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Studying the Benefits of Active Recall in learning Physics Formulas at Young Achievers' School

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Abstract

This study examined the benefits of using active recall as a study technique for learning general physics formulas among Grade 12 Science, Technology, Engineering and Mathematics students at Young Achievers' School of Caloocan in the school year 2025–2026. A quasi-experimental research design was employed which involves 30 respondents chosen through simple random sampling. The participants were divided into two groups: the experimental group, which used active recall, and the control group, which depended on traditional memorization. Pre-test and Posttest were given to both groups and then the survey was conducted using Likert scale questionnaire made by the researchers. The findings showed that although both groups improved, the experimental group's mean score (8.33) was greater than the control group (4.13). The null hypothesis was rejected since the computed t-value of 2.23 was greater than the critical value of 2.048 at 0.05 level of significance. This suggests that students' learning outcomes were significantly improved by active recall. The survey also revealed that while some students were unsure about the long-term retention advantages of active recall, the majority of students had a positive view of it and were willing to use and suggest it as a study method. The study determined that active recall improves physics formulas retention, comprehension and its use more than traditional memorization.

Keywords: Grade 12 Students, Active Recall, Physics Formulas, Retention, Comprehension

Introduction

General Physics is known for its broad scope, fundamental and complex concepts, and elusive formulas. The formulas in general physics involves a wide range of equations that describe the principles of the subject. The various formulas are often abstract and require a deep understanding of fundamental physics principles – reasons why many students struggle to understand and memorize them. According to Wangchuk *et al*. (2023) [8], 84% of students struggle to understand and remember general physics formulas. Most students rely on rote memorization rather than conceptual understanding. To address the issue, the researchers thought of a solution to help Science, Technology, Engineering, and Mathematics (STEM) students overcome these struggles. The researchers discovered a study technique called Active Recall. Active recall is a learning method in which a person repeatedly tests themselves by retrieving information from memory, rather than passively re-reading or highlighting notes. According to Xu *et al*. (2024) [9], active recall is the most effective and productive study technique in the world because it enhances memory retention and improves test performance. Active recall is effective for understanding complex concepts such as general physics formulas. Active recall is known worldwide as an effective study technique. According to a study by Oxford student Mackenzie (2025) [5], 90% of Oxford students use active recall because it is proven to be effective. A youtuber known as Penolopie said in one of her videos that she used to have troubles in subjects like General Physics, but after she learned about active recall, her scores went up a lot and she started getting higher grades. Active recall is also recommended by the Harvard Summer School (SSS) as one of the basic learning strategies. According to Tokuhuma-Espinosa (2024) [4], "Your brain absolutely loves to learn through all of your senses. The more input, the better." In Asia, active recall is also widely used and considered to be beneficial in countries like India, China, Japan, Korea and the Philippines. Additionally, in the Physics Achievement Test conducted by Enerio (2021) [3] from the University of the Philippines Manila, there was an improvement in students' physics scores after they used active recall. This included the improvement in recalling complex physics formulas. At Young Achievers' School of Caloocan, Inc (YASCI), many students are struggling to comprehend and apply general physics formulas. With their elusive and often complex nature, general physics challenge students, especially in word problems and numerical equations. In this case, the problem is the question itself but remembering the correct formula to solve it. Since general physics is a major subject in the STEM strand, students at YASCI need an effective learning strategy. The Enhanced Basic Education Act of 2013, also known as the Republic Act No. 10533, promotes learner-centered approaches and strengthens the curriculum with the aim to improve the Philippine educational system. This legal requirement identifies the importance of improving learning quality through the use of innovative and effective teaching and study techniques. Thus, this study investigates the use of active recall as a strategy to improve students' understanding and retention of physics formulas. This study will study how active recall may help students in learning physics concepts, which supports RA 10533's goals of promoting critical thinking, deeper comprehension and long-term retention in senior high school students. Therefore, in this study, the researchers aimed to study the benefits of using active recall in understanding and remembering general physics formulas. By promoting the best study technique and proving that active recall is effective when done with discipline, students can approach general physics with more confidence. Solving physics formulas will no longer be troubling because remembering the formulas will no longer be a problem.

