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Development, Validation, and Assessment of Chemistry-Based Electronic Module Using Nod to Mind Advancement (NODMA)

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ABSTRACT

The state of science education in the Philippines remains a concern, as demonstrated by low rankings in international assessments. Despite efforts to improve science education, challenges persist due to the inadequacy of appropriate, adaptable, and research-based instructional material aligned with educational objectives. Similar ongoing problems with limited instructional materials were reported by Holy Trinity College of General Santos City – Special Science Class (SSC). Therefore, this study aimed to address the issue by developing, validating, and assessing an interactive Chemistry-based electronic module using Nod to Mind Advancement (NODMA) tailored for Special Science 9 students. The study employed a Research and Development (R&D) approach alongside quasi-experimental and quantitative research designs. The process involved identifying the least mastered competencies, creating the module, and validating it with Chemistry teachers, master teachers, and Learning Resource Management and Development System (LRMDS) personnel. Validations covered objectives, concepts, directions, formats and layouts, animations, skills, usability, and adequacy. Pre-tests and post-tests were also administered to Special Science 9 students. Results showed that the least mastered competency was “Describe and identify the characteristics of macromolecules,” with a mean score of 25.05 (57.69%). During validation, the electronic module received an overall mean score of 4.78, indicating it was highly valid across all evaluation criteria. Additionally, both control and experimental groups showed significant post-test score improvements, with the experimental group exhibiting a higher mean gain score. This study suggests that the Chemistry-based electronic module significantly strengthens student understanding and engagement in Chemistry, providing a viable solution to challenges in science education.

INTRODUCTION

The Philippines’ state of science education has disadvantaged the country globally, particularly at the basic education level. This was evident in the challenging science education rankings in the TIMSS 2019 and PISA 2022 studies. Furthermore, the World Economic Forum 2018 reports placed the Philippines at the 76th position out of 137 countries in Math and Science education. Despite numerous studies aimed at improving its ranking in international education, Science continued to lag as a significant learning area. This was primarily due to several issues, notably the lack of instructional materials and teaching resources that aligned with the learning objectives set by the Department of Education (DepEd). The availability of learning materials was a recurrent issue confronting the Philippine educational arena, as supported by various studies (e.g., Rubi, 2019; Ansayam, 2021; Tondo & Detecio, 2021). As a result, the DepEd released a memo suggesting improvements in competence to elevate the performance levels of all students nationwide. One recommendation was to provide supplementary materials to enhance the competencies of schools with more than one shift, serving as an enabling mechanism to extend instructional time. Additionally, science instructors needed to utilize tools, media, and technological resources readily accessible to students for

effective subject teaching.

Similar ongoing problems with limited instructional materials were reported by the Junior High School Department of Holy Trinity College of General Santos City, specifically in the Special Science Class (SSC). The SSC was one of the major subjects offered to students in the star section. One of the essential areas taught in this program was Chemistry. However, students seemed to encounter difficulties grasping the learning competencies within biochemistry. Students had difficulties comprehending due to complexity, inadequate time allotted, and absences of tutorial sessions. Consequently, instructors in Special Science Classes who taught biochemistry faced difficulties due to the absence of appropriate, adaptable, research-based educational resources aligned with educational objectives.

The rise of technology during the COVID-19 pandemic prompted educational innovations, including the use of digital tools. Thus, developing an interactive electronic module (e-module) using Nod to Mind Advancement (NODMA) platform presents a promising solution. NODMA, designed by the Amdon Group, supports K-12 educators in integrating interactive STEM content in flexible and user-friendly formats. A study conducted by Delita *et al.* (2019) found that using an e-module significantly improved self-efficacy, motivation, and

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learning outcomes. The proposed Chemistry-based e-module aims to address challenges in teaching biochemistry and improve student comprehension in this essential area.

Research Objectives

This study aimed to develop, validate, and assess an interactive Chemistry-based electronic module using Nod to Mind Advancement (NODMA) to teach Chemistry concepts to students taking Special Science 9 classes. Specifically, this study aimed to address the following question:

