A Simulation-based Guided Inquiry Laboratory Package in Teaching Mirrors and Lenses for Grade 10 Learners

Kennette M. Arboiz, Sotero O. Malayao Jr.

Mindanao State University – Iligan Institute of Technology, Iligan, Lanao del Norte, Philippines

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ABSTRACT

The perennial problem of Philippine education characterized by the lack of uniform laboratory apparatus and activities across schools, can be one culprit of low performance in the PISA examinations and ranking. During its conceptualization stage, this study intended to develop a set of activities for optics that allow the guided- inquiry opportunity. A series of evaluation refined the activity to its optimum version and was implemented in a single section in one public school in the Division of Misamis Occidental. Trend of student performance showed that students had a good performance and that the guided inquiry activities helped them in their learning acquisition. The quality of performance task output also showcased the depth of learning acquired by students. The normalized also yielded a medium gain that signifies the guided inquiry virtual activities can engender learning despite the absence of 3- dimensional hands-on laboratory activities.

Keywords: simulation-based learning, guided inquiry, laboratory package, teaching light mirrors and lenses

INTRODUCTION

Science laboratories play a significant role in learning scientific concepts effectively. A laboratory is a learning environment where the students engage in groups or learn individually through observation, exercise, and practical experiments using materials and phenomena. It gives them chances to put into practice several theoretical concepts. Since the nineteenth century, the scientific laboratory learning environment has been a substantial component of science education (Nyutu et al.,2021). It was affirmed by de Borja and Marasigan (2020), who considered laboratories the heart of science, wherein learners can perform the science concepts they learned. Even so, numerous public schools around the Philippines are confronted by a shortage of scientific equipment and materials and their laboratory facilities (Hadjiet al., 2020). Simulation can be seen as a transformative technology that revolutionizes learning methods, providing group reflections, integrating both theory and practice, and creating new prospects for exploratory, challenging cases (Maria Zenios, 2020). A simulation is a practical approach to practice and learning that can be applied to various disciplines. It serves as a proxy to reinstate and enhance real experiences with piloted ones, imitating significant attributes of the real world in a fully interactive manner (Hong, J. et. Al., 2022). The practical application of simulation-based training provides the instructions of real-world circumstances, helping to analyze the content, and hence reducing the barrier between the online or offline learning ecosystem and the real-environment (Almasri, F., 2022). This practicality underscores the effectiveness of simulation-based learning in preparing students for real-world scenarios.

The underlying motive for such action is the lack of school facilities—laboratory rooms, to be specific—that allow engaging science activities, which often require a variety of apparatuses. Science laboratories play a significant role in learning scientific concepts effectively. A laboratory is a learning environment where the students engage in groups or learn individually through observation, exercise, and practical experiments using materials and phenomena Moreover, no systematic study that evaluated the status of secondary schools' science Laboratory under the Davao del Sur Division in the Philippines. Hence, this study presented a picture of the status of this significant learning environment for Science Education.

In an interview with the teachers and the students in one of the public schools in Calamba, Misamis Occidental, it has come to a consensus that to effectively teach the concepts of light, mirrors, and lenses is through the use of laboratory apparatuses such as actual mirrors (plane and curved mirrors) and lenses. At the same time, it is also a challenge for teachers and students to learn science. Science, such as physics, is conceptual science grounded in experiments, implying that one must have accurate tools to grasp scientific knowledge fully. While laboratory apparatus holds a promising future in empowering students to be interested in taking the field of science as a career, the country is at the mercy of a nationwide scarcity of laboratory infrastructure. Globally, several studies revealed the status of laboratories in different international universities. It was emphasized by An et al. (2019) that general chemistry laboratories should have the necessary equipment for the students to learn practical laboratory skills since laboratories are part of a science student's identity. But Bogusevschi et al. (2020) argued that because of the limited budget and high maintenance conditions, public schools are prone to lack materials and equipment in their different laboratories, especially in science. Daba et al. (2016) added that even with the acknowledgment of authors on how integral science laboratories are, inadequate materials and equipment are still observed. Research showed the low status of Wolaita Zones, Ethiopia in terms of science equipment and has indicated that laboratory furniture such as tables, cabinets, shelves, sinks, etc., were absent totally in some schools and are not properly setup in other high schools which do not support authentic teaching and learning in science (Zengele & Alemayehu, 2019). A study conducted by Gudyanga and Jita (2019) revealed that in South Africa, even with the effort to make a stronghold in science laboratories for physical sciences, they are still experiencing finite access to these materials. This is reflected in their view of a successful Physics classroom as highly facilitative of hands-on learning. The use of simulation and video is also far from ideal because of the lack of computers to cater to individual students. With the lack of learning facilities in public schools, the academic achievement of Filipino learners plummeted as the country participated in the Trends in International Mathematics and Science Study (TIMSS) in 2019 and Programme for International Student Assessment (PISA) in 2022 which debuted the result of PISA 2018. Thus, this study aimed to develop a simulation-based learning package in Mirrors and Lenses, as an alternative to public schools' lack of laboratory apparatus. The developed material will provide Physics teachers in public schools with additional support in pursuing a profound and deeper student understanding through simulation-based learning. This will also help students possess the topic's fundamental concepts.

