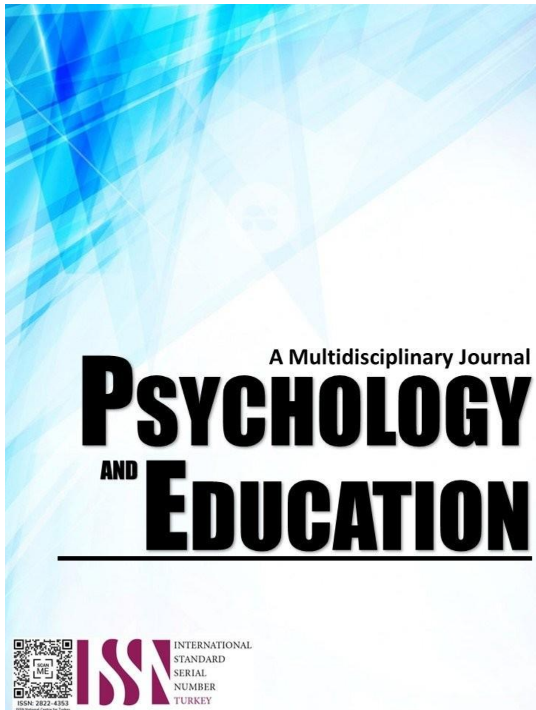
SYNERGIZING VIRTUAL LABORATORY APPLICATION IN SCIENCE AND GUIDED INQUIRY ACTIVITIES IN LEVERAGING BASIC SCIENCE PROCESS SKILLS OF GRADE 7 STUDENTS



PSYCHOLOGY AND EDUCATION: A MULTIDISCIPLINARY JOURNAL

Volume: 37
Issue 7
Pages: 678-692
Document ID: 2025PEMJ3599
DOI: 10.70838/pemj.370703
Manuscript Accepted: 04-15-2025

Psych Educ, 2025, **37**(7): 678-692, Document ID:2025PEMJ3599, doi:10.70838/pemj.370703, ISSN 2822-4353
Research Article

Synergizing Virtual Laboratory Application in Science and Guided Inquiry Activities in Leveraging Basic Science Process Skills of Grade 7 Students

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Abstract

Science Education in the Philippines raises many concerns, the inadequate science laboratory in public schools is one of these problems. The researcher conducted a study about virtual simulation, one of the newly created virtual simulations of the Department of Science and Technology is the Virtual Science Laboratory Application in Science (VLAS) with the integration of Guided Inquiry Activities (GIA). This study explored the synergistic effects of VLAS and (GIA) on enhancing the basic science process skills (BSPS) of Grade 7 students. This study focuses on the significant difference between the level of BSPS (observation, communication, classification, measurement, inference, and prediction) of students before and after using the VLAS. This study utilized explanatory sequential mixed methods. This design was suitable for answering the research questions of the study, as it incorporated elements of both quantitative and qualitative research. The respondents of the study were divided into 2 groups, 36 learners for the experimental group who were subjected to the use of Virtual Laboratory Application (VLA) and Guided Inquiry Activities (GIA). Meanwhile 36 students were the control group, they were only subjected to the use of Laboratory Application (VLA). Wilcoxon Signed Rank Test, Thematic Analysis, and triangulation of data were utilized to ensure that the accuracy of the results is obtained. Findings from the study revealed that there is a statistically significant difference in the pretest and posttest scores of students in the basic science process skills before and after using VLAS. These findings imply that the VLAS and GIA make the learners understand complex concepts into simple concepts by showing procedural activity so that the students can easily learn it. It indicates that integrating VLAS into science education can effectively improve learners' BSPS which is essential in the development of scientific literacy. The study concludes that VLAS helps improve the BSPS of the learners. And VLAS combined with GIA offers a more intense approach to enhancing BSPS. This present study thereby recommends; Development of Guided Inquiry Activity modules specifically designed to complement VLAS activities, Provide professional development for science teachers, Future researchers should investigate the long-term effects of VLAS and GIA on BSPS, and Developers of VLAS should consider adding more interactive and gamified activities.

Keywords: *virtual laboratory, guided inquiry activities, basic science process skills*

Introduction

Science education in the Philippines has a diverse range of settings. In the implementation of the K12 Basic Education Curriculum, science subjects are taught to be in a spiral progression. Teaching science is divided into four major branches namely, Biology, Chemistry, Physics, and Earth Science. These diverse lessons bring a whole different stage for the learning of the students. It is noticeable that the trend of education has been shifting from traditional to modernized ways of teaching. Learners nowadays are expected to reach a certain level of minimum proficiency in the most essential competencies in the curriculum to identify them as competent. Given these circumstances, there are issues when it comes to the results of assessments both national and international. In the recently concluded test results of the Programme for International Student Assessment (PISA) in 2022. The test results show that the Philippines scored less than the average scores in the assessment in terms of science. The results also imply that there is a 0.8% decrease in science proficiency. This shows that there is a need for improving science proficiency among learners. In line with this problem, the Department of Education launched its recently revised curriculum branded as the MATATAG Curriculum under DepEd Memorandum 054 s.2023. DepEd recognizes the need to enhance science literacy among students to compete with local and global standards.

One of the widely recognized problems in science education is the lack of facilities for science teaching, especially since public schools do not have enough science laboratories to facilitate the development of practical science skills. In a study conducted by Abas et. al., (2020), the lack of laboratory facilities hinders the development of science process skills by the students, it also found that teachers in a school with a lack of laboratory facilities usually ended up not practicing teaching laboratory activities with the students resulting in a low science proficiency level.

Contrastively, with the help of modern technology, the problem of the lack of a laboratory has now been addressed by different technological methods. One of these is virtual laboratories. A virtual laboratory is an interactive application or software that uses digital inferences and situations that simulate the real-world scenarios that take place in an actual laboratory. According to the study of Eaman (2022), virtual laboratories were effective for Anatomy and Physiology courses in the Philippines, improving academic performance, reducing learning time, and enhancing the quality of the learning process. Additionally, Virtual science laboratories, along with physical labs, enhance physics achievement and metacognition in Philippine high schools (Padıos & Tobıa, 2023).

Various STEM education innovations were developed by the Department of Science and Technology-Science Education Institute (DOST-SEI) to enhance the country's science and technology (S&T) human resources. The DOST-SEI developed the Virtual Laboratory Application in Science (VLAS), a fully interactive and advanced digital laboratory simulation in a 3D and 360-degree environment to be used as supplementary resources for schools without physical science laboratories.

In the current situation of the students situated at a public secondary school in Balut Tondo, Manila where there are no available physical facilities for laboratory activities and based on the recent Learning Recovery Report from the school year 2022-2023, the students have low learning proficiency in science, this is supported by the fact that most of the students fall in the range of low proficiency level in the conducted summative test. The average score of the student is 52.23 out of 100 points in the test item. The minimum proficiency level for a 100-point test is 60. Therefore, there is a need to address students' low science proficiency level and bridge the gap brought by the lack of laboratory facilities to enhance the students' science process skills. Through this DOST-VLAS application software, the researcher aims to enhance the current level of science process skills of the students to make learners reach the minimum proficiency level. It is important to take note of the fact that addressing these issues is significant to the development of cognitive skills and practical skills of the students in science. This will also help in the development of more advanced alternative technology that will help schools to be resourceful when there is no physical facility available.

Science Education in the Philippines raises many concerns, the inadequate science laboratory in public schools is one of these problems. Various studies have shown that the role of a well-equipped science laboratory is crucial to the achievement of competencies set by the Department of Education. However, there are challenges faced by the school such as the lack of facilities, faulty apparatus, insufficient lavatories, and overcrowded classrooms persist, impeding both teachers' instructional effectiveness and students' conceptual development (Abas et al., 2020; De Borja et. al., 2020).

Furthermore, there is a considerable link between the lack of physical facilities for conducting laboratory procedures to the science process skills of the students. It was found that the low academic performance of students in science is related to the lack of necessary equipment and materials that can limit students' use of their science process skills (Noroña, 2021).

Despite these challenges, teachers have shown resiliency by creating innovative teaching practices to avoid resource limitations (Juanico et al., 2019). However, given the continuing inadequacy of physical facilities, exploring alternative pedagogical approaches becomes necessary.

