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Effectiveness of collaborative learning in handling compound light microscope to Science 7 students

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ABSTRACT

In science education, the fusion of collaborative learning with equipment-based inquiry offers a potent avenue for deepening conceptual understanding, fostering scientific reasoning, and enhancing engagement. This study assessed the effectiveness of collaborative learning in manipulating compound light microscope equipment for Science 7 students at Kal-anan National High School, Kal-anan, Tabogon, Cebu, during the 2nd quarter of the school year 2025–2026, as a basis for laboratory exercises of compound light microscope equipment. A quantitative method was used. The study was conducted at Kal-anan National High School, Kal-anan, Tabogon, Cebu, during the 2nd quarter of the school year 2025–2026 with over 50 respondents. The questionnaire used in the study was adopted. The statistical analysis of the data in the study involved descriptive measures, like the weighted mean and t-test. The data gathered were then analyzed statistically. Findings indicated that despite a modest mean difference of 2.89 points favoring the experimental group, both groups fell within the Did Not Meet Expectations category. Competency 2 showed the highest pre-test performance, while Competencies 1 and 3 were lower. Moderate standard deviations indicate variability in students' prior knowledge. In addition, post-intervention gains in both groups, with markedly higher performance in the experimental group. The experimental group achieved a mean score of 28.41 classified as Outstanding, whereas the control group obtained 19.81 and remained in the Did Not Meet Expectations category. Across all competencies, the experimental group consistently outperformed the control group, attaining over 92% in each area. Although the control group demonstrated improvement from pre-test levels, its continued classification below proficiency indicates the limited effectiveness of traditional instruction alone. Moreover, the student perceptions of challenges encountered during collaborative learning while manipulating compound light microscope science equipment, revealed an overall Strongly Agree. In conclusion, there is a significant difference between the pre-test scores and post- test scores of the students in the compound light microscope. Thus, the null hypothesis is rejected. Thus, based on the findings, this study recommends the development and implementation of laboratory exercises.

Keywords: Teaching Science, compound light microscope, pre-and post-test, collaborative learning, descriptive quantitative, laboratory exercises, Kal-anan, National High School.

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INTRODUCTION

In science education, the fusion of collaborative learning with equipment-based inquiry offers a potent avenue for deepening conceptual understanding, fostering scientific reasoning, and enhancing engagement. The study of collaborative learning in science equipment, specifically compound microscope equipment is grounded in the need to enhance students' practical understanding of scientific concepts through hands-on, inquiry-based experiences. Moreover, environments that integrate technology-supported collaborative inquiry, such as virtual labs or shared digital platforms, have been shown to enhance scientific literacy and subject understanding by enabling students to explore, and reason together (Wang & Yu, 2025). In many classroom settings, particularly in under-resourced schools, students often lack opportunities to fully engage with science equipment due to limited resources, large class sizes, and teacher-centered instruction. By integrating collaborative learning, students can share roles, responsibilities, and resources, allowing more equitable access to laboratory tools while promoting deeper cognitive engagement (Denton & Kulesza, 2024).

Moreover, in many countries worldwide, collaborative learning approaches in Science education, especially those involving laboratory equipment, specifically compound light microscope equipment, are increasingly being adopted to foster deeper conceptual understanding, critical thinking, and 21st-century skills. International studies show that structured, peer-based engagement using science tools and technology enhances learners' academic performance, engagement, and practical skills (Chen & Chen, 2024). These policies support the use of collaborative strategies to foster higher-order thinking skills, scientific attitudes, and communication abilities. Recent research supports these pedagogical priorities. Gonzales et al. (2024) found that students involved in collaborative science learning environments reported higher academic achievement, improved attitudes toward science, and greater motivation.

While collaborative learning in science laboratories offers significant educational benefits, students frequently encounter barriers that undermine its effectiveness. Many schools particularly in developing regions, lack adequate laboratory facilities and functioning equipment, forcing students to share limited resources. This scarcity often diminishes the quality of hands-on engagement, hampers experimentation, and negatively impacts academic performance (Lazaro & Paglinawan, 2024). Group-based science activities often reveal disparities in participation. Some students monopolize equipment and decision-making while others remain passive, creating imbalances in skill development and learning gains (Nix et al., 2023).

