LEARNER-DESIGNED EXPERIMENTS APPROACH: AN INNOVATIVE TOOL IN TEACHING SCIENCE AT LABORATORY JUNIOR HIGH SCHOOL OF PALAWAN STATE UNIVERSITY

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Research Article

Learner-Designed Experiments Approach: an Innovative Tool in Teaching Science at Laboratory Junior High School of Palawan State University

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Abstract

The study investigated the impact of learner-designed experiments on the instruction of Science 10 in terms of academic outcomes and subjective evaluations of students who were taught using the Learner-Designed Experiments Approach (LDEA) compared to those who received traditional classroom education. Additionally, it analyzed the correlation between academic achievement and the perception of science. The research was carried out at Palawan State University Laboratory Junior High School over ten weeks. A quasi-experimental approach was used, including forty Grade 10 students selected from the top and worst quartiles of the class. The Science teacher-researcher implemented two distinct teaching methods: the Learner-Designed Group (LDG) and the Traditional Teaching Group (TTG). The LDG got regular instruction using the LDEA approach, whereas the TTG received regular instruction using the standard teaching approach. Initially, it was discovered that Grade 10 students in TTG and LDG courses demonstrated good to extremely satisfactory academic performance in science and had favorable attitudes towards the subject. After conducting experiments for ten weeks, it was seen that the LDG class performed 3 points better than the TTG class. This improvement was statistically significant and was associated with the students' exposure to the LDEA teaching method in science. The research found a direct link between students' scientific performance and their impression of science, especially among experimental groups. These results provide evidence for the effectiveness of learner-designed experiments in improving scientific education and motivating instructors to pursue teaching strategies that foster 21st-century abilities.

Keywords: *Academic Performance, Learner-designed Experiments, Regular Classroom Instruction, Traditional Teaching Approach,, Experimental Group, Perception In Science, 21st-century Skills*

INTRODUCTION

The Department of Education aims to produce scientifically literate citizens who can apply scientific knowledge to impact society and the environment significantly. To achieve this, the Science Curriculum Framework for Basic Education emphasizes inquiry skills, including asking questions, designing and conducting investigations, and communicating results. The Science, Technology, Engineering, and Mathematics (STEM) track of the Philippine K to 12 – Enhanced Basic Education Curriculum is designed to develop learners' skills from simple to complex problems in science, technology, engineering, and mathematics.

Despite the government's efforts, Filipino students' performance in science and math still needs to improve. According to the National Assessment Test (NAT) and the Program for International Student Assessment (PISA), Filipino students need to improve in applying their knowledge to tasks. The World Economic Forum 2018 reports that the Philippines ranked 55th out of 137 countries in higher education and 76th in math and science education quality(Cariaga, 2023). Science teachers are challenged to be more innovative to improve student achievement and develop a favorable attitude towards science. Teachers need to re-examine how they teach science and move from a traditional method to a more productive one.

The Framework for Philippine Science Teacher Education prioritizes the facilitation of active inquiry, the observation and measurement of phenomena, the formulation of hypotheses, and the documentation of tasks. Research has shown that the implementation of practical experiments effectively supports students in enhancing their creative problem-solving abilities, promoting self-reliance, and enhancing their attitudes towards learning (Călinescu, 2023; Cariaga et al., 2024).Typically, students have a preference for activities that possess the qualities of being well-structured and authentic, using both commercially available and improvised resources, and taking place in a group or collaborative environment (Ginoo et al., 2023; El Halaissi et al., 2023).

This study aimed to determine the effect of designing simple laboratory experiments as an instructional approach to improve students' academic performance in science. The investigation focused on the instructional intervention's effect on students' affective domain.

Statement of the Problem

This study aimed to determine the effect of designing simple laboratory experiments as an instructional approach and a learning tool in teaching Grade 10 Science on the academic performance of Grade 10 students. Specifically, this study sought to answer the following questions:

1. What is the pre-and post-academic performance of Grade 10 students in science in both control and experimental groups?
2. What are the pre-and post-perceptions of Grade 10 students in science as a subject in terms of the following:
   a. students b. teacher, and c. science laboratory environment?
3. Is there a significant difference between control and experimental groups in terms of:
   a. pre-and post-academic performance, and b. pre-and post-perception towards science as a subject?
4. Is there a significant difference in the experimental group before and after the implementation of LDEA in terms of:
   a. academic performance, and b. perception towards science as a subject?
5. Is there a significant relationship between academic performance and student's perception towards science after the implementation of LDEA?

