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Development and Validation of a STEM Teaching Kit for Grade 8 Physics Students

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Abstract
The Department of Education in the Philippines enhanced the K to 12 curriculum by integrating STEM (Science, Technology, Engineering, and Mathematics) education to improve student performance, especially in science subjects. This study aimed to assess the impact of developing and validating a STEM Teaching Kit (STK) for Grade 8 students, focusing on its effectiveness for both teachers and students. A mixed-methods approach was employed, using surveys, observations, and assessments to gather quantitative and qualitative data. A survey of science teachers from two high schools in Iligan City identified challenges such as time constraints and resource limitations which informed the development of the STK. Three physics experts validated the kit. In the pilot testing, the results showed positive feedback from both teachers and students, highlighting the STK's adaptability, user-friendly design, and positive impact on student performance. However, the participants suggested allocating more time for its implementation to maximize its effectiveness fully. The findings indicate a favorable response to integrating the STEM approach into the classroom. This study contributes to advancing physics education in the classroom and enriches the ongoing discourse on effective STEM integration. The STK is aimed at supporting educators, enhancing student engagement, and fostering critical thinking skills. To gain further data and a deeper understanding of its impact on student learning, implementing this kit in other schools is the next step.

Keywords: STEM Teaching Kit, STEM Education, Science Teachers, development, K to 12 curriculum

Introduction

The rapid advancement of technology has transformed the educational landscape, creating new opportunities and challenges for students and educators alike. In particular, the demand for 21st-century skills has become a critical focus of modern education, emphasizing the need for students to develop their critical thinking, creativity, collaboration, and problem-solving skills. As a key component of the curriculum, science education is no exception to these shifts. The K to 12 curriculum has undergone significant revisions in the Philippines, particularly in how science is taught, integrating innovative teaching methodologies like STEM (Science, Technology, Engineering, and Mathematics). This shift has aimed to better prepare students for the complex,

rapidly changing world they will encounter in their future careers (K To 12 Basic Education Curriculum | Department of Education, n.d.; Abragan et al., 2022).
The K to 12 curriculum adopts a spiral approach, particularly for junior high school education, emphasizing a learner-centered framework. This structure prioritizes progressively complex and advanced content delivery over an extensive, concentrated focus on a single subject area. The spiral design ensures that students revisit key concepts and skills at increasing difficulty levels, promoting a more profound understanding and long-term retention. Based on Jerome Bruner's Spiral Progression model, the curriculum requires that specialized science teachers have a profound understanding and make use of effective teaching strategies across four key science domains: biology, chemistry, physics, and earth science. However, this approach has posed challenges for educators. Specifically, science teachers teaching diverse science topics need help preparing lessons. They need help with the daunting task of mastering the core subjects, leading to difficulties in lesson planning and execution. This struggle underscores the need for targeted support and professional development initiatives to empower teachers and enhance the country's science education quality (Tirol, 2022).

In the shift from the old curriculum to the spiral progression approach (SPA) introduced in the new K to 12 curriculum, both teachers and students have expressed positive and negative perceptions. These teachers, responsible for instructing various science subjects across different grade levels, have encountered significant difficulties during the initial one to two years of implementing the SPA. One key challenge stemmed from the mismatch between their expertise and the subjects they were required to teach. For instance, biology teachers might find themselves teaching chemistry, physics, and earth science, leading to confusion about the most suitable teaching strategies for each subject. Additionally, these educators have had to cultivate openness to new teaching methods, adaptability to learning novel topics, and the willingness to confront challenges head-on. Moreover, their time constraints were a significant concern, as they have had to meticulously prepare lessons while simultaneously mastering the content of multiple subjects. These challenges highlight the intricate nature of their transition to the SPA, emphasizing the need for comprehensive support and tailored training in this new educational approach (Lazaro, 2023; Batidor & Casinillo, 2021a; Tinapay et al., 2021b).

Integrating STEM (Science, Technology, Engineering, and Mathematics) education into the curriculum presents a formidable challenge, especially considering the teachers' struggles in their day-to-day teaching responsibilities. STEM education's overarching goal of preparing the future workforce is vital in today's rapidly advancing technological landscape. However, implementing STEM is complicated by the difficulties educators encounter with traditional teaching methods. The complexity of integrating STEM disciplines emphasizes the importance of making connections between science, mathematics, and engineering clear for students. Additionally, it reveals the challenges to do with balancing curricular coherence with the need to incorporate all relevant science standards (Roehrig et al., 2021). This issue is underscored by the low rankings of students in international assessments like Trends in International Mathematics and Science Study (TIMSS). Addressing these challenges requires improving education standards and ensuring that students have the necessary skills and knowledge to thrive in an increasingly technology-driven world. Therefore, innovative approaches, comprehensive teacher training, and targeted educational interventions are essential to bridge the existing gaps and successfully integrate STEM education into the learning environment (Orbeta, Melad, & Potestad, 2021).