Existing studies often focus on broader or urban settings, but the unique challenges, perceptions, and traditional evaluation methods often fail to capture individual contributions within group-based laboratory tasks, leading to limited accountability and unclear grading standards in rural schools like Kal-anan National High School, Kal-anan, Tabogon, Cebu which is underexplored. Qualitative findings from remote schools in Negros Occidental reveal that teachers must rely on self-made instructional materials due to the absence of essential gadgets, power, and connectivity compromising the fidelity of microscope-based lessons. In these conditions, instructors resort to lectures and textbook learning instead of hands-on experimentation, resulting in limited student engagement (Nuevo, 2024).

In the recent validation and inspection of the science equipment and laboratories, the combination of scarce equipment, improvised resources, and traditional group lab assessments where individual contributions are very difficult to assess because it undermines accountability

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and clarity in grading practices in rural contexts like Kal-anan National High School. Such constraints not only undermine the intended pedagogical outcomes but also perpetuate systemic inequities between rural and urban schools and basically and simply makes the study new.

In summary, this study aims to address the limited access to laboratory equipment in rural schools by investigating the effectiveness of collaborative learning strategies on Grade 7 students' mastery of compound light microscope skills.

Statement of the problem

This study assessed the effectiveness of collaborative learning in manipulating compound light microscope equipment among Science 7 students at Kal-anan National High School, Kal-anan, Tabogon, Cebu, during the 2nd quarter of the School Year 2025–2026, as a basis for developing laboratory exercises involving compound light microscope equipment.

Specifically, it sought to answer the following research questions:

1. What are the pre-test scores of the control and experimental groups of Grade 7 students in using a compound light microscope in terms of the MATATAG Curriculum competencies of identifying the parts and functions of a compound microscope, demonstrating proficiency in safely handling a compound microscope, and using proper techniques in observing and identifying the parts of a cell, such as the cell membrane, nucleus, cytoplasm, mitochondria, chloroplast, and ribosomes?
2. After implementing collaborative learning in manipulating a compound light microscope, what are the post-test scores of the control and experimental groups in the aforementioned MATATAG Curriculum competencies?
3. Is there a significant difference between the pre-test and post-test scores of the students in using a compound light microscope?
4. Is there a significant difference in the mean gain between the pre-test and post-test scores of the students in using a compound light microscope?
5. What challenges are encountered by the students during collaborative learning in manipulating compound light microscope equipment?
6. Based on the findings of the study, what laboratory exercises involving compound light microscope equipment aligned with the MATATAG Curriculum may be developed?

METHODOLOGY

This section presents the methodological process of the study, which includes the methods and design, the flow of the study, the environment of the study, the sources of data, the instrument, the data collection procedures, the data analysis, and the scoring procedures.

This study employed a quantitative research method with a qualitative component to assess the collaborative learning in manipulating the compound light microscope among Grade 7 Science students at Kal-anan National High School, Kal-anan, Tabogon, Cebu, during the second quarter of the School Year 2025–2026. The quantitative method was appropriate because it enabled the researcher to measure the students' level of collaborative learning using a structured research instrument and statistically analyze the collected data. This approach also facilitated the examination of relationships among the identified variables within the target population in an efficient and systematic manner. To enrich and validate the quantitative findings, a qualitative component was integrated during the experimentation phase. The researcher conducted laboratory activities in which students worked collaboratively while manipulating the compound light microscope following the prescribed laboratory procedures

under the MATATAG Curriculum. During these laboratory sessions, the researcher observed and documented the students' interactions, participation, communication, cooperation, task-sharing, and problem-solving behaviors using observation notes. Informal interviews and reflective discussions were also conducted after the laboratory exercises to gather students' experiences, challenges encountered, and suggestions for improving collaborative learning during microscope manipulation. The qualitative data served to explain and support the quantitative results, providing a more comprehensive understanding of students' collaborative learning experiences and informing the development of enhanced laboratory exercises for the use of the compound light microscope.

