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Instructional Modules for Constructivist Environmental Learning in Science, Technology and Society (STS) Subject

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ABSTRACT

Modules enable students to engage with content at their own pace, fostering autonomy and deeper understanding. The modular approach ensures clarity in presenting objectives, instructions, and concepts, while having illustrations, activities, and assessments could enhance comprehension and retention. This paper was a developmental study on STS module for college students using the ADDIE Model (Analysis, Design, Development, Implementation, and Evaluation). Sampled 673 first-year students from Northwest Samar State University participated in the study, with 299 participating in a test try-out and 374 in the students' performance evaluation. Three expert evaluators with backgrounds in science, English, and psychology, each with over four years of experience, assessed the modules to ensure alignment with the study's constructivist learning goals and instructional integrity. The findings revealed that both students and experts had rated the instructional module positively, indicating its effectiveness in facilitating learning and completing lessons. Key aspects such as the style of illustrations and written expressions, the usefulness of learning activities, and the guidance provided by illustrations and captions were especially well-received. The module was praised for its clear objectives, understandable instructions, and engaging tasks like trivia and puzzles. Expert evaluations highlighted relevance, simplicity, and balanced emphasis on topics in the module content. Furthermore, students in test group demonstrated significant improvement in performance, with post-test scores notably higher than pre-test scores, confirming the module's effectiveness in enhancing learning outcomes. Consequently, this paper provides an opportunity to integrate science learning with initiatives aimed at promoting environmental preservation and driving social change.

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1. Introduction

Education is a dynamic process that allows students to gain information through experiences, reflection on their learning path, and interaction with their surroundings. It serves as the cornerstone upon which societies develop and flourish, paving the way for better futures for both people and communities. However, there are frequently holes in this complex educational framework that could limit its capacity to transform[1]. Instructional materials have a crucial role in promoting students' critical thinking and comprehension in the context of higher education, especially in Science, Technology, and Society (STS) courses. Innovative evaluation techniques that complement these new learning modalities must be implemented in light of the present demand for distance learning skills[2].

Meaningful learning, according to constructivist learning theories, happens when students actively engage in the educational process and build knowledge by introspection and imaginative inquiry. Learner-centered approaches are given priority in constructivist approaches, which allow students to expand on their prior knowledge by incorporating new experiences into interactive learning activities[3]. According to[4, 5], this pedagogical approach emphasizes the vital role that instructional modules play in facilitating comprehension through useful and contextually relevant applications, rather than only serving as knowledge stores. Collaborative learning spaces are essential in this dynamic educational setting because they allow students and teachers to engage in a shared investigative process, which enhances the learning process[6, 7].

Student autonomy and intrinsic motivation are key to successful learning. Theories like Moore's and Knowles' emphasize student control over their education[8]. Giving students this autonomy boosts motivation and develops crucial problem-solving and decision-making skills. This research explores how instructional modules can support self-directed learning, letting students personalize their education to meet their goals[9, 10]. This approach fosters independence and responsibility, aligning personal ambitions with academic success.

Vygotsky's Zone of Proximal Development (ZPD) highlights the importance of teaching materials that offer both challenge and support, effectively bridging learning gaps[11]. This is crucial for Science, Technology, and Society (STS) courses covering complex topics like climate change and renewable energy, which demand high-level thinking. Using structured activities and relevant examples in learning modules helps students progress from foundational knowledge to expertise, preventing overwhelm and fostering mastery of skills needed to tackle current issues[12, 13].

Grounded in these foundational psychological principles, this study seeks to develop validated instructional modules tailored to the needs of Filipino students in higher education. By emphasizing constructivist approaches, self-directed learning, and the application of the ZPD framework, the proposed modules aim to close existing educational gaps in STS topics. These tools are designed to not only enhance students' academic performance but also cultivate environmental awareness, critical thinking, and the ability to apply knowledge meaningfully in real-world scenarios. This initiative ultimately aspires to contribute to a more equitable and impactful education system that prepares students for the demands of a rapidly evolving global society.

2. Literature Review

Instructional modules are powerful tools in modern education, designed to foster meaningful engagement between students and educational content while promoting experiential learning. Rooted in constructivist principles, these modules support active learning by enabling students to build knowledge through reflection and hands-on experiences[14]. Constructivist pedagogy emphasizes the significance of learner-centered strategies that integrate students' prior knowledge with new concepts, allowing for deeper comprehension of topics[15]. This approach directly corresponds to the goal of creating instructional modules that encourage meaningful interactions and facilitate real-world applications, equipping students to address the intricate chal-

lenges of Science, Technology, and Society[4].