While studies have explored the challenges educators face in transitioning to the K to 12 curriculum, there is limited research on the specific struggles of science teachers in navigating the spiral progression approach alongside STEM integration. The existing literature primarily focuses on the theoretical advantages of the spiral curriculum and STEM education. However, it falls short of addressing the teachers' practical difficulties in their day-to-day responsibilities. Furthermore, there is a gap in the understanding of the need for targeted support and professional development strategies that could alleviate these challenges and enhance the quality of science education.

The primary aim of this study was to assess the integration of the STEM approach in science instruction through an STK. Specifically, this research sought to answer the following questions:

1. Does the science teacher integrate the STEM approach into teaching physics?
2. What is the validity of the developed STEM Teaching Kit (STK) among science teachers and STEM experts?
3. What impact does the implementation of the STK have on student performance and output?
4. What are the views of the teacher and students regarding the implementation of the STK?
5. Is there a significant difference between the student's pre-test and post-test performance?

Through this research, we aimed to understand how STEM-based teaching resources can be effectively integrated into the classroom, enhancing the students' learning experiences and improving their academic performance in science.

Method

Participants

Three physics experts validated the STEM lesson plan for its content and pedagogical validity. These experts had advanced qualifications, having completed master's degrees in physics education. They were actively teaching science and had conducted research related to STEM education, thus ensuring that their expertise aligned with the study's objectives.

For the pilot testing of the STK, a total of 85 Grade 8 students participated. The participants were from two sections at Iligan City East National High School-Sta. Filomena. Specifically, 40 students came from the Grade 8-Aristotle section, while 45 were from the Grade 8-Leeuwenhoek section. Both sections were taught by the same science teacher, ensuring consistency in the instructional delivery across the groups.

Design

This research employed a mixed-methods approach combining qualitative and quantitative techniques to gather comprehensive data. The qualitative method involved in-depth interviews with teachers and students. At the same time, quantitative data was collected through surveys and assessments—this blend of methods aimed to provide a holistic view of the research questions. The study investigated the effectiveness of the developed STEM-Lesson Plan for Grade 8 students. The PDSA (Plan, Do, Study, Act) Research Model was utilized. This repetitive, cyclical process involved (1) Planning – choosing a focus and outlining the current approach to addressing the identified need; (2) Doing – putting the plan into action and gathering data; (3) Studying – examining and interpreting the collected data; and (4) Acting – reflecting on the outcomes and taking action by applying the next step in the research process, which teachers can use in the classroom.

Materials

The STEM Teaching Kit (STK) consisted of a developed STEM lesson plan and STEM activities, which were validated and subsequently used by Grade 8 students. For the validation process, the STEM lesson plan was evaluated using a Rating Sheet, while the STEM activities were assessed using the STEM Activity Evaluation Form.

After the pilot testing, the students completed the Student Activity Perception Checklist to provide feedback on their experience. Lastly, a teacher survey was administered to assess trends and gather insights regarding implementing the STEM approach in education.

Procedure

The data collection follows the PDSA (Plan, Do, Study, Act) model, utilizing a cyclical approach for continuous improvement. This process allows for the ongoing refinement of the teaching strategies, ensuring that adjustments are based on real-time feedback to enhance student outcomes.

Plan

A survey was conducted among 21 science teachers from two schools in the Division of Iligan. The survey aimed to evaluate the teachers' knowledge, attitudes, and the application of the STEM approach. Also, it intended to identify the challenges they encountered in its implementation.

The survey results provided critical insights into the areas where the teachers required additional support. These findings served as the foundation for developing the STEM Teaching Kit (STK), ensuring that it was tailored to address the specific needs of science educators. By aligning the STK with the teachers' needs, the study aimed to strengthen science education by equipping educators with practical tools and strategies to implement the STEM approach more successfully in their classrooms.

The STEM Teaching Kit (STK) development was carefully aligned with the K to 12 curriculum to ensure relevance and coherence with the prevailing educational standards. The initial version of the STK underwent a rigorous validation process conducted by physics experts who possessed qualifications and experience in the domain of STEM education. Based on their feedback and suggestions, refinements were made to improve the kit's content, structure, and overall effectiveness. These revisions ensured that the STK met both the curriculum's objectives and the practical needs of educators and learners.

