United International Journal for Research & Technology

Volume 04, Issue 07, 2023 | Open Access | ISSN: 2582-6832

Development and Validation of Inquiry-Based Learning Activity Sheets in Physical Science

Rona E. Aguila[1] and Jhonner D. Ricafort[2]

***Abstract*—** This study aimed to develop and validate the inquiry-based learning activity sheets in Physical Science for Grade 11 ABM at Gubat National High School for the school year 2022-2023. It used the developmental method of research. The respondents were the thirty (30) Grade 11 ABM students in Gubat National High School who were randomly chosen and five (5) experts teaching in science who were purposively chosen. The statistical tools utilized were the weighted mean, frequency, and t-test for dependent samples.

The study revealed that the developed inquiry-based learning activity sheets were successful in teaching basic Science concepts as supplementary instructional materials. Experts firmly agreed that the instructional content of the said material is commendable. Moreover, the developed inquiry-based learning activity sheets clearly demonstrate that standards are adhered to and used in conjunction with the proper pedagogies for the subject matter as determined by the experts. As revealed in the pretest and posttest results in terms of lessons in Aristotelian vs Galilean views of motion, freefall, graphing motion, acceleration, and Newton's laws of motion, the developed learning activity sheets are effective in improving the performance of Grade 11 students in physical science.

It was recommended that the developed inquiry-based learning activity sheets in Physical Science be used to improve the retention and mastery of the lessons of the Grade 11 ABM students and of other academic strands and TVL strands. It was recommended that the developed LAS may be subjected to validation using other criteria and be tested for acceptability. It was also recommended that the effectiveness of the developed learning activity sheets be tested using a robust experimental design. Future research on the development of other instructional materials is encouraged to reinforce teaching various fields in science and across learning areas at different grade levels.

***Keywords*—** development, validation, inquiry-based, learning activity sheets, performance level.

I. INTRODUCTION

Benjamin Franklin, a renowned statesman and one of the United States' Founding Fathers, once said, "Tell me and I forget, teach me and I may remember, involve me and I learn." This statement has become a guiding principle for modern education and highlights the importance of active participation in the learning process.

In recent years, there has been a growing recognition of the importance of active learning in education. Active learning refers to teaching methods that engage students in learning, requiring them to participate actively in their own learning. Inquiry-based learning (IBL) is an example of active learning that has gained widespread acceptance in many educational settings.

Inquiry-based learning is a student-centered teaching and learning approach that emphasizes hands-on activities. It encourages students to ask questions, investigate and find answers through experimentation and problem-solving. The teacher in an IBL classroom serves as a facilitator to guide students through the inquiry process and provide support as needed.

The use of inquiry-based learning (IBL) in Philippine education is supported by several legal bases and policies. One of the main policies is the K-12 program, which was implemented in 2013 through Republic Act No. 10533. The K-12 program aims to enhance the basic education system in the Philippines by strengthening the curriculum and increasing the number of years for basic education. It also includes the adoption of new teaching and learning strategies, such as IBL, to promote critical thinking and problem-solving skills among students (Department of Education, 2012).

The National Science and Technology Plan 2017-2022 in the Philippines promotes STEM education and the use of IBL as a teaching strategy to develop students' scientific inquiry skills. Studies in the Philippines have also shown the effectiveness of IBL in enhancing academic performance and attitude toward learning science, such as in a study by Macapagal and Dacut (2019) on grade 7 students.

Similarly, a study by Manaois and Castañeda (2017) developed IBL materials for secondary mathematics in collaboration with mathematics educators and mathematicians. The study showed that the use of IBL materials resulted in higher engagement and interest among students and improved their problem-solving skills.

These legal bases and studies suggest that the use of IBL in Philippine education is not only supported by policies but also has positive effects on students' academic performance and attitudes toward learning. The use of inquiry-based learning (IBL) in Philippine education, as supported by various policies and studies, is a response to the challenges faced by the country in terms of student achievement in international and national assessments such as the Trends in International Mathematics and Science Study (TIMSS) and the National Achievement Test (NAT).

In the TIMSS 2019, the Philippines ranked 54th out of 58 participating countries in science and 57th out of 58 in mathematics. Similarly, in the NAT results for the last ten years, only around 50% to 60% of students were able to meet the proficiency level in subjects such as science and mathematics.

Based on the results of the National Achievement Test (NAT) for the last ten years, science got an average MPS of 52.83 which is significantly lower than the target of 75 MPS. As such, the Department of Education (DepEd) issued a memorandum that recommends enhancing the competencies needed to improve the performance of all students across the country. One recommendation state that “provide supplementary materials to enhance the competencies of those in schools with more than one shift as an enabling mechanism to extend time.” (“NAT overview and 2012 test results”, p 28). The low MPS in science got by Grade 10 students would mean low mastery of the learning competencies. This would result in a learning gap once they reached senior high school.

In the Bicol Region, science got an average MPS of 49.88. In the Division of Sorsogon, there is an increasing trend in the NAT IV MPS in science for the last four school years. Based on the results, the students obtained an average MPS of 43.52. On the other hand, in Gubat Cluster, the students obtained an average MPS of 44.69. Both results are below the required standard which is 75. As such the division issued a memorandum encouraging school heads and teachers to design and implement creative and innovative strategies or measures to continuously improve the NAT MPS in Science.

