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Effectiveness of Enhanced SCI Station Approach on Learners' Academic Performance in Biology

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Abstract

This study was conducted to determine the effectiveness of the SCI Station Approach—an instructional strategy based on the principles of Simplify, Connect, and Illustrate—in improving Grade 8 learners' retention of Science concepts to address the need for an effective, learner-centered instructional strategy that enhances learners' academic performance in Biology and reinforces understanding through illustrative activities. The SCI Station Approach is a student-centered teaching method that organizes classroom instruction into different learning stations. Each station is designed to simplify complex concepts, connect them to real-life applications, and illustrate key ideas through visual aids, hands-on activities, and collaborative tasks. This model encourages active learning, supports diverse learning styles, and aims to improve comprehension and long-term retention of subject matter. A quasi-experimental method of quantitative research was used in the study. Two groups of Grade 8 students participated: the control group received instruction through traditional teaching methods, while the experimental group was taught using the SCI Station Approach. Pre-test and post-test assessments were administered to both groups to measure baseline knowledge and learning gains. The findings indicate that SCI Stations are strongly convincing in enhancing Grade 8 students' retention of Science concepts; thus, it is recommended that Science teachers integrate this approach into classroom instruction.

Introduction

In today's rapidly evolving world, education must continually adapt to meet changing societal needs. With the rise of new technologies and innovations, teaching methods—especially in science—are shifting to become more engaging and impactful. Biology, in particular, plays a crucial role in helping students understand the natural world, develop critical thinking, and build scientific literacy. However, many students in the Philippines struggle with retaining key Biology concepts, which affects their ability to connect lessons to real-life situations. Visual retention—our ability to remember and apply what we see—is especially important in mastering complex subjects like Biology. Tools like diagrams, videos, and infographics help students break down and internalize challenging ideas. Yet, as shown by the 2018 PISA assessment and local data from public schools in San Miguel, Bulacan, students often fall short in scientific literacy, underscoring the need for more effective teaching strategies.

One promising approach is the SCI Station Model, a form of active learning where students rotate through various hands-on, interactive learning stations. This method supports diverse learning styles and enhances engagement, collaboration, and understanding. A study by Mohammed *et al.* (2020), Pho *et al.* (2021), and Johari *et al.* (2023) highlight the benefits of using tactile and visual tools in station-based learning, showing how they boost critical thinking and real-world application. A systematic review by Utami (2018) further confirmed that students using the station rotation model performed significantly better academically," as it

evaluated students' pre- and post-test results, comparing control and experimental groups, and found clear improvement in learning outcomes after implementing the SCI Station Model. Ultimately, this approach offers a more meaningful and effective learning experience, helping students better retain and apply scientific concepts in everyday life.

Understanding heredity can either ignite curiosity or cause confusion among Grade 8 learners, as genetics often feels abstract and complex. That's why research has emphasized the importance of strategies that help students not only learn content but also truly understand and remember it. Contextualized learning, as shown by Capuyan (2021), allows students to relate lessons to real life through Learning Activity Sheets (LAS), while multimedia tools such as animations and videos (Ansay, 2021; Dayrit, 2019) give students opportunities to visualize and revisit concepts. Inquiry-based learning (Guerrero & Bautista, 2023), collaborative strategies (Telamo, 2024), and scaffolding (Mocan, 2021) also play a key role in connecting new knowledge to prior learning and correcting misconceptions. According to Pillado *et al.* (2020), active learning through experiments and retrieval tasks helps students retain ideas longer, while digital tools and flipped classrooms (Thomas & Kumar, 2024) empower students to take charge of their own learning.

To address challenges in teaching genetics, models like SCI Station have emerged as highly effective. Rooted in the CARSCI strategy—Critical Analysis and Reasoning Skills: Simplify, Connect, Illustrate—this approach turns abstract concepts into meaningful experiences (Almacen & Labitad, 2024b; Lisao, 2023; Cabungcal *et al.*, 2024). Multimedia and visual tools transform how students engage with content, while collaborative inquiry (Rogayan et al., 2019) and real-world applications (Akpan & Beard, 2019; Mebert *et al.*, 2020; Wilton *et al.*, 2019) increase motivation and relevance.