Do

Before conducting the pilot testing, permission was obtained from the Division of Iligan City, and approval was sought from the school principal. The pilot testing was carried out with two sections of Science Curriculum students at Iligan City East National High School-Sta. Filomena. Unfortunately, due to time constraints and the teachers' schedules, pilot testing could not be conducted at Hinaplanon National High School. Consequently, only the two sections from ICENHS-Sta Fe, comprising 85 students, were considered.

After receiving approval from the school principal, consent forms were distributed to the assigned science teacher, and to the students participating in the pilot testing. This was done two weeks prior to the testing to give the teacher ample time to prepare and collect the signed consent forms before the scheduled day of the pilot testing.

The pilot test spanned three days. The teacher facilitated a discussion on the initial day and provided instructions for the STEM activity. On the subsequent day, they involved the students by actively engaging them in the development of the prototypes, with the flexibility to continue their work during break times. Also, a peer evaluation was administered to the students to monitor and assess the students' participation. Following the implementation, an activity perception test was administered to assess the students' perceptions of their experience with the activity. Additionally, the teachers were surveyed to gauge the applicability of the developed STEM lesson plan to the students and to understand the trends related to the use of the STEM approach in education.

Study
This research employed a comprehensive approach to assess the validity and impact of the STEM Teaching Kit (STK). Descriptive analysis was conducted on the data gathered from multiple sources, including evaluations by physics experts, the pre-test and post-test results of the concept tests administered to students, peer evaluations within groups, feedback from students using a perception checklist, and insights from teachers obtained through a survey on the Scale of Trends Towards the STEM Approach in Education. The physics experts provided valuable input on the STK's validity, while student performance and dynamics were measured through concept tests and peer evaluations. The students' perceptions and experiences with the STK were captured through the perception checklist, and the teachers' attitudes towards the STEM approach were gauged through the survey. This comprehensive data collection strategy aimed to provide a holistic understanding of the STK's effectiveness in the classroom. The findings from the descriptive analysis will guide decisions on potential revisions to the STK, with successful outcomes potentially leading to recommendations for its broader implementation among physics teachers.

Act
After analyzing the data gathered during the pilot testing phases, the need for revision will be incorporated into the developed STK. The researcher will revisit the cycle to incorporate a better plan if the student's performance does not meet expectations. If successful, the revised STK will be incorporated into classroom practices and recommended to other physics teachers. Additionally, the insights gained from the previous cycle will help shape and enhance the development of new plans for the next phase, supporting the achievement of the research objectives.

Results
The results of this study provide valuable insights into integrating the STEM approach in science instruction through the use of the STEM Teaching Kit (STK). The findings indicate that science teachers were able to integrate the STEM approach into their physics lessons, although challenges such as time constraints impacted lesson preparation. The validation of the STK by physics experts confirmed its relevance and effectiveness as a teaching resource. Additionally, the implementation of the STK positively influenced the students' performance, with significant improvements observed in their pre-test and post-test results. Both teachers and students expressed favorable views of the STK, highlighting its potential to enhance learning experiences and academic outcomes in science education.

Integration of STEM Approach in Teaching Physics among Science Teachers
This study aimed to develop a STK for science teachers. Before developing the STK, a survey was conducted to gauge the science teachers' perceptions of the STEM approach, examine their knowledge, attitudes, and application of STEM and identify challenges in its implementation. The survey involved 21 science teachers from Hinaplanon National High School (HNS) and Iligan City East National High School-Sta Filomena (ICENHS-Sta. Fe). The survey questionnaire, comprising 30 statement items and two open-ended questions, was adapted from Wahono and Chang's (2019) study.

As a result, most teachers displayed a positive attitude toward STEM education, as well as a significant willingness to incorporate STEM methods into their classrooms. Their openness to learning and applying STEM principles reflects their proactive approach toward innovative teaching practices. It demonstrates their eagerness to embrace STEM methodologies, reflecting the educators' positive and enthusiastic attitude. This positive attitude is crucial for effectively implementing the STEM approach and enhancing their students' learning experiences.

In terms of the knowledge of the teacher of STEM, most teachers demonstrated a foundational understanding. However, there were discrepancies in specific areas, particularly regarding the nature and advantages of STEM education. This variation highlighted the need for targeted professional development to understand integrated STEM concepts comprehensively. The results also mentioned the challenges that the teachers faced when integrating STEM. The teachers' challenges when implementing the STEM approach included the need for more learning materials and laboratory facilities.