According to the government's K-to-12 program, senior high school learners must have the necessary abilities for their future employment. Therefore, to develop those skills, effective and pertinent teaching techniques are required. To support this mission, Section 10.2 (e) Implementing Rules and Regulations for R.A. 10533 otherwise known as the Enhanced Basic Education Act of 2013 explicitly stated that “The curriculum shall use pedagogical approaches that are constructivist, inquiry-based, reflective, collaborative and integrative”.

Moreover, DepEd Order No. 39, s.2016 aims for learners to have a child-friendly, gender-sensitive, safe, and motivating learning environment. Educators are urged to conduct evidence-based studies under the research agenda, particularly on teaching methods, lesson plans, and educational materials. Inquiry-based learning activity sheets align with this goal under research agenda theme 1: Teaching and Learning.

The Philippines' K to 12 basic education program has been in place for over a decade, but there is still a lack of available learning materials, particularly for Senior High School Modeling. To address this, the DepEd created the Learning Resources Management and Development System (LRMDS) to increase access to teaching, learning, and professional development resources. However, there are currently only 582 learning resources available for senior high school, with only 11 resources for Physical Science in Grade 11. Likewise, there is no available learning material for Physical Science in the region and division, unlike other core subjects in senior high school.

Senior high school teachers in the Gubat cluster face challenges in enhancing teaching instruction due to these limited resources. This has prompted the teacher-researcher to develop learning activity sheets for physical science, which can be used by both teachers and students. The researcher conducted the study also because of poor student performance in physical science in the past years.

The researcher believes that despite the limited resources, a teacher's commitment to their profession and their students can make a significant difference in the quality of education. Teachers can act as influential change agents in their communities by fostering a

growth mindset and motivating their students to overcome challenges, enabling them to realize their full potential despite limited resources and other adversities.

Statement of the Problem

The study aimed to develop and validate the inquiry-based learning activity sheets in Physical Science for Grade-11 ABM students at Gubat National High School for the school year 2022-2023.

Specifically, it sought answers to the following problems:

1. What inquiry-based learning activity sheets may be developed in Physical Science along the following topics:

    a. Aristotelian vs. Galilean views of motion,
    b. Freefall,
    c. Graphing motion,
    d. Acceleration, and
    e. Newton's Laws of Motion?

2. What is the validity of the developed learning activity sheets based on DepEd LRDMS along:
    a. Content, and
    b. Mechanics?

3. How effective are the developed inquiry-based learning activity sheets in improving the performance of the students in Physical Science along the identified topics?

II. METHODOLOGY

This study aimed to develop and validate the inquiry-based learning activity sheets in Physical Science for Grade 11 students. This study also determined the validity of the said instructional materials along content and mechanics. In general, this study utilized the developmental research design. The developmental research method is a systematic approach to designing, developing, and evaluating instructional processes and products. The method involves iterative cycles of design, development, and evaluation, with the goal of improving both the instructional product and the process of instruction itself. The criteria for success in this method are both internal consistency and effectiveness, meaning that the instructional product should be internally coherent and logically consistent, while also achieving its intended learning outcomes Gustafson and Branch (2012).

In addition, the one-group pretest-posttest pre-experimental design was used to obtain quantitative data, specifically to investigate the intervention pertaining to the utilization of the developed learning activity sheets. The one-group pretest-posttest design is a type of quasi-experiment in which the outcome of interest is measured twice: once before and once after exposing a non-random group of participants to a certain intervention/treatment. The one-group pretest-posttest design has 3 major characteristics: (1) The group of participants who receives the intervention is selected in a non-random way — which makes it a quasi-experimental design;(2) the absence of a control group against which the outcome can be compared; and (3) the effect of the intervention is measured by comparing the pre-and post-intervention measurements (the null hypothesis is that the intervention has no effect, i.e. the 2 measurements are equal).

Before the conduct of the study, the researcher prepared a request letter addressed to the schools' division superintendent for proper approval. The researcher also asked permission from the School Head/Principal and Science Subject Group Head through a formal letter to administer the test and to gather the data and information significant to the study.

After the approval was granted, the researcher personally conducted the pretest on January 27, 2023 to the group. The respondents were given instructions on the manner of answering the test. They were given one hour to answer the 40-item multiple-choice test. The test papers and answer sheets were retrieved by the researcher right after the examination and the results were checked, recorded, and made available for statistical interpretation.

The physical science class of the single group was scheduled. An orientation about what inquiry-based learning was all about was done in the first session. The researcher also asked the group to create a messenger group chat exclusively for them. The presentations, enrichment activities, and students' outputs were sent to the said group chat. The group received lessons on Mechanics in Grade 11 Physics utilizing the developed learning activity sheets. They were personally taught by the researcher.

The identified topics learned by the respondents were Aristotelian vs Galilean views of motion, freefall, graphing motion, and Newton's Laws of Motion. These

topics were taken from the K to 12 Curriculum Guide of DepEd. After discussing all the identified topics, a posttest was administered on March 16, 2023 to the group. The respondents were oriented about the nature of the test. They were given enough time to answer the test questions. The test papers and answer sheets were collected right after the time had finished and were subjected to checking and recording purposes.

The data gathered were tallied, analyzed, and interpreted with the use of statistical tools to determine the level of performance of the group. The entire duration of activity lasted for 28 school days starting from the pretest to the posttest.

