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Revealing Insights: An Action Research Study on the Effectiveness of 'Hydrocarbon Quest: Myths and Mysteries' in Boosting Student Engagement and Understanding of Organic Compounds, its General Classes and Use

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ABSTRACT

In an era where education is increasingly recognized as a cornerstone of personal and societal development, the need for effective teaching strategies has never been more critical. The rapid advancement of technology and the disruptions caused by the COVID-19 pandemic have transformed the educational landscape, particularly in chemistry, where abstract concepts are often difficult for students to grasp. This study examined a Strategic Intervention Material titled Hydrocarbon Quest: Myths and Mysteries, implemented among Grade 9 students at Tabawan Integrated School during School Year 2025–2026 to address least-mastered competencies on organic compounds, their classes, and uses. Using a quasi-experimental design, pre-test and post-test scores of an experimental group using the SIM and a control group receiving traditional instruction were compared. Results showed a substantial improvement in the experimental group, whose mean score increased from 7.45 (34% MPS) to 20.55 (91.45% MPS), while the control group exhibited minimal gains. Findings indicate that the SIM effectively bridges learning gaps, enhances engagement, and promotes deeper understanding. The study recommends broader integration of SIM-based approaches across subjects, continuous development of contextualized materials, and strategies that encourage active participation. Leveraging innovative resources can help mitigate learning loss, rekindle interest in science, and support the development of resilient, informed learners capable of applying scientific knowledge in real-world contexts.

Keywords: *Education, Educational Technology; Instructional Innovation, Learning Intervention, Strategic Intervention Material*

INTRODUCTION

Education serves as the cornerstone of personal and societal development, equipping individuals with the knowledge and skills necessary to navigate an increasingly complex world (UNESCO, 2020). According to Bonitez (2021), education is geared toward meeting the needs of youth. Young learners are uncovering their strengths and shaping their aspirations for the future. They are developing both physically and mentally, gaining a deeper understanding of themselves and their surroundings. As educators, it is our responsibility to provide high-quality education, which serves as a solid foundation of knowledge to help them achieve their dreams. Education also develops the talents and skills of our youth, who will be leading countries and the world in the next generation. It is also the responsibility of the educators who are the implementers of education to develop and train the thinking skills of students needed to pursue their dreams and make a better society (Suarez & Casinillo, 2020).

Further, the importance of education has been magnified in recent years, particularly with the rapid advancement of technology that has transformed traditional teaching and learning methods. The integration of technology into educational practices has not only enhanced student engagement but has also facilitated deeper understanding of complex subjects through interactive and multimedia resources (Hattie & Donoghue, 2016). However, the COVID-19 pandemic has posed unprecedented challenges to education, leading to significant learning losses and gaps, particularly in subjects like chemistry, where abstract concepts can be difficult to grasp without hands-on experiences and interactive learning environments (Dorn et al., 2020).

The pandemic forced educational institutions worldwide to pivot to remote learning, resulting in a myriad of challenges for both educators and students. Many students faced disruptions in their learning due to inadequate access to technology, limited resources, and a lack of engagement with traditional teaching methods (Engzell, Frey, & Verhagen, 2021). Research indicates that students experienced substantial learning losses during this period, with some estimates suggesting that students returning to school with only 70% of the learning gains they have achieved in a typical year (Kuhfeld et al., 2020). This is particularly concerning in subjects like chemistry, where foundational knowledge is critical for understanding more advanced concepts. Misconceptions and difficulties in grasping critical topics, such as organic compounds and hydrocarbons, have become more pronounced, highlighting the urgent need for effective educational strategies that can bridge these gaps and rekindle students' interest in science (Kuhfeld et al., 2020).

In Tabawan Integrated School, which is the focused of this action research, students particularly Junior High Students from Grade 7 to Grade 10 experienced problems when it comes to learning. Students suffer from learning losses and learning gaps which hinder their ability to easily comprehend and understand concepts discussed that in return affects their mastery of the required competencies. In every quarter, there are more competencies that is least-mastered especially in science. According to the data obtained from the item analysis conducted by the subject teachers every quarter, there were 2-3 competencies in the subject that were least-mastered by the students. In Grade 9, students are having difficulty mastering the competencies that is related to organic compounds, especially on the general classes and uses of organic compounds.

