Game-Based Strategic Intervention Material (G-SIM) and Learning Proficiency in Force, Motion, and Energy (FME) among Grade 8 Learners

Rangelou C. Ogale
rangelouogale11@gmail.com
Leyte Normal University – Graduate School, Tacloban City, Leyte, Philippines

Abstract

Strategic Intervention Material (SIM) was found to play an effective role in bridging learning gaps in Science by focusing on those competencies that students have mastered the least. However, no studies have been found on strategic intervention materials integrated with game-based learning in Science education. This study aimed to develop and evaluate the effectiveness of Game-Based Strategic Intervention Material (G-SIM) in improving students' learning proficiency in Force, Motion, and Energy (FME), particularly in the identified least mastered competency. A quasi-experimental design was used in this study, specifically a one-group pretest-posttest design, since no comparison group was involved. The class was selected using purposive sampling and the respondents were obtained through total enumeration. A researcher-made 15-item pretest-posttest and an adapted 10-item perception survey were validated and used to gather data for one class of Grade 8 students (N= 37) in School Year 2025-2026 from a public secondary school in Tacloban City. Descriptive statistics and paired sample t-test were used to analyze the data. The results revealed that the posttest mean score (M= 10.86, SD= 2.08) was considerably higher than the pretest (M= 8.43, SD= 1.99). The use of G-SIM was statistically significant in improving the learning proficiency of the learners in the identified least mastered competency in FME, t(36)= 10.68, $p< .001$. Also, the learners expressed a very high perception of the effectiveness of using G-SIM (M= 3.47, SD= 0.57). This study implies that G-SIM is effective as an instructional method in improving learning proficiency in FME. Further investigations on the effectiveness of G-SIM in improving learning competencies in Science and other subjects are recommended.

Keywords: Force motion and energy; game-based strategic intervention material; grade 8 learners; learning proficiency; quasi-experimental

1. Introduction

Strategic Intervention Material (SIM) has become one of the intervention strategies used in improving student's mastery of least learned competencies in Science education. In the Philippines, the Department of Education implemented the use of SIM through DepEd Order No. 39, s. 2012 to bridge learning gaps and support struggling students in mastering difficult concepts (Department of Education, 2012b). The implementation of the MATATAG Curriculum further emphasized the need for innovative and learner-centered instructional materials that promote scientific literacy, critical thinking, and problem-solving skills among students (Department of Education, 2023). Globally, science education continues to face challenges in terms of low learner achievement, insufficient instructional resources, and difficulty in applying scientific concepts to real-life situations (Assem et al., 2023; Chrysostomou et al., 2023; Tijap et al., 2022; Wells et al., 2019). These educational concerns highlighted the importance of developing contextualized and engaging intervention such as Strategic Intervention Materials in learning Science.

International and national assessments showed poor performance of learners in Science, particularly in competencies related to Physics. The Programme for International Student Assessment (PISA) 2022 revealed that Filipino learners performed significantly below the international average in Scientific literacy (OECD, 2023). Similarly, the Trends in International Mathematics and Science Study (TIMSS) reported low proficiency levels among Filipino learners in understanding scientific concepts and solving scientific problems (Mullis et. al., 2020). Many studies found that learners struggled with abstract concepts in Physics due to its dependence on mathematics and the lack of engaging instructional strategies (Assem et al., 2023; De Jesus, 2019). The existing studies also confirmed that Strategic Intervention Materials improved student achievement and conceptual understanding in Science (Borabo & Dio, 2025; Labe et al., 2025; Ma & Pulmano, 2024). However, most studies focused only traditional printed or digital SIMs and no studies explored the integration of game-based learning into strategic intervention materials (Aparicio et al., 2023; Dandan, 2022)

This study was anchored on the theories of Scaffolding by Lev Vygotsky and Jerome Burner, Personalized System of Instruction by Keller, and Game Theory by von Neumann and Morgenstern. The Scaffolding theory highlighted the significance of instructional supports in guiding students to improve a high level of learning within their zone of proximal development (Zhou, 2020). The concept of Personalized System of Instruction by Keller supported mastery and self-paced learning through structured learning activities and immediate feedback (Eyre, 2007). Meanwhile, Game theory described on how structured challenges, rewards, and interactive learning environments boosted motivation and conceptual understanding

among students (Clark et al., 2016). These theories collectively supported the use of Game-Based Strategic Intervention Material (G-SIM) as an engaging and structured remediation tool in Science Education.