The researcher used the evaluation tool based on DepEd LRMDS to ensure the validity of the developed LAS in deepening the understanding of Aristotelian vs Galilean views of motion, freefall, graphing motion, acceleration, and Newton's laws of motion. Weighted mean was used in determining the validity of the instructional material. This is utilized in analyzing the ratings of the experts on the indicators in which the inquiry-based LAS is evaluated along content and mechanics. The interpretations of mean rating obtained are the following:

Mean Rating	Description
4.50-5.00	Very Evident
3.50-4.49	Evident
2.50-3.49	Adequately Evident
1.50-2.49	Fairly Evident
1.00-1.49	Not Evident

The study sought to determine the effectiveness of the developed inquiry-based learning activity sheets in improving the performance level of students in physical science. To evaluate the effectiveness of instruction, the researcher employed a pretest and posttest design, which measured the students' scores before and after the instructional intervention. The mean score was computed by summing up all the individual scores and dividing it by the total number of students in the population, allowing for a comparison of the students' performance across the two tests. This analysis enabled the researcher to determine the level of improvement achieved through the instructional intervention. The researcher adopted the scale from DepEd Order No.8, s. 2015 to determine the performance level and description of the students in the pretest and posttest. The performance level and its corresponding description are as follows:

Performance Level	Description
96%-100%	Outstanding
85%-95%	Very Satisfactory
80%-84%	Satisfactory
75%-79%	Fairly Satisfactory
Below 75%	Did Not Meet the Expectations

To test whether there is a significant difference between scores in the pretest and the posttest, the researcher utilized the t-test for dependent variables or paired sample t-test. The paired sample t-test is a statistical test used to compare the means of two related groups of scores, where the same subjects are measured twice, such as before and after a treatment or intervention (Aron, Aron, & Coups, 2019).

III. RESULTS AND DISCUSSIONS

The presentation and analysis of the data were as follows: 1) development of inquiry-based learning activity sheets along Aristotelian vs Galilean views of motion, freefall, graphing motion, acceleration, and Newton's laws of motion; 2) validation of the developed learning activity sheets based on DepEd LRMDS along content and mechanics; and 3) effectiveness of the developed learning activity sheets along the identified topics.

1. Development of Inquiry-based Learning Activity Sheets (LAS)

This section discusses the development of inquiry-based learning activity sheets along Aristotelian vs Galilean views of motion, freefall, graphing motion, acceleration, and Newton's laws of motion. The topics and competencies included were based on the most essential learning competencies (MELC) in Physical Science such as 1) Compare and contrast the Aristotelian and Galilean conceptions of vertical, horizontal, and projectile motion. (S11/12PS-IVc-46), 2) Explain how Galileo inferred that objects in a vacuum fall with uniform acceleration. (S11/12PS-IVc-47), 3) Explain how the position vs. time graph and velocity vs time graph of constant velocity motion differs from that of constant acceleration motion. (S11/12PS-IVc-48), 4) Recognize that everyday usage and the Physics usage of the term "acceleration" differ. In Physics, an object that is slowing down, speeding up, or changing direction is said to be accelerating. (S11/12PS-IVc-49); and 5)

Explain Newton's three laws of motion. (S11/12PS-IVc-50).

The developed learning activity sheets utilized the 7Es instructional model with the following parts: Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend. The developed LAS also have the features of an inquiry-based strategy wherein the students were able to learn through both guided and open inquiry activities. Each LAS contained the basic parts of the LAS anchored on Regional Memorandum No. 86 s.2020 such as the header, introduction, most essential learning competencies from the curriculum guide, learning objectives, activities, reflection, answer key, and references.

- ***Learning Activity Sheet 1***

Learning activity sheet 1 is entitled "Aristotelian vs Galilean Views of Motion". It addresses the competency of comparing the ideas of Aristotle and Galileo on horizontal motion, vertical motion, and projectile motion. The engage part aims to tap into students' prior ideas about the ideas of Aristotle and Galileo on different types of motion. The inquiry-based approach is utilized by letting the students design their investigation, developing their critical thinking skills. In the explain phase, the opposing views of Aristotle and Galileo on different types of motion were discussed, providing a narrative on their different approaches in philosophy and science to deepen learners' understanding.

In the evaluate phase, a table was provided to compare Aristotle and Galileo's ideas on different types of motion, and learners were asked to supply the table based on the curriculum's learning competency. The enrichment activity in the extend phase was made to apply the concepts learned, discussing the strengths and weaknesses of Aristotelian and Galilean views of motion and how they have influenced the understanding of motion in different fields. Overall, the activities utilized the inquiry-based approach through exploration, promoting critical thinking and a deeper understanding of the opposing views of Aristotle and Galileo on different types of motion.

- ***Learning Activity Sheet 2***

The second LAS is all about projectile motion. To activate students' prior knowledge, students were asked what is depicted in the picture shown. Inquiry-based learning is evident in this activity since the students related their previous experiences to the type of motion being shown. To engage the learners, an activity on unjumbling words was presented. The open-inquiry activity in the explore phase allows students to make their hypotheses and procedures, do observations, and draw conclusions. In the 2nd activity, students' critical thinking skills were enhanced by video analysis.