For the past few years, virtual laboratories have been one of the emerging solutions to the challenges brought by the inadequacy of science laboratories. These digital platforms offer a convenient solution to the problem. It is a simple means for students to be engaged in scientific inquiry without the need for a traditional laboratory. (Coleman & Smith, 2019). By simulation of the real laboratory scenario, a virtual laboratory provides teachers and learners with a versatile learning environment that enhances science education (Estriegana et al., 2019; Mayer, 2020). The use of virtual laboratories can possibly bridge the gap that has identified with the lack of experience in laboratory experiments of the students and their science process skills (Abdelmoneim et. al., 2022; Azhar & Irianti, 2023)

Integrating virtual laboratories into the curriculum can improve not just the shortage of physical facilities but also the continuous development of ICT integration in the curriculum. This integration can potentially improve students' performance. Therefore, these virtual laboratories can be considered as one alternative to use in the Philippine education setting. Nowadays, students tend to be digital natives, and students tend to exhibit a high level of interest in using digital tools, making virtual laboratories a promising opportunity for enhancing learning outcomes (Ibanga et al., 2023).

Given the difficulties that the education sector continues to face and the potential benefits of virtual laboratories, this study aims to examine how using virtual labs impacts students' proficiency levels and process skills in science. By gathering the perspectives of both students and teachers on virtual labs, this research hopes to provide useful strategies on how technology can enhance science education and address the need for laboratory access in schools in the Philippines.

The researcher decided to conduct a study about virtual simulation, one of the newly created virtual simulations of Department of Science and Technology is the Virtual Science Laboratory Application in Science (VLAS). The VLAS Project is spearheaded by the Science Education Institute of the Department of Science and Technology (DOST-SEI) in partnership with the University of the Philippines-Los Banos, Laguna College of Arts and Sciences for the content and PCI Innovations and Technologies for the digitization of modules. The VLAS project was conceptualized to assist schools without physical laboratory. Through the 3d and 360 degree and immersive feature of VLAS learners will be able to experience a simulation of laboratory activities virtually whether in desktop operation or using virtual reality tools. The VLAS includes the following features, it contains detailed illustrations of scientific interactive images that can be manipulated inside the virtual space. This feature allows students to navigate the materials such as zooming in and out of the present resources. It also allows students to experience realistic use of laboratory equipment. It also contains assessment after each activity in the VLAS to test the learning of the students. Teachers and students can use the VLAS for free access through download sites. VLAS has the potential to revolutionize how students interact with biology and other scientific subjects by becoming a common instrument in science education globally with more assistance and cooperation. The accomplishment of this project demonstrates the value of internationalization in promoting the Philippines' inventiveness and innovation, as well as guaranteeing that the nation would remain a key participant in the world of science and technology.

Research Questions

This study explored the potential synergistic effects of combining Virtual Laboratory Applications and Guided Inquiry activities to the Basic Science Process Skills of Grade 7 Students in a public secondary school in Balut Tondo, Manila. Specifically, the study answered the following questions:

1. What is the level of Basic Science Process Skills (observation, communication, classification, measurement, inference, and prediction) of students before using the VLAS?
2. What is the level of Basic Science Process Skills (observation, communication, classification, measurement, inference, and prediction) of students after using the VLAS?
3. Is there a significant difference between the level of Basic Science Process Skills before and after using the VLAS?
4. What are the perceptions of the students on the use of Virtual Laboratory Applications in Science in terms of:
    4.1 student engagement; and
    4.2 ease of use?
5. What program of activities can be crafted from the findings of the study?

Methodology

Research Design

This study employs an explanatory sequential research design. This design consists of two distinct phases: a quantitative phase followed by a qualitative phase. The aim is to first gather numerical data to assess the impact of the interventions and then collect qualitative data to provide deeper insights into the quantitative findings.

The explanatory sequential design allows for a comprehensive understanding of how Virtual Laboratory Applications (VLA) and Guided Inquiry Activities (GIA) synergistically enhance basic science process skills among Grade 7 students. The methodology is structured as follows:

In this design, the quantitative and qualitative strands took place in two distinct, yet interactive phases. In the first phase, quantitative data was collected and analyzed and took priority for addressing the research questions. Following the quantitative phase is the collection and analysis of qualitative data. The results of the quantitative phase were used to inform data collection and analysis in the qualitative phase. The qualitative results are used to gain insight into the quantitative findings (Creswell, 2014). Using the same topic as provided above, quantitative data were collected and analyzed with the purposes of determining if VLAS can enhance the level of basic science process skills of the students. To obtain a greater understanding of the perceptions of the students with the use of Virtual Laboratory Application in Science (VLAS), the researcher conducted an interview with the Grade 7 Learners.

This study undergone three phases, the Preparatory Phase, Immersion Phase and Data-gathering Phase. In the preparatory phase, after gathering permissions and consent, the participants undergone orientation that gives them an idea of the objectives of the study and technical assistance which allows them to have a trial use of VLAS to prepare them and make them familiar with the technicality of using a virtual laboratory to ascertain the improvement in post-test is attributed to the intervention. A pretest was administered to both groups of students to test the level of basic science process skills of the students. The result of the pretest provides a baseline measure of students' basic science process skills.

In the implementation phase, the researcher facilitated student engagement using VLAS every science time specifically, from prelab activity will be on Monday, Laboratory time from Tuesday and Wednesday, Thursday will be post-laboratory and Friday will be journaling. This ensures that there is a thorough structured activities, hands-on virtual experiments, and collaborative learning experiences for the learners. Also, Monitor the implementation process closely, addressing any issues or challenges that arise promptly to ensure the smooth execution of activities. An outside observer was invited for cross- validation. Both experimental group and control group utilized the use of VLAS but experimental group was given Guided Inquiry Activities. In addition to accessing virtual labs, the experimental group was engaged in guided inquiry activities where they are provided with structured prompts or questions to guide their exploration and experimentation within the virtual lab. This helped scaffold their learning and deepen their understanding of scientific concepts.

In the Data-gathering phase, the research questions are primarily addressed through the collection and analysis of quantitative data from the experimental groups. The Pretest, and Posttest are the tools to gather the needed quantitative data for the analysis of how DOST-VLAS enhances the science process skills of the students. The change in scores from the pretest to the posttest was used to compare the level of basic science process skills of the students before and after using.

To obtain a greater understanding of the perception of the students regarding the use of virtual laboratories, the researcher modified a survey questionnaire to the research of Yih-Yih et. al., (2021) and in the qualitative phase, to gather insights and experiences of the students with exposure to VLAS the researcher interviewed the respondents. Focus group discussions and observations of the teacher were utilized for further support of the findings. To integrate quantitative and qualitative data, the data triangulation was used as Cross-

Validation. Quantitative findings from surveys and assessments were cross validated with qualitative insights from Focus group Discussions, interviews, and observations.

Respondents

The participants of the study were divided into two groups namely the control group and the experimental group. The control group namely the group A consisting of 36 students, 18 male and 18 female they only used VLAS. Meanwhile, the experimental group that were exposed to the use of VLAS and Guided Inquiry Activities were the group B consisting of 36 students, 18 male and 18 female. These sections were selected based on the following criteria to ensure the study's reliability and validity. Equal representation, these sections have the same number of males and females. Homogeneity in age minimizes the variability due to developmental and educational differences and experiences and also baseline knowledge, since the population has similar level of achievement in the previous year, this was ideal in observing the initial impact of virtual laboratories on developing science process skills and understanding of scientific concepts.

For the survey on the perception of students in the use of VLAS, and the qualitative part which is to gather insights and views of the students as well as their suggestions, both sections were also the respondents, and they had undergone focus group discussion.

Instrument

This study explored the potential synergistic effects of combining Virtual Laboratory Applications and Guided Inquiry activities to the Basic Science Process Skills of Grade 7 Students in a public secondary school in Balut Tondo, Manila. The following instruments were used by the researcher to address the research questions. The surveys, assessments, and FGD topic guide were reviewed by experts in the field of science teaching that ensure the topic adequately covers the constructs of interest.