A key factor in achieving success in learning is self-direction, as emphasized in Moore's Independent Learning Theory and Knowles' Self-Directed Learning Theory. Both of these frameworks emphasize the necessity of providing students with the appropriate tools and strategies to navigate their educational paths autonomously. Self-directed learning fosters independence, promotes critical thinking, and empowers students to effectively apply their knowledge without the need for constant supervision[16]. Instructional modules that integrate these concepts offer learners the chance to align their educational experiences with their personal goals, thus enhancing engagement and motivation[17]. Such autonomy-driven modules are particularly crucial in addressing the interdisciplinary challenges of STS education, where students benefit from a combination of individual accountability and collaborative exploration.

The Zone of Proximal Development, based on Vygotsky's theoretical framework, underscores the importance of instructional materials that help students progress beyond their current capabilities through guided assistance[18]. For STS courses, this means designing instructional modules with scaffolded learning activities that gradually build in complexity, enabling learners to master challenging concepts effectively[19]. Incorporating scaffolded tasks ensures that instructional content remains both demanding and achievable, fostering students' confidence and competence in addressing multifaceted topics such as climate change and renewable energy[20].

Instructional materials are most effective when they combine theoretical foundations with practical applications, allowing learners to connect abstract concepts with real-world contexts. Misbah et al.[21] argue that modules integrating interactive and practical examples enhance students' comprehension and engagement significantly. Modules exploring environmental issues, for instance, can include activities such as localized case studies, simulations, or community-based initiatives. These activities, grounded in constructivist principles, help students link academic content to tangible outcomes, deepening their understanding of STS-related challenges[22].

This includes organized processes that assist guarantee that the modules are in line with certain learning objectives and evaluate their impact on student performance, such as expert reviews and pre- and post-test assessments[23]. In the context of STS education, this entails ensuring that instructional modules follow CHED criteria while addressing contemporary environmental challenges in ways that foster critical thinking and problem-solving skills in students[24]. These validation processes are essential to preserving the caliber and adaptability of educational resources and making sure they continue to meet evolving needs in the classroom.

Instructional modules must address the diverse learning requirements of students by offering inclusive and flexible environments. Seo and Yi[25] emphasize the need for integrating multimedia tools, culturally relevant content, and adaptable learning strategies within modules. Aligning with the principles of constructivism, self-directed learning, and ZPD, these elements create a comprehensive and equitable educational experience. By tailoring modules to meet individual and collective needs, educators can not only prepare students for academic success but also equip them with the skills to address pressing environmental and societal challenges within STS courses[26].

3. Methods

3.1. Research Design

This study employed a developmental research design to create instructional modules addressing the CHED mandated and emerging environmental-related topics within the STS course. The research followed the ADDIE (Analysis, Design, Development, Implementation, Evaluation) Model as the guiding framework for the creation and refinement of the instructional modules[27]. This model ensured a systematic and structured approach to the development process.

The study incorporated constructivist principles, which emphasize the active construction of knowledge through meaningful interactions and hands-on experiences. Furthermore, the research integrated self-directed learning approaches[28], grounded in Independent Learning Theory and Knowles'[29] Self-Directed Learning Theory, which enable learners to take ownership of their learning and educational experiences. The modules also adhered to the Zone of Proximal Development (ZPD), ensuring that the content was appropriately scaffolded to help students bridge the gap from their current knowledge to more advanced competencies[30].

3.2. Sampling Process

Universal selection with Slovin's sampling was employed to sample student experiences and perspectives, which ensured a representative and substantial sample size for generalizability of the findings[31]. Selected 673 first-year students from Northwest Samar State University participated in the study during the Academic Year 2023–2024. There were 299 students participated in for test try-out while 374 students participated for pre-test and post-test and module evaluation.

Purposively, three knowledgeable assessors were chosen based on their backgrounds in psychology, education, and language. To verify that the modules fit the study's objectives of promoting constructivist learning, autonomy, and scaffolded progression, this multi-expertise approach made sure they were thoroughly evaluated from a variety of angles. These experts were chosen based on their educational qualifications and relevant experience, ensuring their capability to contribute to the development of a credible instructional module. The first evaluator was an expert in science with a Master of Arts in Education, Major in Science; the second was an English expert with a Master of Arts in Education, Major in English; and the third was a professional psychometrician with a Bachelor of Science in Psychology. The selected experts have been actively practicing in their respective fields for over 4 years.