Literature Review

Learner-Designed Experiments

Educators play a crucial role in preparing learners for the world by using teaching methods that enable students to gain knowledge and acquire valuable skills. Active learning methods, such as guided inquiry learning, increase students' assessment performance compared to traditional lecturing (Călinescu, 2023; Cariaga, 2024; Freeman et al., 2014).

Inquiry learning involves students working through an inquiry cycle comprising several phases: orientation, conceptualization, investigation, conclusion, and discussion (Pedaste et al., 2015). The investigation phase is pivotal, as students design and conduct experiments to conclude. Crawford (2007) emphasizes that scientific inquiry should develop students' critical thinking skills, enabling them to deeply understand a topic and provide robust answers to research questions.

Tafa (2012) identified four levels of investigation, ranging from level zero (replicating known answers) to level three (students designing and conducting experiments). Guided-inquiry-based practical activities encourage students to develop their inquiring mindset. Newton et al. (1999) argue that traditional recipe based practical activities do not enhance students' thinking skills, whereas inquiry-based laboratory approaches are more effective.

Inquiry-Based Instruction

Inquiry-based instruction enhances the development of scientific knowledge (NRC, 2000). Herried (2007) and Hmelo-Silver (2004) highlight the importance of case study and problem-based learning in encouraging critical thinking and problem-solving. Kahn and O'Rourke (2004) state that inquiry-based teaching awakens students' curiosity, encouraging them to participate and actively seek out new knowledge.

Laboratory experiments, which are inquiry-based learning, support students in applying their knowledge, understanding real-world situations, and discovering scientific facts and principles. In inquiry-based learning environments, students are more active in guiding their own learning process (Evrim, 2016).

Epistemological beliefs are individual ideas about the nature of knowledge and its construction (Hofer & Pintrich, 1997). Investigative tasks engage students in scientific inquiry, including formulating questions, planning investigations, and analyzing data. Hodson (2009) emphasizes the importance of a complete investigation process, which includes design, planning, performance, reflection, and recording phases. Laboratory experiments support students in applying their knowledge, understanding real-world situations, and discovering scientific facts and principles.

Student's Perception Towards Science

Science instruction aims to develop students' scientific literacy, critical thinking skills, and ability to apply scientific knowledge to real-world situations (Zahradnik, 2018). Students' perception of science is crucial, affecting their performance and learning outcomes.

If students' perceptions of a lesson are good, they will feel encouraged and motivated to take it. Students with a positive perception of science will emerge enthusiastic about learning science, thus positively affecting student learning outcomes (Jebson et al., 2016). A positive attitude towards science has been reported to improve students' academic achievement in science and other subjects (Movahedzadeh, 2011).

RESEARCH METHODOLOGY

Participants

Data were collected from Palawan State University Laboratory Junior High School consisting of Grade 10 Mouse Deer and Grade 10 Bearcat. The target population for the study consisted of forty (40) Grade 10 students whose general average (G.A.) in Science 9 of the AY 2019 - 2020 falls on the upper and lower 25% of the total Grade 10 classes. The selection of this target population for both the control and experimental was taken through purposive sampling. The treatment was assigned through a random sampling method for two classes. The two class names were written on a rolled paper and placed inside an empty container. The first-class name drawn was assigned as the control group (TTG), while the other class was assigned as the experimental group (LDG). The distribution of students per class and the treatments are shown in Table 1.

Table 1. Students' Distribution Per Class and the Treatments

Section	Number of students per class	Actual Sample	Treatment
Grade 10 Bearcat	40	20	TTG: Exposed to traditional teaching only
Grade 10 Mouse Deer	40	20	LDG: With LDEA

The TTG group served as the control group since it received only traditional science instruction. The students in the LDG group were exposed to regular science instruction with a learner-designed experiments approach. The Hawthorne effect, also called the observer effect, was considered during the experimental period. This is a type of reactivity in which individuals modify an aspect of their behavior in response to their awareness of being observed (McCarney et al., 2007). To avoid the Hawthorne effect in the study and so that the two groups of students would not be aware that they were taking part in an experiment, the researcher did not single out the target population. Instead, the treatments were administered to the intact classes/sections, with only the researcher knowing who the 40 target students/population would be. This will allow the participants who will be part of the study to act normally and keep them unaware of their involvement. The intention was to ensure the internal validity of the study. Henry A. Landsberger (2012) stated that. individuals may alter their performance or behavior positively or negatively due to their awareness of being observed.