Pretest and Post-test

To measure how Virtual Laboratory Application in Science (VLAS) enhanced the student's basic science process skills, the pretest and posttest were developed by the researcher and followed the format of Kavak, et. al., (2021) in accomplishing the table of specification of test items (TOS). The format of the basic science process skills scale consists of observation, classification, prediction, measurement, inference, and communication as the framework of the test. In selecting and designing the test questions, the researcher developed test items that can be answered using basic science process skills. Assessment items were reviewed by subject matter experts to ensure alignment with curriculum objectives and content validity. The Pretest and Post-test were validated by the experts in the field of science teaching. The validation rubric made by Bajamundi (2019) was used to determine the face validity, construct validity, and content validity of the test items. The author granted open permission to be used by another researcher. A pool of test items was created, with attention to clarity, accuracy, and appropriateness for the target grade level. The test items were administered to 30 students to evaluate item difficulty, discrimination, and clarity. Based on pilot test results and expert feedback, items were revised and finalized for use in the study.

The result of Cronbach Alpha reliability testing shows 0.939 reliability coefficient which is excellent in terms of internal consistency. This indicates that the items are strongly related to each other and effectively measure the same underlying construct. In practical terms, this high reliability coefficient means that the test is likely to generate consistent results when conducted under similar conditions, making it a dependable tool for assessing the particular construct or variable in question.

Meanwhile the validity testing of the test items shows that the test is highly valid having a 3.86 average validity score. This score indicates that the test items are successful at measuring their intended targets. A high validity score confirms that the test accurately assesses the particular concept or learning result it was created to measure, establishing it as a reliable tool for educational or research-related decision-making.

Survey Questionnaire

The survey questionnaire to determine the perception of students in the use of Virtual Laboratory Application in Science (VLAS) made by Yih-Yih et. al., (2021) was modified to be used in this study. The respondents will answer using a scale of 5 – Strongly Agree (SA) as Extremely Positive; 4 – Agree(A) as High Positive; 3 – Neutral (N) as Moderately Positive; 2 – Disagree (D) as Low Positive; and 1 – Completely Disagree (CD) as Very Low Positive. This modified survey questionnaire was piloted by a small number of students to check its internal consistency. A pilot survey was administered to (30) grade 7 students to identify any ambiguities or difficulties in understanding the questions. The reliability test (Cronbach's alpha) shows a result of 0.840 respectively, demonstrating the acceptable reliability of the questionnaires. Aside from reliability testing, it also underwent content validation by three Science education experts. Survey items shows that the survey questionnaire is highly valid having a 4.29 average validity score making it a reliable tool for educational or research-related decision-making. Based on feedback from the pilot test, and content validation, survey items were revised for clarity and relevance.

This instrument aligns with the study, each item on the questionnaire supports the assessment of various aspects of the student's perception and experiences in using VLAS. Each item question can easily be understood by the students which is very important in ensuring that the students can effectively engage with VLAS. It assesses whether the objective of using virtual simulations is clearly communicated to the student. It also measures if the virtual simulations effectively capture students' interest and motivate them to participate. In terms of concept visualization, this questionnaire provides insights on how VLAS can help students visualize and understand scientific concepts which are very important in experiential learning. It also helps in knowing the feedback mechanism of VLAS is helpful to students. Overall, the questionnaire can provide valuable insights into the perception and experiences of students in using VLAS in terms of usability, student engagement, visualization of concepts, and the role of feedback in virtual simulation.

Interview Questions

To gather qualitative data on the insights and experiences of the students in using Virtual Laboratory Application in Science (VLAS). The interview questions were also modified from the interview questions made by Yih-Yih et. al., (2021). The questions on the interview were validated to be suited in the local setting. It consists of 3 main themes namely, educational values; individualization of learning; and areas of enhancement. The Guide questions on the interview for this research were revised based on the comments and suggestions of the evaluators. The feedback of the first evaluator is listed below (1) start with what questions and can be answered by yes or no to be followed by how questions. (2) avoid lengthy questions the target level is grade 7 make sure it is easy to understand. (3) positive questions first. (4) in the question "How does virtual laboratory application in science (VLAS) help you to visualize the practical procedures in the laboratory?" was changed into "In what ways does virtual laboratory application in science (VLAS) help you to visualize the practical procedures in the laboratory?". The second evaluator said that the interview questions were excellent to be used in the study.

Virtual Laboratory Application in Science (VLAS)

Virtual Laboratory Application in Science – Virtual Reality (VLAS-VR) is a computer-based software that integrates a virtual reality platform to simulate real-world laboratory experiments and activities in a virtual environment. It is designed to replicate the experience of conducting scientific experiments in a physical laboratory setting but within a digital space. These applications leverage various technologies, such as computer graphics, simulations, and interactive interfaces, to provide users with an immersive and educational experience.

The scope of this VLAS consists of thirteen (13) Biology modules with platforms in MS Windows, Apple OS, and WebGL, the following are the names of modules included: Introductory Laboratory; Laboratory Safety (Part 1); Laboratory Safety (Part 2); Microscopy (Part 1); Microscopy (Part 2); Levels of Biological Organization; Comparing Plants and Animal Cell; Fungi, Protist, Bacteria; Sexual and Asexual Reproduction; Cell Cycle and Cell Division; Mendelian Genetics; Linkage; Nucleic Acids DNA; Central Dogma of Molecules; and Mutations. In this study, the following modules will be used Microscopy (Part 1); Microscopy (Part 2); Levels of Biological Organization; Comparing Plants and Animal Cell; Fungi, Protist, Bacteria; Sexual and Asexual Reproduction; and Cell Cycle and Cell Division only.

The VLAS includes the following features, it contains detailed illustrations of scientific interactive images that can be manipulated inside the virtual space. This feature allows students to navigate the materials such as zooming in and out of the present resources. It also allows students to experience realistic use of laboratory equipment. It also contains assessment after each activity in the VLAS to test the learning of the students.

The researcher asked permission on the utilization of the Department of Science and Technology Virtual Laboratory Application in Science through Ms. Josephine Feliciano the Science research specialist in charge of the development of this software application. The researcher also asked for the full cooperation of the project developer of VLAS regarding the materials that are essential in the implementation of the study. The DOST granted permission to researcher the use and full technical support of using VLAS for this research.

The Virtual Laboratory Application in Science (VLAS) underwent user testing which resulted in impressive outcomes. A significant number of users expressed high levels of satisfaction. Specifically, 42.5% of users were very satisfied with the appearance and layout, while 41.1% felt the same about the functionality and interactivity. Additionally, 45.2% of users gave a very satisfied rating for the animation and simulation aspects, and the lesson presentation. Notably, the highest level of very satisfied responses, 52.1%, was for the knowledge and information gained. These results showcase the effectiveness and user-friendliness of the VLAS in various aspects.

VLAS Integrated Lesson Plan

The Learning plan for grade 7 is already crafted in the implementation of the MATATAG K to 10 Curriculum for the school year 2024 – 2025. It is a weekly Learning plan which includes activating prior knowledge, establishing lesson purpose, developing and deepening understanding, making generalization, and evaluating learning. This format of the lesson plan is equivalent to the 5 E's learning cycle which includes Engage, Explore, Explain, Elaborate, and Evaluate wherein the researcher integrates the use of Virtual Laboratory Application in Science and the guided inquiry activities in the Explore and Explain section of the learning plan.

The lesson plan for the control group includes the Engage part where the teacher activates the prior knowledge of the students about the lesson. This is done by using a simple teaching strategy. For example, the lesson will start with a word search puzzle that the students will answer or introduce a KWL chart for students to have an idea of what the lesson is all about and what they already know about the lesson. The Explore and explain part of the lesson plan includes establishing the lesson purpose and developing and deepening understanding this is where the researcher inserted the use of VLAS. The VLAS modules has an animated teacher which talks. It teaches the students the content of the lesson and it also tells the students what the next thing is to do to keep going and finish the module. One of the best features of the VLAS is that it is easy to use. For the elaborate part of the learning plan, it includes making generalization, which is done for example, towards the end of the lesson the students will revisit the KWL chart this allows the students to identify the takeaways of the lesson. The researcher calls this part of the lesson plan as the post lab discussion where there is an interaction between the students and the teacher. It is in the form of a question and answer it's like a clarification part. Finally, the teacher will ask the students, do you have more questions about the lesson? And in the Evaluate part of the lesson plan this is done by having a formative assessment to measure the learnings of the students. It can be in the form of a multiple-choice test or an essay or a Venn diagram.