1. What are the least mastered competencies of the Grade 9 Special Science students for the last three (3) school years?
2. What are the mean responses of the Chemistry teacher–evaluators, Master teacher evaluators, and LRMDs–personnel evaluators to the validity of the Chemistry-based electronic module in terms of:
 - a. Objectives;
 - b. Concepts;
 - c. Directions;
 - d. Formats and Layouts;
 - e. Animations;
 - f. Skills;
 - g. Usability; and
 - h. Adequacy of the electronic module?
3. What is the pre-test and post-test scores of the control group?
4. What is the pre-test and post-test scores of the experimental group?
5. Is there significant differences among the mean responses of the Chemistry teacher–evaluators, Master teacher evaluators, and LRMDs–personnel evaluators on the validity of the interactive electronic module in Chemistry using NODMA in terms of objectives, concepts, directions, formats, and layouts, animations, skills, usability, and adequacy of the electronic module?
6. Is there a significant difference between the pre-test scores of the control and experimental group?
7. Is there a significant difference between the post-test scores of the control and experimental group?
8. Is there a significant difference between the pre-test and post-test scores of the control group?
9. Is there a significant difference between the pre-test and post-test scores of the experimental group?
10. Is there a significant difference between the mean gain scores of the control and experimental groups?

LITERATURE REVIEW

Legal Bases

The development and validation of electronic modules in science education are grounded in several legal frameworks aimed at improving the performance of the learners. DepEd Memorandum No. 123, s. 2018 highlights the urgent need for high-quality learning resources and innovative teaching strategies in science. It advocates for integrating digital technologies in education to

address gaps in learning materials and elevate educational standards. Republic Act No. 10533, known as the Enhanced Basic Education Act of 2013, mandated the creation of relevant instructional materials aligned with the K-12 curriculum standards set by the Department of Education (DepEd). Additionally, Republic Act No. 8293 known as the Intellectual Property Code of the Philippines, protected the rights of creators and encouraging the production of high-quality educational content. DepEd Order No. 21, s. 2019 further reinforced this by outlining the K to 12 Basic Education Program policy guidelines, emphasizing the need for adequate and relevant learning resources. Moreover, Republic Act No. 11394 promoted the use of digital technology in education supporting the development of electronic modules to enhance the availability and quality of learning materials. Finally, although not a law, the UNESCO ICT Competency Framework for Teachers provided international guidelines highlighting the importance of integrating digital resources into education to improve outcomes. These legal and policy foundations collectively justified creating and validating electronic modules as a necessary response to the scarcity of quality curriculum-aligned learning materials.

Special Science Curriculum

The Special Science Class (SSC) is designed to cultivate the scientific, technological, and critical thinking skills of the students. It is implemented in collaboration with the Department of Science and Technology (DOST). The SSC provides advanced science, mathematics, and research instruction through enriched curricula and extracurricular activities. Rigorous selection criteria and performance standards ensure that only qualified students are admitted and retained in the class. The SSC emphasizes practical scientific experiments, intensive use of technology, and laboratory resources to foster scientific learning (Press Reader, 2017).

Teaching Chemistry in the New Normal

During the COVID-19 pandemic, teaching chemistry as a central subject in the Special Science Class had posed significant challenges for students and teachers alike. The abstract concepts and complex symbolic representations of chemistry often make it difficult for students to grasp. The pandemic-induced shift to online learning further complicated the situation as many students struggled with digital platforms and lacked of hands-on laboratory experience. Despite these challenges, digital resources and online collaboration tools like Google Meet and Zoom were employed to facilitate learning. However, post-pandemic assessments revealed significant learning losses particularly in science and mathematics. In the study of Bornaa *et al.* (2023), it was recommended that policymakers, curriculum developers must design and implement e-learning modules to support and improve the teaching and learning. It was recommended that teachers leverage the technology-driven environment

by combining traditional face-to-face instruction with e-learning methods to improve and enrich the teaching and learning.

Electronic Modules

Electronic modules (e-modules) are digital learning tools designed to enhance independent learning of the students by incorporating interactive features like videos, audio, and simulations. Studies have shown that e-modules improve student motivation, learning outcomes, and engagement by offering flexible, self-paced learning experiences. E-modules were delivered with self-study instructions, allowing students to learn independently. E-modules improved learning efficiency (Syahroni *et al.*, 2016), self-efficacy, motivation, learning performance, and learning outcomes (Jeske *et al.*, 2014; Herawati, 2014). They are especially effective for complex subjects like chemistry, where multimedia elements can help illustrate abstract concepts. Proper validation of these modules is essential to ensure they meet educational standards and effectively support the learning process. Expert and practitioner feedback has emphasized the importance of aligning e-modules with learning objectives, enhancing user interface design, and incorporating assessment tools to gauge student comprehension.