Additionally, there needs to be more time to prepare the materials and for teachers to study the process. Another significant hurdle arises from teachers who need more specialization in subjects like physics but are required to teach them due to the spiral design of the curriculum. Despite these hurdles, their active efforts to incorporate STEM methodologies emphasized their determination to adapt and innovate their teaching practices. Thus, one of the challenges they faced was a lack of materials, highlighting the need to develop a STEM-based learning model that supports the integration of STEM in science education. Therefore, one solution that may be possible is developing readily available materials for teachers. By creating ready-to-use materials, teachers have the opportunity to familiarize themselves with the STEM approach, enabling them to implement it more effectively in the classroom.

Validity of the developed STK

The STEM Teaching Kit (STK) consisted of two major components: the STEM Lesson Plan and the STEM Activity Evaluation Form. The same set of validators validated both components.

The rating sheet for the lesson plan of the STEM kit was adopted from the study of Anduyan (2019). Its primary purpose was to assess the appropriateness of the lesson plan in terms of the language used in the lesson content and the activities included. The rating sheet focused on evaluating the lesson's content and the designed activities. Three physics experts assessed the STEM lesson plan using this rating sheet.

The STEM lesson plan was evaluated based on the following stages: identification of social issues, identification of potential solutions, need for knowledge, decision-making, development of a prototype of the product, testing and evaluation of the solution, socialization and completion of decisions, layout, and spelling and grammar. The following point scale was used: excellent (4 points), good (3 points), fair (2 points), and poor (1 point).

Table 1. Rating Sheet for Validating the STEM Lesson Content

STAGES	DESCRIPTION	E1	E2	E3	Average
1. Identification of Social Issues	1.1. Clarity of the instructions	4	4	4	4.00
	1.2. Identification process	4	4	4	4.00
	1.3. Identified issues	4	4	4	4.00
	1.4. Issues are commonly observed	4	4	4	4.00
	1.5. Greatly needs attention	4	4	4	4.00
2. Identification of Potential Solutions.	2.1. Clarity of the instructions	4	4	3	3.67
	2.2. Identification process	4	4	4	4.00
	2.3. SMART	4	4	4	4.00
	2.4. Potential Solution	4	4	4	4.00
	2.5. Safety of the learners	4	4	4	4.00
3. Need for Knowledge	3.1. Conceptual knowledge	4	4	4	4.00
	3.2. Clarity of statements and facts	4	4	4	4.00

	3.3. Appropriate for age, year level, and maturity	4	4	4	4.00
	3.4. Application of the prototype in the topic	4	4	3	3.67
	3.5. Efficiency of the strategy	4	4	4	4.00
4. Decision-making	4.1. Clarity of the instructions	4	4	3	3.67
	4.2. Time-allocation	4	3	3	3.33
	4.3. Implemented approach	4	4	4	4.00
	4.4. Applied strategy	4	4	4	4.00
	4.5. Instructions that lead to the objectives	4	4	4	4.00
5. Development of prototype or product	5.1. Doability of the product	4	4	4	4.00
	5.2. Clarity of the instructions	4	4	4	4.00
	5.3. Precision of the instructions for the teacher	4	4	4	4.00
6. Testing and evaluation of the solution	6.1. An approach that induces creativity	4	4	4	4.00
	6.2. Appropriateness of the questions for the product	4	4	4	4.00
	6.3. Precision and clarity of the statements	3	4	4	3.67
7. Socialization and completion decision stage	7.1. Precision of the instructions for the teacher	4	4	4	4.00
	7.2. Clarity of statements	4	4	4	4.00
8. Layout	8.1. Readability of the text	3	4	4	3.67
	8.2. Consistency of the format	4	4	3	3.67
	8.3. Location of important elements	4	4	4	4.00
	8.4. Proper spacing	4	4	4	4.00
9. Spelling and Grammar	9.1. Correctness of the words' spelling	4	4	4	4.00
	9.2. No grammatical errors	4	3	4	3.67
	9.3. Words used	4	4	4	4.00
	9.4. Delivery of ideas	4	4	4	4.00

Legend: 3.25 – 4.00 (Excellent); 2.50 – 3.24 (Good); 1.75 – 2.49 (Fair); 1.00 – 1.74 (Poor)