Studies by Mohammed et al. (2020) support the use of learning stations for building deductive thinking, while Pho *et al.* (2021) highlight SCI Station's success in boosting both academic performance and engagement. Ultimately, this model supports a dynamic, learner-centered environment where students not only retain knowledge but apply it meaningfully—making science both accessible and impactful.

This study aims to determine the effectiveness of SCI Station in enhancing the retention of Grade 8 students on their academic performance in Biology at Vedasto R. Santiago High School in San Miguel, Bulacan, especially focusing on sections S. Osmeña and C. Aquino, for the school year 2024-2025. Specifically, this study seeks to answer the following:

1. How may the pre-test result of control and experimental groups be described?
2. How may the post-test result of control and experimental groups be described?
3. Is there a significant difference between the pre-test and post-test results of the control group and experimental group before and after the conduct of the study?

Materials and Methods

This study utilized a quasi-experimental design to evaluate the effectiveness of the SCI Station Approach in improving Grade 8 students' retention in Biology. Due to the natural structure of school settings, random assignment was not possible, but the design allowed for structured group comparisons using pre-test and post-test measures. As Villegas (2023) notes, quasi-experimental methods offer practical insight by capturing real-world classroom dynamics. The SCI Station model was implemented in existing classes, reflecting authentic learning conditions and increasing the relevance of findings for everyday educational practice. The SCI Station Approach is built around three core strategies: Simplify, Connect, and Illustrate. It integrates hands-on activities, multimedia resources, peer collaboration, and real-world applications to help students engage with and internalize Biology concepts more effectively. By promoting active, learner-centered experiences, the strategy addresses varied learning preferences and encourages deeper understanding. Research supports this model's effectiveness in enhancing motivation and comprehension through visual aids and interactive learning (Pho *et al.*, 2021).

The study was conducted in a public high school in San Miguel, Bulacan, focusing on two Grade 8 sections: 8-S. Osmeña (experimental) and 8-C. Aquino (control). Each group was composed of 30 students. Purposive sampling was used to select participants, following the recommendation of Denieffe (2020) that this method is ideal when targeting specific groups for in-depth analysis. Participants were selected using purposive sampling based on: (1) enrollment in Grade 8 Biology at the selected school, and (2) comparable class size and academic level. The experimental class lacked access to a television, making them suitable for the SCI Station's visual and interactive tools, while the control group continued with traditional instruction.

In conducting the study, specific tasks were assigned at each station, including the sequence and

contextualization of rotations for Grade 8 Biology, and the manner in which the approach facilitated differentiated, activity-based learning opportunities that are not present in conventional lecture-based methods. Additionally, student feedback was systematically collected through reflective prompts, offering insights into their perceptions of the stations as engaging, supportive, and effective for enhancing conceptual understanding and vocabulary retention. These enhancements provide greater depth and nuance to the study, illustrating the adaptive features and instructional advantages of the station model beyond a simple pre- and post-test comparison.

The Enhanced SCI Station Approach was implemented for eight (8) weeks, covering two (2) SCI cycles per week. The approach was enhanced by increasing the frequency and duration of sessions, providing learners with more consistent exposure to the SCI strategies to improve understanding and retention. Each instructional session lasted 60 minutes, consistent with the allotted class time for Science 8. In total, learners underwent 16 SCI station sessions, ensuring adequate exposure to the intervention before the post-assessment.