To address these challenges, the use of Strategic Intervention Materials (SIMs) has emerged as a promising solution. SIMs are designed to provide targeted support and enhance learning outcomes by presenting content in engaging and accessible formats (Baker et al., 2018). According to Aranda et. al. (2019), SIM is an instructional material for remediation purposes, which is one of the solutions employed by the Department of Education (DepEd) in the Philippines to enhance academic achievements of students performing low in the field of Science and Technology and other disciplines. These materials can be particularly effective in addressing specific learning gaps and misconceptions, allowing educators to tailor their instruction to meet the diverse needs of their students.

In this context, the researcher would like to find the effectiveness of using the SIM titled "Hydrocarbon Quest: Myths and Mysteries" in helping and teaching students understand the concepts about organic compounds, its general classes and uses.

Specifically, this sought to answer the following research questions;

1. What is the level of students' academic performance on the competency: recognize the general classes and uses of organic compounds, particularly on the topic alkanes, alkenes and alkynes?

2. Is there a significant mean difference between the students' academic performance on the competency: recognize the general classes and uses of organic compounds, particularly on the topic alkanes, alkenes and alkynes on the control and experimental groups before and after the utilization of SIM?

This SIM aims to demystify hydrocarbons and their applications while addressing common misconceptions that hinder student understanding. By incorporating interactive elements, real-world contexts, and inquiry-based learning approaches, this material seeks to foster a more engaging learning experience for students in general classes. This research will further provide valuable insights into how innovative educational materials can enhance understanding and rekindle enthusiasm for chemistry in a post-pandemic educational landscape. This study's findings will also contribute to the development of effective pedagogical strategies that can support students in overcoming learning losses and gaps, paving the way for a more resilient and informed generation.

Literature Review

Teaching organic chemistry remains one of the most challenging areas in science education because it requires students to understand abstract ideas, symbolic representations, and multi-step reasoning. In fact, Thoms et al. (2026) explain that chemistry understanding requires navigating macroscopic, submicroscopic, and symbolic levels, each with increasing abstraction and difficulty. Moreover, many learners struggle with topics such as hydrocarbon classification, structure, and application because these require both conceptual understanding and strong visualization skills. As a result, students frequently develop misconceptions and demonstrate low academic performance when instruction relies heavily on traditional lecture-based approaches (Byusa et al., 2022).

This challenge is further intensified by the growing problem of learning loss and learning gaps in science education, particularly following disruptions in instructional delivery. Learning loss refers to the decline in academic knowledge over time, while learning gaps denote uneven mastery of essential competencies among learners. Studies by Engzell et al. (2021) and Kuhfeld et al. (2020) reveal that these issues significantly affect students' performance in cumulative subjects like chemistry, where concepts are highly interconnected. Consequently, when learners fail to grasp foundational concepts such as atomic structure or chemical bonding, they encounter greater difficulty in understanding more complex topics like organic compounds and their reactions, thereby compounding existing misconceptions and learning difficulties. The COVID-19 pandemic further widened these learning gaps. Research by Dorn et al. (2020) found that students experienced significant academic delays in science and mathematics due to limited face-to-face instruction and reduced laboratory exposure. Similarly, Hammerstein et al. (2021) reported that science achievement declined in many countries, particularly among students with limited access to digital learning tools. These gaps have long-term consequences, as science learning is hierarchical in nature, meaning missing one concept affects future understanding.

Moreover, in chemistry classes, not grasping the basics can make students disengaged and unsure of themselves. A report by the OECD (2023) shows that students with ongoing science knowledge gaps are less likely to join in class activities and more likely to struggle with tests. This is particularly true in organic chemistry, where understanding the connection between a molecule's shape, its reactions, and its practical uses is key. To address these challenges, educators have shifted toward student-centered and active learning approaches. Active learning allows students to participate directly in the learning process, which improves understanding and reduces misconceptions (Prince, 2024). Byusa et al. (2022) emphasized that students learn chemistry better when they are actively involved in tasks rather than passively listening to lectures.