The study took the input-process-output strategy, which demonstrated how the study was carried out, from collecting raw data to organizing and analyzing the data to produce findings. This strategy was presented in a figure of the flow of the study, which was arranged in three boxes labeled input, process, and output. The first box contained the variables in the statement of the problem. The first dealt with the pre-test scores of the students in compound light microscope Science equipment. The second was the post-test scores of the students in compound light microscope Science equipment after the use of collaborative learning. The third was the challenges encountered by the students in collaborative learning using compound light microscope Science equipment. The pre-test and post-test scores of the Grade 7 students were measured on the following MATATAG Curriculum competencies: identifying the parts and functions of the compound microscope; manipulating proficiency in safely handling the compound microscope; and using proper technique in observing and identifying the parts of a cell with a microscope, such as the cell membrane, nucleus, cytoplasm, mitochondria, chloroplast, and ribosomes. The process box showed the steps and procedures undertaken by the researcher to finish the research work. It included the descriptive method of research, administration of the questionnaire, data gathering, data analysis, data organization, and interpretation of data of the study. In the figure, these steps were shown as obtaining the permit to conduct the study, administering the survey on academic assessment, conducting the focus group discussion, gathering of data, applying the descriptive method of research, and carrying out data gathering, data organization, analysis, and interpretation of data. The researcher personally administered the test to the respondents to ensure secrecy and validity of the results. Moreover, the timeline of the data collection was from August to October 2025, provided that it did not disturb and suspend any class lessons of the teachers. The output box presented the laboratory exercises of compound light microscope equipment in the MATATAG Curriculum. The outcomes of this investigation could lead to the development of laboratory exercises of compound light microscope equipment in the MATATAG Curriculum. The positive impact of collaborative learning on students' engagement with science equipment will be used to structure group-based laboratory activities within the learning guide. Observed challenges, such as unequal participation in group tasks, could be addressed by including structured group roles and accountability measures in the laboratory exercises of compound light microscope equipment. Insights from the study could ensure the learning guide promotes equitable access to science tools through guided sharing, peer support, and low-resource adaptations.

The study was conducted at Kal-anan National High School, Kal-anan, Tabogon, Cebu, the location of which was illustrated in a map of the research environment. The school has a total land area of 10,000 sq.m., donated by the Lobitaña family and heirs. It started its operation where students were housed in the ancestral home of the donors for two (2) years until it acquired a 3-room prefab Marcos-type building. The Junior High School has three sections for each year level, while the Senior High School has only two sections for each year level. The school has 22 teaching staff and 5 non-teaching staff. In addition, many rural schools in Cebu operate with limited or outdated science laboratories and teaching equipment, restricting hands-on collaborative experiments and peer-supported inquiry activities. Kal-anan NHS reportedly

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received a gas range as an award, but there is no mention of full science equipment or dedicated lab space, suggesting minimal provision of lab tools. Teachers often rely on improvised or self-made instructional aids due to lack of official or standardized materials, which can diminish quality of lab-based collaboration. The teaching environment at Kal-anan NHS is likely constrained by inadequate lab spaces and science tools, inconsistent learning resources, limited electricity and connectivity, and weak support for inquiry-based pedagogy. These factors collectively hinder effective collaborative learning, particularly when students must work together using science equipment.

The respondents of the study were the Grade 7 students of Kal-anan National High School, Kal-anan, Tabogon, Cebu. The purposive sampling method was applied to the selection of the respondents, with a total of 50 Grade 7 students. The researcher chose these respondents for faster and more convenient administration and survey of the research questionnaire. The distribution of the respondents showed that Grade A had 15 male respondents (f = 15, 30.00%) and 10 female respondents (f = 10, 20.00%), for a total of 25. Section B had 13 male respondents (f = 13, 26.00%) and 12 female respondents (f = 12, 24.00%), for a total of 25. Altogether, there were 28 male respondents (56.00%) and 22 female respondents (44.00%), for a total of 50.00.