The implementation of the Enhanced SCI Station Approach was aligned with the Science 8 content standards and most essential learning competencies (MELCs) on earthquakes and volcanoes. It specifically addressed competencies on explaining how earthquakes and volcanic eruptions occur (S8ES-Ia-b-10), describing how energy is released during an earthquake (S8ES-Ia-b-11), and inferring the impacts of these geologic events on people and the environment (S8ES-Ic-d-13). These standards guided the design of station activities and served as the basis for assessing learner performance in both the experimental and comparison groups. The primary tools were pre-tests and post-tests designed to assess conceptual understanding and retention. These were reviewed and validated by experienced Science educators to ensure alignment with curriculum standards and learning competencies. The tests measured both content knowledge and application, with clear instructions and consistent formatting to maintain reliability and reduce extraneous variables. All materials used in the Enhanced SCI Station Approach were validated by three experts Biology professors for clarity, accuracy, and alignment to MELCs, and only those meeting the required validity rating were used in the implementation.

A pre-test was administered to both groups to establish baseline knowledge, followed by implementation of the SCI Station in the experimental group. After the intervention, a post-test measured learning gains. The process followed ethical research standards, ensuring confidentiality and transparency. Descriptive statistics (mean, standard deviation, frequency) were used to summarize results, while an Independent Sample T-Test determined whether performance improvements were statistically significant (Fernandes *et al.*, 2021; Daines, 2023). This analysis helped validate the SCI Station's impact on students' academic performance in Science.

Ethical procedures were strictly observed in the conduct of the study. Informed consent and assent were obtained from participating students and their parents or guardians, and approval was secured from the school administration. Participants were assured of confidentiality, voluntary participation, and the use of data solely for research purposes.

Results and Discussion

Table 1. Results of Learners' Scores in the Pre-Test of Control and Experimental Group

Range	Control Group		Experimental Group	
	Frequency (f)	Percentage (%)	Frequency (f)	Percentage (%)
26 – 30	0	0.00	0	0
21 – 25	0	0.00	0	0
16 – 20	2	6.67	0	0
10 – 15	18	60.00	15	50
0 – 9	10	33.33	15	50
Mean	10.93		9.57	
VI	**Fairly Satisfactory**		**Fairly Satisfactory**	
SD	3.05		3.11	

Legend: Outstanding (26-30); Very Satisfactory (21-25); Satisfactory (16-20); Fairly Satisfactory (10-15); Did Not Meet Expectations (0-9)

Table 1 presents the pre-test scores of the control and experimental groups. The control group, taught using traditional methods, had a mean score of 10.93 (SD = 3.05), while the experimental group had a slightly lower mean of 9.57 (SD = 3.11); both were interpreted as "Fairly Satisfactory." Score distributions show that 33.33% of control group students scored between 0–9, while 60% fell within 10–15. For the experimental group, 50% scored in the 0–9 range, and 50% in the 10–15 range. No students in either group scored above 15. The mean difference between groups was 1.36, indicating relatively similar performance levels before the intervention. Establishing comparable baseline levels is essential for attributing subsequent learning gains to the intervention rather than prior differences (De Witte & Rogge, 2020). Recent studies on personalized and station-based learning also show that such approaches demonstrate clearer effectiveness when implemented among groups with equivalent starting performance (Patrick & Chambers, 2022; Kim *et al.*, 2021). Thus, the minimal mean difference of 1.36 supports the methodological soundness of comparing outcomes under the Enhanced SCI Station Approach.

This baseline similarity strengthens the validity of comparing outcomes under the SCI Station approach, which may outperform the traditional lecture-based methods. However, literature suggests that traditional lecture-based teaching may not effectively support long-term retention or engagement. Studies by Tutal & Yazar (2023) highlight the superiority of active learning methods in improving academic outcomes. Further, research by Fulbeck *et al.* (2020) and Gyeltshen (2024) supports the use of station-based and visual learning strategies, showing improved understanding, retention, and enthusiasm for Science. This aligns with the need for innovative, student-centered approaches like the SCI Station model.