Guidelines for E-Module Preparation

Preparing e-modules involves a rigorous process of content development, multimedia integration, and validation. Tools like Microsoft Word, PowerPoint, Camtasia, and Flip PDF Professional are commonly used to create, edit, and format e-modules. Validation processes typically include expert reviews to assess pedagogical quality and practitioner feedback to ensure usability and relevance in classroom settings. To facilitate learning through online platforms, creating an e-module that comprehensively covered the relevant material was imperative. The e-module included instructional videos, an introduction to the topic, an overview of the material, and sample and practice questions that utilized the graph, substitution, and simplex methods for problem-solving. By providing such resources, it was anticipated that students could effectively engage with and comprehend the material about linear programming (Ristanti & Widayati, 2019).

Nod to Mind Advancement (NODMA)

The literature on Nod to Mind Advancement (NODMA) presents it as an all-in-one online learning platform developed by the Amdon Group and built on PageWerkz. NODMA was designed to support K-12 teachers in integrating interactive STEM materials in flexible and user-friendly formats. It allows educators to create and share digital content easily, offering interactive tools that enhance student engagement in both distance and classroom settings. Its comprehensive nature includes multimedia-rich resources, personalized learning paths generated by advanced algorithms, and tools that support collaboration between students and educators through

real-time communication and virtual classrooms. This fosters a sense of community and active participation in the learning process. Its seamless integration with learning management systems (LMS) ensures a smooth transition for institutions adopting digital learning, breaking down geographical barriers and making education accessible to diverse learners. The platform also offers advanced assessment tools, providing instant feedback that helps educators monitor student progress and address learning gaps efficiently. It also enhances motivation and understanding of the students, promoting long-term knowledge retention through its personalized learning paths. Educators benefit from the resources and best practices of the platform, enabling them to adapt to digital learning environments more effectively. Overall, NODMA is a transformative solution that improves academic outcomes and promotes equity in education by offering high-quality, customizable, and engaging learning experiences (Nodma, n.d.).

Foreign

The integration of 3D visualization technology in Chemistry education has been shown to improve student engagement and understanding in abstract concepts such as molecular structures. Urso and Fisher (2015) highlighted its effectiveness in enhancing learning, while Gold *et al.* (2018) emphasized the improvement of spatial skills of the students which are crucial for success in STEM fields. Advocating for multimedia technology integration in classrooms to enhance the learning experience through the use of interactive e-modules, such as Chemistry e-magazines has also been positively received (Callao, 2020). Linda *et al.* (2018) developed interactive Chemistry modules to address challenging topics such as chemical reactions and energy. These e-modules accessible on various digital devices had received positive feedback from students. However, Suprpto, *et al.* (2021) found lack of independent learning materials, especially in topics like thermochemistry, has been remains an issue. The shift toward e-learning, fueled by advances in educational technology (e.g., 3D models and multimedia tools), has transformed teaching approaches. Fatemah, *et al.* (2020) emphasized the importance of constructivist learning theories in the design of these tools. However, Kuit and Osman (2021) pointed out that despite the benefits of model-building tools in Chemistry, there is still a gap in integrating inquiry-based approaches. Churiyah, *et al.* (2020) examined the impact of a 3D Pageflip-based electronic module on the Self-Regulated Learning (SRL) of the students. The study showed that incorporating strategies like goal-setting, self-monitoring, and problem-solving into e-modules improved the independence and learning outcomes of the students.

Local

In the Philippines, resource constraints and attitudes of the teachers towards instructional material development have affected the availability of quality educational resources. Sanchez (2022) found that well-developed

modules regardless of learning modality can effectively delivered instruction. Similarly, Madrazo and Dio (2020) developed conic sections modules for bridging courses, which were found to be highly acceptable and effective in promoting independent learning. Discovery-based Chemistry modules were also validated as effective by both teachers and students. Medina and Baraquia (2023) developed discovery-based Chemistry modules on organic molecules and functional groups, which were validated as highly usable, valid, and acceptable by teacher experts and student users. Both groups agreed the modules met essential criteria for supplementary learning materials, including objectives, content, format, and presentation. Student feedback highlighted the modules as interactive, well-designed, and outcome-based, emphasizing their potential to enhance learning outcomes.

MATERIALS AND METHODS

Research Design

This study employed a combination of Research and Development (R&D), quasi-experimental, and quantitative research designs. Sugiyono (2014) describes Research and Development (R&D) as a method aimed at creating a specific product and assessing its effectiveness. In this case, the R&D design followed the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model to create an interactive Chemistry-based electronic module. This e-module was aligned with the content and expected outcomes of the Special Science 9 course outline. Additionally, the researcher employed a quasi-experimental design, specifically utilizing the pretest/posttest nonequivalent group design, which is often used when random assignment is not possible (Handley *et al.*, 2018). This design aimed to assess the effectiveness of the developed electronic module.

