standard deviation of 0.49. The outcome shows that the proliferation of collaborative learning occurs when team-based learning is considered. The results showed marked improvements in observation, analysis, and critical thinking skills. This study demonstrates how Team Based Learning enables science learners to hone crucial process abilities by working together to resolve problems.

Moreover, in the assessment of Think-Pair-Share the top three items are confident in the ability to detect and identify errors in reasoning in group discussions, improved understanding of topics through collaboration with a partner, and the ability to judge effective strategies for achieving goals during group projects. The results reflect the strengths of TPS in improving participants' analytical skills, comprehension, and strategic evaluation abilities. This could be because TPS is a structured methodology that allows active collaboration, thoughtful exchange, and constructive discussion.

Highest scored items in the Extent of the Utilization of the Collaborative learning with respect to Case Study include listening to ideas before making decisions, finding case study analysis an effective learning method, and improving communication skills through case study discussions. This means that case studies can improve the ability to gather ideas from others, become a better learning strategy, and enhance the communication ability of students. The results indicate that the implementation of case studies as a learning approach is not only interactive, but it also positively influences students' language, social and cognitive skills.

Problem 3. What is the academic performance of the respondent in the third quarter?

Table 2 Third Quarter Respondents' Academic Achievement (Mean)

Section	Number of Respondent	Mean Score
Section 1 (ANNEX)	17	89.65
Section 1 (MAIN)	17	90.00
Section 2 (ANNEX)	18	90.39
Section 2 (MAIN)	16	90.50
Section 3 (ANNEX)	16	90.31
Section 4 (ANNEX)	16	90.50
General Average	**100**	**90.22**

The data represented the average assessments confirmed by the respondents from the different units of ANNEX and MAIN locations, in which there were in total 100 participants, and the average score was 90.22. In conclusion, every part turned out to be outstanding, with almost the same scores of a high level in all of them, and with just a slight difference where the comparison was available, the ANNEX and MAIN locations were observed.

Problem 4. Is there significant difference on the extent of the utilization of the collaborative learning as evaluated by the respondent with respect to cited variables when grouped according to profile?

The results demonstrate that in Problem-Based Learning, students' t-values of -2.03 and p-values of 0.045 (both of which are less than 0.05) suggest a statistically significant difference. Because of this, age is a major influencer of how collaborative learning is used in Problem-Based Learning. This may affect the way they view collaborative learning. On the other hand, the other methods like Team-Based Learning, Think-Pair-Share, and Case Study, do not demonstrate age-related statistical differences because all three of their p-values are larger than the significance level of 0.05.

In connection, for the four domains, the corresponding p-values were 0.768, 0.430, 0.471, and 0.730, which is better than the significance level of 0.05. Since no significant differences were found according to the respondents' sex, the null hypothesis was accepted. This generally means that such collaborative learning approaches are just as effective and friendly to males as they are to females.

However, grouping respondents by section yields p-values of 0.056, 0.151, 0.113, and 0.584, indicating that there is no statistically significant difference in the extent to which they utilize collaborative abilities in problem-based learning, team-based learning, think-pair-share, and case study.

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Problem 5. Is there a significant relationship between the extent of the utilization of the collaborative learning and the academic performance of the respondent?

Table 3 Significant Correlation between Academic Achievement and the Frequency of Collaborative Tasks

Variables	Df	p-value	Decision on H_o	Conclusion
Collaborative Learning and Academic Performance	98	0.568	Accept	Not Significant

Significant at p< 0.05

With a p-value of 0.568, which is higher than 0.05, Table 11 indicates that academic success is not significantly related to collaborative skills. These suggest that students' academic performance is unaffected by the use of collaborative skills. There is no substantial correlation that may be attributed to the differences in the assessment design. The limited utilization of the skill may also contribute. It also emphasized that strategy, which allows the students to think individually, discuss these ideas or opinions with peers, and share their insight with the class, led to deeper understanding in academic performance.

Problem 6. Based on the study's findings, what instructional materials may be proposed?

In connection herewith, a chemistry worksheet titled "Exploring Acid-Base Reactions and Solubility Equilibria: A Hands-On Investigation" was created and applied as an intervention in learning. The worksheet was chosen to be used in the present study because it complements well with the premises of inquiry-based learning and benefits engaged in terms of pedagogy. Being well-structured and clear, it helped the students in the gradual clarification of concepts in chemistry, covering the basics of acid-base reactions, pH levels, production of gases, and gas solubility equilibria with minimum confusion.

The main output of the study is a set of inquiry-based worksheets focused on the topic of acid-base reactions in Grade 11 Chemistry. This competency was deliberately chosen because acid-base reactions are conceptually challenging for many STEM students, requiring both abstract understanding and practical application. These topics are also central to understanding broader chemical principles and have real-world relevance in fields like biology, medicine, and environmental science.

8. SUGGESTIONS

The researcher made these suggestions after reviewing the data and drawing conclusions from the study.

1. To assess how collaborative learning worked in different settings, future studies may involve larger numbers and more schools for the research.
2. Conducting interviews, focus groups, or classroom observation will provide insight into how students perceive collaborative work and how it influences their learning.
3. Continuous observation is required for a long period to monitor the effect of collaborative learning on student performance through various grading sessions and school years.
4. It is necessary to consider what synergy collaborative learning has with the different teaching methods to identify the most effective ways of engaging students and raising their achievement.
5. To understand student performance more comprehensively, habits of study, style of learning, motivation, and the way teachers teach may be investigated.
6. The research utilized a worksheet that ought to be reconsidered and upgraded if necessary and can serve as a resource for the facilitation of collaborative skills in science education.

9. CONCLUSION

The following conclusions were drawn by the researcher from the findings.

1. Most respondents (68%) were 17 or older, with an equal number of male and female participants. Students were evenly distributed across Grade 11 sections, ensuring a balanced and inclusive sample.
2. Students actively used their collaborative skills in all four learning approaches. Problem-Based, Team-Based, and Think-Pair-Share methods helped them work better together, communicate more clearly, and solve problems more effectively. Although Case Study was also commonly used, students still struggled a bit with investigation and connecting what they learned to real-life situations.
3. Majority of students are high achievers, demonstrating dedication to their studies. Their strong academic performance may suggest that effective learning strategies, engagement, and collaboration contribute to their success.
4. The findings suggest that age, gender, and grade level have little impact on how students use collaborative skills across the different learning approaches. Although Problem-Based Learning seemed more effective for older students, overall, all methods supported collaboration equally well for students of all ages, genders, and sections. This shows that these approaches are accessible and beneficial to everyone involved.
5. Students who participated collaboratively showed no significant relationship between collaborative skills and academic performance. This implies that collaboration is a major component of learning; however, it may not directly influence academic success. Other factors, such as individual study habits, instructional approaches, and student motivation, likely also play a significant role in students' performance.

10.FIGURES, TABLES AND REFERENCES

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