The explain phase shows coherence and excellent organization in discussing projectile motion, starting with the definition of a projectile and followed by discussions on its horizontal and vertical components. The elaborate phase presented a table of comparison to help students understand that the projectile's horizontal and vertical motions are independent of each other. In the evaluate phase, the assessment given was parallel to the learning objectives and activities. In the extend phase, students explored more advanced concepts using projectile motion simulation software, providing opportunities to deepen their understanding of core concepts and develop new skills beyond what is covered in their regular curriculum.

- ***Learning Activity Sheet 3***

LAS 3 is entitled "Freefall". The focus of this LAS is to explain the rate of falling of objects of different masses and surface areas. The learners were expected to explain how Galileo inferred that objects in a vacuum fall with uniform acceleration.

The explore phase consists of two activities, guided-inquiry, and open-inquiry, which allow students to maximize their scientific abilities and skills. The content for this phase was obtained from various internet sources and teaching materials. In the explain phase, the discussion on Galileo's thought experiment was presented comprehensively, and operational concepts were logically explained. Additionally, a sample problem with a complete solution was provided, and concepts of freefall and air resistance were elaborated. The illustrations and concepts presented in this phase were taken from online sources. In the evaluate phase, students were encouraged to defend their answers, which helps in developing critical thinking skills. For enrichment activities, students are asked to provide a written reflection or research project on the history of freefall and modern physics.

- ***Learning Activity Sheet 4***

LAS 4 is entitled "Position vs Time Graph", which is a subtopic of Graphing Motion. Its focus is on describing the position vs time graphs of constant velocity and

constant acceleration. Learners are expected to interpret the object's motion by computing the slope of the graph. For the elicit and engage phase, students are asked to rearrange the letters to define a graph. Basic knowledge of graphing is required in the discussion of position vs time graph and velocity vs time graph.

In the explore phase, students completed two activities, one of which was an open-inquiry activity where they related the slope of the position vs time graph to the object's velocity. In the explain phase, the topic was introduced with a description of the position vs time graph and followed by p-t graphs of different types of motions. The compare and contrast approach used in the elaborate phase presented p-t graphs of constant velocity and constant acceleration to facilitate learners' understanding of the concepts. In the evaluate phase, a simple assessment was given parallel to the learning objectives to foster higher-order thinking skills. Furthermore, an enrichment activity was assigned to the learners to write a short story of any genre from the given graph. This task allowed the students to be creative and develop skills in critical thinking, writing, mathematics, and communication.

- ***Learning Activity Sheet 5***

The 5th LAS is entitled "Velocity vs Time Graph", which is another subtopic on Graphing Motion. It is expected that learners be able to relate the shape and slope of the velocity vs time graph to the acceleration of the object. The lesson begins with the elicit and engage phase, where students recall previous concepts to better connect new information. In the explore phase, three activities target specific learning objectives, encouraging curiosity, exploration, diverse learning styles, collaboration, and reflection. The explain and elaborate phase presents ideas logically, supported by illustrations that challenge students to analyze and interpret visual information, developing critical thinking skills. In the evaluate phase, students are assessed with multiple-choice questions and analyzing a given velocity vs time graph, while in the extend phase, they apply learned concepts to real-life scenarios by creating a velocity vs time graph for a rollercoaster.

The inquiry-based learning approach promotes the development of various skills necessary for success in the 21st century, including data literacy, analytical skills, critical skills, problem-solving, communication skills, and creativity. The use of various activities, assessments, and enrichment activities supports this approach, encouraging students to think critically and apply their knowledge in meaningful ways.

- ***Learning Activity Sheet 6***

The LAS on Acceleration aims to teach students about the difference between everyday and Physics usage of the term "acceleration" and the concept of positive and negative acceleration. In the elicit and engage phase, previous knowledge on the topic is elicited through questions to encourage critical thinking. The explore phase includes varied activities that require students to be critical thinkers, analytical, investigative, and imaginative.

The explain and elaborate phase presents information systematically from the curriculum guide and internet sources, with the "Watch Out!" section addressing student misconceptions. In the evaluate phase, learners' understanding is assessed through a test that requires justification and examples. In the extend phase, students relate the topic to daily life activities to increase relevance, understanding, critical thinking, and transferability of knowledge, which is the essence of inquiry-based learning.

- ***Learning Activity Sheet 7***

The 7th LAS focuses on Newton's 1st Law of Motion or the Law of Inertia. In the elicit and engage phase, students were asked questions and did a simple activity to connect academic concepts to their own lives and understand their application to the world around them. In the explore phase, varied activities were presented to encourage critical thinking and problem-solving skills. In the explain phase, everyday applications of the law of inertia were presented, and the information was obtained from internet sources and relevant materials available. In the evaluate phase, questions were asked to test students' understanding of the concepts, and an enrichment activity called the "Mindful Movement Challenge" was given as a way for students to explore Newton's 1st Law of Motion through mindfulness and body awareness.

Understanding the physics behind daily activities can help improve decision-making, performance, and resource optimization while inspiring curiosity and wonder about the natural world. By providing students with opportunities to apply their knowledge in real-life situations, inquiry-based learning can help them develop critical thinking, problem-solving, and analytical skills.

- ***Learning Activity Sheet 8***

The 8th LAS focuses on Newton's 2nd Law of Motion and the relationship between mass and acceleration. The lesson is designed to help learners demonstrate the law of acceleration through various activities. In the elicit phase, students were asked to recall key terms such as force, mass, and acceleration to establish a shared understanding of the concepts that will be used throughout the lesson. In the engage phase, thought-provoking questions were posed to generate excitement and spark interest in the topic.