Table 1 shows the evaluation of the physics teachers on the lesson plan. On average, the designed lesson plan was rated as excellent. This means that the designed lesson plan could be an excellent tool for teaching the concept of electricity. The feedback on the STEM Lesson plan offered valuable insights for improvement and acknowledged the positive aspects. Suggestions were made to enhance the clarity of potential solutions by providing step-by-step instructions, particularly in defining the components of the house plan. Regarding what the teacher can implement during the decision-making phase, it was recommended to include a straightforward, step-by-step procedure, ensuring seamless understanding. A formatting note emphasized the importance of uniform font usage, pointing out the variations between Times New Roman and Arial. Despite these suggestions, the overall impression was positive, highlighting the clear articulation and coherence of the lesson plan and STEM activity. Additional guidance included using specific symbols and equations in Microsoft Word, and incorporating diagrams illustrating concepts such as current, voltage, and resistance. These recommendations aim to refine the lesson plan's instructional clarity, consistency, and visual elements.

The physics experts utilized the STEM Activity Evaluation Form to assess the developed STEM activity. This evaluation form, adapted from Okulu and Oguz-Unver (2021), was designed to evaluate the STEM activity by considering various pedagogical approaches. These methods include project-based learning, collaborative learning, problem-based learning, inquiry-based learning, and design-based learning. The evaluation sought to thoroughly assess the STEM activity, examining how well it aligns with various pedagogical approaches. The scoring for student activity was based on 11 items corresponding to the sub-themes mentioned above and employed a four-point Likert scale (1, 2, 3, and 4). This structured approach allowed for a comprehensive assessment of the STEM activity, covering key aspects of the learning environment, student engagement, content integration, and the interconnectedness of the STEM components.

Table 2. Evaluation of the Physics Experts regarding the Students' Activity Sheet

Theme	Sub-Theme	Item	Score			Average
			E1	E2	E3	
1.STEM Learning Environment	1.1. Organization	1.1.1. A proper learning environment for the activity is organized.	4	4	4	4.00
		1.1.2. The duration of the activity is sufficient.	4	4	4	4.00
		1.1.3. Transitions between the sub-activities occur systematically.	4	4	4	4.00
	1.2. Material	1.2.1. The activity materials are appropriate for the learning objectives.	4	4	4	4.00
		1.2.2. Required materials are available for the activity.	4	4	4	4.00
2. Activation of students	2.1. Learning objectives	2.1.1. The activity is relevant to the learning objectives.	4	4	4	4.00
		2.1.2. Sufficient time is spent on achieving for learning objectives.	4	4	4	4.00
	2.2. Participation	2.2.1. The activity enables students to participate equally in the sub-activities.	4	4	4	4.00
		2.2.2. Students are encouraged to participate in the sub-activities.	4	4	4	4.00
	2.3. Engagement	2.3.1. The activity involves hands-on and minds-on activities.	4	4	4	4.00
	2.4. Evaluation	2.4.1. The activity includes process-oriented measurements and evaluation techniques.	4	4	3	3.67
3. STEM content and practice	3.1. STEM disciplines	3.1.1. The activity emphasizes various STEM disciplines.	4	4	4	4.00
		3.1.2. The activity includes STEM integration.	4	4	4	4.00
		3.1.3. The activity includes the engineering design process.	4	4	4	4.00
		3.1.4. Mistakes are an essential part of learning.	4	4	4	4.00

		3.1.5. The activity allows students to provide evidence that they accurately understand scientific concepts.	4	4	4	4.00
		3.1.6. The activity focuses on artifact construction.	4	4	4	4.00
	3.2. STEM practices and scientific inquiry	3.2.1. The activity allows students to engage in scientific questions.	4	4	4	4.00
		3.2.2. The activity supports the students' evidence-based thinking skills.	4	4	4	4.00
		3.2.3. The activity allows students to reveal their current ideas.	4	4	4	4.00
		3.2.4. The activity allows students to do research.	4	4	4	4.00
		3.2.5. The activity enables the students to use data collection, analysis, and interpretation.	4	4	4	4.00
		3.2.6. The activity allows students to suggest different solutions to a problem.	4	4	4	4.00
		3.2.7. The activity allows the students to share their ideas or findings with their peers.	4	4	4	4.00
	3.3. Reflection	3.3.1. The students are encouraged to reflect on what they have learned.	4	4	4	4.00
		3.3.2. The activity allows the students to reflect on what they have learned.	4	4	4	4.00
4. Connecting STEM	4.1. Connection to real-life	4.1.1. The activity connects problems or subjects related to real life and the students' experiences.	4	4	4	4.00
	4.2. 21st century skills and attitudes	4.2.1. The activity supports the students' interest in STEM disciplines.	4	4	4	4.00
		4.2.2. The activity supports the development of the students' 21st-century skills.	4	4	4	4.00