This study evaluated the effectiveness of the Game-Based Strategic Intervention Material (G-SIM) in improving the learning proficiency among Grade 8 learners in Force, Motion, and Energy (FME) for School Year 2025-2026. Specifically, this study sought to determine the level of learning proficiency of learners in the pretest and posttest, determine whether there was a significant difference between the pretest and posttest scores, and identify the learners' perceptions regarding the effectiveness of the G-SIM. This study hypothesized that there is no significant difference between the pre-test and post-test scores among the Grade 8 learners in Force, Motion, and Energy (FME) after using the G-SIM. The findings of the study were expected to provide evidence regarding the effectiveness of integrating game-based elements into SIMs for Science instruction.

This study significantly contributed to the development of Science instruction under the MATATAG Curriculum. For learners, this study provided an interactive intervention material that supported motivation and mastery of difficult science concepts. For teachers, this study developed an innovative and learner-centered instructional material that could be adapted for remediation in Science class. For school administrators, this study presented findings that could support the development and use of Game-based instructional intervention in schools. Moreover, this study provided a reference for future researchers interested in exploring the effectiveness of game-based strategic intervention material in Science and other subjects. Since many students struggle with understanding abstract science concepts, this study was conducted to determine the effectiveness of Game-Based Strategic Intervention Materials (G-SIM) in improving Grade 8 learners' proficiency in Force, Motion, and Energy (FME).

2. Methodology

2.1. Research Methodology

This study employed a Quasi-experimental research design, specifically the one-group pretest–posttest design, to investigate the effectiveness of the Game-Based Strategic Intervention Material (G-SIM) in improving the learning proficiency among Grade 8 students in Force, Motion, and Energy (FME). The one-group pretest-posttest design allowed the researcher to measure learner's performance before and after exposure to the intervention (Cook & Campbell, 1979). This design was appropriate in describing the study because the identified respondents, who were the Grade 8 students, took the pretest first, then learned with the use of the G-SIM, and lastly took the posttest, which had the same items but different arrangement as the pretest (Labe et al., 2025). Moreover, this study used the quantitative method to collect numerical data from the pretest, posttest, and perception survey (Dandan, 2022). This method provided measurable evidence regarding the effectiveness of the G-SIM in improving learning proficiency.

2.2. Research Locale

This study was conducted in one of the public secondary schools in Tacloban City during the School Year 2025-2026. The following inclusion criteria were used to select the location of the study: a public school located in Tacloban City, participated in the National Achievement Test (NAT) in Science, and accessibility to the researcher. These criteria were set to ensure that the selected school represents a learning environment where intervention materials were necessary to address gaps in Science proficiency, thereby allowing the study to measure the potential effectiveness of the Game-Based Strategic Intervention Material (G-SIM).

2.3. Research Respondents

The respondents of this study consisted of one class of Grade 8 students (N= 37) enrolled in a public secondary school in Tacloban City. The class was selected purposively and total enumeration was used to obtained the respondents (Aranda et al., 2019). For a class of Grade 8 students to qualify as respondents, the class had to consist of 100% officially enrolled learners for School Year 2025–2026, to have completed the lessons in Force, Motion, and Energy (FME) in the 4th quarter, regular class attendance, and an average performance in the Summative Test in FME. The inclusion criteria were meant to identify the specific group upon which the intervention was focused.

2.4. Research Instrument

This study utilized a researcher-made pretest and posttest and an adapted survey questionnaire. The pretest and posttest composed of 15-multiple choice items based on the least mastered competency in Force, Motion, and Energy (FME) identified through summative test results and item analysis, with a Table of Specification (TOS) ensuring balanced coverage of lower-order and higher order thinking skills. The perception survey questionnaire, adapted from Sinco (2022), consisted of 10-items measured using a 4-point Likert scale to determine students' level of agreement on the effectiveness of using G-SIM. Both instruments were validated by experts using the Content Validity Index (CVI) (Waltz & Bausell, 1983), and were

found to have excellent content validity with a scale-level CVI of 1.00. The reliability was determined through pilot testing, yielding a KR-20 coefficient of 0.75 for the pretest/posttest and Cronbach's alpha of 0.84 for the perception survey, indicating acceptable and good reliability, respectively.