The explore phase includes two activities, one utilizing guided inquiry and the other open inquiry, to provide a well-rounded and engaging learning experience that fosters critical thinking, collaboration, creativity, and student ownership of their learning. Discussions on the 2nd law of motion were presented in the explain phase, with sample problems provided to assist learners in applying the equation to problem-solving. The evaluation phase includes both conceptual understanding and operational knowledge assessments, and the extend phase involves learners creating a video script to apply what they have learned.

- ***Learning Activity Sheet 9***

The LAS on Newton's 3rd law of motion focuses on explaining the law of interaction, identifying action and reaction forces, and comparing their magnitude and direction. The explore phase includes activities that use guided and open inquiry tasks, such as making a rocket balloon and investigating its kinematics. This phase allows students to develop a deeper understanding of the topic, develop critical thinking and problem-solving skills, and foster a scientific mindset.

In the explain phase, a detailed discussion on the Law of Interaction is presented, which includes explanations on paired forces, several examples of paired forces, and identification of action and reaction forces. For enrichment, students are asked to apply their knowledge of Newton's three laws of motion through personalized tasks such as composing songs, rap, spoken poetry, educational video, or poster. This allows for personalization of learning, increased motivation, and promotion of diversity while emphasizing problem-solving and critical thinking skills.

In summary, the study utilized an inquiry-based approach to enhance active engagement and higher-order thinking skills in Physical Science learning activity sheets. This approach is grounded on constructivism and Hull's contextual learning theory, which emphasizes that students construct ideas from their experiences and that learning takes place when new information is processed in a way that makes sense to students. The 7Es instructional model was employed to guide the inquiry-based approach, with a strong emphasis on student-centered, active learning, and inquiry. This approach was found effective in developing students' mastery in science concepts and basic science process skills, as concluded in a previous study. The inquiry-based method used in the study aims to improve students' performance in physical science and could be used as additional instructional material to help students learn more effectively.

2. Validation of the developed Learning Activity Sheets (LAS) based on DepEd Learning Resource Management Development System (LRMDS) along Content and Mechanics

This section includes the validation of the developed learning activity sheets utilizing the DepEd LRMDS in along content and mechanics. The validation was conducted by five (5) master teachers and science teachers with at least five years of experience in teaching science. The LAS was examined and assessed using DepED LRMDS for content and mechanics. The experts also provided comments and suggestions for further improving the developed LAS, which the researcher considered when revising the LAS.

Content. To master the learning competencies, it is necessary to develop content-based instructional materials. Teachers typically regard this as a vital component of any learning resource since it serves as the foundation for the development of any subject to be delivered to students. Teachers must ensure that this factor is considered for the success of students' learning.

Table 1A presents the validation of LAS along content and includes the 12 indicators, weighted mean, and the interpretation of data. From the table, it is evident that the developed LAS followed the standards and appropriate pedagogies for the learning area as manifested by the overall weighted mean of 4.86. Looking at each indicator, it can be noted that the experts rated the nine LAS with weighted mean that ranges from 4.69 to 5 which is interpreted as very evident. It further revealed that indicator 1 got a perfect weighted mean of 5. However, the remaining indicators, although below 5, are also interpreted as very evident.

Table 1A: Validation of the Developed LAS along Content

Indicators	Weighted Mean	Interpretation
1. Learning objectives are anchored on the MELC.	5.00	Very Evident
2. Learning objectives are appropriately sub-tasked for the lesson	4.93	Very Evident
3. The LAS provides an appropriate introduction on what the learners are expected to do and learn in the lesson.	4.89	Very Evident
4. The LAS provides an activity, task, or complementary material that will enhance the learner's understanding of concepts.	4.89	Very Evident
5. Activities in the LAS are logically sequenced and arranged from simple to complex.	4.87	Very Evident
6. The number of activities is just enough and appropriate to meet the individual learning needs of learners.	4.80	Very Evident
7. The LAS provides varied and interesting activities.	4.78	Very Evident
8. Questions and tasks allow for the development of higher-order thinking skills.	4.80	Very Evident
9. The directions for activities are simple and clear to guide learners or home learning facilitators.	4.85	Very Evident
10. The LAS provides assessment strategies that are aligned with the lesson objectives.	4.87	Very Evident
11. A rubric is provided for assessment strategies that require for it.	4.98	Very Evident
12. Sources references, supplementary, and complementary materials including images and graphics used in the LAS are cited.	4.78	Very Evident
Overall Weighted Mean	4.87	Very Evident

The study developed learning activity sheets that are suitable for learners' level of development, promote creativity and innovation, and improve skills such as communication, teamwork, and leadership. The activity sheets were found to be effective in teaching basic science concepts, and the experts considered them feasible instructional materials for improving learners' performance. The findings are consistent with the study conducted by Monding and Bunel (2021), which also showed that the worksheets developed were effective instructional materials for teaching basic science concepts. Both studies demonstrate the effectiveness of utilizing well-designed instructional materials in teaching and improving students' understanding and appreciation of the subject matter.

Mechanics. Instructional materials offered to learners should have specific features to ensure their effectiveness, particularly on the part of the clientele. Teachers should be aware that the procedure for developing any learning resources should be considered. Instructional materials should be carefully designed to align with the learners' needs, interests, and abilities to promote active and engaged learning and foster a lifelong love of learning.