Table 2 reveals that the physics experts consistently assigned mostly individual scores of 4 and reflected the same in the average scores. This consistently high score across the themes suggests that the quality of the developed activity is notable, supported by compelling and consistent evidence. These scores indicate excellence in the crafting of the STEM activity, particularly addressing the topic of electricity. Additionally, a physics expert noted that the activity was generally well-received, commenting, "So far, so good." Positive remarks were made about the interactive design, highlighting its effectiveness in fostering student collaboration, a crucial aspect of 21st-century learning. However, there were specific suggestions for improvement, such as enlarging the text in the activity for better readability. Another constructive suggestion involved attaching rubrics or drawings related to the activity on the activity sheets. These recommendations aim to enhance the overall effectiveness and clarity of the STEM activity, ensuring an optimal learning experience for the students.

Impact of the STK on the Students' Performance and Output

The students participating in the pilot testing were grouped into six groups for each section. Before the class, the teacher instructed the students to bring their art materials with them for the activity preparation. The students were introduced to the topic on the first day, and the teacher provided instructions for the activity. Following the discussion, the teacher allowed the students to perform the activity. On the second day of the pilot testing, the students had the entire day to work on their activity, and they were also permitted to continue during their free time, provided they documented their progress. Each group assigned the members specific tasks during the development phase to minimize wasted time. The last day of the pilot testing involved the presentation of the students' outputs, with the groups graded according to a rubric and peer evaluations being administered to assess individual contributions.

Figure 1. Grade 8-Aristotle students during their activity at the mini-forest at ICNHS-Sta Fe

Figure 2. Grade 8- Leeuwenhoek students during the activity in their classroom

Figure 3. Some of the outputs of the Grade 8 Aristotle students

Figure 4. Some of the outputs of the Grade 8-Leeuwenhoek students

The student activity sheet served as a comprehensive guide for the students while they were developing their prototypes. Accompanying the activity sheet was a rubric outlining the grading system. Additionally, each group provided reflections after the activity, particularly on the challenges encountered while planning and developing their prototypes. A common issue identified by many groups was the constraint of time, hindering them from achieving an even better output. Another challenge highlighted was the limited space available for construction. Despite these challenges, the students demonstrated commendable performance, leading the teacher to award them mostly high grades for their outputs. Towards the conclusion of the activity, the students engaged in a peer evaluation process, assessing their groupmates' performance and contributions and reflecting on their own. The overall collaboration among students was positive, with mutual support evident within the groups.

Table 3

Measure 1		**Measure 2**	**t**	**df**	**p**
Pre-test	-	Post-test	-26.861	84	< .001
Note. Student's t-test.					

Note. Student's t-test.

Table 3 shows the significant differences between the student's pre-test and post-test results since the p-values have less than 0.05 significance levels. This means that the students, in reference to both sections, performed better in the post-test than in the pre-test, as also observed in the t-value of -26.261. The table underscores a significant difference in outcomes between the pre-test and post-test, robustly affirming the study's initial implementation as being highly effective in teaching the dual nature of the topic. This observation suggests that innovative devices effectively enhance student performance (Tolba & Al-Osaimi, 2023). Significantly, the concept test administered for both the pre-test and post-test was adapted from the modular designed by the Department of Education for Grade 8 physics.

After administering the STK to the students, an Activity Perception Test was conducted using the adapted Activity Perception Checklist from Deci, Vallerand, Pelletier, and Ryan (1994). This checklist is strategically designed to evaluate the motivational aspects of the students' engagement and perception during educational activities. Its specific objectives include measuring the students' levels of self-determination, intrinsic motivation, and overall engagement in the learning process. This checklist enables researchers and educators to gain valuable insights into how students perceive their activities, identifying whether their motivation is intrinsic or externally regulated. Understanding these motivational factors is pivotal for assessing the effectiveness of teaching methods and devising interventions to enhance the students' intrinsic motivation and overall engagement in educational settings.

The perception checklist consists of 25 statements concerning the activity experience. The students provided responses on a scale ranging from 1 (Not true) to 5 (Very true). This scale allowed them the opportunity to express the extent to which each statement resonated with their perceptions of the activity, providing valuable insights into their overall experience and engagement.