The study involved a research-based questionnaire. The questionnaire was adapted from the study of Oguezue et al., (2025) and Department of Education learning modules. The study reported a Cronbach's alpha reliability coefficient of 0.94 for its questionnaire, indicating excellent internal consistency. Overall, the study showed strong internal trustworthiness in terms of both reliability and validity, but its findings were best applied to similar demographic and regional contexts, with some caution about broader generalization. The questionnaire was composed of three parts. The first part dealt with the pre-test scores of the students in compound light microscope Science equipment on the following competencies. This was an adopted test from the learning modules of DepEd with 30 multiple test items. The second part dealt with the post-test scores of the students in compound light microscope Science equipment on the following competencies. This was likewise an adopted test from the learning modules of DepEd with 30 multiple test items. The third part dealt with the challenges encountered by the students in collaborative learning using compound microscope Science equipment. This was done through a questionnaire through enumeration.

The data-gathering procedure of the study was conducted in three phases: before, during, and after the data collection, to ensure the systematic implementation of the research. Prior to the conduct of the study, the researcher prepared the research proposal, questionnaire, laboratory activities, observation guide, and other necessary research documents for evaluation and approval by the research adviser and the Dean of Cebu Technological University–Main Campus. After the approval of the proposal, the researcher secured a letter of endorsement from the university and sought permission from the Schools Division Superintendent of the Schools Division of Cebu Province, the Public Schools District Supervisor of Tabogon District, and the School Principal of Kal-anan National High School to conduct the study. Upon approval, the researcher coordinated with the Grade 7 Science teacher regarding the schedule of the laboratory sessions and questionnaire administration to ensure that the conduct of the study would not interrupt regular classroom instruction. The research instrument underwent content validation by experts, and the necessary revisions were incorporated based on their recommendations. The researcher also explained the purpose of the study to the respondents and their parents or guardians, distributed informed consent and assent forms, assured the participants that their responses would be kept confidential, and informed them that their participation was voluntary.

During the data collection, after obtaining all necessary approvals and consent, the researcher conducted the study among the identified Grade 7 Science students of Kal-anan National High School during the second quarter of the School Year 2025–2026. The respondents participated in a series of laboratory exercises involving the proper manipulation and use of the compound light microscope following the learning competencies prescribed under the MATATAG Curriculum. During the laboratory activities, the students performed collaborative tasks in small groups where they shared responsibilities, communicated with one another, solved laboratory-related problems, and completed the assigned activities. The researcher closely observed the students' collaborative behaviors, including participation, communication, cooperation, leadership, task distribution, and problem-solving while handling the microscope. Observation notes were recorded to supplement the quantitative findings. After the completion of the laboratory activities, the researcher administered the validated questionnaire to measure the respondents' collaborative learning experiences. The respondents were given adequate time to answer all items independently, while the researcher remained available to clarify instructions without influencing their responses. The data collection was conducted from August to September 2025, following the schedule approved by the school administration to ensure that no regular classroom instruction or school activities were disrupted.

Upon completion of the questionnaire administration, the researcher collected all accomplished instruments and checked them for completeness and accuracy. The responses were encoded, organized, tabulated, and subjected to the appropriate statistical analyses to answer the research questions. The qualitative observation notes gathered during the laboratory activities were reviewed, organized into meaningful categories, and analyzed to support and explain the quantitative findings. All data were treated with strict confidentiality by assigning codes instead of participants' names and storing the records securely. Finally, the researcher interpreted the results, formulated the conclusions and recommendations, and utilized the findings as the basis for developing enhanced laboratory exercises.

This study adhered to established ethical principles to protect the rights and welfare of the respondents. Participation was voluntary, and informed consent was obtained after clearly explaining the study's purpose and procedures. The anonymity and confidentiality of all respondents were maintained by safeguarding their identities and responses. The researcher ensured that participation posed no harm or risk and that respondents could provide only what they were comfortable sharing.

The statistical analysis of this study employed statistical tools such as the simple percentage and the t-test for significant difference and data analysis. The Percentage (P) was appropriate as it determined the pre-post-test scores of the students in compound light microscope Science equipment on the following competencies. The t-test was appropriate as it assessed the significant difference between the pre-test scores of the students in compound light microscope Science equipment on the following competencies and their post-test scores after the use of collaborative learning.