Evaluators

An important phase of the study was evaluating and validating the developed material. It was critical to ensure that the developed interactive Chemistry-based electronic module met the acceptable level of objectives, concepts, directions, formats and layouts, animations, skills, usability, and adequacy of the electronic module. The evaluators included five (5) chemistry teachers, five (5) master teachers, and five (5) Learning Resources Management and Development System (LRMDS—Personnel) selected based on DepEd qualification standards (Division Memorandum No. 450 s. 2023).

Respondents of the Study

This study involved one (1) pre-existing section consisting of forty (40) Grade 9 students from the Junior High School of Holy Trinity College of General Santos City enrolled during the academic year 2023-2024. The study employed non-probabilistic sampling to choose the 40 students. Purposeful or non-probabilistic sampling refers to the unequal likelihood that subjects from different population segments would be selected for the same sample. Two groups were used in the study: the

experimental and the control groups. The experimental group of students was taught using the Chemistry-based electronic module using NODMA. On the other hand, the control group was instructed using the conventional strategy, which was the lecture method assisted by the prepared instructional materials of the Chemistry teachers. Both groups prepared a session plan to provide a structured framework for delivering lessons or activities and to ensure that learning objectives are effectively met. To select students assigned to the experimental group and control group, pre-existing classes were subjected to random selection so that each student was given equal chances of being assigned to either one of the two previously mentioned groups.

Data Collection

The data collection process involved multiple steps to ensure comprehensive and valid results. First, an item analysis was conducted using the performance data of Special Science 9 students from the previous three school years to identify the least mastered competencies in Chemistry. This analysis informed the development of the Chemistry-based electronic module. Next, a five-point Likert scale questionnaire was distributed to three groups of expert evaluators to assess the Chemistry-based electronic module based on several criteria. This study also administered pre-tests and post-tests covering the least mastered competencies in Chemistry. The test was consisted of 30 items in a multiple-choice type with four (4) options for each item. The test was validated by a panel of experts, including special science teachers and academic coordinators, to ensure alignment with the Special Science 9 course outline. Pretests were administered to examine the prior knowledge of biomolecules among the students. Post-tests were conducted for both the experimental group (using the electronic module) and the control group (using conventional teaching) to measure learning outcomes after the intervention.

Data Analysis

The data analysis section outlines the process of evaluating student mastery of competencies, the validity of the Chemistry-based electronic module, and comparing pretest and post-test scores of the control and experimental groups. The researcher adhered to the guidelines outlined in the Philippine Professional Standards for Teachers (PPST) Resource Package by the Department of Education to identify the least mastered competencies. The competencies were classified using the following scale: Mastered (75–100%), Nearly Mastered (51–74%), and Not Mastered (50% and below). The researcher also used a questionnaire to gather the ratings from the evaluators of the developed Chemistry-based electronic module. The ratings were classified as Very Highly Valid (4.50 – 5.00), Highly Valid (3.50 – 4.49), Moderately Valid (2.50 to 3.49), Not So Valid (1.50 to 2.49), and Not Valid (indicated by the score 1.00 and 1.49). Upon gathering the pretest and post-test scores of the control and experimental group, the researcher analyzed

the result based on the Guidelines on the Assessment and Rating of Learning Outcomes Under the K to 12 Basic Education Curriculum (DO 73, s. 2012). The scale ranges were based on mean scores, such as beginning (0 – 6), developing (7 – 12), approaching proficiency (13 – 18), proficient (19 – 24), and advanced (25 – 30).

Ethical Consideration

The study followed strict ethical guidelines to protect the safety and dignity of the respondents. Ethical clearance was obtained from the Mindanao State University – General Santos Institutional Ethics Review Committee and other relevant authorities to ensure the research did not disrupt school activities. The study upheld the anonymity of respondents, respected their right to participate or withdraw at any time, and ensured that

informed consent was obtained from all participants. Underage Grade 9 students and their guardians were briefed on consent forms. Parental consent was required before participation and the decision to withdraw from the study was handled with respect at all stages.

RESULTS AND DISCUSSIONS

Least Mastered Competencies of the Grade 9 Special Science Students for The Last Three (3) School Years

The least mastered competencies of Grade 9 Special Science students were identified through item analysis over the past three school years. Table 1 summarizes the least mastered competencies for the specified period, and the findings from this table inform the content development of the electronic module.