Table 4. Students' activity perception on the STK activity

Statements	**Aristotle N=40**	**Leeuwenhoe k N=45**	**Average N=85**
1. I believe that doing this activity could have some value for me.	4.512	4.178	4.345
2. I believe I had some choice about doing this activity.	4.070	3.844	3.957
3. While I was doing this activity, I was thinking how much I enjoy it.	3.953	4.000	3.977
4. I believe that doing this activity is useful for improved concentration.	4.349	4.091	4.220
5. This activity was fun to do.	4.256	4.067	4.161
6. I think this activity is important for my improvement.	4.512	4.244	4.378
7. I enjoy doing this activity very much.	4.093	3.956	4.024
8. I really did not have a choice about doing this activity.	2.000	2.818	2.409
9. I did this activity because I wanted to.	3.814	3.644	3.729
10. I think this is an important activity.	4.558	4.378	4.468
11. I felt like I was enjoying the activity while doing it.	4.073	3.911	3.992
12. I thought this was a very boring activity.	1.571	2.200	1.886
13. It is impossible that this activity could improve my study habits.	2.548	2.800	2.674
14. I felt like I had no choice but to do this activity.	2.116	2.622	2.369
15. I thought this was a very interesting activity.	4.116	4.068	4.092
16. I am willing to do this activity again because I think it is somewhat useful.	3.952	4.156	4.054
17. I would describe this activity as very enjoyable.	3.953	4.156	4.055
18. I felt like I had to do this activity.	3.651	3.711	3.681

19. I believe doing this could somewhat benefit me.	4.256	4.044	4.150
20. I did this activity because I had to.	3.524	3.467	3.495
21. I believe doing this activity could help me do better in school.	4.140	4.178	4.159
22. While doing this activity, I felt like I had no choice.	2.233	2.378	2.305
23. I would describe this activity as very fun.	3.837	3.956	3.896
24. I felt like it was not my own choice to do this activity.	2.233	2.244	2.239
25. I would be willing to do this activity again because it has some value for me.	3.930	3.778	3.854

1- Not true 2- Slightly true 3- Moderately true 4- Mostly true 5- Very true

Table 4 outlines the students' perceptions of the STK activity, considering two pilot testing sections—Aristotle and Leeuwenhoek—comprising 85 students. The students' perceptions overwhelmingly indicate a belief that the activity holds significant value for them. On average, there is moderate agreement that they enjoy engaging with the STEM activity, showcasing an overall positive perception. The results further show that students do not perceive the STEM activity as boring. Instead, they recognize its importance and helpfulness. Their perspectives on the activity are notably positive, emphasizing its potential benefits for their learning experience. Moreover, the students are positively willing to conduct the activity, demonstrating enthusiasm and enjoyment. This positive response extends to their openness to engage in other similar activities.

An interview was conducted with the students, and they shared both positive and negative feedback about the activity. On the positive side, students expressed their enjoyment. One student mentioned, "I really enjoyed doing this activity as it helped me understand the topic better and allowed me to form new bonds and experiences". Another student commented, "[Enjoy kay sya Ma'am] It was enjoyable, Ma'am." These quotes show that the activity was fun and engaging. However, on the negative side, some students found the time limit challenging. One student from Grade 8 shared, "[Mas ayos tana sya Ma'am kung daghan oras] It would have been better if we had more time." Several other students echoed similar sentiments, stating that they could have produced better results with more time. The activity was a new experience for them, especially since they were tasked with building their prototype. While they were initially excited, they also felt confused at first. Overall, despite the time constraints, the students found the activity fun, challenging, and a valuable experience.

Teacher's View on Implementing STK

Like the students, the teachers were also surveyed after the STK implementation to gather insights into their experiences during the implementation process. The researcher employed a survey questionnaire adapted from Altakhyneh and Abumusa (2020). The primary aim of the survey questionnaire was to assess the attitudes of the participants, in this case, teachers, towards the STEM approach. The questionnaire, consisting of 19 paragraphs organized into four core areas, sought to measure the teachers' willingness to apply STEM strategies, evaluate their ability to foster critical thinking and problem-solving skills, assess their motivation for self-learning, and gauge their proficiency in communication and collaboration within the context of STEM education. The teacher provided her responses on a scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). By collecting data on these crucial aspects, the questionnaire provided valuable insights into the perspectives and readiness of teachers to engage with STEM concepts. Additionally, it informed the development of effective STEM-related lessons in science, mathematics, engineering, and technology.