One of the most effective strategies for addressing learning gaps is game-based learning (GBL). Game-based learning provides structured challenges that help students revisit and reinforce previously missed concepts. A meta-analysis by Hu et al. (2022) found that game-based learning significantly improves both achievement and motivation in chemistry education. Similarly, Elmali et al. (2025) reported that gamification helps reduce learning gaps by allowing students to repeatedly practice difficult concepts in an

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engaging environment. Empirical studies also support the effectiveness of educational games in improving chemistry understanding. Crucho et al. (2025) found that students who participated in a role-playing chemistry game showed higher achievement and stronger conceptual understanding compared to traditional instruction. This suggests that interactive learning tools can help close gaps in knowledge while improving engagement.

Meanwhile, another widely recognized intervention for addressing least-learned competencies is the use of Strategic Intervention Materials (SIM). Recent studies highlight that SIM serves as a structured remediation tool designed to simplify complex concepts and provide guided, learner-centered activities. For instance, Barrameda (2024) found that Computer-Aided Strategic Intervention Materials (CA-SIM) significantly improved students' academic performance and engagement in Chemistry, as these materials made lessons more interactive and accessible to learners. Similarly, a meta-analysis by Borabo and Dio (2025) revealed that SIM has a large positive effect on students' achievement in science and mathematics, with most studies showing substantial improvement in their academic performance and motivation.

Moreover, empirical classroom-based studies consistently demonstrate that SIM effectively bridges learning gaps by targeting specific least-mastered skills. Suarez and Casinillo (2020) reported that students exposed to SIM significantly outperformed those taught through conventional methods, particularly in mastering difficult science competencies. In addition, Romero (2021) emphasized that SIM enhances remediation by using structured components such as guide cards, activity cards, and assessment tasks that support step-by-step learning. More recent developments also show that contextualized and localized SIMs further strengthen conceptual understanding. For example, Allonar et al. (2024) found that contextualized SIMs improved students' comprehension of scientific concepts by aligning materials with learners' real-life experiences. Likewise, Carlos (2025) noted that validated SIMs increase student motivation, engagement, and conceptual clarity when aligned with curriculum competencies.

Mobile and digital learning tools also play an important role in addressing learning loss. Pereira et al. (2021) developed a game-based application for organic reactions and found that it helped students reinforce previously learned concepts. These tools provide immediate feedback, which is important for correcting misconceptions and filling knowledge gaps. In addition, Erika et al. (2023) emphasized that instructional media such as educational games help students understand complex chemistry topics more easily by presenting content in visual and interactive formats. This is especially useful for learners who have fallen behind due to missed lessons or weak foundational knowledge.

Engagement is another key factor linked to learning gaps. Fredricks et al. (2024) defined engagement as behavioral, emotional, and cognitive involvement in learning. Students with learning gaps often show low engagement, which further worsens their academic performance. Active and enjoyable learning experiences can help reverse this trend. Further, collaborative learning also helps reduce learning gaps. Johnson and Johnson (2020) explained that group work allows students to explain concepts to each other, which strengthens understanding and fills missing knowledge. This is similar to game-based learning, where teamwork and interaction are often required.

Meanwhile, Gilbert (2023) stated that students understand science better when it is connected to real-life situations. In organic chemistry, linking hydrocarbons to fuels, plastics, and everyday materials helps reduce abstraction and improve understanding. With this idea at hand, Deci and Ryan (2020) highlighted the role and importance of motivation in helping students improved their academic performance. They further mentioned that these students perform better when they feel autonomous, competent, and socially connected. Game-based learning supports these needs by making learning more engaging and interactive.

Overall, the literature shows that learning loss and learning gaps significantly contribute to poor performance in science, especially in organic chemistry. However, strategies such as game-based learning, active learning, collaborative approaches, and action research-based interventions can help address these issues effectively. The development of "Hydrocarbon Quest: Myths and Mysteries" is therefore grounded in strong evidence, as it combines engagement, conceptual reinforcement, and interactive learning to help students overcome gaps and improve understanding of organic compounds.

METHODS

Research Design

The study took a quantitative approach, involving measurements and amounts, in order to determine the answers to queries such as how many, how much, how long, and to what extent (Russell, 2013). Moreover, this study employed a descriptive, quasi-experimental type of research, specifically pretest and posttest design to measure the effectiveness of the use of the SIM titled Hydrocarbon Quest: Myths and Mysteries in the performance of Grade 9 students of Tabawan Integrated School in their Science 9 subject.