2.5. Data Gathering Procedures

In the process of gathering data for this study, the researcher first secured a permission letter from the public secondary school in Tacloban City to formally conduct the study. After the approval, the researcher coordinated with the Grade 8 adviser regarding the schedule for intervention. The Summative test scores in Force, Motion, and Energy (FME) along with the Item analysis report were collected to determine the least mastered competency of the Grade 8 learners. This study employed a researcher-developed Game-Based Strategic Intervention Material (G-SIM) titled Ready! Set! Graph! as the primary intervention material, and was developed based on the identified least mastered competency in FME involving the construction and annotation of distance-time and velocity-time graph representing uniform and non-uniform acceleration. The G-SIM was anchored on the mobile game Hill Climb Racing, catching the attention and interest of the students by using familiar game context. The intervention material composed a cover page, guide card, activity card, assessment card, enrichment card, reference card, and answer key card.

For the intervention schedule, it was carefully arranged during the students' spare time to avoid disrupting the usual class hours. Also, parental consent and informed consent/assent forms were secured before the intervention started to ensure ethical compliance throughout the study. The researcher prepared a lesson plan and sought guidance from the adviser to ensure a smooth implementation of the intervention. The intervention was conducted through number of sessions to provide sufficient time for learners to engage with the least mastered competency in Force, Motion, and Energy (FME). The pretest-posttest were given before and after the intervention, respectively. Lastly, the learners completed the perception survey after the posttest.

2.6. Data Analysis

This study used descriptive statistics and t-test to analyze the gathered data. Frequency counts, percentages, means, and standard deviations were used to determine the level of learning proficiency in Force, Motion, and Energy (FME) and student's perceptions regarding the effectiveness of the Game-Based Strategic Intervention Material (G-SIM): Ready! Set! Graph!. The t-test, specifically paired-sample t-test, was utilized to determine whether there was a significant difference between the pretest and posttest scores of the learners after exposure to the intervention. Prior to conducting the paired-sample t-test, the data were tested for normality using Shapiro-Wilk and results indicated that the data were normally distributed and free from significant outliers, thereby satisfying the assumptions required for the use of paired-sample t-test. The statistical analysis was conducted at 0.05 level of significance to determine the effectiveness of the G-SIM: Ready! Set! Graph! in improving the learning proficiency of the learners. The interpretation of learning proficiency levels and perception ratings followed the scales adapted in the study (Department of Education, 2012a; Sinco, 2022).

2.7. Ethical Considerations

This study followed ethical principles throughout the process to ensure the protection and welfare of the learners. This study obtained an ethical clearance from the University's Research Ethics Committee (REC) and approval to conduct the study from the school authorities before data collection. Informed consent from parents and informed consent/assent from the learners were secured prior to participation in the study. Confidentiality and anonymity of the respondents were maintained by ensuring that no identifying information was disclosed in the study. Participation in the study was voluntary and learners were informed that they could withdraw from the study at any time without any consequences. The collected data were used strictly for academic and research purposes only.

3. Results and Discussion

This section presents the findings and discussions on the effectiveness of the Game-Based Strategic Intervention Material (G-SIM): Ready! Set! Graph! in improving the learning proficiency of the Grade 8 learners in Force, Motion, and Energy (FME). The results include the pretest and posttest of the learners, the significant difference between the two test scores, and the perception of the learners regarding the effectiveness of using the G-SIM: Ready! Set! Graph!. The collected data were analyzed and interpreted to determine the effectiveness of the G-SIM: Ready! Set! Graph! in addressing the least mastered competency. Also, this study used relevant literatures and studies to support and explain the findings of the study.

3.1. Level of Learning Proficiency among Grade 8 Learners in the Pretest

Table 1 presents the level of learning proficiency among Grade 8 learners in the pretest before exposure to the G-SIM: Ready! Set! Graph!. The computed mean score (M= 8.43, SD= 2.0) corresponded to a Mean Percentage Score (MPS) of

56.22%, interpreted as an Average level based on the mastery level scale of DepEd (Department of Education, 2012a). It indicates that most learners had a prior understanding of the target competency before the intervention but were not yet proficient. Notably, the absence of learners at higher levels indicates that the learners had not yet attained mastery of the learning competency.