For the scoring procedure, the researcher adopted the Department of Education (DepEd) Electronic Class Record (ECR) to measure the performance level of students, as stipulated in DepEd Order No. 8, s. 2015, also known as the Policy Guidelines on Classroom Assessment for K to 12 Basic Education Program. The DepEd ECR followed a standardized format for recording students' scores, ensuring consistency and accuracy in grading across different scores and teachers. In the scoring procedure for the performance in collaborative learning in compound microscope, an item number of 9-10 was categorized as Mastered, which meant that the learners' performance level was between 96%-100%. An item number of 7-8 was categorized as Closely Approximating Mastery, which meant that the learners' performance level was between 86%-95%. An item number of 5-6 was categorized as Moving

Towards Mastery, which meant that the learners' performance level was between 66%-85%. An item number of 3-4 was categorized as Average Mastery, which meant that the learners' performance level was between 35%-65%. An item number of 0-2 was categorized as Low Mastery, which meant that the learners' performance level was between 16%-34%. The range interpretation was likewise defined as follows. A range of 90 and above was interpreted as Outstanding, denoting exceptional performance that exceeds expectations and demonstrates mastery of the competencies. A range of 85-89 was interpreted as Very satisfactory, denoting strong performance that meets and slightly exceeds expectations with minor areas for improvement. A range of 80-84 was interpreted as Satisfactory, denoting adequate performance that meets basic expectations and shows acceptable understanding of the competencies. A range of 75-79 was interpreted as Fairly satisfactory, denoting below average performance that partially meets expectations and requires improvement in several areas. A range of Below 75 was interpreted as Did not meet expectations, denoting insufficient performance that fails to meet the expected standards and demonstrates significant gaps in understanding.

The researcher likewise employed a four-point Likert scale to assess the level of challenges encountered by the Grade 7 Science students in collaborative learning while manipulating the compound light microscope during the conduct of the laboratory exercises. A weight of 4, with a range of 3.25-4.00, was interpreted as Strongly Agree, which meant that the respondent strongly agrees with the statement. A weight of 3, with a range of 2.50-3.24, was interpreted as Agree, which meant that the respondent agrees with the statement. A weight of 2, with a range of 1.75-2.49, was interpreted as Disagree, which meant that the respondent does not agree or disagree with the statement. A weight of 1, with a range of 1.00-1.74, was interpreted as Strongly Disagree, which meant that the respondent disagrees with the statement.

RESULTS AND DISCUSSION

This chapter presents, analyzes, and interprets the data gathered from 50 Grade 7 Science students of Kal-anan National High School, Kal-anan, Tabogon, Cebu, who were selected through purposive sampling and divided into a control group and an experimental group of 25 students each. The study employed a quantitative research method with a qualitative component. Pre-test and post-test scores were gathered through a research-based questionnaire adapted from Oguezue et al. (2025) and Department of Education learning modules, while the challenges encountered in collaborative learning were gathered through a four-point Likert scale. The data were treated using the simple percentage and the paired-samples t-test. The discussion is grounded in the data gathered, and the results are interpreted in direct relation to the objectives of the study, namely, to determine the pre-test and post-test scores of the students in the compound light microscope competencies, to determine the challenges they encountered in collaborative learning, and to determine the significant difference between the pre-test and post-test scores.

Pre-test scores of the control and experimental groups

The pre-test results show that both groups began the study with comparable baseline performance across the three learning competencies. The control group obtained mean scores of 5.63 (SD = 0.97, 56.30%) in Learning Competency 1, 6.00 (SD = 1.33, 60.00%) in Learning Competency 2, and 5.78 (SD = 1.55, 57.80%) in Learning Competency 3, with an overall mean of 17.41 (SD = 2.63, 58.02%). The experimental group obtained 7.07 (SD = 1.36, 70.70%), 6.59 (SD = 1.19, 65.90%), and 6.63 (SD = 0.97, 66.30%) in the same competencies, with an

overall mean of 20.30 (SD = 2.15, 67.65%). All of these values fell within the Did Not Meet Expectations category, since each was below 75 on the DepEd scale. The 2.89-point difference between the overall means indicates that the experimental group entered the study with slightly higher baseline knowledge, although neither group had attained the expected level of proficiency in the use of the compound light microscope. Such low initial performance is consistent with the view that students often find science equipment unfamiliar when they have had limited hands-on experience, a condition that is common in rural schools where laboratory tools are scarce.