Research Locale

The action research was conducted at Tabawan Integrated School, a public integrated school under the Schools Division of Calbayog City. The school is situated in Barangay Tabawan, Calbayog City, Philippines. It serves as one of the key educational institutions in the area, catering to learners from both elementary and secondary levels within the community. Tabawan Integrated School is characterized by its commitment to providing accessible and quality basic education to its students, most of whom come from the local barangay and nearby rural areas. The school operates within a typical public-school setting, equipped with standard classrooms, basic instructional facilities, and learning resources that support the implementation of the K to 12 Curriculum. As part of a geographically and socioeconomically diverse community, the school reflects a range of learner abilities and educational needs, making it a suitable site for instructional innovation and intervention-based studies. Its environment provides an appropriate context for examining the effectiveness of teaching strategies, particularly in addressing least-mastered competencies in science subjects such as chemistry.

Participants and Sampling Technique

The respondents of the study came from the Grade 9 Department of Tabawan Integrated School. Moreover, a census purposive sampling technique under experimental type of study was used. Since it is a non-probability sampling technique where researchers select participants based on specific characteristics or criteria that are relevant to the research objectives. According to Palinkas (2015), it is a process of gathering data from every individual in the population. It is often used when the population size is manageable and when researchers want to ensure comprehensive data collection.

The respondents of these action research where the Grade 9 students of Tabawan Integrated School for school year 2025-2026. Table 1 shows the frequency distribution of the Respondents.

Table 1: *Frequency Distribution of the Respondents*

Section		No. of Males	No. of Females	Total (f)	Teaching Method used
A	Experimental Group	13	12	25	SIM Aided Discussion
B	Experimental Group	11	12	23	SIM Aided Discussion
C	Control Group	11	15	26	Traditional Teaching
D	Control Group	12	11	23	Traditional Teaching
		N= 47	N= 50	N=97	

There is a total of 97 enrolled Grade 9 students who were divided into 4 sections. 25 students for section A comprising 13 males and 12 females. 23 students for section B comprising of 11 males and 12 females. 26 students for section C with 11 males and 15 females. And 23 students for section D with 12 males and 11 females. These classes were group into two such as the experimental and control group. The experimental group where the Section A and B. While the control group where the Section C and D.

Research Instrument

The study utilized a standardized pre-test and post-test examination composed of 30 items, carefully designed to assess students' knowledge and skills in hydrocarbons. The test was divided into three parts. Part I consisted of 10 multiple-choice questions that measured students' basic understanding of key concepts related to hydrocarbons. Part II assessed students' ability to construct and represent molecular formulas, condensed formulas, and structural formulas of various hydrocarbon compounds, thereby evaluating their conceptual and procedural knowledge. Part III focused on students' ability to classify compounds into alkanes, alkenes, and alkynes, which tested their higher-order thinking skills in analysis and categorization. The instrument was aligned with the Most Essential Learning Competencies (MELCs) for Grade 9 Chemistry and was validated to ensure clarity, relevance, and appropriateness of the items.

In addition, a strategically designed instructional material, the Strategic Intervention Material (SIM) titled Hydrocarbon Quest: Myths and Mysteries, was employed as the primary intervention tool. The SIM is a gameboard-based learning material composed of interactive components that allow students to actively engage with the lesson through manipulation and exploration. It includes a Guide Card that outlines the learning objectives and provides essential background information to support understanding. The material also features a series of activity cards, enrichment cards and assessments cards that present structured tasks and challenges aimed at reinforcing key concepts and developing students' skills. Finally, the SIM contains a Reference and Answers Key Card, which offers additional information and serves as a guide for self-checking and feedback. This comprehensive design ensures that the material supports independent learning, enhances engagement, and facilitates mastery of hydrocarbon concepts.

Data Gathering

Classes were grouped into two such as the experimental and control group. The experimental group where the Section A and B. While the control group where the Section C and D.