Instruments of the Study

The study used the 40-item assessment test and the student perception survey. The 40-item multiple choice test with four options was prepared based on the topics in Unit 1 about Earth and Space with three (3) chapters: Chapter 1- Into the Moving Earth, Chapter 2 - Along the Plate Edge, and Chapter 3 - The Blue Planet. The test included the following: a 20-item test on scientific concepts, ten items on scientific processes, and ten items on scientific skills categorized under knowledge, comprehension, application, and analysis cognitive level corresponding to the lessons in Unit 1. A table of specifications guided the construction of the achievement test based on the content coverage and learning competencies set for the topic. This was presented to two (2) science experts to ensure content validity. The evaluators' average rating of not less than three signified that the achievement test was valid. Items were revised based on comments/suggestions made. After validation, the instrument was pilot tested on October 26, 2020, on Grade 10 Pangolins through their Google Classroom before its administration to Grade 10 Mouse Deer and Grade 10 Bearcat that were involved in the study. Each item was analyzed for discrimination and difficulty indices with a reliability coefficient equal to 0.73.

Another instrument used in the study was a 30-item researcher–made student perception survey to determine how students feel and think about their science class, their perception of the students, the teacher, and their laboratory experiences. For internal consistency of the perception survey instrument, the responses of the pilot students were computed using Cronbach's Alpha test, which gave a reliability result of 0.897. The result signifies that the instrument was reliable and internally consistent. The surveys survey was administered before and after the implementation of the LDEA to assess their perception of their Science class in general.

Procedure

The researcher sought permission from the Palawan State University administration to conduct the study at the Laboratory Junior High School. Parental consent was secured for the students involved.

This study was implemented based on the result of the survey on the Readiness of 936 PSU LJHS Learners, Parents, and Teachers to Flexible Learning Options conducted in June 2020 with considerations on COVID-19 restrictions imposed by the City Government of Puerto Princesa and in compliance with the DepEd Required Health Standards for Covid-19 under DepEd Order No. 014, s. 2020. The online classes for synchronous sessions were conducted for four hours a week for two sections, one hour every day except Friday. For the LDG (10 Mouse Deer), synchronous sessions were scheduled every Tuesday and Wednesday from 2:30 PM – 3:30 PM and 10:30 AM – 11:30 AM respectively. Likewise, for the TTG (10 Bearcat), the synchronous sessions were scheduled every Monday and Thursday from 2:30 PM to 3:30 PM. The remaining two hours to complete a 6hour session for a week for two sections were allotted for the asynchronous sessions for students' consultation and feedback. This study was conducted in a cluster scheme, where science was scheduled in cluster 2. The class schedules for science were as follows: the first quarter took place from November 3 to December 12, 2020, and the second quarter from February 8 to March 25, 2021. The third quarter was held from April 12 to April 30, 2021, and the final quarter occurred from May 24 to June 11, 2021.

The actual experiment used Google Classroom as a learning management system (LMS) w. The university availed itself of this learning platform to capacitate teachers to implement and manage the adoption of flexible learning options based on the technology resources, readiness assessment results, and implementation plans. Modules, activity sheets, assignments, videos, tests, and other learning materials were stored in Google Drive and uploaded to their respective Google classrooms before the scheduled class.

To test students' prior knowledge of Earth and Space, the researcher administered a 40-item multiple-choice pretest and a 30-item researcher-made student perception survey to both the control and experimental groups during the first week of November 2020 before treatment. This was done by creating Google forms for the test and the survey and uploading them to their respective Google Classrooms during their virtual classes with an automatic time set for an hour.

Before implementing the Learner-Designed Experiments Approach in the experimental group, the topics of science laboratory room, laboratory experiment, laboratory safety precautions, designing a science laboratory experiment, and writing laboratory reports in Module 1 and 2 were discussed with the students for two weeks. They were oriented on the principles and importance of this instructional approach, including the guidelines and steps to design simple experiments. A template with thorough steps was provided as the students designed their experiments. The students designed three simple experiments for ten weeks as part of their performance tasks. The four phases involved in the implementation of the Learner-Designed Experiments Approach were as follows:

Phase 1: *Designing an Experiment* – The topics in Module 3: Into the Moving Earth, Module 4: Along the Plate Edge, and Module 5: Along the Plate Edge were presented and discussed with the students for the next three weeks. As part of the performance task activities, the students designed their experiment for each topic discussed using the outline in the Design Your Experiment Template uploaded in their Google Classroom. While designing their experiment, they were taught how to write and identify testable questions, develop appropriate experimental procedures, formulate hypothesis statements, and identify the dependent and independent variables based on the discussion about designing a science laboratory experiment in Module 2. Their output was assessed using an Inquiry Rubric reflecting the components of the scientific inquiry, process, and skills. Five modules were covered and discussed in this phase for six weeks.