The development of effective instructional materials requires good mechanics, which involve the proper use of formatting, layout, and design principles to create visually appealing and easy-to-read materials. The use of graphics, multimedia, and interactive features can enhance engagement and improve learning outcomes for learners. The developed learning activity sheets in the present study evidently followed the mechanics prescribed by DepEd LRMDS and were evaluated by five identified experts. The overall weighted mean of the validation of the developed LAS along mechanics was 4.75, which is interpreted as very evident. All indicators along mechanics in the validation tool have very evident weighted means ranging from 4.58 to 4.91.

The language used in instructional materials plays a crucial role in their effectiveness. The learning activity sheets developed in the present study used vocabulary that was within the learner's level of competence in the language used. The weighted mean of the indicator that stated this was 5.0, indicating that the experts perceived the language as appropriate for Grade 11 students. Using vocabulary that is within the learner's level of competence is important in creating effective learning activity sheets, as it improves comprehension, engagement, language development, and confidence.

Table 1B contains the weighted means and interpretation on the validation of the developed learning activity sheets along mechanics.

The data revealed that the developed LAS evidently followed the mechanics prescribed in the DepED LRMDS as evaluated by the five identified experts with an overall weighted mean of 4.75, which is interpreted as very evident. Further, it can be noted that all indicators along mechanics in the validation tool have very evident weighted means ranging from 4.58 to 4.91.

From Table 1B, it can be deduced that the weighted mean of indicator 1 which states that the learning activity sheets use vocabulary that is within the learner's level of competence in the language used was 5.0. This clearly means that the experts perceived that the language is appropriate for Grade 11 students.

Table 1B: *Validation of the Developed LAS along Mechanics*

Indicators	Weighted Mean	Interpretation
1. The LAS uses vocabulary that is within the learner's level of competence in the language used.	4.76	Very Evident
2. The length and structure of sentences are appropriate to the learners.	4.69	Very Evident
3 The LAS is free from grammatical, factual, and computational errors.	4.58	Very Evident
4. The LAS is free from violations of social content guidelines.	4.73	Very Evident
5. The total number of pages of the LAS is sufficient to carry out the intended lesson.	4.89	Very Evident
6. The ready-to-print LAS is properly encoded and laid out according to the required specifications for the grade level.	4.91	Very Evident
7. The electronic LAS is formatted to be accessible and usable in any electronic device i.e., computer, tablet, android phone, etc.	4.71	Very Evident
Overall Weighted Mean	4.75	Very Evident

The use of appropriate vocabulary in learning activity sheets (LAS) is crucial to ensure effective learning. Using vocabulary that is within the learner's level of competence can improve comprehension, engagement, language development, and confidence.

The study on the LAS developed for teaching basic concepts in physical science showed that the use of appropriate vocabulary and well-organized instructional materials can help students better understand scientific concepts and improve their learning outcomes.

The study also verified previous findings that the organization and presentation of classes evaluated by students and instructors are highly accepted.

The study by Lundeberg et al. (2011) also supports this by suggesting that providing clear and organized instructional materials, such as graphic organizers, can help students better understand complex scientific concepts.

Furthermore, Tambongco's (2021) study on the evaluations of students and instructors of generated materials showed that language and style are essential in creating effective instructional materials. In summary, the provision of relevant, well-organized, clear, and effective instructional materials is crucial in studying science. It can enhance understanding, provide context, increase engagement, facilitate critical thinking, and improve retention, as supported by the cited studies.

3. Effectiveness of the developed Learning Activity Sheets

Teachers are instrumental in creating effective instructional materials that can improve student learning outcomes. They have the expertise to design materials that are relevant, well-organized, and engaging, tailored to the specific learning styles and abilities of their students.

Effective instructional materials can support students in developing a deeper understanding of the subject matter and improve motivation and academic achievement.

To excel as educators, teachers must possess key attributes such as creativity, talent, resourcefulness, dedication, and a commitment to staying current with the latest developments in their field.

Table 2A: *Pretest and Posttest Performance of the Students*

Topics	Pretest		Posttest	
	PL	Description	PL	Description
Aristotelian vs Galilean views of motion	46.67	DNME	93.33	VS
Freefall	63.33	DNME	90.48	VS
Graphing motion	59.63	DNME	97.78	O
Acceleration	42.50	DNME	83.33	S
Newton's laws of motion	49.26	DNME	93.70	VS
Mean PL	52.28	DNME	91.72	VS

Legend: PL-Performance Level; DNME-Did Not Meet the Expectations; VS-Very Satisfactory; S-Satisfactory; O-Outstanding

Table 2A contains the performance level of the students in the pretest and posttest in utilizing the developed learning activity sheets of the selected topics in physical science. As reflected in the table, the group got a low rating in the pretest along the five topics. The ratings of the group were described as did not meet expectations. The result inferred that the students scored low on the pretest. This may be attributed to the spiral progression of topics under the K to 12 Curriculum as well as the learning gaps caused by remote learning during the pandemic. According to Kuehn (2019), students are not expected to know the answers to all the questions in a pretest, however, students should be expected to utilize previous knowledge to predict rational answers.

