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Evaluating the effectiveness of suggested learning activity sheets and problem-based learning in teaching of non-Mendelian law: Enhancing conceptual understanding, problem-solving, and critical thinking skills

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ABSTRACT

The purpose of this study was to evaluate the efficacy of the Problem-Based Learning (PBL) approach and Suggested Learning Activity Sheets (SLAS) in teaching Grade 9 students at Bongabong National High School in Tangub City, the Non-Mendelian Law of Inheritance in the academic year 2024–2025. The study focused on enhancing students' conceptual understanding, problem-solving techniques, and critical thinking skills. Pre- and post-test evaluations were used in a quantitative design to gauge the effectiveness of different teaching techniques. Students showed a moderate degree of diversity in their comprehension of non-Mendelian genetics before the intervention. Students' comprehension and capacity to comprehend intricate genetic patterns significantly improved once SLAS and PBL were implemented. The outcomes showed a noteworthy rise in student achievement, suggesting that these approaches successfully expanded their understanding of the material. Additionally, statistical analysis demonstrated a significant difference between pre- and post-test scores, confirming the intervention's beneficial effects. According to the study's findings, integrating SLAS and PBL greatly improves students' genetics education while promoting stronger critical thinking and problem-solving abilities. Based on the results, it is suggested that these creative teaching strategies be implemented in order to enhance students' learning outcomes in challenging scientific subjects.

Keywords: problem-based learning, suggested learning activity sheets, quantitative method, Tangub, Philippines

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INTRODUCTION

Students need to be self-directed and must acquire lifelong learning skills. Nowadays, they need to be critical thinkers, problem solvers, and analytical in their approach. Because of the multidisciplinary nature of their work, they must be able to integrate knowledge and skills from a

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variety of fields and develop interpersonal skills that will aid them in realizing their full professional potential. Teachers play a crucial role by carefully selecting the teaching strategies needed to recognize and achieve these goals.

Looking at the traditional method of teaching where the instructor presents how to solve the problem, learners will listen attentively and remember everything that the teacher has told. However, this instructional strategy will not work well in many cases. The content is distant, unimportant, and students miss some details, forget important information or even space out after some minutes. Instructors are now faced with finding ways to create more engaging and deeper learning experience, which is when Problem-based Learning (PBL) comes in.

As a student-centered, inquiry-based teaching method, Problem-Based Learning (PBL) encourages students to tackle a real-world problem that requires further investigation (Jonassen & Hung, 2008). In this course, students learn to identify knowledge gaps, conduct research, and apply their learning to develop solutions and present their findings based on the problem. This strategy also promotes teamwork or collaboration, fosters problem solving and metacognitive skills, engagement in learning, and innate motivation.

Learning Activity Sheets (LAS) have drawn a lot of attention as crucial resources for educators, especially in settings where in-person instruction is either scarce or needs to be supplemented. They act as well-organized mentors who help students learn by giving them assignments that build upon and supplement what they learn in class. The significance of learning activity sheets in the classroom is examined in this research review, with particular attention paid to how they can improve learning outcomes, encourage autonomous learning, enable varied instruction, and increase student engagement.

According to recent Program for International Student Assessment (PISA) results, math, reading, and science proficiency among Filipino students is still among the lowest in the world. The nation's performance on recent tests has not significantly improved since 2018. Similar to 2018, the most recent PISA results demonstrate that the Philippines underperformed the global average across the board, moving up in the national rankings just slightly above those of nations who saw their rankings decline as a result of the pandemic's effects on student learning.

However, the Philippines' performance in PISA 2022 was not much different from that of 2018, with changes to the nation's average score in every category being minimal, only a few points. The average science score for the Philippines fell from 356 to 355 by one point. The Philippines is currently ranked sixth lowest out of 81 countries in reading and mathematics, and third lowest in science. This is better than how it was placed in the 2018 cycle, when Filipino students came in second in math and science and lowest in reading comprehension. Furthermore, they attained a rudimentary level of scientific proficiency. According to PISA 2022, only one Filipino student out of every four have the necessary abilities to "recognize the correct explanation for familiar scientific phenomenon" and support findings.