Phase 2: *Preparing a Prelab Report*—Before experimenting, the students prepared a pre-lab report using the uploaded template for Lesson 5: Writing My Lab Reports to review the steps for writing a pre-lab report. Similar steps were followed for the other experiments. The prelab report write-up was graded out of a possible maximum score of 20 using a Prelab Report Rubric.

Phase 3: *Performing an Experiment* – After preparing a prelab report, the students reviewed their designed experiment, prepared the materials needed, and performed the experiment. They requested somebody in the household to take a video as they experimented. They noted the following tips in creating a video: (a) the video must have a minimum length of one minute and a maximum length of two minutes, and (b) the video must be uploaded to their Google Drive with a copy of the link of the uploaded video. Their laboratory performance was assessed using the Laboratory Performance Rubric.

Phase 4: *Preparing a Postlab Report*—Finally, the experimental group prepared the postlab report to

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describe the experiment being carried out in the laboratory and communicate the results. Using the Post-lab Report Rubric, the post-lab write-up was rated out of a possible maximum score of 30.

The traditional online science instruction was conducted to the control group through Google Classroom throughout the study. Before the performance of the experiments, the topics of science laboratory room, laboratory experiment, laboratory safety precautions, designing a science laboratory experiment, and writing laboratory reports in Module 1 and 2 were discussed with the students for two weeks. The students were provided three traditional recipe-based experiments to perform as part of their performance tasks. The attached laboratory activity sheets taken from the Grade 10 Laboratory Manual were used as a guide in doing the experiments. They were instructed to read thoroughly the background, objectives, and procedure indicated before answering the prelab questions. Then, they prepared the materials needed and started to experiment. Somebody from the household was asked to take a picture as the students experimented. These photos were attached to the template uploaded in their classwork with corresponding descriptions. Afterward, the post-lab questions were answered, including the results and conclusion parts of the experiment.

After ten weeks of the experiment, the researcher made a science test, and the questionnaire was administered again to the study participants for statistical analysis. The data gathered were cross-analyzed with the associated baseline data to determine if there were significant changes in their academic performance and perception after the experimental period.

Ethical Considerations

The researcher adhered to ethical principles and legal procedures throughout every phase of the study. Before the research was conducted, permission was obtained from the school authority. Respect, objectivity, and truthfulness were diligently maintained throughout the study. Parents or guardians of the participating students were requested to provide their consent, allowing their children to decline participation if they so choose. It was communicated to the students that their refusal to participate would not impact their grades.

The purpose and rationale behind the study were explained to the students. They were encouraged to respond truthfully to the questions and reassured that their identities and answers would be kept confidential. Furthermore, the data were recorded and tabulated professionally. Procedures were followed thoroughly to ensure authentic research outcomes without manipulation.

RESULTS AND DISCUSSION

Academic Performance of Grade 10 Students in Science. Tables 2a and 2b present the academic performance of Grade 10 students in the TTG and LDG classes before and after the treatment period.

Table 2a. Science Performance of Grade 10 Students in TTG Class

Science Performance	Pretest		Post-test	
	F	%	f	%
Outstanding (33 – 40)	1	*5.0*	2	*10.0*
Highly Satisfactory (25 – 32)	12	*60.0*	16	*80.0*
Satisfactory (17 – 24)	7	*35.0*	2	*10.0*
Reasonably Satisfactory(9 – 16)	0	*0.0*	0	*0.0*
Poor (0 – 8)	0	*0.0*	0	*0.0*
Total	20	*100.0*	20	*100.0*

Initially, the average academic performance of students in science with lecture discussion as an instructional strategy ranged from *satisfactory* to *highly satisfactory*. Specifically, the descriptive measures imply that for every ten (10) students, 1 has an *outstanding* Science performance, 6 have a *highly satisfactory* level, and 3 have a *satisfactory* level of performance.
Though the class did not have any additional teaching intervention, their average academic performance in science was higher during the post-test than their prescience performance. Numerically, from a total of 20 students, two are *outstanding*, 16 are *highly satisfactory,* and two are identified to have *satisfactory* performance in science. Though there was an observed increase in students' academic performance in science, this change required further statistical analysis to test for significance.