Table 1. Level of Learning proficiency of Learners in Pretest

Learning Proficiency	N	Mean	SD	Mean Percentage Score (MPS)	Descriptive Level
Pretest	37	8.43	2.0	56.22%	Average

Mean Percentage Score (MPS) Interpretation: 0-13% (Absolutely No Mastery); 14-26% (Very Low); 27-40% (Low); 41-60% (Average); 61-73% (Moving Toward Mastery); 74-86% (Closely Approximating Mastery); 87-100% (Mastered)

These findings were consistent with the study of Cornejo (2022), which found that students were struggling to attain scientific and mathematical competencies such as computing, graphing, and interpreting. It also revealed that one of the least mastered competencies among the students was in the topic of Kinematics. Similarly, students' pretest scores in Physics were low, suggesting limited understanding of the subject matter (Aparicio et al., 2023). Moreover, it relates to some relevant studies revealing that students performed low in pretest in Science prior to the implementation of SIM (Aranda et al., 2019; Dandan, 2022; Manlapig et al., 2024; Ma & Pulmano, 2024; Sinco, 2020).

3.2. Level of Learning Proficiency among Grade 8 Learners in the Posttest

Table 2 presents the level of learning proficiency among Grade 8 learners in the posttest after exposure to the G-SIM: Ready! Set! Graph!. The computed mean score (M= 10.86, SD= 2.1) corresponded to a Mean Percentage Score (MPS) of 72.43%, interpreted as Moving Toward Mastery level, approaching the Closely Approximating Mastery level, based on the mastery level scale of DepEd (Department of Education, 2012a). It indicates that most learners demonstrated an improved understanding of the target competency after using G-SIM, as evidenced by the pretest and posttest results. Notably, a substantial shift in learning proficiency were observed, as most of the learners were able to move beyond the lower mastery level after the intervention.

Table 2. Level of Learning proficiency of Learners in Posttest

Learning Proficiency	N	Mean	SD	Mean Percentage Score (MPS)	Descriptive Level
Posttest	37	10.86	2.1	72.43%	Moving Toward Mastery

Mean Percentage Score (MPS) Interpretation: 0-13% (Absolutely No Mastery); 14-26% (Very Low); 27-40% (Low); 41-60% (Average); 61-73% (Moving Toward Mastery); 74-86% (Closely Approximating Mastery); 87-100% (Mastered)

These results suggested that after engaging with the game-based intervention, the majority of learners increased their understanding of the construction and annotation of distance–time and velocity–time graphs representing uniform and non-uniform acceleration, the least mastered competency. These findings were in lined with studies that found that game-based learning materials significantly improved learners' academic performance in science through meaningful and contextualized practice (Cahyana et al., 2019; Partovi & Razavi, 2019). The results likewise aligned with the claim of Rajendrana et al. (2024) that an improved performance of students in academic studies was observed through combining GBL with assessment strategies; gaining learning outcomes through integrating GBL activities in the classroom (Pan et al., 2021). Similarly, relevant studies using SIM greatly improved learners' performance evidently shown through the posttest (Aranda et al., 2019; Dandan, 2022; Manlapig et al., 2024; Ma & Pulmano, 2024; Sinco, 2020).

3.3. Significant Difference Between the Pretest and Posttest Scores

Table 3 presents the paired-sample t-test results between the pretest and posttest scores among the Grade 8 learners. The paired-sample t-test yielded $t(36)= 10.68$, $p< .001$, consequently, the null hypothesis of no significant difference between the pretest and posttest scores was rejected. Hence, G-SIM: Ready! Set! Graph! was statistically significant in improving the learning proficiency of the learners in Force, Motion, and Energy (FME), specifically on the identified least mastered competency. This finding indicated that the improvement in the learners' learning proficiency was not a product of chance

but was statistically meaningful and attributable to the exposure of the G-SIM. Moreover, the large effect size (Cohen's d= 1.76) showed substantial and meaningful improvement in learners' proficiency after the intervention.