3.3. Instrumentation

There were two measures used to gather the responses from the participants: the expert evaluation and student evaluation. In addition, the achievement test measured the A 5-point rating scale, adapted from[32], was used to assess the acceptability of the instructional module. The evaluation of the instructional module had five statements assessing each of the following aspects: Objectives, which were well-planned, relevant, and aligned with student needs; Content, designed with balance, precision, and illustrations to support learning; Format and Language, featuring organized layouts, clear symbols, and simple, comprehensible language; Presentation, characterized by logical sequencing, clarity, and engaging examples; and Usefulness, highlighting the module's practicality in enhancing students. thinking skills and serving as supplementary learning material.

The student evaluation, based on[32], consisted of 10 statements for each aspect: Content and Format. The Content section assessed students' understanding of lessons, appreciation of illustrations, and evaluation of exercises. The Format section evaluated the sequence, design, font clarity, emphasis on symbols, and the positioning of images and subsections.

The achievement test was used as a pre-test to assess students' baseline knowledge and as a post-test to measure learning after exposure to the instructional module. A 60-item test was developed and validated through item analysis. Experts evaluated the test based on relevance, clarity, and representativeness, requiring at least 75% inter-rater agreement to retain, revise, or remove items. The test retained 49 of 60 items (81.6%) after analysis.

3.4. Procedure

The study employed the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) Model as a guide for developing the instructional module and conducting data gathering. The data collection process was divided into four phases: planning, designing/developing, validation and try-out, and evaluation and finalization.

Phase 1 – Planning

The researcher reviewed relevant print and non-print materials to determine essential topics for inclusion in the module. Activities included selecting the instructional setting, estimating module production costs, and allocating the budget for printing. In order to identify important subjects including climate change, energy crises, and environmental management, the researcher examined CHED rules, institutional forms, and pertinent literature during the Analysis phase[33]. Based on constructivist ideas, this phase included localized examples and real-world applications to make the learning process interesting and relevant for the students[34].

Phase 2 – Designing/Developing

This phase involved structuring the modules through the following steps: determining the module design, specifying objectives and sub-topics, planning instructional activities, and preparing the achievement test to serve as pre- and post-tests. A table of specifications was developed to ensure the validity and reliability of the test items. The instructional modules were organized into sections such as "What's In," "What's

More," "What Can I Do," and "Assessment." These sections promoted self-directed learning by encouraging students to explore the content in a gradual and independent manner. **Figure 1** presents the final module developed for the STS subject.