METHODOLOGY

2.1 Research Design

This study utilized a descriptive method in examining the gathered data. The quantitative method was involved in this study, especially in determining the significant difference in the development of guided-inquiry laboratory activities with the aid of smartphones. The research design in this study follows the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model of instructional framework to investigate the effectiveness of simulation-based guided inquiry laboratory activities for Mirrors and Lenses in Grade 10 students during the school year 2023-2024.

2.2 Research Subjects

This study's subjects are the students enrolled in Grade 10 for the school year 2023-2024. These students are currently taking up topics on physics as stipulated in the Department of Education's Curriculum Guide and MELCs (Most Essential Learning Competencies)

2.3 Research Setting

This research was conducted in one of the public schools in Calamba, Misamis Occidental. In this study, the whole process for gathering the data will be (a) the development of the activities, (b) the implementation of the activities. The researcher will be mapping the objective of the Grade 10 competency under the K-12 Basic Education Curriculum. The activities will make use of the Phet Interactive simulation on geometric optics. The developed laboratory package was assessed by a panel of evaluators who hold graduate degrees in physics education or have taught physics for longer than three years.

2.4 Data Gathering Procedure

2.4.1 Development of the laboratory package

The researcher uses the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) to develop the laboratory package. The laboratory package includes crafting the lesson plan for the topic of mirrors and lenses, the corresponding laboratory activities, written works such as quizzes, and the achievement test following the context of mirrors and lenses. An open-ended questionnaire will be given to the teachers and the Grade 10 learners to assess the difficulties they have encountered when learning the concepts of mirrors and lenses.

2.4.1.1 Need analysis for students and teachers

The needs analysis is an open-ended survey questionnaire administered to teachers and students in a public school. The survey questions are related to learning the concepts of mirrors and lenses. This will help gather collective information on the teachers' teaching and learning experiences, including the difficulties they have experienced on the topic and their opinions and insights on the integration of simulations in learning the concepts of mirrors and lenses.

2.4.1.2 Use ADDIE Model

The ADDIE model will be used as a guide in developing the laboratory package. This includes the needs for analysis of the teachers and the learners, designing and developing the laboratory package, including the lesson plan, the laboratory activities, and the achievement test. It will also provide insights and comments from the teachers and learners regarding the manual of the laboratory package, which in turn will be used to enhance the developed laboratory package.

2.4.2 Evaluate the laboratory package based on the Department of Education-approved assessment tool by a panel of evaluators.

2.4.2.1 Educational Quality Evaluation

Educational Quality Evaluation is among the Learning Resources Management and Development System (LRDMS) evaluation instruments. It determines the accuracy of the laboratory package's print manual, which will be evaluated using the criteria discussed under the LRMDS evaluation tool in terms of accuracy, content, correctness, appropriateness, and sustainability of the presentation, language, and visuals for target users.

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2.4.3 Investigate the efficacy of the developed laboratory package based on a) the performance of the students and b) their respective gain scores.

2.4.3.1 Performance of the students

The students' performance has two (2) segments: written works (30% of the actual grade contribution) and performance task (40% of the actual grade contribution).

a. Written Works

The written works consist of the pretest, activities 1 and 2, quiz, and posttest; the performance task consists of the project and a video discussion of the students.

b Performance Task

The performance task was composed of the project pinhole camera and a video discussion on how an image is produced using the constructed pinhole camera.

2.4.3.2 Gain Scores of the Students

The scores obtained by the students in the achievement tests (pretest and posttest) are used in this section to determine their respective gain scores. Note that the study includes forty-five (45) students. However, five (5) of these students, S8, S10, S18, S42, and S45, did not have a pretest or posttest due to their absence. In this case, only forty (40) students were included in the section.

2.4.4 Gather the feedback and insights of the students on the use of the laboratory package

After this study was implemented, the students were given a questionnaire designed to gather their insights and feedback on using the laboratory package. Their answers were analyzed thematically to find a consensus on an overarching answer to this study.