And for the experimental group, the researcher inserted the use of the Guided inquiry activities in the Explore and Explain part of the lesson plan. This is introduced before using the VLAS. The GIA includes the title of the activity, objectives, materials to be used, and the guided questions that the students will answer as they explore the Virtual lab. The purpose of this GIA is to let the students have an understanding to what the lesson is all about. This also makes the students excited to use the VLAS to get the answers to the guiding questions.

The learning plan ensures that all the included VLAS modules and guided inquiry activities are present in the Grade 7 lessons and that competencies of the Second Quarter in the K10 MATATAG Curriculum are targeted.

Procedure

Following the guidelines set by the National Teachers College and the Department of Education National Capital Region under DepEd Order No. 16, s. 2017, otherwise known as the Research Management Guidelines (RMG), the researcher employed a careful data-gathering procedure to ensure the privacy and confidentiality of all the participants.

The researcher was granted permission from the Head Research Developer in the Department of Science and Technology to use the software application (VLAS) after receiving permission in the use of VLAS, the researcher secured an assent form from the parents or guardians of participants who were below the age of 18. Following the Data Privacy Act of 2012, this is in line with the principles that require the consent of the data subject (or their guardian, in the case of minors) for the processing of personal data. An informed consent form was also given to the students, so they know that their participation in the study is voluntary.

The researcher set up an orientation program for the parents and learners to inform them of what the study is all about. During the orientation, it was explained to them that their children were the target participants of the study. Moreover, it is also the time that they were given the Parents' Consent Form for them to be aware of the study's purpose, procedure, benefits, risks, and rights to withdraw from their participation. The consent form contained the following information: key information about this research study; number of participants; procedures for the study; safeguards; confidentiality; voluntary participation; benefits of taking part in the study; and the risk of participating in the study. Additionally, one of the science teachers was the administrator for giving the consent form to parents and learners, this is to lessen the pressure on parents and learners to give positive feedback.

Moreover, the researcher gave sufficient time for parents and learners to ask questions during the program so that all participants, especially minors, understood their rights and the implications of participation, and decided whether to let their children participate or not. This is to ensure that they understand all information regarding participation in the study.

After orientation, the permits from parents were secured, the researcher also gave an Assent Form to the participants to ensure that the learners were all aware that they were permitted by their parents to participate in the study

The Data on the current level of Basic Science Process Skills (observation, communication, classification, measurement, inference, and prediction) was collected through a pretest during face-to-face classes. Since the use of pretest and posttest could cause anxiety and stress to the students, the researcher explained that the pretest was not graded but it is required for them to take the pretest to measure their current knowledge level, the researcher ensured that students were at ease in answering the pretest by letting them take the test for the whole hour and ensuring them that it was not a basis for them to pass or failed the subject. After concluding the result of the pretest, the students will participate in the use of VLAS in face-to-face classes to collect the needed data to know the level of Basic Science Process Skills (observation, communication, classification, measurement, inference, and prediction) after using it.

After using the VLAS for learning science, students have undergone a posttest, to alleviate the pressure in answering the posttest, the researcher explained to them that the posttest will not be the determinant of the whole summative score, it will be a portion only of the summative score.

After collecting both pretest and post-test data, it will be used to compare if there is a statistically significant difference between the level of students' basic science process skills before and after using VLAS.

Data Analysis

After collecting all the data gathered from the pretest, posttest, questionnaires, and interview with the respondents, it was organized, tabulated, and analyzed using some statistical tools. The researcher employed the following statistical treatment.

For problem 1 and 2, descriptive statistics such as mean and standard deviation was used to describe the student's basic science process skills (observation, communication, classification, measurement, inference, and prediction) before and after using VLAS. Descriptive statistics is used to describe the attributes, occurrences, and styles in a population (McCombes, 2023).

For problem 3, Wilcoxon Signed Rank test was used to determine if there is a statistically significant difference between the level of Basic Science Process Skills (observation, communication, classification, measurement, inference, and prediction) of students before and after using VLAS.

For problem 4, descriptive statistics such as mean and standard deviation was employed. This statistical treatment was used to determine the perception of students in the use of VLAS. Descriptive statistics is used to describe the attributes, occurrences, and styles in a population (McCombes, 2023).

For the gathered qualitative data on the conducted interview, the interpretation was done using thematic analysis. One method for analyzing qualitative data is thematic analysis. It is commonly used to characterize a collection of writings, such transcripts or interviews. To identify recurring themes—subjects, ideas, and meaning patterns—the researcher carefully examines the data. (Caulfield, 2023).

In this study, the students were interviewed by a teacher observer that lessens the pressure of giving positive feedback and to draw honest answers from the students. Before the interview, the researcher prepared thoroughly by creating a comprehensive interview guide with questions focused on three main themes: educational values, individualization of learning, and areas of enhancement. After the interview the answers of the interviewed learners were analyzed, the researcher conducted thematic analysis by first familiarizing themselves with the data, which included reading and re-reading transcripts and surveys to fully understand the content and depth. After that, the researcher generated initial codes by identifying and marking significant sections of the data that stood out. Next, the researcher searched for occurring themes, assessing how well these themes aligned with the data collected. After identifying potential themes, the researcher reviewed them to ensure coherence and relevance. The researcher then defined and named each theme, articulating their meanings clearly. Finally, the researcher compiled a comprehensive report summarizing the analysis and findings of the interview.

Ethical Considerations

To know the perception of the students in using VLAS, the researcher will conduct a survey, and a recorded interview with the participants. However, They are free to withdraw from the study at any time without facing any repercussions. No personally identifying information will be connected to any of the data, which will all be anonymized and safely kept in password-protected folders.

For the interview, the students were interviewed by a teacher observer to lessen the pressure of giving positive feedback and to draw honest answers from the students. Before the interview, the researcher prepared thoroughly by creating a comprehensive interview guide with questions focused on three main themes: educational values, individualization of learning, and areas of enhancement. The guide was reviewed by education and qualitative research experts, and necessary revisions were made based on their feedback. Ethical considerations were carefully addressed, including obtaining approval from the relevant ethics committee and preparing detailed consent forms for participants. These forms clearly outlined the study's purpose, data usage, and participants' rights, including the ability to withdraw at any time. Confidentiality and anonymity protocols were also strictly adhered to.

In the recruitment phase, the researcher identified and contacted students with experience using the Virtual Laboratory Application in Science (VLAS). Participants were provided with in-depth information about the study, including the interview process, expected duration, and discussion topics. The researcher worked closely with participants to schedule interviews at convenient times, ensuring in-depth conversations. Quiet and comfortable locations were chosen for in-person or virtual interviews, and all recording equipment was rigorously tested. Backup recording methods were prepared to avoid potential technical issues, and printed copies of interview guides, consent forms, and other necessary documents were organized in advance.

During the interview, the researcher introduced the interview's purpose and the study's aims. The topics to be covered were reiterated, and participants were assured of confidentiality and anonymity. Verbal consent to record the interview was obtained before following the interview guide, asking questions in a conversational style to encourage open and honest responses. The researcher probed further when necessary, maintaining a neutral tone and avoiding leading questions. Participants were given ample time to express their thoughts, and brief notes were taken to document key points and non-verbal cues. As the interview concluded, the main points discussed were summarized, and participants were invited to share additional thoughts or questions. Finally, the researcher expressed gratitude and confirmed participants' comfort with the information shared being recorded and used in the study.

After the interview, the recording was promptly transcribed with accuracy and verbatim to preserve the data's integrity. The transcription was reviewed to correct any errors or omissions. To safeguard the data, recordings and transcriptions were securely stored with limited access to authorized personnel. Pseudonyms or participant codes were used to maintain anonymity, and data was backed up securely. In the analysis phase, responses were coded according to the three main themes, and patterns, similarities, and differences were meticulously identified. Qualitative data analysis software was used if necessary. When preparing the report, findings were summarized, and key insights and illustrative quotes were highlighted, accurately reflecting participants' views while maintaining anonymity. The report was reviewed by experts before finalizing. Finally, the researcher followed up with interested participants, providing a summary of the findings and offering to clarify any points or answer additional questions.