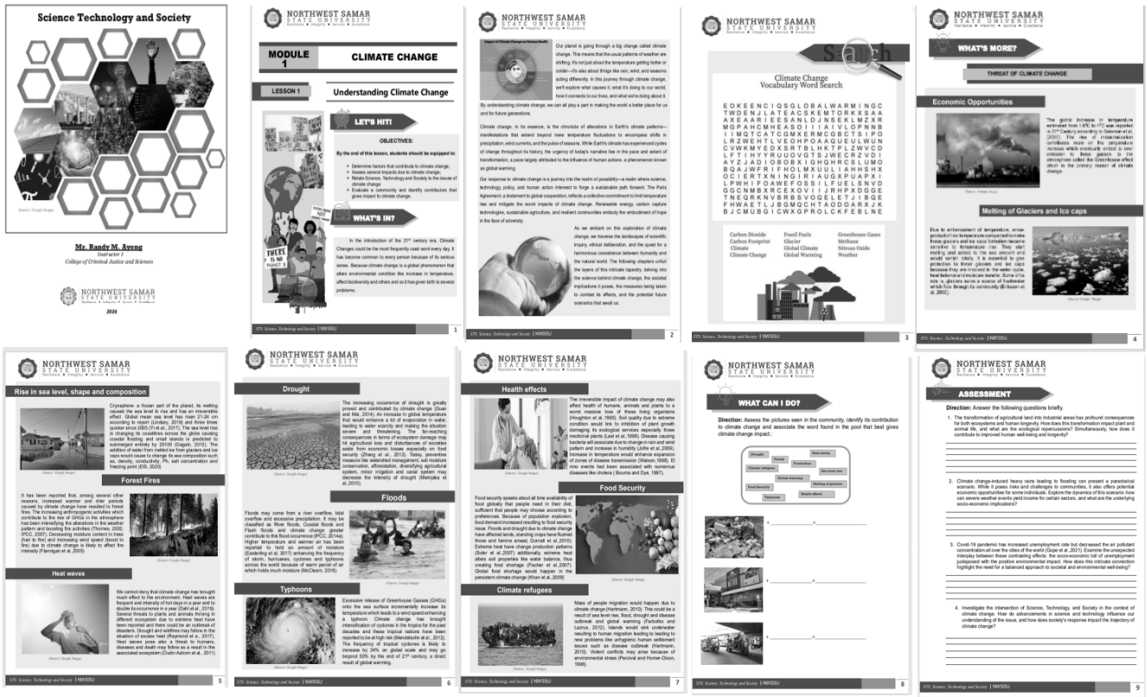

Figure 1. Compilation of final 10-page module for STS subject.

Phase 3 – Validation and Try-Out

The achievement test underwent expert validation and item analysis to ensure adequacy in measuring the intended constructs. The first draft of the instructional module was reviewed by the researcher's adviser, panel of examiners, and experts, and revisions were made based on their feedback. Experts evaluated the modules using five indicators: objectives, content, format and language, presentation, and usefulness. At least 75% inter-rater agreement was required for item acceptance [35]. A pre-test was administered to students, followed by a two-month module utilization period, after which the post-test was conducted with the same students.

In gathering the data, strict ethical research procedures were followed throughout the study to safeguard each participant's rights and welfare [36]. All participants gave their informed consent after being fully informed about the goals, possible risks, and advantages of the study [35]. All personal data was anonymised, and participant confidentiality was maintained. Furthermore, no content could be deemed offensive or discriminatory because the educational modules and tests were meticulously created to be inclusive and culturally sensitive [37]. The study complied with all established ethical norms, as confirmed by the institutional review boards' ethical approval [38].

Phase 4 – Evaluation and Finalization

In addition to expert evaluation, the instructional module was validated by student feedback and by comparing pre-test and post-test results. The module was finalized based on evaluation outcomes, reproduced, and distributed to the respondents. Permission was obtained from the school administrator, and the student-respondents were contacted for test administration. Data collected were subjected to statistical analysis for interpretation.

3.5. Data Processing

Jeffreys's Amazing Statistics Program (JASP) version 0.19.0.0. was used in the data analysis. Expert and student evaluations of the modules were compiled using descriptive statistics, such as frequency counts, means, and standard deviations [39]. A paired t-test was used to compare pre-test and

post-test scores in order to evaluate the modules' efficacy; statistical significance was determined at an alpha level of 0.05 [40]. Furthermore, the Intraclass Correlation Coefficient was used to measure the evaluations' dependability, guaranteeing validity and consistency in assessments from experts and students [24].

4. Results

According to students, the module was *very good* in helping them to study and complete lessons (Mean = 4.42; SD = 0.87). The highest-rated aspects were the style of illustrations and written expressions (Mean = 4.55; SD = 0.69), the usefulness of learning activities (Mean = 4.52; SD = 0.66), and the guidance provided by illustrations and captions (Mean = 4.54; SD = 0.70), all of which were rated *excellent*. Participants found the objectives, instructions, and concepts easy to understand, and enjoyed interactive tasks such as trivia and puzzles. **Table 1** presents the summary about how students evaluated the contents of the module.

In **Table 2**, the experts' evaluation of the content of the module revealed excellent ratings across all items. According to experts, the content of the module was highly effective and well-received by the experts (Mean = 4.87; SD = 0.352), with minimal variability in responses, as indicated by the low standard deviation. Notably, the content was found to be directly relevant to the defined objectives (Mean = 5.00; SD = 0.00), simple and easy to understand (Mean = 5.00; SD = 0.00), and each topic was given equal emphasis (Mean = 5.00; SD = 0.00). The topics were also fully discussed (Mean = 4.67; SD = 0.58) and supported by illustrative examples, with practice tasks appropriately suited to the students' level (Mean = 4.67; SD = 0.58).

Table 1. Students' evaluation on the contents of the module.