Materials and Methods

This quantitative study applied quasi-experimental research design. Quantitative research is the process of collecting and analyzing numerical data. It can be used to find patterns and averages, make predictions, test causal relationships, and generalize results to wider populations. (Bhandari, 2020). This research used a quantitative method to study the effect of active recall on students' learning and retention of physics formulas. Quasi-experimental research is a systematic and scientific approach in which the researcher manipulates one or more independent variables and observes the effect on a dependent variable while controlling for extraneous variables. This method allows for the establishment of cause-and-effect relationships between variables. (Soha, 2024) [7]. A quasi-experimental approach will be used to determine the effect of these technique on memory retention. This method is appropriate since it allows the researcher to isolate active recall as a variable and observe its influence under controlled conditions. This study was conducted at the Young Achievers School of Caloocan, as it is our own school. Conducting the study here was an advantage for us as students since the expenses were reduce significantly, and the resources were unchallenging for us since the location is our own school. The respondents of this study are 30 Grade 12 STEM students from Young Achievers' School of Caloocan in the school year 2025–2026. The study utilized simple random sampling to select the 30 students, which means all Grade 12 STEM students had an equal chance of being picked. To ensure the reliability and relevance of the research findings, the respondents of the study were selected based on the following criteria: Grade level and strand, subject background, willingness to participate and availability. The intervention was conducted for two days after approval. On the first day, the researchers were divided the participants into two groups. Each group were given a 10 item pre-test questions asking about the formulas. This tested whether they have knowledge already about the formulas. Then, each group were given cards or papers of general physics formulas. The first group were told by the researchers to just memorize the given general physics formulas. While the second group were told to memorize and understand the given general physics formulas with the use of active recall. They done it for a whole day. On the second day, before breaktime, the researchers came back to gather back the cards or papers of general physics formulas. After breaktime, the researchers came back to give the participants a 10 item post test questions regarding on they memorized and understood. After writing down the general physics formulas, the researcher gave the participants the survey questionnaire to answer. This study used a survey questionnaire that is self-made by the researchers, because these questionnaires gave the researchers free will to ask specific questions to the respondents and fill the gap that is trying to be solved in the research. The survey questionnaire consists of 10 questions to gather information about the experiences, learnings, and responses to active recall. The survey questionnaire has a Likert scale, from which the grade 12- STEM students may select the best answer that is based on their perspectives. The survey questionnaire consists of choices: Very Unlikely, Unlikely, Neutral, Likely, and Very Likely. The academic professionals reviewed the questions before the distribution to determine if the questions were suitable and could be understood by the target audience. This validation process assisted with improving the validity of the data collected for the research study and enhanced the reliability of the instrument. In this study, the researchers used t-test as the statistical tool to analyze the data. A t-test is a statistical tool that determines whether there is a significant difference between the means of two groups. To determine whether there is a significant difference in the ability of two independent groups to learn and recall physics formulas, this tool is suitable for comparing the mean performance scores of the active recall and traditional memorization groups. The t-test was used to compare the recall scores between the two groups. If the results show a statistically significant difference, it means that active recall has an effect on students' learning and retention of physics formulas.

Results and Discussion

Table 1: Pre-test and Post test Scores of Experimental and Control Groups

Experimental Pre-Test	Experimental Post test	Control Pre-test	Control Post test
4	7	2	7
5	8	4	9
3	8	3	8
3	8	5	3
6	7	5	5
2	8	0	8
4	9	1	7
2	7	0	8
1	9	3	7
2	7	2	7
0	10	4	8
3	7	4	9
4	10	1	6
7	10	4	6
4	10	7	9

Table 1 presents the scores obtained from the pre-test and post-test of both the experimental group or the one that used active recall and control group or the one that used traditional memorization. The data clearly indicate that there was a consistent increase in the scores of the respondents after the intervention was conducted. While both groups showed improvement, the experimental group indicated a more gain in their post test results compared to the control group.