Learning Competency 2, which concerns manipulating the microscope safely, yielded the highest control group baseline (6.00, 60.00%), whereas the experimental group scored highest in Learning Competency 1, which concerns identifying the parts and functions of the microscope (7.07, 70.70%). Learning Competency 1 produced the lowest control group mean (5.63, 56.30%), and Learning Competency 2 produced the lowest experimental group mean (6.59, 65.90%). The standard deviations ranged from 0.97 to 1.55 in the control group and from 0.97 to 1.36 in the experimental group, which indicates moderate variability and suggests that students held heterogeneous prior knowledge. This variability supports Vygotsky's (1978) notion of the zone of proximal development, in which learners at different readiness levels benefit from peer support and guided interaction, the very conditions that collaborative laboratory work is designed to provide.

Post-test scores of the control and experimental groups

The post-test results reveal improvement in both groups, but the improvement was far greater in the experimental group. The control group obtained means of 6.48 (SD = 1.19, 64.80%) in Learning Competency 1, 6.52 (SD = 1.25, 65.20%) in Learning Competency 2, and 6.81 (SD = 0.75, 68.10%) in Learning Competency 3, with an overall mean of 19.81 (SD = 2.15, 66.05%), which remained in the Did Not Meet Expectations category. The experimental group obtained 9.67 (SD = 0.88, 96.70%), 9.52 (SD = 0.98, 95.20%), and 9.22 (SD = 0.93, 92.20%), respectively, with an overall mean of 28.41 (SD = 1.45, 94.69%), which placed the group in the Outstanding category. The experimental group therefore advanced from 67.65% at baseline to 94.69% after the use of collaborative learning, whereas the control group moved only from 58.02% to 66.05%.

The experimental group exceeded the control group by 3.19 points in Learning Competency 1, with 9.67 against 6.48. A comparable gap appeared in Learning Competency 2, where the experimental group reached 9.52 and the control group 6.52, and in Learning Competency 3, where the experimental group reached 9.22 and the control group 6.81. Because students in the experimental group handled the microscope together, shared roles, and corrected one another's procedures, they had repeated opportunities to link the names and functions of microscope parts with actual handling and observation. This interpretation is consistent with Hattie (2023), who emphasizes that peer interaction and immediate feedback help learners clarify misconceptions and reinforce procedures. The control group's gain, by contrast, left its post-test mean in the Did Not Meet Expectations category, which suggests that conventional instruction alone was insufficient to bring students to the expected level of mastery in these competencies.

Test of significant difference between pre-test and post-test scores

A paired-samples t-test was conducted at the .05 level of significance to determine whether the changes between pre-test and post-test scores were statistically significant. In the control group, Learning Competency 1 showed a mean difference of 0.85 (t = -3.690, d = 0.79,

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p = 0.001), Learning Competency 2 showed 0.52 (t = -2.762, d = 0.40, p = 0.010), and Learning Competency 3 showed 1.04 (t = -5.106, d = 0.84, p < .001). The overall control group result was a mean difference of 2.41 (t = -5.306, d = 1.00, p < .001). In the experimental group, Learning Competency 1 showed a mean difference of 2.59 (t = -14.475, d = 2.27, p < .001), Learning Competency 2 showed 2.93 (t = -15.873, d = 2.70, p < .001), and Learning Competency 3 showed 2.59 (t = -15.165, d = 2.73, p < .001), while the overall result was a mean difference of 8.11 (t = -26.321, d = 4.43, p < .001).

Because every p value was below .05, the null hypothesis of no significant difference between pre-test and post-test scores was rejected for both groups in all competencies and overall. Both instructional approaches therefore produced statistically significant improvement. However, by Cohen's (1988) benchmarks, in which 0.20 is small, 0.50 is medium, and 0.80 is large, the effect sizes differed markedly. In the control group, the effect size was small to medium in Learning Competency 2 (d = 0.40) and large in Learning Competencies 1 and 3 (d = 0.79 and d = 0.84) and overall (d = 1.00). In the experimental group, every effect size was far above the large benchmark, ranging from 2.27 to 4.43, and the 3.43-point difference between the overall effect sizes (4.43 against 1.00) indicates exceptionally high practical significance. The largest differential appeared in Learning Competency 3, where the experimental group's d = 2.73 compared with the control group's d = 0.84, a difference of 1.89, followed by Learning Competency 2, where d = 2.70 compared with d = 0.40, a difference of 2.30, and Learning Competency 1, where d = 2.27 compared with d = 0.79, a difference of 1.48. Such magnitudes are rarely observed in educational research, and they suggest that structured group roles, shared responsibility, and peer support during the laboratory exercises strongly strengthened both conceptual understanding and procedural competence.