And after the conduct of second quarter examination and identification of least mastered competencies through an item analysis, a 30-item pre-test was administered. The pre-test uses the standardized questionnaire that undergo content validation among master teachers, science program supervisors and the division LRMDS coordinator to ensure its validity and reliability. Subsequently, another item analysis was conducted based on the pre-test results to determine, check, and compare whether the identified least mastered competency from the quarterly exam aligns with the least mastered competency identified in the pre-test, which was based on the standardized questionnaire created. Then, this least mastered competency was used as the bases for constructing the SIM as an intervention material.

The least mastered competency identified in both the quarterly exam and the conducted pre-test focuses and revolved around Regular classes and uses of organic compounds with the code S9MT-IIh-18. The construction of SIM is grounded on the study of Abad (2005) and Luz (2017). To ensure the suitability of the SIM, three types of content validity were carried out: the Guide for Reviewing or Evaluating the SIM, the Learning Resources Management and Development System (LRMDS) educational soundness evaluation checklists, and the LRMDS specifications and guidelines for managing intellectual property rights. The content was validated by five Master Teachers from Tabawan Integrated School to confirm that it adhered to the Department of Education's guidelines for reviewing the SIM. Furthermore, the LRMDS district coordinators, which included principals along with the LRMDS division coordinator and its technical working group, provided additional content validity for the SIM. Subsequently, the SIM was implemented over a one-week period, featuring a 45-minute intensive intervention using the SIM for the experimental group, during which students were properly instructed on how to use the materials during lectures. In contrast, the control group received daily instruction without the aid of the SIM through a traditional 45-minute teaching method. After the intervention, both groups took a post-test consisting of the same questions from the conducted pre-test prior to the intervention, which served as the basis for assessing the students' academic performance.

Data Analysis

The data collected in this study were organized, processed, and analyzed to serve as a basis for interpretation. Standard statistical techniques and formulas were utilized to ensure reliable conclusions. The researcher applied statistical treatments, including Mean, Standard Deviation, Minimum and Maximum values, and Mean Percentage Score (MPS), to analyze the data and provide a descriptive interpretation of each item in the instrument. To compare the two mean scores after the implementation of the SIM, both paired t-tests and independent t-tests were conducted.

Ethical Consideration

This research study was conducted with an academic focus, ensuring that no sensitive information was obtained from the students. As a result, there was no need to seek parental consent for participation. It is important to note that involvement in the study was entirely voluntary, allowing students to choose whether or not to participate without any pressure.

Before the study commenced, the students were informed about the measures in place to protect their privacy. They were assured that all data collected would be handled with the utmost confidentiality and would be used solely for the purposes of this action research. This commitment to confidentiality was emphasized to foster trust and encourage open participation, ensuring that the integrity of the study was maintained while respecting the rights and privacy of all individuals involved. By prioritizing these ethical considerations, the research aimed to create a safe environment for participants, allowing for a more accurate and honest representation of the data collected.

RESULTS AND DISCUSSION

Descriptive Analysis of the Academic Performance

In the analysis of students' academic performance prior to the implementation of the Strategic Intervention Material (SIM) titled Hydrocarbon Quest: Myths and Mysteries, Table 2 presents and shows the data results for both the Experimental and Control groups. The data revealed that the Experimental Group, consisting of Sections A and B, had a total of 48 participants. This group achieved a mean score of 7.45, with a standard deviation of 3.67. The scores ranged from a minimum of 3 to a maximum of 11, resulting in a Mean Percentage Score (MPS) of 34%.

In contrast, the Control Group, comprising Sections C and D, included also 48 participants. This group recorded a lower mean score of 5.70, accompanied by a standard deviation of 2.08. The scores for the Control Group varied from a minimum of 2 to a maximum of 9, leading to a Mean Percentage Score (MPS) of 24.47%.

This data findings indicated that both groups got a low and alarming results similar to their second quarter examination results. That is why, an intervention and innovative strategy through SIM was needed to improve and help them master the identified least learned competency.

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Table 2: *Level of Students' Academic Performance on the Experimental and Control groups before the aid of SIM*

Section	Pre-test	N	Mean	SD	Minimum Score	Maximum Score	MPS
A and B	Experimental Group	48	7.45	3.67	3	11	34%
C and D	Control Group	48	5.70	2.08	2	9	24.47%

Note: Total Item Score is 30

Further, the results presented in Table 2 align with the research conducted by Jotia & Matlale (2011), which revealed that insufficient material resources adversely impact students' academic performance. This inadequacy affects not only how effectively a student completes their tasks and studies but also influences the overall level and quality of their educational outcomes.