For the Data Management and Security Plan, participants' confidentiality was the top priority, each student had a unique identification number. Each student had a designated label, starting with Student 1 as G701, and continuing sequentially. This number was used for all data collection and analysis, to ensure that individual students cannot be linked to their responses. Only the researcher has access to digital and physical information.

The electronic data such as the recorded interview and the tallied scores of participants, were stored on a USB Drive which is restricted to anyone, only the researcher has access to the electronic data. This drive is regularly backed up and monitored for security breaches. All data was encrypted using password-protected file features of Adobe Acrobat, and it was stored in a dedicated folder with restricted access so that it ensures the security of the data. All electronic data was retained until the conclusion of the research, after the study period, the data was electronically deleted through permanent deletion of files. all data were securely deleted using a certified data erasure tool (BitRaser).

To ensure the integrity and confidentiality of physical data, such as test papers and survey questionnaires, the researcher implemented a secure storage system. These documents were kept in a locked, designated area within the faculty room, accessible only to the researcher. Each document was clearly labeled with a unique identifier and organized systematically to prevent accidental mixing. The storage area was equipped with security measures such as surveillance cameras and access control systems to protect against unauthorized access and damage. After the project was completed, physical data were retained for one month and then securely disposed of through shredding and incineration. This comprehensive approach guarantees the responsible handling and disposal of physical data, safeguarding participant privacy, and maintaining the integrity of the research.

Overall, the researcher is committed to upholding ethical standards by adhering to the following considerations: voluntary participation and withdrawal. Students have the right to choose whether not to participate in the study. They can withdraw at any time without facing negative consequences. Informed consents were given to parents or guardians, and students themselves were provided with assent. The researcher used language that students could understand and avoid jargon or complex terms that may confuse the respondents. No personally identifiable information was linked to students' data. Proper acknowledgment, fairness, and data protection compliance. There was also a declaration of absence of conflict of interest by the researcher and a declaration of anti- plagiarism. Ensuring that there is no potential threat that the researcher will pose in this study.

Results and Discussion

This chapter presents the results and the interpretation of the data collected in this study through Pre-test, Post-test, survey questionnaires, and interviews. The purpose is to determine whether the Synergy between Virtual Laboratory Application in Science (VLAS) and Guided Inquiry Activities (GIA) can enhance the Basic Science Process Skills of the Grade 7 Learners at a public secondary school in Balut Tondo, Manila. S.Y. 2024- 2025.

Basic Science Process Skills of Grade 7 Students Before the Treatment

The assessment of Grade 7 Learners regarding their level of Basic Science Process Skills (observation, communication, classification, measurement, inference, and prediction) before and after using the VLAS are summarized in Tables 2, 3, 4, and 5.

Basic Science Process Skills (observation, communication, classification, measurement, inference, and prediction) of students before using the VLAS.

To be able to determine the level of Basic Science Process Skills of the learners before using VLAS, the students have undergone Pretesting. Pretest refers to the test given before the participants undergo a specific type of treatment to have baseline data of the current level to be tested in a research study.

Table 1. *Level of Basic Science Process Skills before using VLAS for Control Group*

Basic Science Process Skills	*Mean*	*Standard Deviation*	*Verbal Interpretation*
Communicating	1.97	1.230	Very Low
Measuring	4.14	1.376	Low
Classifying	2.42	1.903	Very Low
Observing	3.03	1.964	Low
Inferring	2.56	1.463	Very Low
Predicting	2.97	1.444	Low
Grand Mean	2.85		Low

Legend*: 1.00–2.79 = Very Low (VL); 2.80–4.59 = Low (L); 4.60–6.39 = Moderate (M); 6.40–8.19 = High (H); 8.20–10.00 = Very High (VH)*

Before the introduction of VLAS, the control group showed low levels in basic science process skills. Communication skills were notably weak, with students having difficulty sharing and explaining scientific concepts. Measuring skills were better but still

Psych Educ, 2025, **37**(7): 678-692, Document ID:2025PEMJ3599, doi:10.70838/pemj.370703, ISSN 2822-4353
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considered low, along with other skills like classifying, inferring, observing, and predicting. The variability in performance indicated that some students had stronger skills than others, emphasizing the need for educational interventions to enhance these essential skills.

Table 1 demonstrates the level of basic science process skills of the control group before using VLAS. The basic science process skills of students in the control group prior

to treatment displayed a range of mean scores, with a very low mean of 1.97 in Communicating and a low mean of 4.14 in Measuring.

The skill with the lowest score was in Communicating, which had a mean of 1.97 and a standard deviation of 1.230. Among 36 students who took the test only 1 student got a passing score in this skill with a percentage of only 2.78%. This very low score indicates that students struggled to effectively share and explain their ideas, observations, and findings in science. In this study, Communicating refers to the ability to describe procedures, express observations, and share results clearly, whether through speaking or writing. These results suggest that students faced challenges articulating scientific information, possibly due to limited opportunities to practice this skill in traditional classroom settings.

On the other hand, the skill with the highest score was Measuring, which had a mean of 4.14 and a standard deviation of 1.376, still categorized as low. Out of 36 students only 16 of them got a passing score in this skill with a percentage of 44.4%. Measuring involves using appropriate tools and units to accurately quantify observations. Although students performed better in this area compared to the other skills, the low score indicates that further practice is needed to enhance this ability.

Other skills showed similarly low scores: Classifying had a mean of 2.42 (standard deviation = 1.903), and Inferring had a mean of 2.56 (standard deviation = 1.463). Classifying involves grouping objects or events based on their similarities, while Inferring entails drawing conclusions based on observations. The very low scores highlight that student struggled with these skills; additionally, the higher standard deviation in

Classifying suggests a wider variance in performance, with some students demonstrating better abilities while others faced more significant challenges.

For Observing, the mean score was 3.03 with a standard deviation of 1.964, and for Predicting, it was 2.97 with a standard deviation of 1.444, both of which were considered low. Observing refers to gathering information using the senses, while Predicting involves making educated guesses about future occurrences based on prior knowledge. These slightly higher scores in these areas imply that students possessed some ability but still required considerable improvement.

The results imply that the control group had a low overall level of basic science skills before using VLAS. The group struggled most with communication skills, highlighting a clear need for improvement in this area. While measuring skills were the strongest among the group. The standard deviation suggests that there was significant variability in performance within the control group, meaning some individuals may have had higher skills than others. The findings also suggest that Grade 7 students exhibit deficiencies in fundamental science process skills, particularly in communicating and classifying, which are critical for effective scientific inquiry and understanding. This analysis underscores the necessity for innovative educational strategies like synergizing VLAS and GIA to bolster basic science process skills among students, paving the way for improved scientific literacy and inquiry capabilities in future learning environments.

Table 2. *Level of Basic Science Process Skills before using VLAS for Experimental Group*

Basic Science Process Skills	*Mean*	*Standard Deviation*	*Verbal Interpretation*
Communicating	1.72	1.186	Very Low
Measuring	2.83	1.732	Low
Classifying	2.50	1.502	Very Low
Observing	2.92	1.317	Low
Inferring	2.92	1.645	Low
Predicting	2.33	1.724	Very Low
Grand Mean	2.54	4.555	Very Low

***Legend**: 1.00–2.79 = Very Low (VL); 2.80–4.59 = Low (L); 4.60–6.39 = Moderate (M); 6.40–8.19 = High (H); 8.20–10.00 = Very High (VH)*

Before using VLAS, the experimental group showed generally low levels of basic science skills. Communication skills were especially weak, with students having difficulty expressing scientific ideas. Skills in measuring, classifying, observing, inferring, and predicting also scored low, showing a lack of ability in key scientific areas. The low standard deviations across all skills suggest a consistent lack of proficiency among the students. Overall, these pre-VLAS results highlight the need for programs to improve these important skills in the experimental group.