Table 2. Results of Learners' Scores in the Post-Test of Control and Experimental Group

Range	Control Group		Experimental Group	
	Frequency (f)	Percentage (%)	Frequency (f)	Percentage (%)
26 – 30	0	0	0	0
21 – 25	0	0	4	13.33
16 – 20	5	16.67	16	53.33
10 – 15	24	80	10	33.33
0 – 9	1	3.33	0	0
Mean	13.83		17	
VI	**Fairly Satisfactory**		**Satisfactory**	
SD	2.55		3.39	

Legend: Outstanding (26-30); Very Satisfactory (21-25); Satisfactory (16-20); Fairly Satisfactory (10-15); Did Not Meet Expectations (0-9)

Table 2 displays the post-test results for both the control and experimental groups. The control group, taught through traditional methods, had a mean score of 13.83 (SD = 2.55), retaining the "Fairly Satisfactory" interpretation from their pre-test. Most students (80%) scored between 10–15, with only 16.67% reaching 16–20. In contrast, the experimental group, exposed to the Enhanced SCI Station Approach, achieved a higher mean score of 17 (SD = 3.39), interpreted as "Satisfactory." Here, 53.33% of students scored 16–20, and 13.33% reached 21–25, with none scoring below 10. The mean difference of 3.17 clearly indicates that the experimental group outperformed the control group.

These results affirm the effectiveness of the SCI Station Approach, which centers on Simplify, Connect, and Illustrate, in enhancing student retention and engagement. Unlike the control group, students in the experimental group showed a notable shift toward higher scores, reflecting deeper understanding and better retention of Science concepts.

This supports findings from Rogayan (2019) and Alsaadi & Al Sultan (2021), who highlight the effectiveness of station-based and learner-centered methods in improving academic performance. Similarly, Apolonio (2023) emphasized how interactive strategies like SIM enhance concept retention. The study confirms that active, visual, and contextualized learning strategies such as SCI Station not only improve test performance but foster curiosity, motivation, and real-world application of scientific knowledge—making it a powerful model for 21st-century Science education.

Table 3. Test of Significant Difference on the Pretest Scores of the 8- C. Aquino (Control Group) and 8-Osmena (Experimental Groups)

Comparison Group	t-value	p-value	Decision	VI
Control Group vs. Experimental Group	1.72	0.09	Accept H_o	Not Significant

*Legend: p< 0.05 = significant** = Highly Significant*

Table 3 shows the test of the significant difference between the pre-test scores of the control and experimental groups. With a t-value of 1.72 and a p-value of 0.09, the results exceed the 0.05 significance threshold, indicating no statistically significant difference between the groups prior to the intervention. This confirms that both groups had comparable baseline knowledge, reinforcing the validity of attributing any post-test differences to the SCI Station Approach. The findings support Binag (2020), who demonstrated that learning stations tailored to students' multiple intelligences significantly improved performance and engagement in Biology. Likewise, Benek and Kocakaya (2019) found that station-based strategies enhanced retention and achievement in Science classes, echoing the results of this study. The absence of significant differences in pre-test scores strengthens the conclusion that the SCI Station model, with its interactive and learner-centered design, played a key role in the academic improvements observed in the experimental group.

Table 4. Test of Significant Difference on the Post-test Scores of the 8- C. Aquino (Control Group) and 8-Osmena (Experimental Group)

Comparison Group	t-value	p-value	Decision	VI
Control Group vs. Experimental Group	-4.09	0.00	Rejected H_o	Significant

Legend: p< 0.05 = significant
*** = Highly Significant*

Table 4 presents the post-test score comparison between the control and experimental groups. A t-value of -4.09 and a p-value of 0.00 indicate a highly significant difference in favor of the experimental group, leading to the rejection of the null hypothesis.

This result supports the effectiveness of student-centered, visual-based strategies in improving academic performance. Students in the experimental group showed deeper conceptual understanding, improved retention, and greater engagement—outcomes consistent with findings by Wilson *et al.* (2022), who emphasized how visual tools enhance scientific comprehension. Similarly, Martinez and Lopez (2023) found that station-based learning led to better recall and application of science concepts, particularly among visual learners.