RESULTS

3.1 Developed Laboratory Package

(2020) study, laboratories are considered the heart of science, wherein learners can perform the science concepts they learned. Numerous public schools around the Philippines are confronted by a shortage of scientific equipment and materials and their laboratory facilities (Hadji et al., 2020). Garcia et al. (2022) also added that the science primary students they interviewed about their experience in the absence of science laboratory activities during online learning concluded the experience as "finding light in the dark." Moreover, Berame (2022) states that one of the challenges of senior high school students in doing science-related tasks during online classes is finding science laboratories. Not only the lack of laboratories or apparatuses was the leading factor in the low performance of the students in learning light, mirrors, and lenses. The student respondents

3.1.1 Budget of Works

The activities were allotted for eight (8) days of simulation-based guided inquiry learning implementation. The manual has undergone two (2) iterative revisions based on the evaluators' comments and suggestions to ensure that it is error-free. It contains the lesson plan, achievement test, quiz, laboratory activities, and project.

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3.2 Evaluate the laboratory package based on the Department of Education-approved assessment tool by a panel of evaluators.

Using the LRMDS to evaluate the laboratory package manual, it obtained an average score of 3.9 in ‘content’, 3.89 in ‘format’, 3.92 in ‘presentation and organization’, and 4 in ‘accuracy and up-to-dateness’. Since the manual garnered a perfect score of 24 points in the fourth category—accuracy and up-to-dateness—it was suitable to use. These are the average scores of the evaluators on each factor.

Table 3.2.1 Overall rating of the laboratory package

Components	Average Mean	Interpretation
Factor 1: Content	3.9	Very Satisfactory
Factor 2: Format	3.89	Very Satisfactory
Factor 3: Presentation & Organization	3.92	Very Satisfactory
Factor 4: Accuracy & Up-to-datedness	4	Very Satisfactory
Overall Rating	**3.9**	**Very Satisfactory**