Table 3. Paired-Samples t-Test Between the Pretest and Posttest Scores

	statistics (t)	df	*p*		Effect size	Decision
Pretest-Posttest	10.68	36.0	<.001	Cohen's d	1.76	Reject H_0

The present results corroborated the findings of Lasala (2023), which inferred that the integration of game-based activities into supplementary instructional significantly enhanced the conceptual understanding and engagement of Filipino students in Science lesson and learning process; thus, game-based learning in teaching and learning process is effective and made the student productive in science learning (Abuton et al., 2025; Cadiz et al., 2023). Similarly, even in the absence of game-based elements, the use of Strategic Intervention Materials (SIM) has been consistently shown to improve students' academic performance in science. Studies have demonstrated that SIM, as a targeted remediation tool, significantly enhances learners' understanding and achievement in least mastered competencies (Aranda et al., 2019; Dandan, 2022; Manlapig et al., 2024; Ma & Pulmano, 2024; Sinco, 2020).

3.4. Perceptions of the Learners on the Effectiveness of Using G-SIM: Ready! Set! Graph!

Table 4 presents the learners' perceptions regarding the effectiveness of the G-SIM: Ready! Set! Graph!. The overall mean (M= 3.47, SD= 0.57) corresponded that 76-100% of the learners strongly agreed with the effectiveness of the G-SIM, demonstrating a very high overall perception of using the developed intervention material. The result was similar in the study of Sinco (2022) that the students had a positive perception on the use of Strategic Intervention Materials.

Table 4. Perceptions of the Learners on the Effectiveness of Using G-SIM

Indicative Statement	Mean	SD	Verbal Description	Interpretation
To what extent did students perceive the following:				
1. The G-SIM helps me understand the topic in FME that were not understood during regular classroom teaching.	3.59	.55	Strongly Agree	Very High
2. Confusing concept of the topic in FME was clearly presented.	3.32	.63	Strongly Agree	Very High
3. The instructions are simple and easy to follow.	3.68	.48	Strongly Agree	Very High
4. The G-SIM offers interesting activities.	3.73	.45	Strongly Agree	Very High
5. The G-SIM is student-friendly material.	3.76	.44	Strongly Agree	Very High
6. After using the G-SIM, I learn the concepts that were not fully understood in the regular classroom instruction.	3.46	.51	Strongly Agree	Very High
7. I enjoyed reading and doing all the activities provided in the G-SIM.	3.49	.65	Strongly Agree	Very High
8. I can set up my own pace in learning without feeling pressured about time.	3.24	.60	Agree	High
9. The G-SIM inspired and encouraged me to learn more concepts in Science VIII.	3.22	.67	Agree	High
10. I want to use G-SIM during remediation class.	3.24	.72	Agree	High
OVERALL	3.47	0.57	Strongly Agree	Very High

As shown in the table, 76-100% of the learners strongly agreed on the effectiveness of the G-SIM: Ready! Set! Graph! in terms of conceptual understanding, engagement and usability. It indicates that learners perceived the G-SIM as effective in helping them understand difficult concepts, providing engaging and enjoyable learning activities, and the material was easy to use and student-friendly. The results were supported by the previous studies which emphasized that Strategic Intervention Materials improve mastery and conceptual understanding in Science (Dacumos, 2016; De Jesus, 2019; Orine et al., 2024), while game-based learning enhances engagement, enjoyment, and participation among learners (Clark et al., 2016; Lasala, 2023; Plass et al., 2015).

On the other hand, 51-75% of the learners agreed on the effectiveness of the G-SIM: Ready! Set! Graph! in terms of self-paced learning and motivation. It indicates that learners agreed that the G-SIM allowed them to learn at their own pace

without feeling pressured and encouraged them to become more motivated in learning Science concepts, particularly in remediation class. The results were consistent by the studies showing that game-based learning promotes self-paced learning and supports individual learning pace (Hsu et al., 2017; Sinco, 2022), while SIM's increase learners' motivation and preference for remediation activities (Al-Azawi et al., 2019; Manlapig et al., 2024; Orine et al., 2024).

4. Conclusion

On the basis of the foregoing findings, this study concluded that the developed Game-Based Strategic Intervention Material (G-SIM): Ready! Set! Graph! was effective in improving the learning proficiency of Grade 8 learners in Force, Motion, and Energy (FME). The findings revealed that learners initially demonstrated an Average level of learning proficiency during the pretest (M= 8.43, SD= 2.0). However, after exposure to the intervention, the learners significantly improved to Moving Toward Mastery in their posttest performance (M= 10.86, SD= 2.08), indicating enhanced conceptual understanding of the least mastered competency. The paired-samples t-test confirmed that the improvement in scores was statistically significant ($t(36)= 10.68$, $p< .001$), thereby supporting the effectiveness of the G-SIM as a remediation tool in Science education. Moreover, the learners expressed a very high perception (M= 3.47, SD= 0.57) regarding the effectiveness of the G-SIM in making Force, Motion, and Energy (FME) learning more engaging, interactive, accessible, and understandable. These collectively addressed the research gap identified at the onset of this study, particularly the scarcity of integration of game-based learning and strategic intervention materials for Science topics in Philippine public secondary schools.