Table 2: Mean of Pre-test and Post test Scores of Experimental and Control Groups

Group	N	Mean Pre-test	Mean Post test	Mean Gain
Experimental Group	15	3.33	8.33	5
Control Group	15	3	7.13	4.13

Table 2 presents the mean of pre-test and post test scores and their mean gain. Both groups improved their performance. However, the experimental group, which utilized active recall achieved a higher mean gain of 5 compared to the control group that employed traditional memorization with a mean gain of 4.13. This show that active recall significantly affects learning outcomes. Moreover, the individual takes pre-test and post-test scores revealed that learners in the experimental group consistently showed significant improvement. These findings indicates that active recall is a more effective strategy for enhancing knowledge retention and performance than traditional memorization. These results indicate that the extent of the effect of active recall is significant, as it allows learners to strengthen their memory retention and improved the academic performance. According Pilotti *et al.* (2022) [6] examined the predictive power of memorization practice and verbatim memory performance on GPA among Saudi undergraduate students. They found that strong memorization skills started in frequent recitation practices were moderately predictive of academic success, suggesting that structured memory retrieval positively impacts learning outcomes. The experimental group's significant improvements align with the findings of Pilotti *et al.*, supporting the idea that active recall techniques, which have their start in memorization and retrieval behavior, result in quantifiable gains in academic performance.

Table 3: Post-test Mean Scores Comparison of Experimental and Control Groups

Group	Mean Post test Scores	Description
Experimental Group	8.33	Higher Understanding
Control Group	7.13	Lower Understanding

The data on table 3 shows that the experimental group obtained a higher mean score (8.33) than the control group (7.13), clearly suggesting that active recall was more effective in enhancing retention and comprehension of physics formulas. The Experimental group or the one that used active recall score higher in the post-test compared to the control group or the one that used traditional memorization. This indicates that students' who used active recall remembered and understand formulas better. Also, the difference in performance reflects that active recall helps learners engage more deeply with the material, leading to the higher level of understanding. Durk *et al.* (2020) [2] ran an intensive active-learning physics workshop with secondary school students in the UK. Post-intervention, both self-efficacy and physics ability increased significantly, especially for content covered during the workshop. The higher post-test mean for the experimental group aligns with Durk *et al.*'s findings, indicating that active recall improves retention and understanding. It also suggests that active learning techniques, particularly for recently learned material, successfully increase understanding and confidence.

Table 4: Squared of Post Test Scores

Experimental Group	Control Group
49	49
64	81
64	64
64	9
49	25
64	64
81	49
49	64
81	49
49	49
100	64
49	81
100	36
100	36
100	81

Table 4 presents the squared post test scores of experimental and the control groups. The experimental group or the that used active recall yielded square values ranging from 49 to 100, while the control group or the that used traditional memorization produced values ranging from 9 to 81. The use of squared scores is necessary for solving the t test which is necessary to find the significant difference.

Step by Step Calculation

Step 1. Compute the variance of each group

$$S_1^2 = \frac{\sum X^2}{N} - {\mu_1}^2 \qquad S_1^2 = \frac{\sum Y^2}{N} - {\mu_2}^2$$

$$S_1^2 = \frac{1063}{15} - 8.33^2 \qquad S_1^2 = \frac{801}{15} - 7.13^2$$

$$S_1^2 = 1.48 \qquad S_1^2 = 2.56$$

Step 2. Compute the Standard Error of Difference between Means

$$S_{\mu_1-\mu_2} = \sqrt{(\frac{NS_1^2 + NS_2^2}{N+N-2})(\frac{N+N}{N \cdot N})}$$

$$S_{\mu_1-\mu_2} = \sqrt{(\frac{15(1.48) + 15(2.56)}{15+15-2})(\frac{15+15}{15 \cdot 15})}$$