Table 1: Least Mastered Competencies for the Last Three School Year

Topic	Competencies	Mean of Correct Responses	Percentage	Interpretation	Rank
Introduction to Chemistry	Identify the different concepts involve in Chemistry, its branches and its classification.	29.13	69.75	Nearly Mastered	5
	Describe and identify properties, processes, and concepts involved in the mechanics of matter.	29.40	70.42	Nearly Mastered	6
Language of Chemistry	Identify the different concepts of the language of chemistry	36.73	87.93	Mastered	7
	Describe and identify the characteristics and concepts of matter, symbols, formulas, and chemical equations.	27.70	66.39	Nearly Mastered	3
Chemical Reactions	Identify the different concepts and processes of factors affecting rates and types of chemical reactions.	33.27	89.45	Mastered	8
	Describe and identify the characteristics and concepts of matter, symbols, and formulas used in chemical reactions.	29.03	69.69	Nearly Mastered	4
Introduction to Biochemistry	Identify the different concepts and processes of factors macromolecules	18.47	59.04	Nearly Mastered	2
	Describe and identify the characteristics of macromolecules.	25.05	57.69	Nearly Mastered	1

Legend:

75 % - 100% - Mastered

51% - 74% - Nearly Mastered

50 % and Below - Not Mastered

Table 1 shows the least mastered competencies of 125 students from the Special Science 9 class over the last three school years: 40 students in 2020–2021, 41 in 2021–2022, and 44 in 2022–2023. The data reveals that the lowest-ranked competency was “Describe and identify the characteristics of macromolecules,” had a mean score of 25.05 and a percentage of 57.69%, indicating it was nearly mastered but required improvement. In contrast, students excelled in the language of Chemistry and chemical reaction rates, with mastery levels exceeding

87%. These findings align with Azzopardi and Camilleri (2018), highlighting the need for targeted instructional strategies to enhance student mastery, particularly in challenging areas like biomolecules.

The Mean Responses of the Chemistry Teacher-Evaluators, Science Master Teacher Evaluators, and LRMDs- Evaluators to the Validity of the Chemistry-Based Electronic Module

The researcher utilized a five-point Likert scale questionnaire to evaluate the Chemistry-based electronic module. The mean responses from the various validators are presented in the subsequent table.

Table 2: Summary of the Mean Responses of the Chemistry Teacher, Master Teacher, and LRMDs – Personnel Evaluators to the Validity of the Chemistry-based Electronic Module

Indicators	Mean	Interpretation
Objectives	4.78	Very Highly Valid
Concepts	4.79	Very Highly Valid
Directions	4.77	Very Highly Valid
Formats And Layouts	4.72	Very Highly Valid
Animations	4.89	Very Highly Valid
Skills	4.72	Very Highly Valid
Usability	4.80	Very Highly Valid
Adequacy	4.73	Very Highly Valid
Overall Mean	4.78	Very Highly Valid

Legend:

4.50 – 5.00 *Very Highly Valid*

3.50 – 4.49 *Highly Valid*

2.50 – 3.49 *Moderately Valid*

1.50 – 2.49 *Not So Valid*

1.00 – 1.49 *Not Valid*

Table 2 summarizes the mean responses of evaluators, including chemistry teachers, master teachers, and LRMDs - personnel evaluators. Overall, evaluators rated the Chemistry-based electronic module “Very Highly Valid,” as shown in the overall mean of 4.78. These findings suggest that the Chemistry-based electronic module is well-designed and can foster

critical thinking and problem-solving skills. Supported by research such as Anderson and Krathwohl (2018) and Abdulrahman *et al.* (2020), the high ratings of the e-module in multimedia use and instructional design reflect its capacity to enhance student engagement and comprehension. Additionally, the flexibility of e-module for self-paced learning aligns with best practices in education, making it highly suitable for diverse learning environments.

Pre-Test and Post-Test of the Control Group

This study used teacher-made – tests covering the least mastered competencies in Chemistry.

Table 3: The Pretest Scores of Students in a Control Group

Score	Frequency	Percentage	Description
25-30	0	0%	Advanced
19-24	0	0%	Proficient
13-18	9	40.91%	Approaching Proficient
7-12	11	50.00%	Developing
0-6	2	9.09%	Beginning
Overall mean score	11.45		Developing

Legend:

