

Evaluating the Effectiveness of Self-Learning Module (SLM) on Carbon Compounds Among Grade 9 Learners

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ABSTRACT

This study evaluated the effectiveness of a developed Self-Learning Module (SLM) in improving the academic performance of Grade 9 learners in Chemistry, specifically on the topic of Carbon Compounds. A quasi-experimental pretest–posttest control group design was employed involving twenty-eight (28) Grade 9 learners from a public secondary school in Iligan City, Lanao del Norte, who were divided into a control group taught using the Traditional Learning Module (TLM) and an experimental group exposed to the developed Self-Learning Module. Learners' achievement was measured using validated pretest and posttest instruments aligned with the Department of Education's Most Essential Learning Competencies (MELCs). Due to the small sample size and non-normal distribution of the data, the Wilcoxon Signed-Rank Test and Mann–Whitney U Test were used for statistical analysis. The findings revealed that both instructional approaches significantly improved learners' academic performance from pretest to posttest. However, learners who utilized the Self-Learning Module demonstrated significantly higher posttest performance than those taught through the Traditional Learning Module. The experimental group obtained a significantly higher mean rank, indicating that the Self-Learning Module was more effective in promoting conceptual understanding of Carbon Compounds. The results suggest that learner-centered, self-paced instructional materials can enhance students' learning outcomes and serve as an effective supplement to conventional classroom instruction. As a pilot study, the findings provide preliminary evidence supporting the use of Self-Learning Modules in Chemistry and offer valuable insights for refining the instructional material prior to large-scale implementation.

Keywords: Carbon Compounds, Chemistry Education, Self-Learning Module, Traditional Learning Module

INTRODUCTION

Science education aims to develop scientifically literate learners who can apply scientific knowledge and skills to understand and address real-world problems. Rather than emphasizing rote memorization, effective science instruction encourages learners to develop conceptual understanding, critical thinking, and problem-solving abilities that enable them to make informed decisions in everyday life (OECD, 2019). In the Philippine K–12 curriculum, these goals are achieved by providing learners with meaningful learning experiences that promote the understanding and application of scientific concepts through inquiry-based and learner-centered approaches (Department of Education, 2016).

To support these goals, the Department of Education has developed various instructional resources, including learning modules aligned with the Most Essential Learning Competencies (MELCs). These materials are intended to facilitate independent learning while ensuring that curriculum standards are met. However, despite their widespread use, several studies have reported limitations of existing instructional modules, including complex language, time-consuming activities, and laboratory exercises that require materials not readily available in many schools (Cabili et al., 2015). Such limitations may hinder learners' conceptual understanding, particularly in Chemistry, where abstract concepts often require carefully designed instructional support.

Self-Learning Modules (SLMs) have emerged as an important instructional strategy for promoting learner autonomy and supporting flexible learning environments. Designed to be learner-centered and self-paced, SLMs

provide structured content, guided activities, and assessments that allow learners to construct knowledge independently while achieving intended learning outcomes (Das, 2025). Their significance became particularly evident during the COVID-19 pandemic, when school closures necessitated alternative learning modalities worldwide. In the Philippines, modular distance learning became the most widely adopted delivery modality because many learners had limited access to stable internet connectivity and digital devices (Anzaldo, 2021; DepEd, 2020; UNESCO, 2020). Consequently, SLMs became the primary instructional resource for millions of Filipino learners.

Although the pandemic accelerated the development and implementation of Self-Learning Modules, questions remain regarding their effectiveness in improving students' learning outcomes, particularly in Chemistry. Research suggests that the effectiveness of instructional materials depends largely on the quality of their content, organization, clarity, and alignment with learning objectives (Bao, 2020). Well-designed self-learning materials have been shown to enhance learner engagement, conceptual understanding, and academic performance by allowing students to learn at their own pace while reinforcing key concepts (Bacomo et al., 2022; Natividad, 2021).