Mean gain difference between pre-test and post-test scores

The mean gain comparison confirms this pattern. The control group improved from an overall mean of 17.41 (58.02%) to 19.81 (66.05%), a mean gain of 2.41 points, while the experimental group improved from 20.30 (67.65%) to 28.41 (94.69%), a mean gain of 8.11 points. The experimental group's improvement thus exceeded that of the control group by 5.70 points. By competency, the experimental group gained 2.59 points in identifying the parts and functions of the microscope, 2.93 points in manipulating it safely, and 2.59 points in observing and identifying cell structures, while the control group gained 0.85, 0.52, and 1.04 points, respectively. These gains show that collaborative learning promoted active participation, peer interaction, and shared responsibility, which gave students multiple opportunities to clarify misconceptions, practice scientific procedures, and reinforce learning through social interaction (Hattie, 2023). The findings also indicate that professional development on collaborative instructional practices, together with adequate laboratory resources, can strengthen teachers' capacity to implement learner-centered science instruction and improve students' laboratory competencies and academic achievement (Johnson et al., 2021).

Challenges encountered in collaborative learning

Students' perceptions of the challenges encountered while manipulating the compound light microscope collaboratively yielded an overall weighted mean of 3.31 (SD = 0.72), interpreted as Strongly Agree on the scale of 3.25 to 4.00. The highest-rated statement was that the teacher encourages students to participate in group work (3.92, SD = 0.28), followed by two statements, that collaborative learning activities help students understand basic science

concepts well and that collaborative learning is an effective way to learn basic science (each 3.68, SD = 0.48). Students also strongly agreed that collaborative activities help develop problem-solving skills (3.60, SD = 0.71) and teamwork and communication skills (3.60, SD = 0.76), and that they feel comfortable expressing their ideas during group activities (3.56, SD = 0.65). These ratings show that students maintained a highly positive attitude toward collaborative learning even while acknowledging difficulties.

Several operational challenges were also rated Strongly Agree. These were that some members dominate the activity while others do not participate much (3.36, SD = 0.86), that there is not enough science equipment for every group (3.29, SD = 0.55), that some members do not know how to use the equipment properly (3.29, SD = 0.55), and that groups often run out of time before finishing their experiments (3.28, SD = 0.68). Statements rated Agree, within the range of 2.50 to 3.24, were that groups experience disagreements or misunderstandings during experiments (3.20, SD = 0.76), that students learn more from peers through collaborative activities (3.16, SD = 0.94), that accidents or mishandling of tools sometimes happen (3.16, SD = 1.07), that the teacher has difficulty monitoring all groups during hands-on activities (3.16, SD = 0.55), that science tools are sometimes damaged or incomplete (3.12, SD = 0.73), that students prefer studying basic science alone rather than in a group (2.92, SD = 1.04), that the teacher provides opportunities to share ideas and thoughts during lessons (2.84, SD = 1.11), and that the classroom or laboratory is not well equipped for group science experiments (2.80, SD = 0.76). The lowest ratings concerned the laboratory environment, which is consistent with the limited laboratory facilities described in the study environment. Unequal participation, insufficient equipment, and uneven skill in handling tools reflect the coordination issues, role ambiguity, and differences in motivation that collaborative learning inherently involves (Gillies, 2021). Johnson and Johnson (2022) argue that positive interdependence and individual accountability help students view such challenges as part of a productive learning experience rather than as obstacles, which explains why students could report these difficulties while still rating collaborative learning favorably. These findings also justify the inclusion of structured group roles and accountability measures in the proposed laboratory exercises.