Further, the descriptive rating did not meet the expectations meant that the students needed more improvements in terms of achieving the target performance level of 75 % by DepEd Order No.8, s. 2015. This result is similar to the study of Escultura (2019), on the study of the effectiveness of the Whole Brain Teaching Strategy (WBTS) in teaching Waves. He revealed that the level of performance in the pretest of the control group and experimental group were equal. This meant that the two groups may have the same knowledge and skills in the subject matter prior to the intervention used by the teacher. The observed statistical difference between the pretest and posttest scores of students who were exposed to the developed learning activity sheets indicates a discernible improvement in their knowledge acquisition related to the specific subject matter. This implies that the learning activity sheets were effective in facilitating the learning process, and students were able to assimilate and internalize the knowledge embedded in the instructional materials. Consequently, teachers can utilize these materials as tools for facilitating the learning process, with students playing an active role in their own learning while teachers act as facilitators of the educational process.

The research findings suggest that the use of inquiry-based learning activity sheets in teaching physical science concepts can lead to a statistically significant improvement in student learning outcomes, which is consistent with previous studies emphasizing the benefits of incorporating visual and textual elements in learning materials. Inquiry-based learning activity sheets can also promote student-centered learning, which can increase learner motivation and interest, leading to better learning outcomes.

Table 2B: *Difference between the Pretest and Posttest Results of the Students along the Identified Topics*

Statistical Bases	Aristotelian vs. Galilean views of motion	Freefall	Graphing motion	Acceleration	Newton's Laws of Motion
Computed t-value	14.16	6.67	13.18	15.33	12.58
Decision on Ho	Reject	Reject	Reject	Reject	Reject
Conclusion	Sig	Sig	Sig	Sig	Sig

Legend: α=0.05 df= 29 Critical Value = 2.045 Sig – Significant

Table 2B presents the statistical bases and statistical analyses of the difference between the pretest and posttest of the students in using the developed learning activity sheets along the identified topics. The t-test for dependent samples was used in testing the difference whether it is significant or not.

Table 2B shows the difference between the pre-test and posttest results of the students along the identified

topics. As reflected, the computed t-values of 14.16, 6.67, 13.18, 15.33, and 12.58 for topics such as Aristotelian vs. Galilean views of motion, freefall, graphing of motion, acceleration, and Newton's laws of motion, respectively are higher than the critical value of 2.045 at a 0.05 level of significance and 29 degrees of freedom. Therefore, the null hypothesis is rejected. Hence, there is a significant difference between the pretest and posttest results of the students along the said topics. This implies that the use of the developed instructional materials may have improved their performance.

The results of the study provide evidence that the implementation of well-designed learning activity sheets can enhance students' mastery and comprehension of the selected subject matter. The statistically significant difference observed between the mean pretest and post-test scores along the identified topics confirms the effectiveness of the developed instructional materials. These findings are in line with previous research that highlights the role of instructional materials in facilitating the delivery of organized and structured lessons to learners (Akpan and Akpama, 2021). It emphasizes that instructional materials should be well-designed, relevant, and engaging to enhance learning outcomes. The results are also consistent with the findings of Oyekanmi and Oyekanmi (2021), who recommends that teachers should integrate instructional materials into their teaching to promote effective learning outcomes.

The study's findings emphasize the importance of designing and implementing effective instructional materials to enhance the quality of education. By providing teachers with well-designed learning activity sheets, students can have a more structured and organized learning experience that promotes retention and application of knowledge. The results also provide insights into the need for teachers to embrace instructional materials as an essential component of teaching, as they play a crucial role in supporting the learning process and enhancing students' understanding of the subject matter.

The current analysis supports the results presented in Table 2B, which provides evidence for rejecting the null hypothesis, stating that there is no significant difference between the pretest and posttest scores of the students. Furthermore, the study concludes that the researcher-developed instructional materials have a positive impact on the students' academic performance. These findings suggest that the developed learning activity sheets are an effective tool for promoting performance and mastery levels in physical science among students.

The research demonstrates the value of incorporating instructional materials that are specifically designed to enhance students' academic performance. Additionally, the findings highlight the critical role that instructional materials play in facilitating the delivery of well-structured lessons.

These results demonstrate the effectiveness of the developed learning activity sheets in improving students' academic performance and serve as a valuable resource for educators seeking to enhance the quality of instruction in physical science.

FINDINGS

Based on the analysis and interpretation of the data, the following findings were revealed:

1. Nine (9) inquiry-based learning activity sheets in physical science were developed along 1) Aristotelian vs Galilean views of motion, 2) Freefall, 3) Graphing Motion, 4) Acceleration, and 5) Newton's Three Laws of Motion.
2. The validation along content received the overall weighted mean of 4.86, which is interpreted as very evident. The experts unanimously rated the nine LAS with a weighted mean ranging from 4.69 to 5 which is interpreted as very evident. Along mechanics, the overall weighted mean is 4.75, which is interpreted as very evident. Along mechanics, the LAS was rated with weighted means ranging from 4.58 to 4.91, which is also interpreted as very evident.
3. It revealed that at 0.05 level of significance and 29 degrees of freedom, the computed t-value of 14.16, 6.67, 13.18, 15.33, and 12.58 for topics such as Aristotelian vs. Galilean views of motion, freefall, graphing of motion, acceleration, and Newton's laws of motion, respectively are higher than the critical value of 2.045. This meant that the null hypothesis was rejected. Therefore, the pretest and posttest performances of the group along the identified topics had significant difference.