Table 5. Scale of trends in the use of the STK approach in education

Survey Item	Score
Core (1): Desire to Apply Strategy	
I think the STK is useful to me in teaching.	5
I feel that the tools that have been used in the course on the STK are useful to me.	5
I gained important new experience for me in teaching through the course.	4
I believe that STK has provided elements of complementarity in the three areas of purpose: cognitive, skillful, and compassionate.	5
I feel a desire to apply the STK in teaching math and science courses.	5
I think this strategy develops the learner's motivation to study.	5
Core (2): Thinking and Problem Solving	
I think this strategy is important for the development of creative thinking.	5
I think this strategy is important for the development of critical thinking.	5
I think this strategy is important for the development of computational thinking.	4
STEM's educational strategy develops autonomy in thinking	4
Core (3): Motivation and Self-learning	
I think this strategy is interesting and fun for learners.	5
I think this strategy relieves the students' anxiety in mathematics and science.	4
STEM's strategy has an educational benefit, increasing the self-confidence of learners.	5
The STEM education strategy develops the ability to self-manage and organize.	5
The STEM educational strategy takes into account individual differences among students.	5
Core (4): Collaboration and Communication	
I feel that the STK educational strategy fosters collaborative work among students.	5
STK develops the ability to communicate with others.	5
STK can be applied in math and science classes at all stages.	5
STK tools are multiple and varied.	5

Table 5 presents the teacher's insights into her experiences during the implementation process of the STK. The survey research encompassed four cores. In the first core, the teacher scored almost all items as 5 (strongly agree), indicating that she believed the STK was helpful related to the student's teaching and learning process. The tools used in the STEM system were perceived as beneficial, providing complementarity in the cognitive, skillful, and compassionate areas. The teacher aimed to use the STK in the teaching of math and science subjects and believed that it boosted the students' motivation to learn. This new experience was beneficial to the teacher's teaching throughout the course. In the second core, focusing on thinking and problem-solving skills, the teacher acknowledged the importance of the STK in developing creative and critical thinking. She agreed that the STK was crucial for fostering computational thinking and autonomy in thinking. In the third core, motivation and self-learning, the teacher strongly agreed that the STK was exciting and fun for students, enhancing their self-confidence. It helped learners develop the ability to self-manage and organize while considering individual student differences. The STK lessened the students' anxiety regarding mathematics and science. The teacher strongly agreed with the last core, collaboration and communication. The STK was believed to foster collaborative work among students and develop their communication abilities. Furthermore, the STK was seen as applicable in math and science classes across all grade levels due to its diverse and versatile tools.

In support of the results, the teacher highlighted the positive outcomes of the activity. She mentioned that the activity made the students more active. With the lesson and activities already prepared, it was more convenient for her, as everything was ready. She also added that the activity would benefit non-physics majors who teach science. Although she would like to implement similar activities, the time required to prepare them would be challenging. As she explained, "[Daghan man gud mi ginabuhat. Aside from teaching, ang pag atiman sa advisory ug paper works.] We have many things to do. Aside from teaching, I also handle class advisory along with paperwork." This statement reflects the teacher's reality where she has many responsibilities beyond teaching, such as managing student advisories and handling administrative tasks like paperwork. These additional duties often make it difficult for her to dedicate the time needed to create and implement more complex activities. The prepared lessons and activities for this particular project made it more manageable as they allowed her to focus on guiding students through the process rather than spending an excessive amount of time on preparation. This highlights how the activity benefited the students and made the teacher's workload more efficient, ultimately contributing to the positive impact of the activity.

Conclusion

This study has addressed the challenges teachers face in developing and implementing a STEM-integrated approach in their classrooms, particularly given the time constraints involved in lesson preparation. The findings demonstrate that the STEM Teaching Kit (STK) positively impacted both teachers and students. Students perceived the activities as valuable, enjoyable, and meaningful, expressing a strong willingness to engage in similar activities in the future. However, the time given to them was limited, which they found inconvenient. They believed that if they had more time, they could have developed their prototypes more thoroughly and produced better results. Through the survey responses, teachers showed positive attitudes toward the STEM strategy, highlighting its potential to enhance student motivation, foster critical thinking, and develop problem-solving skills. The results support the effectiveness of the STK in improving the teaching and learning experience, thus providing a beneficial tool for science instruction. Moving forward, the positive outcomes and constructive feedback suggest that the further refinement of STEM resources, like the STK, can help alleviate the challenges educators face and enhance the quality of STEM education. This study underscores the importance of integrating STEM approaches to better equip students with the skills necessary for success in the 21st century.

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