$$S_{\mu_1-\mu_2} = 0.537187776$$

Step 3. Compute the t statistic

$$t = \frac{\mu_1 - \mu_2}{S_{\mu_1-\mu_2}}$$

$$t = \frac{8.33 - 7.13}{0.537187776}$$

$$t = 2.23$$

$$df = N + N - 2$$

$$df = 15 + 15 - 2$$

$$df = 28$$

$$a = 0.05$$

To determine if there is a significant effect on students' performance when active recall is used compared to traditional memorization in learning General Physics formulas, a t test was performed. First, the variance of each group was computed in order to measure the variability of their scores. The experimental group, which used active recall, obtained a variance of 1.48 while the control group, which used traditional memorization, obtained a variance of 2.56. This shows that the control group had slightly more variation in their performance compared to the experimental group. Second, the standard error of difference between means was calculated. This value estimates how much the difference between the two groups means might occur by chance. After the computation, the standard error was found to be 0.537 Third, compute the t value by dividing the difference between the mean scores of the two groups by the standard error of difference. The mean score of the experimental group was 8.33, while the control group was 7.13. Their difference, which is 1.20 was divided by the standard error of 0.537 which results in a computed t value of 2.23.

Table 5: t test Results of Experimental and Control Groups

Group Comparison	t value	t table value	Conclusion
Experimental vs Control Group	2.23	2.048	Reject the H_0

Table 5 shows the result of the t-test between the experimental group or the one that used active recall and the control group or the one that used traditional memorization. 2.23 was the computed t value, while 2.048 was the critical value from the t table with 0.05 level of significance and 28 degrees of freedom. Since the computed value is greater than the critical value, the null hypothesis is rejected. This means that there is a significant effect of using active recall as a study technique on the learning of physics formulas among Grade 12 STEM students at Young Achievers' School Caloocan, Inc.

Table 6: Distribution of Responses in the Likert Scale Survey

S. No		Very Unlikely	Unlikely	Neutral	Likely	Very Likely
1	I am likely to know what active recall is as a study technique.	2	2	2	12	12
2	I am likely to try using flashcards to review physics formulas.	2	2	5	15	6
3	I am likely to feel prepared for physics quizzes after using active recall.	1	4	5	15	5
4	I am likely to consistently use active recall in my physics study sessions.	1	2	9	13	5
5	I am likely to answer better on tests if I use active recall consistently.	1	2	3	14	10
6	I am likely to recommend active recall to my friends and classmates for studying physics.	1	0	9	10	10
7	I am likely to remember physics formulas for weeks or months using active recall.	3	3	13	6	5
8	I am likely to use active recall to apply physics formulas in solving difficult word problems.	2	2	9	9	8
9	I am likely to continue using active recall in studying other STEM subjects.	2	0	3	11	14
10	I am likely to apply active recall in my everyday lives.	1	3	7	12	7

Table 6 shows the distribution of students' perception regarding the effectiveness of active recall in learning general physics formulas. Majority of the respondents answered "Likely" or "Very Likely" in almost all the items, such as knowing what the active recall is with 24 respondents, using flashcards with 15 respondents and feeling prepared for quizzes with 15 respondents also. This indicates that students find active recall effective and beneficial for them in learning physics formulas. However, in item 7, "I am likely to remember physics formulas for weeks or months using active recall", received a majority of neutral response with 13 respondents. This suggest that while students see short term benefits of active recall, some are still uncertain of its long- term effect. Based on the results, it appears that students generally see active recall positively and are willing to use and recommend it as a study strategy for physics and other STEM subjects. In their systematic review of active recall methods, Xu *et al*. (2024) [9] found that retrieval-based practices are consistently linked to improved self-efficacy and higher academic achievement among young adults, which supports these findings. The positive opinions expressed by the students in this study are thus in line with previous research that demonstrates that active recall improves learning outcomes and promotes self-confidence in one's ability to remember and apply knowledge.

Conclusion

The results of this study revealed that active recall is a more effective study technique compared to the traditional memorization in learning physics formulas. The experimental group, which utilized active recall consistently obtained higher post-test scores and mean gain than to the control group. The computed t-test value also confirmed a significant effect of active recall on students' learning performance, thereby rejecting the null hypothesis. Furthermore, students expressed a generally positive perception toward the use of active recall, indicating that they find it useful in preparing for assessment, solving problems, and retaining knowledge. Although some students were uncertain strongly support the use of active recall as an effective learning strategy for mastering complex formula in physics. Therefore, this study concludes that active recall significantly enhanced comprehension, retention, and academic performance among STEM students.

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