On the other hand, Table 2 b presents the academic performance of students who were exposed to the learner-designed experiments approach as an instructional strategy.

Table 2b. Science Performance of Grade 10 Students in LDG Class

Science Performance	Pretest		Post-test	
	F	%	f	%
Outstanding (33 – 40)	1	*5.0*	7	*35.0*
Highly Satisfactory (25 – 32)	12	*60.0*	13	*65.0*
Satisfactory (17 – 24)	7	*35.0*	0	*0.0*

Fairly Satisfactory	(9 – 16)	0	*0.0*	0	*0.0*
Poor	(0 – 8)	0	*0.0*	0	*0.0*
Total		20	*100.0*	20	*100.0*

During the pretest, the majority of the students in the LDG class fell under the category of *highly satisfactory level*, and a portion of the population had an *outstanding* and *satisfactory level* of Science performance. The result confirms that most Grade 10 students in LDG class initially performed satisfactorily in their Science subject.

However, after exposing the LDG Class to a learner-designed experiment approach, their Science scores improved from *satisfactory* to *outstanding*. Specifically, the figures in Table 4b suggest that for every ten (10) students, 3 to 4 students have *outstanding* Science scores, and about 6 to 7 students have *highly satisfactory* performance in science. However, this apparent improvement was tested further to determine whether the supplemental teaching approach improved the student's Science scores.

Perception of Grade 10 Students in Science. Tables 3a and 3b show the perception of the two groups towards their peers, teachers, and the Science laboratory experiments before and after the observation period.

Table 3a. Perception Towards Science of Grade 10 Students in TTG Class

Perception towards Science	**Pretest**		**Post-test**		**Difference**
The Students	3.865	*Positive*	3.870	*Positive*	0.005
The Teacher	3.890	*Positive*	4.005	*Positive*	0.115
The Science Laboratory Experiment	3.490	*Fairly Positive*	3.880	*Positive*	0.390
Overall mean *Sd*	3.748 *0.373*	*Positive*	3.918 *0.532*	*Positive*	0.170

Legend: 4.30 – 5.00 Very Positive
3.50 – 4.29 Positive
2.70– 3.49 Fairly Positive
1.90 – 2.69 Negative
1.00 – 1.89 Very Negative

Prior to the observation period, the TTG class had a favorable opinion of the students (mean=3.865), their instructor (mean=3.890), and their Science laboratory experiments (mean=3.490). Their assessment of their Science lesson was mostly good, with an average score of 3.748. They had the belief that their peers consistently exerted maximum effort to excel in the field of science. In addition, they said that their Science instructor seems to have a kind disposition towards the majority of kids in their class. Regarding their perception of the Science laboratory experiment, they held the belief that engaging in these laboratory activities would enable them to acquire a significant amount of fundamental knowledge.

The table shows that the TTG class's post-perception survey showed that their perception of science improved by 0.170 points compared to their preperception result. Regarding their perception of their classmates, they believed that some of them encouraged them to work harder. Moreover, they also emphasized that their teacher was interested in whether or not they could handle their work independently. They also pointed out that their Science lessons were not boring.

Conversely, students in LDG class who were exposed to the learner-designed experiments approach (LDEA) cast positive results before and after the experimental period. The complete result is presented in Table 3b.

Table 3b. Perception Towards Science of Grade 10 Students in LDG Class

Perception towards Science	**Pretest**		**Post-test**		**Difference**
The Students	3.980	*Positive*	4.100	*Positive*	0.120
The Teacher	3.915	*Positive*	4.220	*Positive*	0.305
The Science Laboratory Experiment	3.515	*Positive*	4.120	*Positive*	0.605
Overall mean *Sd*	3.803 *0.360*	*Positive*	4.147 *0.405*	*Positive*	0.344

Legend: 4.30 – 5.00 Very Positive
3.50 – 4.29 Positive
2.70– 3.49 Fairly Positive
1.90 – 2.69 Negative
1.00 – 1.89 Very Negative

Prior to commencing the experiment, the LDG class had a favorable opinion towards their peers (mean=3.980), their Science instructor (mean=3.915), and the laboratory experiment (mean=3.515). The pretest overall mean score of 3.803 indicates that the participants expressed satisfaction in collaborating with their peers, had high expectations of using the knowledge gained from their Science instructor, and saw Science activities as well thought-out.