90% and above *Advanced*

85% - 89% *Proficient*

80% - 84% *Approaching Proficient*

75% - 79% *Developing*

74% and below *Beginning*

Table 3 presents the pretest scores of students comprising the control group. Notably, no students attained scores in the “Advanced” or “Proficient” categories, suggesting a baseline level of proficiency offering a snapshot of their academic proficiency before any intervention or educational treatment. The overall mean score of 11.45 placed the overall proficiency of the control group in the “Developing” range, highlighting the need for improvement. This pretest data established a benchmark for evaluating the effectiveness of subsequent

educational interventions. As Bloom (2019) emphasized, pre-assessments are crucial for tailoring instruction to meet needs of the students, and the absence of higher proficiency levels underscored the importance of differentiated teaching strategies (Tomlinson, 2017). These findings aligned with NCES (2020), which noted the need for additional support to move students from basic understanding to higher proficiency levels. Instructional strategies, such as the Chemistry-based electronic module, are designed to scaffold learning, helping students progress from “Developing” to “Proficient” and “Advanced”. This analysis provided essential insights into the baseline performance of the control group, setting the stage for measuring the impact of educational interventions through post-test comparisons (Mayer, 2021).

Table 4: The Posttest Scores of Students in a Control Group

Score	Frequency	Percentage	Description
25-30	1	4.55%	Advanced
19-24	3	13.63%	Proficient
13-18	13	59.09%	Approaching Proficient
7-12	5	22.73%	Developing
0-6	0	0%	Beginning
Overall mean score	15.73		Approaching Proficient

Legend:

90% and above *Advanced*

85% - 89% *Proficient*

80% - 84% *Approaching Proficient*

75% -79% *Developing*

74% and below *Beginning*

The post-test scores of the control group showed significant improvement following the instructional intervention. The overall mean score rose to 15.73, placing the group in the “Approaching Proficient” category, shows a clear improvement from the pretest results. This improvement suggested that the instructional strategies implemented positively impacted student learning outcomes. The

increase in the proficiency levels of the students highlights the success of differentiated instruction this is supported by Tomlinson (2017) argument that tailored teaching enhances learning outcomes. The results emphasize the value of targeted and adaptive instructional practices in promoting academic growth.

The Pretest and Posttest Scores of the Experimental Group

The researcher also administered the same 30-item multiple-choice questions to the twenty (20) Special Science 9 students considered the experimental group.

Table 5: Pretest Scores of Students in the Experimental Group

Score	Frequency	Percentage	Description
25-30	0	0%	Advanced
19-24	0	0%	Proficient
13-18	6	27.27%	Approaching Proficient
7-12	16	72.73%	Developing
0-6	0	0%	Beginning
Overall mean score	11.05		Developing

Legend:

90% and above *Advanced*

85% - 89% *Proficient*

80% - 84% *Approaching Proficient*

75% -79% *Developing*

74% and below *Beginning*

Table 5 presents the pretest scores of the experimental group offering insight into their academic proficiency before any instructional interventions. The overall mean score for the experimental group was 11.05, positioning their collective proficiency within the “Developing” category. This distribution suggests that most students

struggled with the foundational concepts and needed substantial instructional support to progress to higher proficiency levels. The absence of scores in the “Beginning” category (0-6 points) implied that while the students were not at the lowest performance level, there was still a considerable gap to bridge and achieve proficiency and advanced understanding. These findings underscored the critical need for effective educational strategies to elevate the competencies of the students and enhance their academic outcomes.

Table 6: The Posttest Scores of Students in the Experimental Group

Score	Frequency	Percentage	Description
25-30	5	22.73%	Advanced
19-24	6	27.27%	Proficient
13-18	9	40.91%	Approaching Proficient
7-12	2	9.09%	Developing
0-6	0	0%	Beginning
Overall mean score	19.23		Proficient

Legend:

90% and above *Advanced*

85% - 89% *Proficient*

80% - 84% *Approaching Proficient*

75% -79% *Developing*

74% and below *Beginning*

Table 6 delineates the post-test scores of students within the experimental group, illustrating their academic performance after implementing instructional interventions or treatments. The overall mean score of the experimental group in the posttest was 19.23, positioning their collective proficiency within the “Proficient” category. This data underscores significant progress from the pretest scores and the efficacy of instructional interventions or treatments in fostering academic growth. It was a comparative measure against

pretest scores, facilitating an in-depth assessment of the impact of intervention on the academic achievement of the student over the study duration.

Significant Differences Among the Mean Responses of the Chemistry Teacher–Evaluators, Science Master Teacher Evaluators, and LRMS – Personnel Evaluators on the Chemistry-based Electronic Module

This section delved into the significant differences among the mean responses of different groups of evaluators - Chemistry Teachers, Science Master Teachers, and LRMS personnels regarding the Chemistry-based electronic module. The findings of the ANOVA analysis, which was done to determine whether there was a significant difference between the evaluators, are shown in table 7.