The approach also fostered collaboration, active participation, and real-life application of scientific knowledge. While the strategy was generally effective, challenges included time constraints and occasional difficulty in managing multiple activities. Despite this, the benefits—enhanced learning outcomes, peer support, and personalized instruction—underscore the potential of the SCI Station model to transform Science education. The results suggest important implications for classroom practice.

The SCI Station Approach provides a structured yet flexible model that promotes active engagement, differentiated learning, and continuous vocabulary reinforcement—all of which contribute to improved achievement in Biology. Its rotational structure allows teachers to address varied learner needs while maintaining consistent exposure to key concepts, making it a practical strategy for enhancing retention and supporting more meaningful, student-centered instruction.

Conclusion

The findings confirm that the SCI Station Approach is effective in enhancing Grade 8 students' retention of Biology concepts compared to conventional teaching methods. The approach not only strengthens conceptual understanding but also results in measurable gains in Science vocabulary, as students demonstrated improved mastery of key terms reinforced across the station activities, contributing to better long-term memory and overall achievement.

The pre-test results indicate that the same level of retention was exhibited by the experimental and control groups. The post-test results reveal a significant discrepancy between both groups, in which the experimental group performs better in mean scores than the control group; this is attributed to the application of the SCI Station approach.

The above findings indicate that the Enhanced SCI Station Approach on Learners' Academic Performance in Science 8 is an effective method for improving retention, vocabulary building, and understanding of Science among students, giving a sharp contrast to conventional teaching methods.

Ethical Statement

This study was conducted in accordance with ethical research standards. Informed consent was obtained from all participants, and their participation was voluntary. Confidentiality and anonymity of the respondents were ensured, and the data gathered were used solely for academic purposes. No harm or undue risk was imposed on the participants throughout the conduct of the study.

Conflict of Interest Statement

The authors declare no conflict of interest related to the conduct and publication of this research. All procedures followed were in accordance with institutional and ethical standards, and there were no financial or personal relationships that could have influenced the outcomes of this study.

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Declaration of Generative AI and AI-Assisted Technologies

During the preparation of this work, the authors utilized Grammarly for checking its grammar and punctuations. Following the use of this tool/service, the authors conducted a review and made necessary modifications, assuming full responsibility for the content of the publication.

Data Availability

The data that supports the findings of this study are available upon request from the corresponding author. Restrictions apply due to the confidentiality of the learners' scores.

Author Contributions

JAD: Data curation and Methodology; **MDC:** Project administration and Investigation; **APYM:** Conceptualization and writing; **YECH:** Supervision and writing

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References

Almacen, J. E. & Labitad, G. F. (2024b). Multimedia tools on learners' performance in Filipino. *International Journal of Research Publications*, *152*(1), 631-648. https://doi.org/10.47119/ijrp1001521720246923

Alsaadi, R., & Sultan, A. A. (2021). The effects of learning stations on socioeconomically disadvantaged students' achievement and self-regulated learning. *IAFOR Journal of Education*, *9*(6), 51–69. https://doi.org/10.22492/ije.9.6.03

Ansay, A. B. (2021). Enhancing the performance of junior high students in Science 8 at Dr. Arsenio Nicolas National High School using interactive genetics video lesson. ResearchGate. https://www.researchgate.net/publication/355442646

Akpan, J., & Beard, L. (2019). Learning and retention: How learning and retention impact academic success. *International Journal of Social Science and Business*, *4*(2), 1–10. https://ijssb.com/images/vol4.no.2/1.pdf

Apolonio, C. D. (2023). Concept retention among senior high school Science, Technology, Engineering, and Mathematics (STEM) students exposed to a strategic intervention material (SIM). ResearchGate. https://www.researchgate.net/publication/369131959

Benek, İ., & Kocakaya, S. (2019). The effect of station technique used in Science and Technology class on students' achievement and retention. Academia.edu. https://www.academia.edu/43021244