After the exposure of the treatment class to LDEA, their perception towards science dramatically changed concerning the students (mean=4.100), the teacher (mean=4.220), and the Science laboratory experiments (mean=4.120). Compared to the pretest overall mean score of 3.803, the post-test overall mean score of 4.147 only means that those students in the experimental class confirmed that all of them enjoyed performing laboratory experiments, their teacher made Science subjects more straightforward to understand, and most of the things that they learned in Science class is interesting.

Difference in the Academic Performance in Science of the Two Groups of Respondents. This section compares the academic performance of two groups of students in science before and after the experimental period. The summarized reports are presented in Tables 6a and 6b. The objective of the comparison is to test the effectiveness of *LDEA* in increasing students' science performance.

The Science performance of TTG and LDG classes in the Science test were compared and examined before the start of the experiment. Table 4a shows the prescience performance of the two treatment groups.

Table 4a. Academic Performance in Science of the Treatment Groups During Pretest

Treatment Group	Pretest		t-value	Significance value
	Mean	Sd		
TTG	24.95	*4.36*	-1.87	***0.0695***
LDG	27.50	*4.27*		

**Significant at 0.05 level*

Comparing the Science performance of the two treatment groups, a t-value of -1.87 and a significance value of 0.0695 imply that initially, there is no significant difference between the academic performance of the TTG and LDG classes. Though the mean pre-science score of the LDG class (mean=27.50) is almost 3 points higher than that of the TTG class, the statistical test suggests that the two groups of students had essentially identical Science scores and were, therefore, comparable in their Science performance at the beginning of the study.

On the other hand, Table 4 b compares the Science performance of the TTG and LDG classes after the 10week experimental period. A t-test for independent samples was employed to test whether there was a significant difference between the academic performance of the two treatment groups after the experiment was conducted.

Table 4b. Academic Performance in Science of the Treatment Groups

Treatment Group	Post-test		t-value	Significance value
	Mean	Sd		
TTG	27.85	*3.66*	-2.22	***0.0327****
LDG	30.35	*3.38*		

**Significant at 0.05 level*

The 20 students in the LDG class who conducted learner-designed experiments had a mean Science performance score of 30.35, which was considerably higher than the mean score of 27.85 achieved by the 20 students in the TTG class. The mean scores of the two groups were compared, resulting in a calculated tvalue of -2.22 and a p-value of 0.0327. This indicates that the students who conducted learner-designed experiments benefitted from the therapy, as seen by their post-test scores being about 3 points higher than the control group. Typically, a student who engages in learner-designed experiments tends to get a score that is 3 points higher compared to a student who relies on conventional teacher-designed experiments.

This study's results contradict Newton et al.'s (1999) claim that laboratory activities do not enhance students' thinking skills. The learner-designed experiments approach motivated the students to become more engaged because they became more focused on self-directed learning.

Difference in the Perception of Science as a Subject of Two Groups of Respondents. The pre- and post-perceptions of the experimental and control groups towards science were evaluated using the t-test for independent samples. Tables 5a and 5b summarize the pre- and post-mean scores of the two groups and the results of the statistical test comparing the two observed perceptions.

The data in Table 5a revealed that the difference between the mean perception scores of students in TTG (mean=3.748) and LDG (mean=3.803) classes was insignificant, wherein its t-value is -0.43 and its significance value is 0.669. The computed values connote that the perceptions towards the science of students in both groups were statistically the same before the start of the experiment. Hence, students in both groups had similar perceptions towards science, though a slight difference in the figures was observed primarily.

Table 5a. Perception of the Treatment Groups towards Science during Pretest

Treatment Group	Pretest		t-value	Significance value
	Mean	Sd		
TTG	3.748	*0.373*	-0.43	***0.669***
LDG	3.803	*0.360*		

**Significant at 0.05 level*

However, figures in 5b below showed that significant differences were noted in the result of post-perception survey5

Table 5b. Perception of the Treatment Groups towards

Science during Post-test

Treatment Group	Post-test		t-value	Significance value
	Mean	Sd		
TTG	3.918	*0.532*	-0.838	***0.041****
LDG	4.147	*0.405*		