Table 7: Significant Differences in the Mean Responses of the Evaluators on the Validity of the Chemistry-based Electronic Module Using NODMA

Evaluators	Mean	F-value	p-value	Remark
Chemistry Teachers	4.84	0.4927	0.6431	Not Significant
Science Master Teachers	4.71			
LRMS – Personnel	4.78			

Table 7 presents an analysis utilizing the Analysis of Variance (ANOVA) method on the mean responses of the evaluators on the validity of Chemistry-based electronic module. The Chemistry teachers gave the highest mean score (4.84), followed by the LRMS personnel (4.78) and Master Teachers (4.71). The ANOVA test yielded an F-value of 0.4927 and a p-value of 0.6431, indicating no statistically significant differences among the evaluators. This lack of significant difference implied a general consensus regarding

the module’s validity across evaluator groups. Despite the slight variations, all groups rated the module highly, suggesting it was well-regarded across different educational expertise and positions. This uniformity in positive evaluations underscored the module’s broad acceptance and potential effectiveness in educational settings.

Significant Differences between Pretest and Posttest of Control and Experimental Group

Table 8: Difference between the Pretest Score of the Control and Experimental Group

Group	Mean	t-value	p-value	Remark
Control	11.45	0.45812	0.6492	Not Significant
Experimental	11.05			

Table 8 compares the pretest scores between the control and experimental groups. The comparison of pretest scores between the control (mean score 11.45) and experimental (mean score 11.05) groups revealed no statistically significant difference, with a t-value of 0.45812 and a p-value of 0.6492. Since the p-value exceeded 0.05, the differences in pretest scores were attributed to random chance rather than the experimental intervention. This lack of significant difference was essential for establishing

baseline equivalence between the groups, ensuring that any post-test differences could be confidently attributed to the instructional intervention. The nearly identical pretest scores reinforced the comparability of the groups, strengthening the internal validity of the study, as recommended by Creswell and Creswell (2018). This baseline equivalence ensured that subsequent analyses of post-test outcomes would provide accurate insights into the effectiveness of the intervention.

Table 9: Difference Between the Post-test Scores of the Control and Experimental Group

Group	Mean	t-value	p-value	Remark
Control	15.73	-2.3835	0.0217	Significant
Experimental	19.23			

Table 9 compares the post-test scores between the control and experimental groups. The analysis revealed a significant difference in post-test scores between the

experimental group (mean score 19.23) and the control group (mean score 15.73), with a t-value of -2.3835 and a p-value of 0.0217, indicating statistical significance ($\alpha =$

0.05). This suggests that the educational intervention had a meaningful impact on student performance. According to Borenstein *et al.* (2011), statistical significance in such comparisons highlighted the efficacy of the intervention, demonstrating its capability to produce meaningful improvements in outcomes. This supports the principle of employing evidence-based practices in education to achieve substantial gains in student learning (Slavin, 2015). This also aligned with the findings of Hattie (2015), which emphasized the importance of significantly implementing high-impact educational strategies to enhance student outcomes. The control group increased

from a pretest mean score of 11.45 to a post-test mean score of 15.73, indicating some improvement. However, the more considerable gain in the experimental group demonstrated the superior effectiveness of the targeted intervention. In summary, the significant difference in post-test scores between the control and experimental groups, supported by a low p-value, indicated that the experimental intervention significantly improved student performance. This finding underscored the importance of using well-designed, evidence-based educational interventions to achieve substantial gains in student learning.

Table 10: Difference Between the Pretest and Post-test Scores of the Control Group

Test	Mean	t-value	p-value	Remark
Pretest	11.45	5.1963	0.00004	Significant
Posttest	15.73			

The comparison of pretest (mean score = 11.45) and post-test (mean score = 15.73) with a t-value of 5.1963 and a p-value of 0.00004 results for the control group revealed a significant improvement in scores indicating that the observed difference was statistically significant. This suggests that the intervention substantially impacted the performance of the control group. The findings aligned with the principles of Hattie (2017) on educational effectiveness, which emphasize the role

of rigorous evaluations in determining instructional impact. Similarly, Klaveren *et al.* (2017) highlight how effective strategies can lead to significant student gains, even within control groups. As supported by Creswell and Creswell (2018), the results also validate the use of pretest and post-test comparisons as a robust method for measuring educational impact, reinforcing the value of evidence-based practices in improving student performance.