Meanwhile, students in Grade 9 frequently find the non-Mendelian Law of Inheritance to be a difficult concept to learn because it deals with abstract and complicated concepts that call for a thorough understanding of genetics. A pattern of inheritance known as non-Mendelian inheritance occurs when features do not segregate in accordance with Mendel's laws, namely the Law of Independent Assortment and the Law of Segregation. Mendel's principles apply to simple dominant-recessive features governed by a single gene. Students may find it difficult to understand the probabilistic aspect of heredity at this educational level, when the results of genetic crosses are not always obvious. Without specific examples or prior genetics expertise, the

ideas of dominant and recessive alleles, genotypes vs phenotypes, and the segregation and independent assortment of alleles can be challenging to grasp and understand.

Therefore, this study is conducted to determine the effectiveness of the Problem-based Learning approach in teaching non-Mendelian's Law of Inheritance among Grade 9 students aided with the Suggested Learning Activity Sheets (LAS) during the school year 2024-2025 as a basis for enhancing students' understanding of the concept, problem-solving technique, and developing critical thinking skills.

Statement of the problem

This research determined the effectiveness of the Suggested Learning Activity Sheets and Problem-based Learning (PBL) approach in teaching non-Mendelian's Law of Inheritance in Genetics among Grade 9 Students at Bongabong National High School, Tangub City during the school year 2024-2025 as basis for enhancing students' conceptual understanding, problem solving technique, and critical thinking skills. Specifically, this answered the following questions:

1. What is the effect of SLAS and PBL on the understanding of non-Mendelian Law concepts among Grade 9 students?
2. Is there a significant increase in students' problem-solving skills after using the Suggested Learning Activity Sheets (SLAS) and Problem-based Learning (PBL) approach?

METHODOLOGY

This study employed a quantitative action research design, specifically a one-group pretest-posttest approach, to evaluate the effectiveness of integrating Problem-Based Learning (PBL) with Suggested Learning Activity Sheets (SLAS) in enhancing conceptual understanding, problem-solving skills, and critical thinking related to the topic of non-Mendelian inheritance among Grade 9 students. Conducted at Bongabong National High School in the Division of Tangub City, Region X, Philippines, during the first quarter of the 2024–2025 school year, the study involved 39 Grade 9 students—23 males and 16 females—aged 14 to 15 years. These participants comprised the entire class cohort under the researcher's instruction, providing a natural classroom environment characterized by diverse learner abilities and preferences. This setting was deemed ideal for assessing the versatility and impact of the instructional intervention.

The intervention, implemented over two consecutive weeks during the third and fourth weeks of the first grading quarter, was aligned with the science curriculum competency "Explain the different patterns of non-Mendelian inheritance (S9LT-Id-29)." The instructional strategy combined two main components. First, Problem-Based Learning served as the primary teaching method: students were divided into diverse cooperative teams and engaged in analyzing real-life, open-ended genetic scenarios such as incomplete dominance, codominance, and sex-linked characteristics. Within these groups, learners identified knowledge gaps, conducted teacher-guided research, and presented evidence-based solutions. The teacher acted as a facilitator, guiding inquiry without directly imparting knowledge. Second, the Suggested Learning Activity Sheets provided structured activities aligned with daily lesson objectives. These worksheets contained guided reading assignments, genetic cross simulations, problem-solving exercises, formative assessments, and reflection tasks to scaffold understanding and encourage individual

learning. The SLAS materials were carefully reviewed and underwent quality assurance prior to use.

The study followed three phases during implementation. In the pre-implementation phase, teachers were oriented on the mechanics of PBL and the effective utilization of SLAS. Student groups were organized, and baseline expectations were set. The pretest instrument, a researcher-developed 30-item multiple-choice test covering key concepts such as incomplete dominance, codominance, multiple alleles, and sex-linked inheritance, was validated by the school science head and science supervisor before administration on August 19, 2024, to assess students' prior knowledge. During the implementation phase, PBL sessions were conducted three times per week within regular science periods. SLAS were distributed each session and collected upon completion. Monitoring of progress included formative assessments, teacher observations, and peer discussions. In the post-implementation phase, an identical post-test was administered on September 2, 2024, to measure learning gains. Additionally, informal interviews and reflective discussions were held with students and teachers to gather qualitative feedback that supported the interpretation of quantitative results.