CONCLUSIONS

Based on the findings of the study, the researcher arrived at the following conclusions:

1. The developed inquiry-based learning activity sheets in physical science were Aristotelian vs Galilean views of motion, freefall, graphing motion, acceleration, and Newton's three laws of motion, which utilize the 7E's lead towards the attainment of most essential learning competencies.
2. The developed inquiry-based learning activity sheets are valid along content and mechanics.
3. The developed inquiry-based learning activity sheets are effective in improving the performance of students in physical science.

RECOMMENDATIONS

Based on the results and in the light of the findings and conclusions drawn, the following recommendations are proposed:

1. The developed inquiry-based learning activity sheets in physical science may be further enhanced through the integration of contextualization to improve the performance of the learners. The developed learning activity sheets may be subjected for further validation and acceptability using other criteria.
2. The effectiveness of developed inquiry-based learning activity sheets may be further tested using a robust experimental design.
3. Future research on the development and validation of instructional materials is encouraged to reinforce in teaching various fields of science and across different disciplines at other academic strands and TVL strands in senior high school.

ACKNOWLEDGMENT

The researcher expresses deep gratitude and appreciation to those who provided support and encouragement throughout the study, as their contributions were instrumental in its successful completion.

REFERENCES

[1] Agoot, J. E. A., Albia, K. O., & Estoque, J. C. (2021). Development and validation of a module on the integration of indigenous knowledge systems and practices (IKSP) in teaching biodiversity. Asia-Pacific Journal of Multidisciplinary Research, 9(2), 1-10.

[2] Balingit, R. A., Garcia, A. L., Rivera, R. E. A., & Pascua, P. L. P. (2020). Development and Validation of an Enhanced Worktext in Technical Drafting for Senior High School. Journal of Engineering and Applied Sciences, 15(9), 2448-2455.

[3] Caballero, C., Abello, R. & Palacio J. (2007). Relation of burnout to academic performance and students' satisfaction. Retrieved from https://scielo.org.co/pdf/apl/v25n2/v25n2a7.pdf.

[4] Cordero, E. D. (2017). Developing and validating modular teaching materials on algebraic factoring. Asia Pacific Journal of Multidisciplinary Research, 5(4), 15-21.

[5] Department of Education. (2012). Basic Education Sector Reform Agenda (BESRA) Framework. Retrieved from https://www.deped.gov.ph/wpcontent/uploads/2013/07/BESRA-Framework.pdf

[6] Estera, J. E., & Janer, S. (2021, November 5). Balidasyon Ng MELC-based Learning Activity Sheets sa Filipino sa Piling Larang Akademik. Puissant, 3, 366-380. Retrieved from //puissant.stepacademic.net/puissant/article/view/83

[7] Fives, H., & Barnes, N. (2021). The complex role of teachers in education research and reform: implications for teacher education. Journal of Teacher Education, 72(3), 255-267.

[8] Hani, M., Yasin, R. M., & Basir, S. A. (2018). The effectiveness of blended learning module in teaching secondary school mathematics. International Journal of Emerging Technologies in Learning, 13(3), 71-86. doi: 10.3991/ijet.v13i03.8104

[9] Justice, L. M., Owens, S. J., & Williford, A. P. (2022). The multifaceted role of teachers in supporting student well-being. Journal of Educational Psychology, 114(1), 1-13.

[10] K to 12 Science Curriculum Guide (2013), Republic of the Philippines, Department of Education, DepEd Complex, Meralco Avenue, Pasig city.

[11] Khan, M. A., & Saleem, M. (2021). Assessing the Validity of Science Textbooks at the Secondary Level in Pakistan. Journal of Education and Practice, 12(23), 150-157.

[12] Lee, Y. (2011). A study on the effect of teaching innovation on learning effectiveness with learning satisfaction as a mediator. World Transactions on Engineering and Technology Education, 9 (2), 92-101. Retrieved November 2022 from https://eric.ed.gov/?id=EJ10567728.

[13] Liao, Y.-C., & Wu, H.-K. (2021). The effectiveness of module-based teaching on physics achievement: An investigation of cognitive and affective outcomes. Journal of Research in Science Teaching, 58(3), 267-292. https://doi.org/10.1002/tea.21620

[14] Manaois, R. O., & Castañeda, M. S. (2017). Developing Inquiry-Based Learning Materials for Secondary Mathematics: A Collaboration between Mathematics Educators and Mathematicians. Journal of Science Education and Technology, 26(6), 668-678.

[15] Palomar, J. R. P., & Sadiwa, B. S. (2021). Learner-centered approach in the 21st century Philippine education: A review of literature. Journal of Educational and Social Research, 11(1), 73-78. DOI: 10.36941/jesr-2021-0012

[16] Pereira, M. V., Barros, S. S., Rezende Filho, L. A. C., & Fauth, L. H. A. (2012). Audiovisual physics reports: Students' video production as a strategy for the didactic laboratory. Physics Education, 47(1), 44–51. Retrieved September 2022 from https://doi.org/10.1088/0031-9120/47/1/44

[17] Shahid, H., & Siddiqui, U. H. (2019). Development and effectiveness of instructional modules in biology at secondary level. International Journal of Evaluation and Research in Education (IJERE), 8(2), 154-162.

[18] Tiglao, L. S. (2016). Teaching Science in the K to 12 Basic Education Curriculum. Retrieved from https://www.pressreader.com/.