Synthesis

Taken together, the findings show that both groups improved significantly from pre-test to post-test, with p values below .05 in every competency and the null hypothesis rejected in each case, but that the experimental group, which learned the compound light microscope competencies through collaborative learning, improved far more, with a mean gain of 8.11 points against 2.41 points, an overall effect size of 4.43 against 1.00, and a post-test mean of 28.41 (94.69%, Outstanding) against 19.81 (66.05%, Did Not Meet Expectations). The challenge ratings, with an overall weighted mean of 3.31 (SD = 0.72), indicate that students valued collaborative learning while recognizing unequal participation, limited equipment, time constraints, and inadequate laboratory facilities. These results address the research objectives by establishing the baseline performance, the post-intervention performance, the significance of the change, and the difficulties that shaped the experience, and they contribute evidence that structured collaborative learning can raise laboratory competence even in resource-limited rural schools. The next chapter builds on these findings by presenting the summary, conclusions, and recommendations, including the enhanced laboratory exercises for the compound light microscope under the MATATAG Curriculum.

CONCLUSION

The present study assessed the effectiveness of collaborative learning in manipulating the compound light microscope among Science 7 students at Kal-anan National High School, Kal-anan, Tabogon, Cebu during the 2nd Quarter of the school year 2025–2026, with the aim of providing a basis for improving laboratory exercises on this equipment. Using a quantitative research design with over 50 respondents, the study examined the pre-test scores of the students across the three competencies in using the compound light microscope, the challenges they encountered in collaborative learning while manipulating the equipment, and the significant difference between their pre-test and post-test scores. Data were gathered through a questionnaire adopted from Oguezue et al. (2025) and Department of Education learning modules, and were analyzed using descriptive measures, the weighted mean, and the t-test. Taken together, the results lead to the conclusion that collaborative learning in manipulating the compound light microscope among Science 7 students is indeed effective.

This conclusion rests first on the pre-test results, which showed that the control and experimental groups performed similarly across the three competencies and were generally classified as Did Not Meet Expectations. Competency 2 obtained the highest scores, while Competencies 1 and 3 reflected lower mastery levels. The comparable starting points of both groups indicate that the differences observed later can reasonably be attributed to the intervention rather than to initial disparities in ability. Following the intervention, both groups improved, yet the experimental group achieved significantly higher scores and reached the Outstanding level across all competencies, whereas the control group showed only moderate improvement and remained below proficiency.

The paired-samples t-test further supported this conclusion by confirming significant gains in both groups, with the experimental group demonstrating greater improvement and larger effect sizes. The experimental group likewise recorded a significantly greater mean gain score than the control group, suggesting that the intervention was more effective in enhancing students' performance in manipulating the compound light microscope. These findings highlight the stronger effectiveness of differentiated instruction in enhancing students' competency development, and they show that the collaborative approach produced learning outcomes that surpassed those of conventional instruction. At the same time, students agreed that they encountered challenges in using the compound light microscope during collaborative learning activities, which points to continuing difficulties in handling the equipment. This shows that, despite its demonstrated benefits, collaborative learning must be supported by adequate resources and guidance so that students can manipulate the apparatus with confidence.

In light of these conclusions, several recommendations are offered. Science teachers may integrate collaborative learning strategies with laboratory exercises involving the compound light microscope to enhance students' mastery of Science competencies under the MATATAG Curriculum. School administrators may provide adequate laboratory resources, instructional materials, and professional development programs that support the effective implementation of collaborative learning approaches in Science classes, and schools may strengthen laboratory management practices and ensure the availability and proper maintenance of science equipment to facilitate meaningful learning experiences. Students may actively participate in collaborative learning activities and laboratory exercises to strengthen their scientific skills, critical thinking, and understanding of Science concepts, while parents may encourage and support students' participation in school-related Science activities and collaborative learning experiences to reinforce learning beyond the classroom. Finally, researchers may conduct similar studies involving other Science 7 competencies, larger sample sizes, or different grade levels to further validate the effectiveness of collaborative learning, and future studies may examine other instructional approaches, variables, or learning outcomes

related to the MATATAG Curriculum, such as students' motivation, scientific process skills, critical thinking, and academic achievement. Together, these recommendations reinforce the study's central finding that collaborative learning, when properly supported, is an effective means of strengthening students' performance in manipulating the compound light microscope.

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