Binag, R. R. (2020). Multiple intelligences as basis for the use of learning station in teaching biology. *IOER International Multidisciplinary Research Journal*, *2*(1), 1–12. https://doi.org/10.54476/iimrj412

Cabungcal, C. J. C., Capuyan, C. M. E., Dechosa, M. T. I. I., Saldua, C. S., Sabio, D. F. R., Toke, R. U., Boiser-Come, G., & Bernel, M. B. (2024). ENHANCING RETENTION OF BIOLOGY CONCEPT THROUGH VISUAL-BASED PEDAGOGY. Zenodo. https://doi.org/10.5281/zenodo.11629594

Capuyan, A. (2021). Effectiveness of Contextualized Learning Activity Sheets (LAS) to the academic performance of Grade 8 science students in Quarter 2. *International Journal of Advanced Multidisciplinary Studies*, *1*(3), 98–108. https://www.ijams-bbp.net/wp-content/uploads/2021/07/AZIEL-P.-CAPUYAN.pdf

Daines, R. (2023). LibGuides: Statistics Resources: Independent Samples T-test. Resources.nu.edu. https://resources.nu.edu/statsresources/IndependentSamples

Dayrit, J. (2019). Determining the level of learning retention of Grade 8 students in laws of motion using animated instruction. https://ojs.aaresearchindex.com/index.php/AAJMRA/article/view/5396

De Witte, K., & Rogge, N. (2020). Problem-based learning and its impact on student performance. *Education Economics*, 28(2), 142–161.

Denieffe, S. (2020). Commentary: Purposive sampling: complex or simple? Research case examples. *Journal of Research in Nursing*, *25*(8), 662–663. https://doi.org/10.1177/1744987120928156

Fernandes, J. A., Gonçalves, G., & Barros, P. M. (2021). Use of frequency tables by prospective teachers to conduct project work. *Uniciencia*, *35*(1), 139–151. https://doi.org/10.15359/ru.35-1.9

Fulbeck, E., Atchison, D., Giffin, J., Seidel, D., & Eccleston, M. (2020). Personalizing Student Learning with Station Rotation: A Descriptive Study. *American Institutes for Research*. https://files.eric.ed.gov/fulltext/ED610292.pdf

Gyeltshen, N. (2024). Learning station approach for teaching biology in grade ten. ResearchGate. https://www.researchgate.net/publication/382066481_ENHANCING_RETENTION_OF_BIOLOGY_CONCEPT_THROUGH_VISUAL-BASED_PEDAGOGY

Guerrero, N. J. S., & Bautista, N. R. G. (2023). Inquiry-based teaching in secondary science. *International Journal of Social Sciences & Humanities*, *8*(2), 146–154. https://doi.org/10.58885/ijssh.v08i2.146.jg

Johari, S. K., Din, R., & Othman, N. (2023). 3D animated videos to improve student knowledge at a primary school in Malaysia. *International Journal of Academic Research in Business and Social Sciences*, *13*(12), 4508–4517. https://doi.org/10.6007/IJARBSS/v13-i12/20291

Kim, H., Park, S., & Lee, J. (2021). Effects of differentiated and station-based instruction on middle school learners. *Journal of Educational Research*, 114(3), 265–276.

Lisao, C. Y., Kilag, K. T., Tamayo, M. G., Abella, J. L., & Frances, C. (2023, December 19). Reimagining Science Education in the Philippines: A Systematic Analysis of the 7E Learning Cycle Model's Efficacy. https://www.researchgate.net/publication/376645975_Reimagining_Science_Education_in_the_Philippines_A_Systematic_Analysis_of_the_7E_Learning_Cycle_Model

Martinez, C., & Lopez, P. (2023). Station-based learning strategies and science retention in middle school students. *International Journal of Science Education*, *46*(6), 1201-1215. https://doi.org/10.1080/09500693.2023.1672311

Mebert, L., Barnes, R., Dalley, J., Gawarecki, L., Ghazi-Nezami, F., Shafer, G., Slater, J., & Yezbick, E. (2020). Fostering student engagement through a real-world, collaborative project across disciplines and institutions. *Higher Education Pedagogies*, *5*(1), 30–51. https://doi.org/10.1080/23752696.2020.1750306

Mocan, D. K. (2021). What do Students Really Understand? Secondary Education Students' Conceptions of Genetics.