Table 3 demonstrates the level of basic science process skills of the experimental group before using VLAS. The basic science process skills of students in the experimental group prior to treatment showed a range of performance, with a very low mean score of 1.72 in Communicating and a low mean score of 2.92 in Observing and Inferring.

The lowest skill level was in Communicating, which had a mean score of 1.72 and a standard deviation of 1.186. Among 36 students who took the test only 2 students got a passing score in this skill with a percentage of only 5.56%. This particularly low score indicates that students struggle to effectively share and articulate their ideas, observations, and findings in science. Effective communication is essential for conveying scientific information clearly, highlighting the need for targeted interventions to improve this skill.

For Measuring, students achieved a mean score of 2.83 with a standard deviation of 1.732, which is considered low. This low standard deviation suggests that most of the data points are near the mean suggesting a consistency of low scores for most of the students. This skill involves accurately using tools and units to gather and quantify data, indicating that students have a limited ability to perform measurements, which is a critical component of conducting experiments.

Classifying received a mean score of 2.50 and a standard deviation of 1.502, categorized as very low. Among 36 students who took the test only 4 students got a passing score in this skill with a percentage of only 11.1%. This suggests that students find it challenging to group or organize information based on shared characteristics, an important step in data analysis.

Both Observing and Inferring had mean scores of 2.92, with standard deviations of 1.317 and 1.645, respectively. While these scores are higher than others, they are still interpreted as low. Observing involves using the senses to gather information, whereas inferring entails drawing logical conclusions from data. These results indicate that students are not yet proficient in these foundational scientific skills.

For Predicting, the mean score was 2.33, accompanied by a standard deviation of 1.724, which is classified as very low. Predicting involves making educated guesses about future outcomes based on prior knowledge and evidence. This score suggests that students are just beginning to develop this skill, and additional practice is needed to enhance their ability to anticipate results based on scientific reasoning. Overall, the results indicate that the level of Basic Science Process Skills of learners is generally low, indicating that they are most likely to have a lower level of knowledge in understanding and practicing science process skills. As seen from the table, all of the Basic science process skills have had a relatively low standard deviation suggesting homogeneity in the student performance meaning all of them struggled in all the science process skills.

This is aligned with the findings of Calleja et. al., 2023 about factors affecting low science proficiency, it includes students' metacognitive reading strategies, their classroom and school experiences, their motivation, and their family experiences and home learning resources. It was found that these are the factors that are not commonly addressed by educational mediation that result in students' low level of science process skills.

Basic Science Process Skills (observation, communication, classification, measurement, inference, and prediction) of students after using the VLAS.

To be able to determine the level of Basic Science Process Skills of the learners after using VLAS, the students have undergone Post testing. Posttest refers to the test given after the completion of an instructional program or segment, this is often used in conjunction with pretest to measure the level of achievement or effectiveness of a program.

Table 3. *Level of Basic Science Process Skills after using VLAS for Control Group*

Basic Science Process Skills	*Mean*	*Standard Deviation*	*Verbal Interpretation*
Communicating	8.28	2.362	Very High
Measuring	7.36	2.113	High
Classifying	8.61	1.498	Very High
Observing	5.64	2.368	Moderate
Inferring	4.81	2.660	Moderate
Predicting	4.31	2.315	Low
Grand Mean	6.5	7.816	High

Legend*: 1.00–2.79 = Very Low (VL); 2.80–4.59 = Low (L); 4.60–6.39 = Moderate (M); 6.40–8.19 = High (H); 8.20–10.00 = Very High (VH)*

The control group showed improvements in basic science process skills after using VLAS, particularly in classifying and communicating skills, which reached high levels. Measuring skills also improved, but observing and inferring skills remained moderate, with inferring showing many failing scores. Predicting skills stayed low, indicating ongoing difficulties. Overall, while VLAS had positive effects, further targeted instruction is needed for inferring and predicting skills.

Table 3 demonstrates the level of basic science process skills of the control group after using VLAS. The basic science process skills of students in this group showed a range of performance, with a very high mean score of 8.61 in Classifying and a low mean score of 4.31 in Predicting.

Classifying received the highest mean score of 8.61, with a standard deviation of 1.498, categorized as very high, indicating that students excelled in organizing and grouping information based on similarities and differences. Among the 36 students, 16 students got a perfect score with a percentage of 44.4%. Similarly, Communicating was rated very high, with a mean score of 8.28 and a standard deviation of 2.362, reflecting strong skills in expressing and sharing scientific observations and findings effectively. Half of the respondents got the perfect score in communicating. Measuring achieved a mean score of 7.36, accompanied by a standard deviation of 2.113, which is considered high, suggesting that students performed well in using tools to gather and quantify data. Based on the observation of the teacher, most of the students are very interested in organizing and grouping information. In one of the activities in VLAS where the students must categorize from which a group of "Tawilis" belongs to, many of the students do not find any difficulty in choosing the population as their level of biological organization. In another activity wherein the students are going to categorize which of the following bacteria is beneficial or harmful most of the students find the activity very interesting and enjoyable. Based on this observation, most of the students find joy in learning concepts in life science by using the virtual lab.

However, students demonstrated only moderate skills in Observing (mean score of 5.64, standard deviation of 2.368) only 2 students got a perfect score in observing with a percentage of 5.56% and Inferring (mean score of 4.81, standard deviation of 2.660) 20 of the student got failing score in inferring with a percentage of 55.56%. Observing involves gathering information through the senses, while inferring requires drawing logical conclusions from observations, emphasizing areas for further improvement. One of the activity in VLAS wherein the students are going to observe the difference between a plant cell and an animal cell some of them excelled in finding which organelle is present only in plant cell and in animal cell while some find it hard to know the difference between the two cells. Based on the observation of the teacher some students are not fully focused on what they are doing while navigating the virtual platform. Focus is very essential in observing things. Predicting, with the lowest mean score of 4.31 and a standard deviation of 2.315, was categorized as low, indicating that students struggled to anticipate outcomes based on patterns and evidence, which is crucial for scientific reasoning. Out of 36 students, 24 of them got a failing score in this skill with a percentage of 66.67%.

The overall results imply that after using VLAS, the control group has an increase in their scores resulting in a more positive enhancement to the overall Basic Science Process Skills some of skills have higher standard deviation while others have a low standard deviation this means that some students showed strong performances in communication, classification, and measuring but weaker performances in inferring and predicting.

Cognitive Load Theory suggests that learning is optimized when instructional materials are designed to manage cognitive load effectively. Virtual laboratories can reduce extraneous cognitive load by providing clear visualizations and interactive elements, allowing students to focus on essential scientific concepts while engaging in inquiry-based activities (Bazie et al., 2024).

Table 4. *Level of Basic Science Process Skills after using VLAS for Experimental Group*

Basic Science Process Skills	*Mean*	*Standard Deviation*	*Verbal Interpretation*
Communicating	8.69	2.040	Very High
Measuring	8.28	1.783	Very High
Classifying	9.47	1.134	Very High
Observing	7.17	2.903	High
Inferring	7.11	2.916	High
Predicting	6.72	2.914	High
Standard Deviation		10.018	
Grand Mean	7.91		High

***Legend**: 1.00–2.79 = Very Low (VL); 2.80–4.59 = Low (L); 4.60–6.39 = Moderate (M); 6.40–8.19 = High (H); 8.20–10.00 = Very High (VH)*

Following the use of VLAS with guided inquiry activities, the experimental group demonstrated strong proficiency across all basic science process skills. Classifying, communicating, and measuring skills showed particularly high levels of performance. Observing, inferring, and predicting skills also improved significantly, reaching high levels. These results suggest that the combination of VLAS and guided inquiry effectively enhanced foundational scientific abilities in the experimental group.

Table 4 demonstrates the level of basic science process skills of the experimental group after using VLAS with guided inquiry activities. The students in this group exhibited strong performance across all skills, with the highest mean score of 9.47 in Classifying, which is categorized as very high, and the lowest mean score of 6.72 in Predicting, which is interpreted as high.