Data collected from the pretest and posttest were manually scored and entered into a spreadsheet for statistical analysis. Descriptive statistics such as mean and standard deviation were computed to describe students' performance trends. A paired-sample t-test was employed to compare the pretest and posttest scores, evaluating the statistical significance of the intervention's impact. A significance level of $p < 0.05$ was set as the threshold for inferential conclusions, ensuring that any observed learning gains could be attributed with confidence to the combined use of PBL and SLAS in teaching the non-Mendelian inheritance concepts.

RESULTS AND DISCUSSION

Effect of SLAS and PBL on the understanding of non-Mendelian Law concepts among Grade 9 students

To assess the effectiveness of the Problem-Based Learning (PBL) approach combined with Suggested Learning Activity Sheets (SLAS) in enhancing student understanding of the Non-Mendelian Law of Inheritance, students' performance was evaluated through a pre-test and a post-test consisting of 30 multiple-choice questions aligned with the learning competency S9LT-Id-29. The mean score on the pre-test was 9.08 out of 30, indicating a relatively low baseline level of knowledge among the students. This low score reflects limited prior understanding of non-Mendelian inheritance patterns before the intervention. The standard deviation of 3.10 suggests a modest variability in student performance, revealing some inconsistencies in their grasp of the topic.

In contrast, the post-test results showed a considerable increase, with a mean score rising to 24.13. This substantial improvement suggests that students were able to grasp core concepts and apply analytical reasoning to address complex genetics problems. The standard deviation increased to 4.41, indicating a wider distribution of scores which could be attributed to differences in individual learning paces and levels of engagement with the instructional materials. The standard error of the mean also rose from 0.50 in the pre-test to 0.71 in the post-test, which aligns with the greater score dispersion observed.

To determine whether this improvement was statistically significant, a paired-sample t-test was performed comparing students' scores before and after the intervention. Both pre-test

and post-test results yielded p-values less than 0.001, confirming that the observed increase in scores is highly statistically significant and not due to chance. The mean difference between the pre-test and post-test was 15.05 points, demonstrating a dramatic enhancement in student performance. Furthermore, the 95% confidence intervals for the mean scores indicate a high degree of precision, showing with strong confidence that the post-intervention performance significantly exceeded the pre-intervention baseline.

Impact on the students' problem-solving skills after using the Suggested Learning Activity Sheets (SLAS) and Problem-based Learning (PBL) approach

The findings strongly indicate that the combined use of PBL and SLAS had a meaningful and measurable impact on student learning outcomes. Students exhibited improvements not only in factual recall but also in problem-solving skills, conceptual reasoning, and critical thinking abilities. These skills are crucial for mastering abstract and probabilistic scientific concepts such as those involved in non-Mendelian inheritance. This outcome is consistent with existing educational research, including studies by Fakhriyah (2014), Hasibuan and Irawati (2017), and Yew and Goh (2016), which emphasize the effectiveness of active, student-centered learning strategies in science education. The low pre-test scores further suggest that passive or traditional teaching methods may be insufficient for helping students comprehend challenging genetic concepts. Conversely, the significant gains observed in the post-test offer compelling evidence that students achieve deeper learning when actively engaged in inquiry-based learning supported by well-structured activity sheets.

CONCLUSION

This study demonstrated that the combination of SLAS and Problem-Based Learning (PBL) greatly enhanced Grade 9 students' comprehension of non-Mendelian inheritance, especially in the domains of critical thinking, problem-solving, and concept mastery. While post-test scores demonstrated a robust and statistically significant rise, confirming the success of the intervention, pre-test results demonstrated students' insufficient knowledge.

The results demonstrate the effectiveness of constructivist, learner-centered approaches such as PBL and SLAS in enhancing the relevance and meaning of difficult genetics subjects. PBL encouraged teamwork and deeper thinking by immersing students in real-world issue scenarios. SLAS reinforced curriculum-aligned core ideas through guided practice and autonomous learning support.

In terms of education, the study recommends that these approaches be used more widely in science classes, particularly for abstract subjects, in order to support the MATATAG Curriculum and national education reform objectives. While school administrators must provide time, money, and professional development to support these innovations, teachers should receive training on how to create and execute PBL and SLAS.

The study suggests that in order to evaluate scalability and impact, future research should examine the long-term impacts of PBL and SLAS, apply the model to other subjects, and perform comparison studies in various circumstances.

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