Table 3: *Level of Students' Academic Performance on the Experimental and Control groups aided with the use of SIM*

Section	Pre-test	N	Mean	SD	Minimum Score	Maximum Score	MPS
A and B	Experimental Group	48	20.55	2.67	25	30	91.45%
C and D	Control Group	48	9.80	1.66	7	14	44.47%

Note: Total Item Score is 30

Table 3 presents the results for both the Experimental and Control groups on the analysis of students' academic performance following the implementation of the Strategic Intervention Material (SIM) on the experimental groups. The data presented that the Experimental group, which includes Sections A and B, consisted of 48 students achieved a mean score of 20.55. This group exhibited a standard deviation of 2.67, indicating a moderate level of variability in their scores. The scores ranged from a minimum of 25 to a maximum of 30, resulting in a Mean Percentage Score (MPS) of 91.45%.

Conversely, the Control Group, comprising 48 students from Sections C and D, recorded a mean score of 9.80, with a standard deviation of 1.66. The scores for this group varied from a minimum of 7 to a maximum of 14, leading to a Mean Percentage Score (MPS) of 44.47%.

Moreover, the data further indicate that the Experimental Group, which utilized the SIM, outperformed the Control Group in the post-test assessment. The higher mean score and MPS for the Experimental Group suggest that the use of the created SIM titled Hydrocarbon Quest: Myths and Mysteries positively impacted learners to master the identified least mastered competency and help them improved their academic performance. Additionally, the greater standard deviation in the Experimental Group implies a wider range of performance levels, which may reflect varying degrees of engagement with the instructional materials.

This findings from Table 3 were anchored and strengthen by Dy (2011) that emphasized that strategic intervention materials are viewed as effective tools for improving the academic performance of students who are struggling. These materials are incorporated into teaching strategies to encourage student engagement and enhance their understanding of the subject matter. Supporting this perspective, Bunagan (2012) described SIM as resources intended to re-teach concepts and skills that students have not fully grasped. They serve as aids to help students develop the competency-based skills that may have been overlooked during regular classroom instruction.

Effectiveness of the Strategic Intervention Material (SIM) titled: Hydrocarbon Quest: Myths and Mysteries

Table 4 shows the T-test value for pretest and posttest score of students in the utilization of the SIM titled Hydrocarbon Quest: Myths and Mysteries under the experimental and control group. The t-test was conducted to assess the differences in the test-results and the academic performance between the

Experimental and Control groups before and after the implementation of the created SIM. It was presented in the table that the Experimental Group t-test value was calculated at 27.18, with 47 degrees of freedom and a p-value of less than 0.001. This indicates a highly significant difference in scores between the pretest and posttest, suggesting that the use of created SIM had a substantial positive impact on helping the students master the identified least mastered competency and would have a direct effect on the academic performance of students in this group. The high t-test value reflects a strong effect of the intervention, demonstrating that the students not only improved their scores but did so to a statistically significant degree.

Table 4: *T-test for pretest and posttest score of students in the utilization of SIM under the experimental and control group.*

Variables	T-test (Value)	Df	p-vale
Experimental Groups *(Pre-test & Post-test)*	27.18**	47	<0.001
Control Groups vs Experimental Groups *(Pre-test & Post-test)*	15.98**	47	<0.001

Note: ** - highly significant at 1% level.

Additionally, when comparing the Control Group to the Experimental Group, the t-test value was found to be 15.98, also with 47 degrees of freedom and a p-value of less than 0.001. This result further emphasizes the effectiveness of the created SIM titled Hydrocarbon Quest: Myths and Mysteries, as it indicates a highly significant difference in performance between the two groups. The Control Group, which did not utilize the created SIM titled Hydrocarbon Quest: Myths and Mysteries, showed less improvement in their scores compared to the Experimental Group, reinforcing the notion that the intervention played a crucial role in helping the students to master the least mastered competency and also helped in enhancing student learning outcomes.