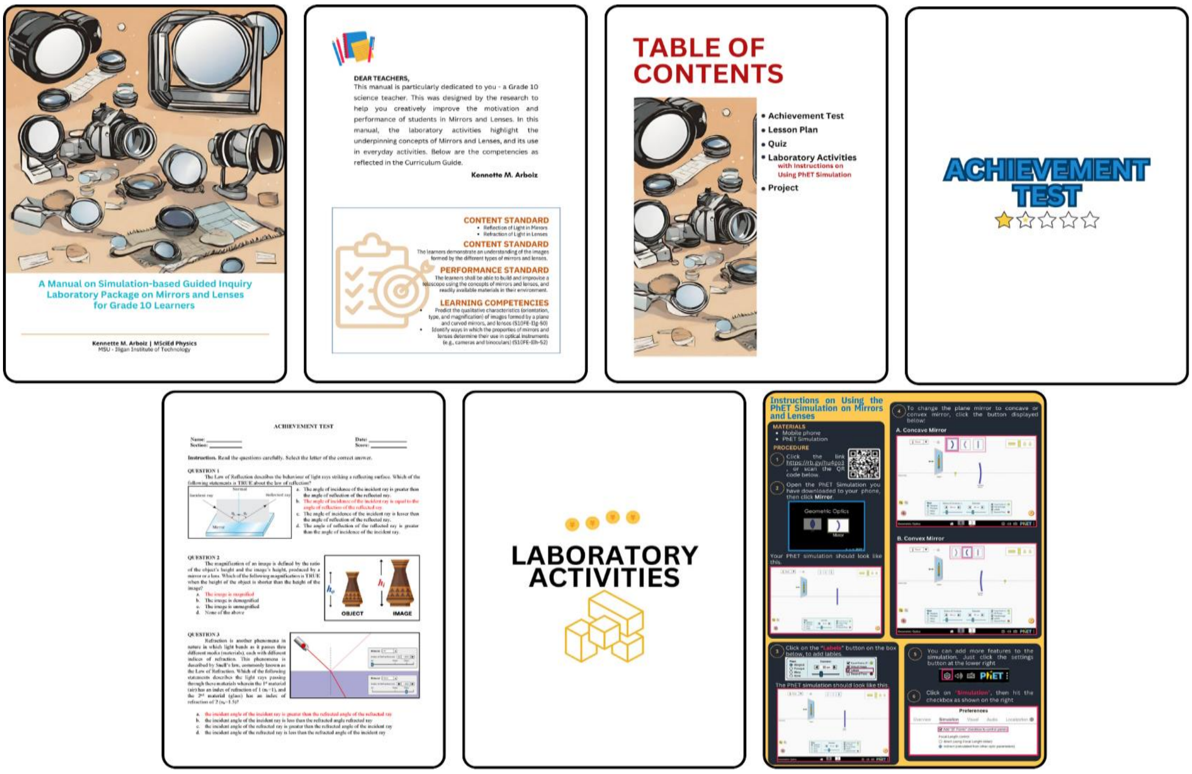

Figure 3.1 Developed Laboratory Package

3.1.2 Needs Analysis

It was determined through needs analysis that teachers found it difficult to teach the concept of image formation in mirrors and lenses without the Presentation & Organization appropriate laboratory apparatus, such as curved mirrors and lenses. More often than not, the main challenge in teaching mirrors and lenses is the lack of the apparatuses/laboratory required for this lesson. The country’s status depends on its laboratory infrastructure. Students are deprived of the opportunity to be equipped by experience due to the unavailability of sci-lab. In de Borja and Marasigan’s

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3.3 Efficacy of the developed laboratory package on a) the performance of the students and b) their respective gain scores.

3.3.a. Performance of the students

Student S26 had the highest score, garnering an actual grade of 61.97. Meanwhile, student S45 had the lowest score, garnering an actual grade of 54.15. While student S45 had a positive trend in his weighted scores, it is important to note that he had the lowest progress, making his scores appear nearly flat.

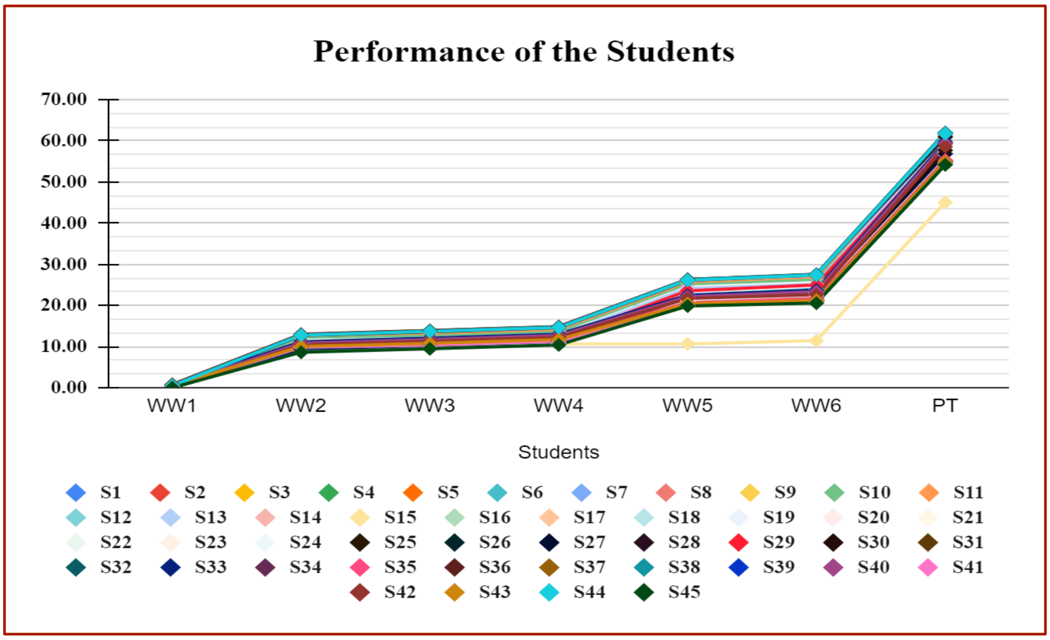

Figure 3.3.a Positive trend in the performance of the students

3.3.b Achievement (Pretest & Posttest)

Table 3.3.b Gain scores of the students

Criteria	Frequency	Percentage
High	5	12.5%
Average	30	75%
Low	4	10%
Stable	1	2.5%
Decreased	0	0%
TOTAL	40	100.00%

The majority of the students in Section Serenity were ‘average’ based on their individual gain scores. On average, the students have garnered a mean gain score of 0.54. About 75% of the students (30 students) have an “average” gain score, 2.50% (1 student) have a “stable” gain score, 10.00% (4 students) have a “low” gain score, and 12.50% (5 students) have a “high” gain score.

3.4 Students’ feedback and insights on the use of the laboratory package

Overall, the grade 10 students found the simulation-based learning to be a different experience than the usual classroom setting. Students noted that they felt engaged, excited, happy, and motivated to participate in physics class, considering that the experience was new to them.

CONCLUSION

The laboratory package implemented has improved the students' academic performance on light, mirrors, and lenses.

RECOMMENDATIONS

With this in mind, it is recommended that science educators and curriculum specialists design and develop another simulation-based laboratory package for a quarter or more. Educators are also encouraged to explore online platforms to incorporate into their classes, which will significantly improve their students' performance.

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