Science Insights Education Frontiers, *10*(2), 1405–1422. https://doi.org/10.15354/sief.21.or061

Mohammed, H., Al-Hafidh, S., & Alhafidh, H. (2020). Effect of using scientific stations strategy in developing deductive thinking of intermediate school students in general sciences ResearchGate. https://www.researchgate.net/publication/348431809

Patrick, S., & Chambers, A. (2022). Evidence of effectiveness in personalized and student-centered learning environments. *International Journal of Learning, Teaching and Educational Research*, 21(5), 45–60.

Pillado, I., Futalana, M., Chona, Z., Comighud, S., & Mae, T. (2020). Factors on Memory Retention: Effect to Students' Academic Performance. https://knowledgecenter.ubt-uni.net/cgi/viewcontent.cgi?article=2713&context=conference

Pho, D. H., Nguyen, H. T., Nguyen, H. M., & Nguyen, T. T. N. (2021). The use of learning station method according to competency development for elementary students in Vietnam. Cogent Education, 8(1), 1870799. https://doi.org/10.1080/2331186x.2020.1870799

Rogayan, D., Albino, M., Öğrencilerin, F., Yaygın, B., Yanılgıları, K., Öğretim, A., & Girdiler, İ. (2019). Filipino Students' Common Misconceptions in Biology: Input for Remedial Teaching. https://dergipark.org.tr/tr/download/article-file/870304

Rogayan, D. V. (2019). Biology Learning Station Strategy (BLISS): Its Effects on Science Achievement and Attitude towards Biology. *International Journal on Social and Education Sciences*, *1*(2), 78–89. https://doi.org/10.46328/ijonses.10

Telamo, J. (2024). Collaborative Learning in Science Courses: Exploring Students' Learning Experiences. ResearchGate; https://www.researchgate.net/publication/382525876_Collaborative_Learning_in_Science_Courses_Exploring_Students

Thomas, A. J., & Kumar, S, R. (2024). Flipped classroom models in science education: increasing student engagement through interactive digital content. ShodhKosh *Journal of Visual and Performing Arts*, *5*(6), 288–306. https://doi.org/10.29121/shodhkosh.v5.i6.2024.1680

Tutal, Ö., & Yazar, T. (2023). Active learning improves academic achievement and learning retention in K–12 settings: A meta-analysis. *Journal on School Educational Technology*, *18*(3), 1–22. https://eric.ed.gov/?id=EJ1378732

Utami, P. (2018). The effectiveness of the station rotation model to improve students' learning outcomes. *Journal of Education and Practice*, 9(12), 45–52.

Villegas, F. (2023). Quasi-experimental research: what it is, types & examples. QuestionPro. https://www.questionpro.com/blog/quasi-experimental-research/#:~:text=Quasi%2Dexperimental%20research%20compares%20groups,statistical%20conclusions%20from%20quantitative%20data.

Wilson, J., Thompson, M., & Patel, R. (2022). The impact of visual learning tools on students' science retention. *Journal of Educational Psychology*, *114*(2), 200-212. https://doi.org/10.1037/edu0000531

Wilton, M., Gonzalez-Niño, E., McPartlan, P., Terner, Z., Christoffersen, R. E., & Rothman, J. H. (2019). Improving Academic Performance, Belonging, and Retention through Increasing Structure of an Introductory Biology Course. *CBE—Life Sciences Education*, *18*(4), ar53. https://doi.org/10.1187/cbe.18-08-0155