**Significant at 0.05 level*

Table 5b compares the perception of the two groups of students. The t-test showed a significant difference in the mean scores of the two groups (t = -0.838, p = 0.041). Thus, there is sufficient evidence to conclude that students who prepared and designed their experiment had a more positive perception towards their peers, their Science teacher, and the Science laboratory experiments despite the limitations imposed by the lack of proximal physical interaction than those students whose Science laboratory experiments were designed by the teachers themselves. The statistical test result suggests that incorporating learner-designed experiments into learning tasks in science could positively change students' perceptions by 0.23 points compared to students exposed to the traditional way of teaching. This study's results support Ervim's (2016) claim that inquiry-based learning, like performing laboratory experiments, encourages students to be more active in guiding their own learning process. It also helps students apply their knowledge, understand real-world situations, and discover scientific facts and principles.

Difference in the Academic Performance in Science of the Respondents Before and After Exposing to Learner-Designed Experiments Approach. This section compares students' Science performance before and after exposing the LDG class to LDEA. A paired sample t-test was used to determine whether there is a statistically significant difference between the pre- and post-science performance of Grade 10 students in the LDG class. The t-test results in Table 6a on the Science performance of the LDG class from the start until the end of the observation period show the comparison mean, standard deviation, t-value, and significance.

Table 6a. Academic Performance in Science of LDG Class in the Pretest and Post-test

LDG	Mean	Sd	t-value	Significance value
Pretest	27.5	*4.17*	3.96	***0.000****
Post-test	30.35	*3.38*		

**Significant at 0.05 level*

The mean Science pretest score of students in the LDG class before to experimentation was 27.5 points, based on a sample size of 40 items. This score indicates that their scientific performance was originally excellent. Following a sequence of experiments devised by the learners themselves, the average Science performance of the students showed an improvement of 2 to 3 points. The observed difference was analyzed using a significance threshold of 0.05 and was determined to be statistically significant. The t-test yielded a calculated t-value of 3.96, accompanied by a p-value of 0.000. Consequently, the students who were exposed to LDEA had a noteworthy rise in their Science scores, indicating a substantial improvement in their Science performance. The findings indicate that when students are involved in designing experiments, it may greatly enhance their performance in science compared to typical Science training, regardless of whether it is conducted in a regular faceto-face setting or online, as was the case in this research.

Difference in the Perception towards Science of the Respondents Before and After Exposing to Learner-Designed Experiments Approach. The perception of students in LDG class was examined and tested to determine if a significant change was observed during the pre-and post-test. A paired sample t-test was utilized to determine if there was a difference between the two observations.

Table 6b. Perception towards Science of LDG Group in the Pretest and Post-test

LDG	Mean	Sd	t-value	Significance value
Pretest	3.803	*0.360*	2.66	***0.016****
Post-test	4.147	*0.405*		

**Significant at 0.05 level*

The statistical analysis in Table 6b reveals that the experimental group had a significant rise of 0.344 points after the treatment period (t=2.66, p=0.016), as shown by the students' perception survey findings. Given that the p-value of the null hypothesis, which states that there is no significant variation in the mean scores of perception, is less than 0.05 (p=0.016), we may infer that the observed average change of 0.344 points, or almost 1 point per student, is not just a result of random chance. This might be ascribed to the experimental methodology, which involves the use of LDEA in the teaching of scientific subjects. Moreover, the significant change in students' perspective implies that mandating

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students to formulate their own experiment design might enhance their impression of science. The researcher saw a significant increase in the level of student engagement and enthusiasm for science among the students in the LDG class. This cohort of students exhibited greater levels of engagement and involvement throughout synchronous class sessions. During online lessons, it was observed that the majority of students had a keen interest in studying science by openly sharing their opinions, ideas, and comments about the subjects offered by the instructor. The validity of these findings was reinforced by several remarks made by the student in the Weekly Monitoring Tool.

"I feel like excited when it comes to science experiments because I can understand better when I'm experimenting.",

"I learned a lot about the different plate boundaries and their interactions because I was the one performing my own experiments.",

"I enjoyed planning and conducting my own experiments because it made me a quick thinker and resourceful."

"Designing my own experiment was exciting, considering that it was my first time. I enjoyed performing the experiment that I designed on my own. It was enjoyable, and I learned a lot.".

"I felt more involved, independent, and in control when I designed my experiments."

These only confirm the findings of Jebson et al. (2016) that students who have a positive perception of science will emerge enthusiastic about learning the subject, thus positively affecting student learning outcomes. The authors operationally defined perception as students' views on how good and engaging the Science lessons are.