Content of the Module	Mean	Description	SD
1. I easily understood the objectives in each lesson.	4.41	Very Good	0.71
2. I easily understood the instructions in each lesson.	4.48	Very Good	0.69
3. I could work on the lessons at my own pace.	4.32	Very Good	0.70
4. I understood clearly the ideas/concepts in each lesson.	4.41	Very Good	0.70
5. The illustrations/captions guided me easily in following the instructions in the modules.	4.54	Excellent	0.70
6. The learning activities helped me to understand fully the topic.	4.52	Excellent	0.66
7. I appreciated the styles of illustrations and written expressions.	4.55	Excellent	0.69
8. I enjoyed answering the practice task as presented in the form of trivia or puzzles.	4.48	Very Good	0.72
9. I found it easier to study the topics using these instructional modules.	4.45	Very Good	0.77
10. I enjoyed working through the lessons until I finished the whole instructional modules.	4.50	Excellent	0.70
Composite	**4.42**	**Very Good**	**0.87**

Note: A 5-point rating scale was used with the following legend: 4.50–5.00 (Excellent), 3.50–4.49 (Very Good), 2.50–3.49 (Good), 1.50–2.49 (Fair), and 1.00–1.49 (Poor).

Table 2. Experts' evaluation on the contents of the module.

Content of the Module	Mean	Description	SD
1. The content of each lesson is directly relevant to the defined objectives.	5.00	Excellent	0.00
2. The content of each lesson is simple and easy to understand.	5.00	Excellent	0.00
3. The topics of each lesson are fully discussed.	4.67	Excellent	0.58
4. The topics are supported by illustrative examples, and the practice tasks are suited to the level of the students.	4.67	Excellent	0.58
5. Each topic is given equal emphasis in the lesson.	5.00	Excellent	0.00
Composite	**4.87**	**Excellent**	**0.352**

Note: A 5-point rating scale was used with the following legend: 4.50–5.00 (Excellent), 3.50–4.49 (Very Good), 2.50–3.49 (Good), 1.50–2.49 (Fair), and 1.00–1.49 (Poor).

In **Table 3**, findings indicate that students generally rated the format of the instructional modules positively (Mean = 4.50; SD = 0.83), suggesting that the module design was effective and well-received. The layout of the modules was found to be logically and sequentially organized (Mean = 4.58; SD = 0.60), and the instructions were well-emphasized (Mean = 4.54; SD = 0.68). The font size and style were readable (Mean = 4.61; SD = 0.62), and the symbols used were well-defined (Mean = 4.53; SD = 0.65). The tables and diagrams were presented clearly and were easy to understand (Mean = 4.43; SD = 0.76), while key points and concepts were highlighted effectively (Mean = 4.53; SD = 0.70). Titles and subtitles were clearly defined (Mean = 4.61; SD = 0.70), and illustrations, pictures, and captions were well laid out for easy reference (Mean = 4.52; SD = 0.69). The steps in the solutions were arranged sequentially and were easy to

follow (Mean = 4.54; SD = 0.67).

In **Table 4**, the experts evaluated the module as *excellent* (Mean = 4.87; SD = 0.35), suggesting a highly effective module in promoting student engagement and understanding. The format and language of the module were rated as excellent across all items, with the highest ratings (Mean = 5.00, SD = 0.00) given for the organization, ease of understanding, clarity, and motivation of the language used. The symbols used in the module were well-defined (Mean = 4.67, SD = 0.58), and the instructions were considered easy to follow and concise (Mean = 4.67, SD = 0.58), though slightly lower than the perfect ratings for the other aspects.

Table 3. Students' evaluation on the format of the module.

Format of the Modules	Mean	Description	SD
1. The layout of the instructional modules is arranged in a logical and sequential order.	4.58	Excellent	0.60
2. he instructions in the modules are well-emphasized.	4.54	Excellent	0.68
3. The font size and font style of the instructional modules are readable.	4.61	Excellent	0.62
4. The symbols used in the instructional modules are well-defined.	4.53	Excellent	0.65
5. The tables/diagrams are well presented and easy to understand.	4.43	Very Good	0.76
6. Key points and key concepts are well highlighted to focus attention while reading.	4.53	Excellent	0.70
7. Titles and subtitles in the instructional modules are clearly defined.	4.61	Excellent	0.70
8. Illustrations, pictures, and captions are properly laid out for easy reference.	4.52	Excellent	0.69
9. The steps in the solutions of the given examples and practice tasks are arranged sequentially and easy to follow.	4.54	Excellent	0.67
10. The instructional modules are generally formatted in a convenient manner considering the paper size used.	4.46	Very Good	0.76
Composite	**4.5**0	**Excellent**	**0.83**

Note: A 5-point rating scale was used with the following legend: 4.50–5.00 (Excellent), 3.50–4.49 (Very Good), 2.50–3.49 (Good), 1.50–2.49 (Fair), and 1.00–1.49 (Poor).