Classifying, with a mean score of 9.47 and a standard deviation of 1.134, indicates that students were highly proficient in organizing and categorizing information based on similarities and differences. In one of the activities in VLAS where the students are going to categorize pictures showing plant cell and animal cell undergoing cell division the students find this activity challenging because it involves knowing first which of the following pictures are plant cell and an animal cell. After which they are going to arrange it based on its phase. With the help also of the guided inquiry activities the students find it easier to understand and learn by themselves the difference in appearance on the stages of mitosis. Similarly, Communicating and Measuring were also rated as very high, with mean scores of 8.69 (standard deviation of 2.040) and 8.28 (standard deviation of 1.783), respectively, showing strong abilities in expressing findings and accurately using tools to gather data. In another activity in VLAS where the students are going to get the total magnification of a specimen under microscope they find this activity interesting because aside from computing the total magnification they could also see the difference when they shift the objective lens and what the specimen looks like under that magnification. This statement is proven based on the scores of the students under the skill measuring. Among 36 students, 34 students got a passing score in the measuring skill part of the test. The low standard deviation of measuring with an mean of 8.28 suggests that most of the students had stronger measuring skill after the integration of VLAS with the guided inquiry activity to their everyday lessons in science.

In Observing, students achieved a mean score of 7.17 with a standard deviation of 2.903, while Inferring had a mean score of 7.11 with a standard deviation of 2.916; both skills were interpreted as high, indicating good performance in gathering data through the senses and drawing logical conclusions. Predicting, with a mean score of 6.72 and a standard deviation of 2.914, was also rated as high, reflecting an improved ability to anticipate outcomes based on evidence. This statement can be proven in one of the activities in VLAS where the students are going to observe a specimen under the microscope based on its appearance and gestures, they can predict what kind of microorganism is seen under the microscope. It is also with the help of the inquiry guided activity that guides the students as they explore the virtual platform, they find it easier to answer the questions and finish the module with ease. In another activity wherein the students are going to toss a coin to determine the identification number of an organism in this activity they can predict if the offspring of the parents will have the same identification number. This activity improves the ability of the students to anticipate outcomes based on the data gathered from tossing a coin.

The results imply that the students in the experimental group showed strong proficiency after using VLAS with guided inquiry activity, with particularly strong performances in classifying, communicating, and measuring. These results highlight the effectiveness of VLAS in enhancing foundational scientific skills, while areas like predicting may benefit from additional focus to achieve even greater mastery.

This is in consonance with the findings of Hartanto (2023) virtual labs can develop science process skills as well as train students in laboratory procedures before exposing them to real-world settings. This will help them observe more, familiarize themselves with the use of laboratory equipment, and teach them in drawing conclusions.

Additionally, the Experiential Learning Theory emphasizes the importance of learning through direct experience, which is essential in both virtual labs and guided inquiry. This approach suggests that when students participate in hands-on activities, they are more likely to remember and use the knowledge they gain. Combining virtual experiments with guided inquiry creates an engaging learning environment where students can explore concepts, try out ideas, and think about what they discover. This method allows students to learn not just from their successes but also from their mistakes, leading to a better understanding of the subject. Through ongoing involvement and self-reflection, students build critical thinking skills and are better prepared to apply their learning in real- world situations, reflecting the main ideas of Experiential Learning Theory.

Difference between the level of Basic Science Process Skills before and after using the VLAS

The normality test using Kolmogorov-Smirnov Test shows that the distribution is not normal, $p<0.05$. Nonparametric tests should be used such as Wilcoxon signed ranks test for paired samples. Table 6 presents the results of Wilcoxon signed ranks test (paired samples) to know if there is a significant difference between the level of Basic Science Process skills such as observing, classifying, measuring, inferring, communicating, and predicting of control and experimental group before and after using the Virtual Laboratory Application.

Table 5. *Test of Significant difference between the level of Basic Science Process Skills of Control and Experimental Group before and after using the VLAS*

Variables	*Z value*	*Sig. value*	*Interpretation*	*Decision to Ho*
Communicating (pre vs post)	-5.252	0.000	Significant	Reject
Measuring (pre vs post)	-5.022	0.000	Significant	Reject
Classifying (pre vs post)	-5.250	0.000	Significant	Reject
Observing (pre vs post)	-4.910	0.000	Significant	Reject
Inferring (pre vs post)	-4.845	0.000	Significant	Reject
Predicting (pre vs post)	-4.881	0.000	Significant	Reject
Overall (pre vs post)	-5.233	0.000	Significant	Reject

Legend: *α = 0.05 Level of Significance (p=0.000<0.05)*

As gleaned from table 6, there is a significant difference in the pretest and posttest scores of students in the basic science process skills under communicating with a Z=-5.252; measuring with Z-value of -5.022; classifying with Z=-5.250; observing with Z=-4.910; inferring with a Z=-4.845; predicting with a Z=-4.881; and the overall Z=-5.233 where all $p=0.000<0.05$. Hence, the null hypothesis is rejected.

In an interview conducted with the respondents they were asked " In what way does VLAS help you to visualize the practical procedures in the laboratory?" They said "Virtual lab helps me because I can virtualize things that cannot be virtualized in real life. Like the microorganisms I saw with a microscope. I also learned how to dissect a fish to see its internal parts as well as the internal parts of a flower. I can also do procedures in the laboratory that I can't do in real life either." This response shows that the VLAS helps in the development of skills that can be obtained in real life scenario, it effectively bridges the gap between theoretical knowledge and practical application. This response also suggests that the VLAS is helpful in enhancing students understanding of scientific concepts because the learners can visualize it.

Additionally, the Teacher-Observer who was in charge with the monitoring of how VLAS is utilize inside the computer lab said, "My overall impression is each learning session in doing virtual labs was meaningful for the teacher and most especially to the learners." This insight from the observer shows that each session with the use of VLAS teaching the learners provides a meaningful learning experience for them enhancing students' interest and motivation.

The results imply that there is a significant difference between the level of Basic Science Process Skills before and after using VLAS. Furthermore, it indicates that integrating VLAS into science education can effectively improve learners' basic science process skills which is essential in the development of scientific literacy. It is also important to take note of the fact that VLAS is a helpful tool in improving students' learning experience inside the classroom.

To ensure that the improvement in students' basic science process skills was due to the Virtual Laboratory Application in Science (VLAS) and not other factors, several measures were taken. The significant differences in pretest and posttest scores, with all p- values below 0.05, indicate that the changes were not due to chance. Interviews with students showed that VLAS helped them visualize scientific concepts and perform lab procedures they couldn't do in real life, making learning more engaging and meaningful. Observations from the teacher confirmed that the sessions were valuable, enhancing student interest and motivation.

Furthermore, the study was in consonance with the findings of Chen et. al., 2024 that learners improved their science process skills, problem-solving awareness, and creative thinking tendencies after exposure to the virtual laboratory. Additionally, Science process skills are significantly improved after exposure to the virtual laboratory. It can be concluded that the use of virtual labs is efficient in the enhancement of basic science process skills. Carrying out experiments in a non-physical environment is almost the same as in the digital world in terms of the accuracy of information and the inferences that students can get (Nisa ea. al., 2023). Furthermore, Ahmad et. al., (2024) revealed that the improvement in the experimental group was higher than that in the control group. These findings suggest that virtual laboratories based on discovery learning are helpful in improving students' scientific attitudes.

According to the Constructivist Theory, the learners construct knowledge through experiences. By engaging in virtual laboratories, students can experiment with scientific concepts in a safe environment, facilitating deeper understanding through exploration and reflection. This aligns with the principles of guided inquiry, where students actively participate in their learning process (Alnaser and Forawi, 2024).

Perceptions of the Learners on the use of Virtual Laboratory Applications in Science

Student perception refers to the impression of the students in using virtual laboratory. It is divided into two which are Student Engagement and Ease of Use. Student engagement refers to the level of attention, curiosity, optimism, and interest that students display towards the material being taught. Ease of use is a measure of satisfaction derived from individuals using the product.

The assessment of Grade 7 Control group and Experimental Group on their perception about use of VLAS in terms of Student Engagement and Ease of Use is presented in tables 6 and 7.