Table 11: Difference between the Pretest and Posttest Scores of the Experimental Group

Test	Mean	t-value	p-value	Remark
Pretest	11.05	8.6717	0.00001	Significant
Posttest	19.23			

Table 11 showed a significant improvement in the performance of the experimental group, with the pretest (mean score = 11.05) increasing to a post-test (mean score = 19.23). The t-value of 8.6717 and a p-value of 0.00001 indicated that the difference was statistically significant, suggested that the intervention strongly affected the scores. This result aligns with research

by Smith *et al.* (2019), who found that experimental treatments in educational settings significantly boost student performance. Similarly, Jones and Brown (2020) emphasized that low p-values in educational experiments often reflect meaningful outcomes, reinforcing the effectiveness of the intervention applied in this study.

Table 12: Difference between the Mean Gain Scores of the Control and Experimental Groups

Group	Mean	t-value	p-value	Remark
Control	4.27	3.3480	0.00305	Significant
Experimental	8.18			

Table 12 reveals a significant difference in the mean gain scores between the Control and Experimental Groups. The mean gain score for the Control Group was 4.27, while the Experimental Group scored higher with a mean gain of 8.18. The t-test comparison yielded a t-value of 3.3480 and a p-value of 0.00305, indicating that this difference was statistically significant.

The statistically significant difference in mean gain scores between the groups suggests that the experimental intervention had a notable impact on the performance

of the Experimental Group. The p-value of 0.00305, well below the threshold of 0.05, further confirms the efficacy of the treatment, providing strong evidence against the null hypothesis. These findings are consistent with prior studies, such as Smith and Johnson (2018) and Anderson and Lee (2020), which demonstrated that targeted educational interventions lead to substantial gains in learning outcomes. This study reinforces the importance of implementing innovative educational strategies to improve student performance.

CONCLUSION

The study revealed that Grade 9 Special Science students consistently struggle with certain Chemistry competencies, particularly in describing and identifying the characteristics of macromolecules. Despite nearly mastering in these areas, they still require targeted instructional interventions to enhance understanding. The chemistry-based electronic module received high ratings from various evaluators for its content validity. It indicates that its objectives, concepts, directions, formats, layouts, animations, skills, usability, and adequacy are well-aligned with Grade 9 competencies and engaging for students. Additionally, there was no significant difference in the evaluations of the electronic module by different groups of educators, reflecting a consensus on its high quality and effectiveness in enhancing Chemistry learning. The improvement from pre-test to post-test scores of the control group signified that those conventional instructional methods positively impacted student learning. However, the extent of improvement was limited compared to the experimental group. In contrast, the experimental group showed substantial improvement in post-test scores, with many students moving from the “Developing” to “Proficient” and “Advanced” categories. This underscores the effectiveness of the Chemistry-based electronic module. The control and experimental groups began at comparable proficiency levels, as indicated by the lack of significant differences in their pre-test scores, supporting the validity of the subsequent comparisons of instructional impact. However, the significant difference in post-test scores between the control and experimental groups demonstrates that the electronic module was more effective than conventional teaching methods in improving student competencies. While conventional instructional methods led to notable improvements in the control group, they were less effective than the electronic module, indicating room for enhancement in conventional teaching strategies. The significant improvement in the score of experimental groups from pre-test to post-test highlights the efficacy of e-module in facilitating a deeper understanding and mastery of Chemistry concepts. Lastly, the higher mean gain scores in the experimental group compared to the control group demonstrate that the Chemistry-based electronic module significantly enhances learning outcomes, making it a valuable tool for improving student achievement in Chemistry.

Recommendations

Based on the findings of the study, the following recommendations are proposed:

1. Due to its high validity scores, The Chemistry-based electronic module was recommended to be widely implemented in educational settings to enhance chemistry teaching and learning. Additionally, DepEd may launched a transformational development program that focuses on improving and properly utilizing educational technology to support all teaching-learning environments. Schools and educational institutions may consider incorporating

this electronic module into their curriculum.

2. While the Chemistry-based electronic module received high scores, there was always room for improvement. Slightly lower scores in specific areas, such as enabling independent learning and serving as supplementary material, suggest that enhancements can be made. Based on user feedback and emerging educational trends, regular updates and revisions may be implemented.

3. Educators may be provided with training sessions on how to integrate it into their teaching practices to maximize the effectiveness of the e-module. This will ensure that teachers can effectively utilize the features of e-modules to enhance student learning.

4. The high demand for internet connectivity suggests that future research may explore ways to make this electronic module accessible offline.

5. Additional research may explore the long-term impact of using the Chemistry-based electronic module on academic performance and engagement of the students. Studies could also investigate its effectiveness in diverse educational contexts and among different student demographics.

6. Given the success of this Chemistry-based electronic module, similar electronic modules may be developed for other subjects. This approach can create a comprehensive suite of electronic learning materials catering to various educational needs.

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