Carbon Compounds is one of the fundamental topics in Grade 9 Chemistry, yet learners frequently encounter difficulties in understanding its concepts because of their abstract nature and the need to relate molecular structures to their corresponding physical and chemical properties. These learning difficulties highlight the need for instructional materials that can facilitate independent learning while strengthening conceptual understanding. In response to this need, this study developed and evaluated a Self-Learning Module on Carbon Compounds for Grade 9 learners. Specifically, the study compared the effectiveness of the developed Self-Learning Module with the Traditional Learning Module by examining learners' pretest and posttest performance. The findings of this pilot study are expected to provide preliminary evidence on the effectiveness of the developed instructional material and serve as a basis for its refinement and wider implementation in Chemistry instruction.

Research Objectives

The primary objective/s of this study was to evaluate the effectiveness of the Self-Learning Module (SLM) in improving the academic performance of Grade 9 learners in Chemistry, specifically on the topic of Carbon Compounds. The study also sought to compare learners' academic performance under the Traditional Learning Module (TLM) and the Self-Learning Module (SLM) by examining their pretest and posttest scores and determining whether significant differences existed between the two instructional approaches.

Specifically, this study aimed to:

1. Assess the pretest and posttest performance of Grade 9 learners on the topic of Carbon Compounds under the Traditional Learning Module (Control Group) and the Self-Learning Module approach (Experimental Group).
2. Determine whether there is a significant difference between the pretest and posttest scores of learners in the Control Group (Traditional Learning Module); and Experimental Group (Self-Learning Module).
3. Determine whether there is a significant difference between the posttest performance of learners in the control group and those in the experimental group on the topic of Carbon Compounds.

Null Hypotheses

To determine the effectiveness of the Self-Learning Module (SLM), the following null hypotheses were tested.

- H_0 : There is no significant difference between the pretest and posttest scores of learners in the control group who were taught using the Traditional Learning Module.
- H_0 : There is no significant difference between the pretest and posttest scores of learners in the experimental group who were exposed to the Self-Learning Module.

- H_0 : There is no significant difference between the posttest scores of the control group and those of the experimental group.

METHODOLOGY

This study employed a quasi-experimental pretest–posttest control group design to evaluate the effectiveness of a Self-Learning Module (SLM) in improving Grade 9 learners' academic performance in Chemistry, specifically on the topic of Carbon Compounds. Two instructional approaches were compared: the Traditional Learning Module (TLM), which utilized the Department of Education (DepEd) prescribed learning modules, and the developed Self-Learning Module (SLM). Learners in the control group received instruction using the conventional modular approach, whereas those in the experimental group were taught using the developed SLM.

The study involved one intact Grade 9 class from a public secondary school in Iligan City, Lanao del Norte, during the Academic Year 2025–2026. The class was composed of twenty-eight (28) learners, who were assigned into two groups consisting of fourteen (14) learners each. One group served as the control group, while the other served as the experimental group. Participants were selected through purposive sampling to facilitate the pilot implementation and evaluation of the developed instructional material.

The research instrument consisted of an adapted achievement test comprising a 10-item pretest and a parallel 10-item posttest covering the topic of Carbon Compounds. The test items were developed in alignment with the Department of Education's Most Essential Learning Competencies (MELCs) for Grade 9 Chemistry to ensure content relevance and curricular alignment. Prior to administration, the instrument underwent content validation to establish its suitability for measuring learners' conceptual understanding.

Data collection commenced with the administration of the pretest to both the control and experimental groups to determine their baseline knowledge of Carbon Compounds. Following the pretest, the control group received instruction using the Traditional Learning Module and the DepEd learning module, while the experimental group completed the developed Self-Learning Module. Both groups were administered the posttest under comparable testing conditions to assess learning gains and the effectiveness of the two instructional approaches. Because the study involved a relatively small sample ($n = 28$) and the data did not satisfy the assumptions of normality, nonparametric statistical techniques were employed. The Wilcoxon Signed-Rank Test was used to determine whether significant differences existed between the pretest and posttest scores within each group. To compare the posttest performance of the control and experimental groups, the Mann–Whitney U test was utilized.

This study is served as a pilot study to evaluate the initial effectiveness of the developed Self-Learning Module for Carbon Compounds and the suitability of the research instruments. Consequently, the findings should be regarded as preliminary and are intended to guide the refinement of the instructional material and assessment instruments. Revisions to the Self-Learning Module may be undertaken based on learners' performance, observations during implementation, and participant feedback prior to conducting a larger-scale experimental study.