Moreover, the findings of this study confirmed the significance of the theories of scaffolding, personalized learning, and game-based learning, as the effectiveness of the G-SIM demonstrated the importance of structured support, mastery of learning, independent learning, and active engagement in enhancing students' learning performance. This study therefore extended existing knowledge on Strategic Intervention Materials by demonstrating that the integration of game-based activities within Strategic Intervention Materials improved learners' engagement and mastery of concepts in Force, Motion, and Energy. The findings supported and reinforced the conclusions of earlier studies on game-based learning (Cahyana et al., 2019; Partovi & Razavi, 2019), while at the same time contributing a Philippine-contextualized, competency-aligned G-SIM that may be adapted by other science teachers working on similarly abstract topics. Hence, the relevance of the findings lay not only in supporting existing knowledge on the effectiveness of game-based pedagogy but also in extending its relevance to the improvement of learner's proficiency in Force, Motion, and Energy concepts within the Philippine MATATAG Science curriculum.

5. Recommendations

Based on the findings, this study recommended that teachers develop and use contextualized Game-Based Strategic Intervention Materials (G-SIMs) to address least mastered competencies in Science and other subjects. School administrators may support the production and validation of G-SIM as part of the remediation program. Also, future researchers are encouraged to conduct similar context involving larger sample sizes, longer intervention periods, and design with control group to further validate the effectiveness of the G-SIM. Further investigation on the effectiveness of G-SIMs in other Science competencies and other subjects are recommended.

Acknowledgements

The researcher would like to express sincere gratitude to Almighty God for His guidance, wisdom, and strength throughout the completion of the study. Deep appreciation is extended to the Department of Science and Technology (DOST) for its generous financial support and to the Leyte Normal University- Office of Graduate Studies (LNU-OGS), specially to the Dean of the Graduate School, Dr. Cleofe L. Lajara, for the unwavering support during the conduct of the study. A heartfelt thanks to the President of Leyte Normal University (LNU), Dr. Gil Nicetas B. Villarino, for his leadership and commitment to academic excellence, which inspired graduate students to pursue meaningful research endeavors. The researcher also acknowledges the course Seminar Paper: Research Writing and Publication (RWP) 200 and expresses sincere gratitude to the course instructor, Dr. Fabiana D. Peñeda, for her guidance, expertise, and invaluable feedback that significantly contributed to the improvement of this study. The researcher also extends heartfelt thanks to the school administrators, adviser, Grade 8 learners, parents, and teachers who participated to the successful conduct of the study. Special thanks are likewise given to family members, friends, and colleagues for their unwavering support, understanding, and motivation during the entire research process.

AI Acknowledgements

In this study, Artificial Intelligence (AI) tools were used only as supporting tool, such as for language refinement, grammar checking, and organize ideas. The researcher made sure that every interpretations, analyses, conclusions, and academic decisions stayed original, and were personally reviewed and validated. The AI-assisted tools did not take over the researcher's critical thinking, data analysis, or scholarly responsibility when carrying out the study. Also, all sources and references that were used were properly recognized and cited according to academic and ethical standards.

References

Abuton, P. I., Malayao Jr., S., Sayson, N. L., Paylaga, G., Caparoso, J. K., & Magsayo, J. R. (2025). Back2Basics: Developing a gamified intervention material in teaching basic mathematical skills in physics. *International Journal of Research in Social Science and Humanities, 06*(04), 158–165. https://doi.org/10.47505/ijrss.2025.4.13

Al-Azawi, R., Al-Faliti, F., & Al-Blushi, M. (2019). Educational gamification vs. game-based learning: Comparative study. *International Journal of Innovation, Creativity and Change, 5*(2), 201–215. https://doi.org/10.18178/ijimt.2016.7.4.659

Aparicio, G. A., et al. (2023). Triple SIMs: Its effect on the student's academic performance in physics during modular distance learning. *Journal of Multidisciplinary Education*. https://doi.org/10.2017/IJRCS/ICRI-2024/A04

Aranda, Y. A., Diaz, R. A., Sombilon, M., & Gicana, C. A. (2019). Integrating strategic intervention materials (SIM) in science to low achieving learners. *Journal of Science Teachers and Educators, 2*(1).