Table 4. Experts' evaluation on the format and presentation of the module.

Scale	Mean	Description	SD
Format and Language of the Module			
1. The format/layout is well-organized, which makes the lessons more interesting.	5.00	Excellent	0.00
2. The language used is easy to understand.	5.00	Excellent	0.00
3. The language used is clear, concise and motivating.	5.00	Excellent	0.00
4. The symbols used are well-defined.	4.67	Excellent	0.58
5. The instructions in the modules are concise and easy to follow.	4.67	Very Good	0.58
Composite	**4.87**	**Excellent**	**0.35**
Presentation of the Module			
1. The topics are presented in a logical and sequential order.	4.33	Very Good	0.58
2. The lessons of the modules are presented in a unique and original form.	4.67	Excellent	0.58
3. The learning activities are presented clearly.	4.33	Very Good	0.58
4. The presentation of each lesson is attractive and interesting to the students.	5.00	Excellent	0.00
5. Adequate examples are given to each topic.	4.00	Very Good	1.00
Composite	**4.47**	**Very Good**	**0.64**

Note: A 5-point rating scale was used with the following legend: 4.50–5.00 (Excellent), 3.50–4.49 (Very Good), 2.50–3.49 (Good), 1.50–2.49 (Fair), and 1.00–1.49 (Poor).

In addition, the experts evaluated the module as *very good* (Mean = 4.47; SD = 0.64), indicating that the module presentation to be mostly effective in engaging students. The topics were presented in a logical and sequential order (Mean = 4.33; SD = 0.58) and the learning activities were also presented clearly (Mean = 4.33; SD = 0.58). The lessons were considered unique and original in form (Mean = 4.67; SD = 0.58), and the presentation of each lesson was rated as highly attractive and interesting to students (Mean = 5.00; SD = 0.00). Adequate examples were provided for each topic, though this received a slightly lower rating (Mean = 4.00; SD = 1.00).

Students' Performance Using the Module

In **Table 5**, the post-test mean (Mean = 36.41; SD = 12.21) is higher than the pre-test mean (Mean = 30.11; SD = 9.82), suggesting that students performed better on the post-test. The positive difference indicates the STS module was effective in improving students' performance. Further, the analysis reveals a significant improvement in students' performance from the pre-test to the post-test, as the post-test mean was notably higher, and the difference was statistically significant ($p < 0.05$).

Table 5. Comparative analysis on students' performance.

Test	Mean	SD	t-Value	Df	Sig.
Pre-test	30.11	9.82	7.823	373	0.00 *
Post-Test	36.41	12.21			

Note: 4.50–5.00 (Excellent), 3.50–4.49 (Very Good), 2.50–3.49 (Good), 1.50–2.49 (Fair), and 1.00–1.49 (Poor).
* Significant at $\alpha = 0.05$.

5. Discussion

In the 21st century, evolving educational practices have equipped students with competencies to thrive in a competitive global economy. To meet these demands, the quality of education must be enhanced by transforming traditional learning paradigms[41]. Modern education emphasizes the acquisition of advanced skills and knowledge, particularly in science, mathematics, engineering, and technology, which are integral to globalization and its benefits. Teaching methods now prioritize active learning strategies, such as the use of instructional modules, to facilitate collaboration among educators, promote the application of innovative practices, and enhance student preparedness for global challenges[42].

However, teacher-centered instruction remains prevalent in Philippine schools, where many science teachers rely heavily on lectures due to limited pedagogical training and subject expertise[43]. This approach often avoids challenging, thought-provoking tasks, further reinforcing students' perception of science as dull and irrelevant[44]. The over-reliance on textbooks and the lack of connection between scientific concepts and real-world contexts diminish the subject's practical appeal[45]. With the ADDIE Model, a module was developed to teach STS in Northwest Samar State University focusing on major global concerns like climate change, food security, floods, and typhoons.