RESULTS AND DISCUSSION

Objective 1. Assess the pretest and posttest performance of Grade 9 learners on Carbon Compounds under the Traditional Learning Module (Control Group) and the Self-Learning Module (Experimental Group).

Table 1: Pretest and Posttest Scores of the Control Group (Traditional Learning Module)

	N	Mean	S.D	Min.	Max
Pretest	14	2.21	1.122	0	4
Posttest	14	3.79	.975	2	4

The results indicate that the mean pretest score of the 14 participants was 2.21 (SD = 1.122), suggesting a relatively low level of knowledge or performance prior to the intervention. Scores ranged from 0 to 4, indicating considerable variability among participants' baseline understanding. Following the intervention, the mean posttest score increased to 3.79 (SD = 0.975), with scores ranging from 2 to 4. This represents an average increase of 1.58 points from the pretest, indicating a substantial improvement in participants' performance. The reduction in the standard deviation from 1.122 to 0.975 suggests that participants' scores became slightly more consistent after the intervention. Moreover, the increase in the minimum score from 0 to 2 demonstrates that even the lowest-performing participants showed improvement.

Table 2. Pretest and Posttest Scores of the Experimental Group (Self-Learning Module)

	N	Mean	S.D	Min.	Max
Pretest	14	3.00	.877	2	4
Posttest	14	4.71	.994	3	7

The descriptive statistics indicate that the 14 participants obtained a mean pretest score of 3.00 (SD = 0.877), with scores ranging from 2 to 4. These results suggest that participants demonstrated a moderate level of performance before the intervention, with relatively low variability in their scores. Following the intervention, the mean posttest score increased to 4.71 (SD = 0.994), with scores ranging from 3 to 7. The average score increased by 1.71 points, indicating a notable improvement in participants' performance after the intervention. Although the standard deviation increased slightly from 0.877 to 0.994, the variability remained relatively low, suggesting that participants generally benefited from the intervention. Moreover, the increase in the minimum score from 2 to 3, together with the higher maximum score from 4 to 7, indicates an overall upward shift in performance across participants. These findings are further supported by Tohidi et al. (2019), who demonstrated that self-learning modules significantly enhanced learners' competency by promoting self-directed and independent learning.

Objective 2. Determine whether there is a significant difference between the pretest and posttest scores of the learners in each group.

Table 3. Wilcoxon Signed-Rank Test for the Traditional Learning Module (TLM) (Control Group)

Ranks	N	Mean Rank	Z-value	p-value at 0.05 level of significance	Qualitative Interpretation
Negative	1	2.00	- 2.972	.003	Significant
Positive	11	6.91			
Ties	2				

A Wilcoxon Signed-Rank Test was conducted to determine whether there was a significant difference between the participants' pretest and posttest scores. The results showed 11 positive ranks, indicating that most participants obtained higher scores on the posttest than on the pretest. Only one participant had a lower posttest score than the pretest (negative rank), while two participants obtained identical scores on both assessments (ties). A Wilcoxon Signed-Rank Test was conducted to determine whether there was a significant difference between the participants' pretest and posttest scores. The results showed 11 positive ranks, indicating that most participants obtained higher scores on the posttest than on the pretest. Only one participant had a lower posttest score than the pretest (negative rank), while two participants obtained identical scores on both assessments (ties). These findings indicate that the intervention produced a statistically significant improvement in participants' performance. The predominance of positive ranks, together with the significant Wilcoxon test result, suggests that the intervention was effective in enhancing participants' learning outcomes.