Assem, H. D., Nartey, L., Appiah, E., & Aidoo, J. K. (2023). A review of students' academic performance in physics: Attitude, instructional methods, misconceptions and teachers qualification. *European Journal of Education and Pedagogy, 4*(1), 84–92. https://doi.org/10.24018/ejedu.2023.4.1.551

Borabo, J. G., & Dio, R. V. (2025). Effectiveness of strategic intervention material (SIM) in improving Filipino students' performance in science and mathematics: A meta-analysis. *Journal of Basic Education Research, 6*(2), 79–89. https://doi.org/10.37251/jber.v6i2.1420

Cadiz, G. S., Lacre, G. J. R., Delamente, R. L., & Diquito, T. J. A. (2023). Game-based learning approach in science education: A meta-analysis. *International Journal of Social Science and Human Research, 06*(03). https://doi.org/10.47191/ijsshr/v6-i3-61

Cahyana, U., Paristiowati, M., Savitri, D. A., & Hasyrin, S. N. (2019). Developing and application of mobile game based learning (M-GBL) for high school students performance in chemistry. *Eurasia Journal of Mathematics, Science and Technology Education, 13*(10), 7037–7047. https://doi.org/10.12973/ejmste/78728

Chrysostomou, A., Cornell, A. S., & Naylor, W. (2023). A three-year comparative study of dominant misconceptions among first year physics students at a South African university. *Physics Education, 59*(1). https://doi.org/10.1088/1361-6552/ad14ea

Clark, D. B., Tanner-Smith, E. E., & Killingsworth, S. S. (2016). Digital games, design, and learning: A systematic review and meta-analysis. *Review of Educational Research, 86*(1), 79–122. https://doi.org/10.3102/0034654315582065

Cook, T. D., & Campbell, D. T. (1979). *Quasi-experimentation: Design & analysis issues in field settings*. Boston, MA: Houghton Mifflin.

Cornejo, M. B. (2022). Students' academic performances and least mastered skills as basis in developing learning modules for General Physics 1. *World Wide Journal of Multidisciplinary Research and Development, 8*(1), 25. https://doi.org/30.10.17605/osf.io/e9qst

Dacumos, L. P. N. (2016). Perspective of secondary teachers in the utilization of science strategic intervention material (SIM) in increasing learning proficiency of students in science education. *AsTEN Journal of Teacher Education, 1*(2). https://doi.org/10.56278/asten.v1i2.293

Dandan, K. B. V. (2022). ESIM in Science 9: An aid to improve online learning performance. *International Journal of Research Publications*. https://doi.org/10.47119/IJRP1001031620223428

Department of Education. (2012a). *Maximizing utilization of the national achievement test (NAT) results to raise the achievement levels in low performing schools* (DepEd Order No. 160, s. 2012). https://share.google/ih3liUUazSJ8ROCiJ

Department of Education. (2012b). *Policy guidelines on addressing learning gaps and implementing a reading and writing program in secondary schools effective school year (SY) 2012-2013* (DepEd Order No. 39, s. 2012). http://www.deped.gov.ph/wp-content/uploads/2012/05/DO_s2012_39.pdf

Department of Education. (2023). *MATATAG Science CG Grade 4 and 7 / Final MATATAG Science Curriculum for Grades 3–10*. https://www.deped.gov.ph/wp-content/uploads/MATATAG-Science-CG-Grade-4-and-7.pdf

De Jesus, R. G. (2019). Improving the least mastered competencies in Science 9 using "Pump It Up!" electronic strategic intervention material. *DLSU Research Congress, 1*.