Table 6. *Perception of Learners on the use of Virtual Laboratory Applications in Science in terms of Student Engagement.*

Item Statement	*Control Group*			*Experimental Group*		
	Mean	*SD*	*Verbal Interpretation*	*Mean*	*SD*	*Verbal Interpretation*
1. I found the activities in the interactive virtual laboratory simulation were engaging.	4.33	.676	Strongly Agree	4.50	.697	Strongly Agree
2. Interactive virtual laboratory simulation helped me to visualize the concepts of Laboratory experiments.	4.45	.460	Strongly Agree	4.46	.378	Strongly Agree
3. I felt safe to make mistakes in the Virtual Laboratory Application in Science (VLAS) as I could repeat as many times as I liked.	4.39	.766	Strongly Agree	4.53	.774	Strongly Agree
4. Making mistakes in the interactive virtual laboratory simulation helped me to learn the experimental procedures.	4.28	.615	Strongly Agree	4.42	.604	Strongly Agree
5. The interactive virtual laboratory simulation provided feedback to me when I made mistakes.	4.53	.560	Strongly Agree	4.50	.697	Strongly Agree
Grand Mean	4.49	0.43	Strongly Agree	4.41	0.43	Strongly Agree

Legend: *1.00–1.79 = Completely Disagree (CD); 1.80–2.59 = Disagree (D); 2.60–3.39 = Neutral (N); 3.40–4.19 = Agree (A); 4.20–5.00 = Strongly Agree (SA)*

Shown in the Table 6, the respondents' perception of VLAS in terms of Student Engagement that the item "I felt safe to make mistakes in the Virtual Laboratory Application in Science (VLAS) as I could repeat as many times as I liked." Received the highest score of 4.53 (Strongly Agree) in the experimental group and 4.39 (Strongly Agree) in the control group. Meanwhile, the item "Making mistakes in the interactive virtual laboratory simulation helped me to learn the experimental procedures." Got the lowest mean score of 4.28 (Strongly Agree) by the control group and 4.42 (Strongly Agree) on the experimental group. A closer look on the table reveals a 4.49 (Strongly Agree) computed mean on control group which is the biggest overall mean compared to 4.41 (Strongly Agree) on the experimental group.

In the interview conducted with the learners', they were asked "What information/knowledge you obtained from VLAS that you could not obtain from a typical laboratory practical session?" they said "What I can learn in the virtual laboratory is the experiments. it's easy to do because you just click on it. Meanwhile when it comes to physical, you really have to do the experimenting procedures. Sometimes it's dangerous."

The teacher-observer also mentioned that " Based on my observations the students are really engaged with the simulations in the virtual labs, some of them are taking down notes while doing the experiments. Since they do not use internet connections this avoids distractions on opening websites that are not related in doing experiments. They are also trained on how to properly care for the laptops provided by the school"

The results suggest that VLAS improves student engagement by offering a safe, interactive, and distraction-free environment for learning scientific concepts and procedures, also because VLAS allows students to repeat the experiment at their own pace, it enhances the students' confidence in utilizing the VLAS and improving their engagement and focus on the learning experience.

This aligns with the study of Celine et. al. (2023) the results pointed out that more learners recognized virtual lab activities as easier to perform, more motivating, and more interesting than physical lab activities. Additionally, students have a high level of awareness of virtual laboratories. This is because students are now digital natives and more inclined to use technology, so it is recommended that the school may use virtual laboratories to enhance students learning (Ibanga et. al., 2023).

Table 8. *Perception of Learners on the use of Virtual Laboratory Applications in Science in terms of Ease of Use.*

Item Statement	*Control Group*			*Experimental Group*		
	Mean	*SD*	*Verbal Interpretation*	*Mean*	*SD*	*Verbal Interpretation*
1. The Virtual Laboratory Application in Science (VLAS) was easy to use.	4.53	.654	Strongly Agree	4.36	.639	Strongly Agree
2. The learning objectives were clearly defined at the beginning of the interactive virtual laboratory simulation.	4.33	.586	Strongly Agree	4.39	.766	Strongly Agree
3. I felt confident in using and navigating around the interactive virtual laboratory simulation program.	4.39	.599	Strongly Agree	4.31	.889	Strongly Agree
4. Interactive virtual laboratory simulation guided me through the steps in the experimental procedure Virtual Laboratory Application in Science (VLAS) stimulated my interest to search for additional information.	4.31	.624	Strongly Agree	4.53	.609	Strongly Agree
5. I believed VLAS assisted me in learning the topic	4.72	.513	Strongly Agree	4.67	.535	Strongly Agree
Grand Mean	4.50	0.61	Strongly Agree	4.50	0.61	Strongly Agree

Legend: *1.00–1.79 = Completely Disagree (CD); 1.80–2.59 = Disagree (D); 2.60–3.39 = Neutral (N); 3.40–4.19 = Agree (A); 4.20–5.00 = Strongly Agree (SA)*

Shown in the table 8, the respondents' perception of VLAS in terms of Ease of Use that the item "I believed VLAS assisted me in learning the topic." Received the highest score of 4.72 (Strongly Agree) in the control group and 4.67 (Strongly Agree) in the experimental group. Meanwhile, the item "I felt confident in using and navigating around the interactive virtual laboratory simulation program." Got the lowest mean score of 4.39 (Strongly Agree) by the control group and 4.31 (Strongly Agree) on the experimental group. A closer look at the table reveals a 4.50 (Strongly Agree) computed mean on both control group and the experimental group.

In the interview conducted with the learners', they were asked "What do you like about virtual labs?" they said, "What I like about the virtual lab is that it is easy to use, and it will help you with the step-by-step procedures that need to be followed".

The teacher-observer also mentioned that "Since the school provides new laptops for each session of VLAS, the students do not find any difficulties in the device compatibility in opening and using the Virtual Laboratory Application in science. They do not need internet connection to access the application. They also have individual earphones for them to focus on doing virtual experiments. The students are well behaving inside the laboratory they're just focus on what to do in their own assigned laptops. After virtual lab sessions the post lab discussions follows. Dusing post labs students are encouraged to share their findings and learnings in the use of VLAS. They relate virtual lab experiments to real world applications."

The results imply that the learners perceive VLAS as easy to use and to navigate around. This feature of VLAS helps learners' in their learning experiences enhancing their knowledge in each topic and VLAS makes them understand complex concepts into simple concepts by showing procedural activity so that the students' can easily learn it.

This is in consonance with the findings of Sison, et. al. (2024), it was found that virtual laboratories should aim to support the learning and performance of the students in terms of comprehension of scientific concepts. It was also noteworthy that virtual labs should be easy to manipulate, give clear instructions, and be aligned with the learning objectives. Additionally, it was found that students have positive attitudes in the use of digital simulations therefore it enhances their learning engagement and academic performance. This improvement is evident in their class participation due to the increase in their knowledge after using digital simulations. Integrating digital simulation in science education shows promising results (Dela Cruz & Hermosura 2024)

Conclusions

Based on the findings of the study, the following conclusions were drawn: the study emphasized critical deficiencies in Basic Science Process Skills (BSPS) among Grade 7 students, particularly in communication and classification.

The successive implementation of VLAS demonstrated its effectiveness in improving these skills across both experimental and control groups. Furthermore, the experimental group, which combined VLAS with Guided Inquiry Activities (GIA), achieved significantly higher proficiency, reinforcing the thought that the integration of VLAS and GIA offers a more intense approach to enhancing BSPS.

Lastly, the positive student feedback regarding VLAS indicates that it is not only an effective educational tool but also one that engages students and facilitates their learning experience.

Based on the findings and conclusions of the study, the following recommendations are proposed. First, the development of Guided Inquiry Activity (GIA) modules tailored to complement Virtual Laboratory Activity Simulations (VLAS) is encouraged to foster a deeper understanding of scientific concepts. Second, it is recommended that professional development opportunities be provided for science teachers to enhance their skills in effectively utilizing VLAS and implementing GIA strategies, thereby maximizing the benefits of this integrated approach. Third, future researchers are encouraged to examine the long-term effects of VLAS and GIA on basic science process skills (BSPS), as well as to explore optimal strategies for integrating these tools across various science topics and educational levels. Lastly, developers of VLAS are advised to incorporate more interactive and gamified features to boost student engagement and enrich the overall learning experience.

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