Modules function similarly to self-instructional learning bundles, allowing students to progress at their own pace based on their unique needs and abilities. A module is a distinct unit of subject matter, including either a single content element or a collection of related topics[46]. It serves as an instructional strategy aimed at the targeted development of specific skills and knowledge, operating as a nearly self-contained component within the broader training process[47]. Using ADDIE Model, the STS module supported learning and completing lessons. Its most praised features included the style of illustrations, clarity of written expressions, and the usefulness of learning activities.

Pulukadang[48] outlined three key stages in the module preparation process. The first stage involves identifying suitable learning methodologies and media, considering the competencies to be developed, student characteristics, and the context in which the module will be utilized. The second stage focuses on producing the physical module, which includes defining learning objectives, addressing learners' needs, and integrating content, activities, and supplementary materials. The final stage is the development of assessment tools to evaluate competencies—knowledge, skills, and attitudes—based on established criteria. Using the STS module, students found the objectives, instructions, and concepts easy to understand and appreciated the inclusion of interactive elements like trivia and puzzles. Similarly, experts believed that the module's format and language had clarity, organization, and motivational impact, which helped in promoting student engagement and understanding.

Early studies indicated that modules, both traditional and electronic, improve students' problem-solving skills[45, 49] and increase academic performance[50]. For example, Malik et al.[45] developed e-modules using the ADDIE Model to develop students' problem-solving skills in the impulse-momentum. Their module received an average feasibility rating of 80%, with learning activities scoring 84%, categorized as very good. Problem-solving skills improved by 0.64, and hypothesis testing revealed significant differences in problem-solving skills after the modules' implementation. The STS module employed the ADDIE Model to structure learning opportunities for college students. The results demonstrated that students achieved notable improvement after the use of STS module, as reflected in their post-test performance (*Mean = 36.41; p = 0.00*). Both students and experts evaluated the module as very good to excellent, highlighting its effectiveness in developing engagement and promoting active learning. The module not only aligns with modern pedagogical standards but also enhances learning outcomes by integrating interactive and contextually relevant content. Such findings suggest that the STS module can

be a valuable tool for improving student performance and providing a holistic learning experience.

The incorporation of environmental education and sustainability principles within the Philippine science curriculum has been inadequate[44]. Maimad[51] expressed the necessity of embedding Education for Sustainable Development (ESD) across the science curriculum, especially in fields such as environmental studies and disaster risk management. This deficiency in integration hinders students' capacity to apply scientific knowledge to real-world challenges, a critical component for cultivating scientific literacy. This paper stressed that using the ADDIE Model in developing instructional modules was effective in identifying essential topics to discuss, targeting the needs of students, develop students' competence, and improve academic performance.

6. Conclusion

Using the ADDIE Model, the module was successful in facilitating students' learning and engagement with the content. The highest-rated aspects included the style of illustrations and written expressions, the usefulness of learning activities, and the guidance provided by illustrations and captions, all of which received excellent ratings. Students found the objectives and instructions easy to understand and enjoyed interactive tasks such as trivia and puzzles. Experts also evaluated the module positively, particularly its alignment with the defined objectives, simplicity and clarity, and equal emphasis on each topic. The module was deemed well-structured, with clear, relevant content and appropriate practice tasks. Finally, based on the 60-item assessment test, students' performance improved significantly, as evidenced by the higher post-test scores compared to the pre-test, with a statistically significant difference.

Experts recommended integrating examples that are culturally and contextually relevant to the students. Using local case studies, scenarios, and references will make the content more engaging and meaningful, helping students relate the material to their everyday lives. Although the module contains well-structured activities such as trivia and puzzles, adding more hands-on tasks and real-life applications could further strengthen students' understanding. For instance, providing opportunities for students to engage in project-based learning, where they apply module content to solve local problems, will enhance their learning experience and retention. Furthermore, including more diverse examples that cater to different learning styles—such as video demonstrations, interactive simulations, and step-by-step visual guides—could further clarify complex concepts. These multimodal resources can complement text-based examples, making the learning process more accessible. Allowing students to reflect on their learning experiences at different stages could also provide valuable insights for both students and instructors, ensuring that the module continues to meet their needs and expectations.

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Institutional Review Board Statement

Ethical review and approval were waived as the study posed minimal risk, involved voluntary participation, and did not collect sensitive or identifiable data.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data will be made available upon request.

Conflict of Interest

The author declares no conflict of interest.

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