Eyre, H. L. (2007). Keller's personalized system of instruction: Was it a fleeting fancy or is there a revival on the horizon?. *The Behavior Analyst Today, 8*(3), 317–324. https://doi.org/10.1037/h0100623

Hsu, Y.-S., Tsai, C.-C., & Liang, J.-C. (2017). Customizing scaffolds for game-based learning in physics: Impacts on knowledge acquisition and game design creativity. *Computers & Education, 113*, 294–312. https://doi.org/10.1016/j.compedu.2017.05.022

Labe, A., Laguindab, D. A., Hairulla, M., & Madale, V. (2025). Development of strategic intervention material (SIM) to improve the least mastered skill in central dogma among the grade 10 learners. *Journal of Innovation, Advancement, and Methodology in STEM Education*. https://so13.tci-thaijo.org/index.php/j_iamstem

Lasala, N. (2023). EDUTainment: Effectiveness of game-based activities in teaching ecosystem topics. *Recoletos Multidisciplinary Research Journal (Online)/Recoletos Multidisciplinary Research Journal (USJ-R. Print), 11*(2). https://doi.org/10.32871/rmrj2311.02.07

Ma Jr., E. B. & Pulmano, R. E. (2024). The science pyramid: An innovative strategic intervention material in physics 8. *World Education Connect Multidisciplinary E-Publication, 4*(7), 162-179. http://dx.doi.org/10.5281/zenodo.12753622

Manlapig Jr., E. F., Acuña, E. B., & Manuel, A. M. (2024). Exploring student academic performance and motivation in physics through electronic strategic intervention material (e SIM). *Anatolian Journal of Education, 9*(1), 145–156. https://doi.org/10.29333/aje.2024.9110a

Mullis, I. V. S., Martin, M. O., Foy, P., & Hooper, M. (Eds.). (2020). *TIMSS 2019 international results in mathematics and science*. International Association for the Evaluation of Educational Achievement (IEA). https://timssandpirls.bc.edu/timss2019/international-results/

OECD. (2023). *PISA 2022 Results*. https://www.oecd.org/pisa/publications/

Orine, P. A., Casipit, J., Fontanilla, A. M., Munar, K. D., Soriano, J. M., & Ong Jr., D. (2024). Transformation city: A pocket strategic intervention material for science 6. *Diversitas Journal, 9*(3). https://doi.org/10.48017/dj.v9i3.3066

Pan, Y., Xu, X., Kao, G. Y.-M., Yang, Y., & Hwang, G.-J. (2021). How to implement game-based learning in a smart classroom? A model of learning activity, game content, design process, and learning evaluation. *Frontiers in Psychology, 12*, 749837. https://doi.org/10.3389/fpsyg.2021.749837

Partovi, T., & Razavi, M. R. (2019). The Effect of game-based learning on academic achievement motivation of elementary school students. *Learning and Motivation, 68*(1), 101592. https://doi.org/10.1016/j.lmot.2019.101592

Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of game-based learning. *Educational Psychologist, 50*(4). https://doi.org/10.1080/00461520.2015.1122533

Rajendrana, M., Rayb, M., Ilangovanb, A., Xavierb, S., & Parthasarathy, G. (2024). Game-based learning and its impact on students' motivation and academic performance. *Multidisciplinary Reviews, 8*(3). https://doi.org/10.31893/multirev.2025074

Sinco, M. (2020). Strategic intervention materials: A tool in improving students' academic performance. *Zenodo (CERN European Organization for Nuclear Research)*. https://doi.org/10.5281/zenodo.3870630

Tijap, H. C., Malamdag, J. E., Paz, P. M., & Pelgone, A. J. (2022). Filipino science teachers' needs, challenges, and practices in the new normal. *Jurnal Pendidikan Mipa, 23*(1):123-151. https://doi.org/10.23960/jpmipa/v23i1.pp123-151

Waltz, C. F., & Bausell, R. B. (1983). *Nursing research: Design, statistics, and computer analysis* (2nded.). Philadelphia: F. A. Davis.

Wells, J. E., Henderson, R., Stewart, J., Stewart, G., Yang, J., & Traxler, A. (2019). Exploring the structure of misconceptions in the Force Concept Inventory with modified module analysis. *Physical Review Physics Education Research, 15*(2), 020122. https://doi.org/10.1103/PhysRevPhysEducRes.15.020122

Zhou, J. (2020). A critical discussion of vygotsky and bruner's theory and their contribution to understanding of the way students learn. *Review of Educational Theory, 3*(4), 82. https://doi.org/10.30564/ret.v3i4.2444