Moreover, the results from the t-test highlights the effectiveness of the created Strategic Intervention Material by the researcher since it helps students master the identified least learned skills and improve their academic performance in some aspects, particularly within the Experimental Group. The significant differences observed in both comparisons underscores the importance of utilizing targeted instructional resources to support student learning and achievement.

CONCLUSION

Based on the findings of the action research, it can be concluded that the Strategic Intervention Material (SIM) titled "Hydrocarbon Quest: Myths and Mysteries" is an effective instructional tool in improving both the engagement and conceptual understanding of Grade 9 students in organic chemistry at Tabawan Integrated School. The results of the study clearly demonstrate that students who were exposed to the SIM showed a significantly higher level of academic achievement compared to those who were taught using conventional methods, indicating that the intervention successfully addressed existing learning gaps in the least learned competencies. This further strengthened by Erika et.al. (2023) who mentioned that instructional media such as educational games help students understand complex chemistry topics more easily by presenting content in visual and interactive formats. And the conducted meta-analysis by Borabo and Dio (2025) that mentioned that SIM has a large positive effect on students' achievement in science and mathematics, with most studies showing substantial improvement in their academic performance and motivation.

A comparative analysis of pre-test and post-test results further confirms the effectiveness of the SIM. The Experimental Group, which utilized the Strategic Intervention Material, exhibited a remarkable increase in performance, attaining a mean score of 20.55 with a mean percentage score (MPS) of 91.45%. In contrast, the Control Group, which did not use the SIM, only achieved a mean score of 9.80 with an MPS of 44.47%. This substantial difference in performance highlights the strong positive impact of the intervention on students' mastery of organic compound concepts. The findings suggest that the SIM not only improved test scores but also enhanced students' deeper conceptual understanding and retention of the subject matter. This finding was further supported by the study of Gilbert (2023) which highlighted that students understand science better when it is connected to real-life situations.

Furthermore, the results of the study reinforce existing educational literature highlighting Strategic Intervention Materials (SIM) as effective pedagogical tools in addressing learning difficulties, particularly in science education. Consistent with the findings of Suarez and Casinillo (2020), students exposed to SIM significantly outperformed those taught through conventional methods, especially in mastering complex science competencies. This improvement can be attributed to the structured and learner-centered nature of SIM, which, as emphasized by Romero (2021), incorporates essential components such as guide cards, activity cards, and assessment tasks that facilitate step-by-step learning and targeted remediation.

Consequently, it can be concluded that the integration of SIM into science instruction fosters a more supportive and effective learning environment, ultimately leading to improved academic performance and deeper conceptual mastery among students.

As a result, several recommendations are proposed to further enhance instructional effectiveness and student learning outcomes. First, given the significant improvement in the academic performance of the Experimental Group after the implementation of the Strategic Intervention Material (SIM), it is strongly recommended that the developed SIM be adopted and utilized across other grade levels and subject areas where learners demonstrate learning difficulties. Expanding its use may help address similar learning gaps and contribute to improved academic performance in a wider educational context.

Second, the positive impact of the SIM highlights the importance of continuous development and refinement of instructional materials. It is therefore recommended that future enhancements of the SIM incorporate systematic feedback from both students and teachers. This will ensure that the material remains relevant, engaging, and aligned with identified least learned competencies, thereby maximizing its instructional effectiveness.

Third, since varying levels of student engagement with the SIM were observed to influence academic performance, it is recommended that teachers implement strategies that promote active participation. These may include collaborative learning activities, peer tutoring, guided group discussions, and interactive learning sessions that fully integrate the use of the SIM. Such approaches can further strengthen student motivation and deepen conceptual understanding.

Fourth, it is recommended that future researchers conduct longitudinal studies to examine the long-term effects of using SIMs on students' knowledge retention and academic performance. This will provide valuable insights into the sustainability of learning gains and determine whether periodic reinforcement or supplementary materials are necessary to maintain mastery of competencies.

Finally, it is recommended that school administrators and education stakeholders allocate sufficient resources for the development, reproduction, and dissemination of SIMs across various subject areas. Investing in these instructional materials can significantly enhance teaching effectiveness and provide targeted support for learners who are academically at risk, ultimately improving overall educational outcomes.

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