Students' Perception of Science about Science Performance. The relationship between students' perception and academic performance in science was examined and analyzed. The *Pearson r* test procedure was employed to determine how one's perception affects the Science performance of the respondent.

Referring to Table 7, the computed *Pearson r* value of 0.485 indicates that the correlation between students' perception and Science performance is moderately positive. Moreover, the correlation is statistically significant; therefore, one's perception can be a good predictor of academic performance.

Table 7. Relationship Between Student's Perception and Science Performance

LDG	Pearson r	Significance value
Perception towards Science	0.485	***0.030****
Academic Performance		

**Significant at 0.05 level*

The Pearson correlation coefficient of 0.485, with a p-value of 0.030, suggests a substantial relationship between perception and academic success in science.

Therefore, a student who has a very favorable view is likely to excel in their scientific topic. Conversely, a student who has a pessimistic outlook is more likely to get poor scores on their Science exam. The results of this research provide solid evidence to corroborate the assertion of Movahedzadeh (2011) that having a good attitude towards studying science is likely to lead to improved academic accomplishment.

SUMMARY OF DISCUSSION

The study, titled "Learner-Designed Experiments Approach (LDEA): A Tool in Teaching Science at Laboratory Junior High School of Palawan State University," aimed to assess and contrast the impact of using simple laboratory experiments as an instructional approach and learning tool in teaching Grade 10 Science on the academic performance of Grade 10 students. It also investigated the correlation between students' perspective and academic achievement in the field of science. This quasi-experimental study was carried out on two complete groups of Grade 10 students who were formally registered at the Palawan State University Laboratory High School during the academic year 2020 – 2021. One class was designated as the experimental group (LDG), and they were instructed to develop their own experimental design. The other class acted as the control group (TTG), and they were taught using typical methods of teaching science. Both groups received normal classroom training in science and were taught the identical topic for two academic quarters by the researcher as part of the experimental control. The data was analyzed using statistical tests such as the t-test for independent samples, t-test for paired samples, and Pearson r-test.

Academic Performance of Grade 10 Students in Science. At the start of the experiment, the students in both groups, TTG and LDG, were identified to have a *satisfactory* to a *highly satisfactory* level of Science performance. Their pre-Science performance was analyzed and found to be comparable.

During the post-test, the science performance of the two groups increased from *satisfactory* to *outstanding.* Though both groups showed improvement, the class exposed to learner-designed experiments had a greater percentage of students who were able to achieve more up to the highest level.

Comparing their post-performance, students in the LDG class demonstrated significantly higher performance than the students in the TTG class. The result suggests that a student with learner-designed experiments scores 3 points higher than a student exposed to a typical Science class only.

Perception of Grade 10 Students in Science. The perception of the two groups of students towards their peers, their Science teacher, and the Science laboratory experiments was determined using a 30–item questionnaire. The responses were tallied systematically in both groups.

Students with typical class discussions were identified to positively perceive science as a subject before and after the experiment, with a computed mean value of 3.748 and 3.918, respectively. Students in TTG class's perception changed, but the improvement was found to be statistically insignificant. Hence, their perception of science remained the same throughout the study.

On the other hand, the perception of students in LDG class who had the learner-designed experiments improved significantly, with computed mean values of 3.803 and 4.147 in the pretest and post-test, respectively. Implementing the LDE approach in teaching science accounted for the average change of 0.344 points.

In terms of the difference between the perception of the two groups of students, students who prepared and designed their experiment had a more positive perception towards their peers, their Science teacher, and the Science laboratory experiments than those students whose Science laboratory experiments were prepared by their teacher. The result suggests that incorporating learner-designed experiments into learning tasks in science could change students' perceptions positively.

Students' Perception of Science about Science Performance. Using the Pearson r test, a student's perception is significantly related to academic performance. It can be assumed that one's self–belief can affect one's Science performance. A student who perceives science positively tends to excel in his Science class. Conversely, a student who perceives science negatively tends to get low marks on his Science tests.

CONCLUSION

The study tested the hypotheses about Grade 10 students' perception and performance in science. Results showed significant changes in academic performance between pre-test and post-test after exposure to a learner-designed experimental method. Students with Learning Disabilities and Educational Assistance (LDEA) showed enhanced views of science, higher academic performance, and an elevated impression of science as an academic discipline. The impression of Grade 10 students strongly correlates with their achievement in science.

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