Table 4. Wilcoxon Signed-Rank Test for the Self-Learning Module (SLM) (Experimental Group)

Ranks	N	Mean Rank	Z-value	p-value at 0.05 level of significance	Qualitative Interpretation
Negative	0	.00	- 3.108	.002	Significant
Positive	12	6.50			
Ties	2				

The Wilcoxon Signed-Rank Test was conducted to determine whether there was a significant difference between the participants' pretest and posttest scores. The results showed 12 positive ranks, indicating that 12 participants obtained higher scores on the posttest than on the pretest. There were no negative ranks, demonstrating that none of the participants performed worse after the intervention. Additionally, two participants obtained identical scores on both assessments (ties). The test yielded a Z-value of -3.108 with a corresponding p-value of .002. Since the p-value is less than the 0.05 level of significance, the null hypothesis is rejected. Therefore, there is a statistically significant difference between the pretest and posttest scores. The findings indicate that the intervention was effective in improving participants' performance. The absence of negative ranks, together with the predominance of positive ranks, suggests that the intervention consistently enhanced participants' learning outcomes, with no evidence of declining performance among the participants. This finding agrees with Bacomo et al. (2022), who reported that learners using Self-Learning Modules demonstrated satisfactory academic performance and that positive engagement with SLMs was strongly associated with improved learning outcomes. Likewise, Natividad (2021) emphasized that well-designed and user-friendly self-learning materials contribute to the successful implementation of modular learning and improve students' academic achievement.

Objective 3: Determine whether there is a significant difference between the posttest performance of the control and experimental groups.

Table 5: Comparison of Posttest Scores Between the Control Group (Traditional Learning Module) and the Experimental Group (Self-Learning Module)

Group	N	Mean Rank	Sum of Ranks	Mann–Whitney U	Z-value	p-value	Decision	Interpretation
Traditional Learning Module (Control)	14	8.50	119.00	14.000	- 4.005	< .001	Reject H_0	Significant
Self-Learning Module (Experimental)	14	20.50	287.00					

Table 5 presents the comparison of the posttest scores between the control group, which was taught using the Traditional Learning Module (TLM), and the experimental group, which utilized the Self-Learning Module (SLM). A Mann–Whitney U test was employed to determine whether a statistically significant difference existed between the posttest performances of the two independent groups. The results revealed that the experimental group obtained a substantially higher mean rank (20.50) than the control group (8.50), indicating that learners exposed to the Self-Learning Module generally achieved higher posttest scores. The Mann–Whitney U test yielded a U value of 14.000, $Z = -4.005$, and a p-value < .001. Since the p-value is less than the 0.05 level of significance, the null hypothesis was rejected. These findings indicate that there is a statistically significant difference in the posttest scores of learners who were taught using the Traditional Learning Module and those who learned through the Self-Learning Module. Specifically, the higher mean rank of the experimental group suggests that the Self-Learning Module was more effective in improving learners' understanding of Carbon Compounds than the Traditional Learning Module.

The results imply that the use of the Self-Learning Module provided learners with greater opportunities for independent, self-paced, and structured learning, which may have enhanced concept acquisition and retention. Consequently, the Self-Learning Module demonstrated superior effectiveness in promoting academic achievement in Chemistry, particularly in the topic of Carbon Compounds. Dapa and Valdez (2021) likewise emphasized that students prefer self-learning modules that are organized, manageable, and learner-friendly, suggesting that carefully designed instructional materials promote greater learner engagement and successful completion of learning tasks.

CONCLUSION

This pilot study evaluated the effectiveness of a developed Self-Learning Module (SLM) in improving Grade 9 learners' academic performance in Chemistry, specifically on the topic of Carbon Compounds. The findings demonstrated that both the Traditional Learning Module (TLM) and the Self-Learning Module significantly improved learners' achievement, as evidenced by the statistically significant differences between their pretest and posttest scores. These results indicate that both instructional approaches contributed positively to learners' understanding of the topic. Despite the significant improvement observed in both groups, learners who used the Self-Learning Module achieved significantly higher posttest performance than those who received instruction through the Traditional Learning Module. The higher mean rank obtained by the experimental group confirms that the developed Self-Learning Module was more effective in facilitating conceptual understanding and improving academic achievement. The learner-centered structure, organized presentation of concepts, and opportunities for self-paced learning likely contributed to the superior performance of the experimental group. The findings provide preliminary evidence that the developed Self-Learning Module is an effective instructional material for teaching Carbon Compounds among Grade 9 learners. Although the study was conducted as a pilot investigation with a limited number of participants, the results support the potential integration of well-designed Self-Learning Modules into Chemistry instruction as a complementary strategy to traditional teaching. Further validation through larger-scale studies is recommended to strengthen the generalizability of these findings.

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