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## TEACHERS' EXPERIENCES IN INTEGRATING VIRTUAL LABORATORIES IN SCIENCE EDUCATION: BASES FOR PROGRAM ENHANCEMENT

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### ABSTRACT

This study was conducted to explore the experiences of science teachers in integrating virtual laboratories in schools as bases for a program enhancement in Oton National High School during the School Year 2025-2026. Specifically, it examined the teachers' experiences in integrating virtual laboratories, benefits toward student engagement and concept understanding, challenges they faced, coping strategies they utilized, and recommendations for enhancement. Using a phenomenological qualitative design, data were collected through researcher-made in-depth interviews with twelve (12) purposively selected science teachers. Thematic analysis was employed to identify key patterns. Findings revealed that the experiences of teachers in integrating virtual laboratories include increasing lesson engagement, providing accessibility and convenience, and providing enjoyment to learners. Teachers' observed benefits are to increase learner engagement, boost learner motivation, enable direct observation, and provide learning flexibility. Challenges encountered during integration include limited access to technology, unstable internet connectivity, inadequate hands-on experience, and lack of time and verification. To overcome these challenges,

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teachers provide backup plans and activities, group learners by needs and encourage teamwork, and utilize personal laptops and alternative technologies.

**Keywords:** *Teachers, Experiences, Virtual Laboratories, Science Education, Enhancement Program*

## INTRODUCTION

The rapid evolution of the digital landscape in the 21st century has fundamentally transformed science education. Traditional instruction, long centered on physical laboratory experimentation, is increasingly complemented or replaced by Virtual Laboratories (VLs)—interactive platforms that allow students to conduct experiments within simulated environments.

Historically, laboratories have served as the "heart" of science education, bridging the gap between theoretical knowledge and practical application. However, global challenges—including prohibitive equipment costs, safety concerns, and the disruptions caused by the COVID-19 pandemic—have accelerated the adoption of virtual alternatives. In recent years, VLs have shifted from supplementary tools to essential curriculum components, effectively overcoming financial and logistical barriers (Engel et al., 2024). These platforms provide safe spaces for experimentation and foster inquiry-based learning; however, their successful adoption remains heavily dependent on teachers' perceptions and digital self-efficacy (Vassiliadou, 2025).

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In the Philippines, the Department of Education (DepEd) has advocated for the "Digital Rise" initiative to address the perennial shortage of physical laboratory facilities. A scoping review of Philippine science teaching from 2020 to 2025 reveals that Filipino science educators have emerged as "highly adaptive innovators," utilizing platforms such as PhET simulations, Labster, and locally developed mobile applications to bridge gaps in hands-on learning.

Nevertheless, the Philippine context is uniquely challenged by a persistent "digital divide" (Abareta & Prudente, 2025). While urban schools migrate toward sophisticated Learning Management Systems (LMS), rural institutions continue to struggle with inconsistent connectivity and hardware limitations (Balbin et al., 2025). Furthermore, a critical disconnect persists between the potential of these tools and their classroom execution. While teachers express enthusiasm for virtual labs, actual integration was often hindered by a lack of Technological Pedagogical Content Knowledge (TPACK), as noted by Avelino (2025). This suggests that hardware provision alone is insufficient without a corresponding evolution in teaching methodology.

Central to the success of virtual laboratories are the teachers who facilitate them. Studies indicate that positive perception alone does not guarantee effective implementation (Busuttil & Calleja, 2025). In the Philippines, teachers frequently reported "digital fatigue" when navigating complex simulations without adequate support (Rivera, 2024). Meta-analyses further indicate that VL efficacy improves when professional development extends beyond basic technical skills; yet, many Philippine divisions lacked structured programs addressing the psychological and pedagogical needs of science teachers (Sankaranarayanan et al., 2023).

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This study was grounded in the belief that sustainable VL implementation required a robust, teacher-centric framework. By documenting and analyzing science teachers' experiences, this research aimed to provide insights for program enhancement, guiding professional development, resource allocation, and curriculum design.

The ultimate goal was to establish a resilient and innovative science education program that empowered teachers to maximize technology while remaining practical and responsive to the realities of public schools.



## MATERIALS AND METHODS

### Research Methodology

This chapter presents the research method, research design, participants of the study, data-gathering procedures, research instrument, and data analysis used in this study. The purpose of this study was to explore the experiences of science teachers in integrating virtual laboratories in schools as bases for a program enhancement in the Municipality of Oton during the school year 2025-2026.

### Research Method

The research method utilized in this study was descriptive method under qualitative research using in-depth interview.

The descriptive research method focuses on systematically describing a phenomenon as it exists in its natural setting, without manipulating variables. According to Elliott (2025), it aims to provide an accurate portrayal of current conditions, practices, or relationships within

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educational settings, enabling researchers to understand trends, patterns, and implications for practice. This approach is particularly useful in educational studies that seek to document and analyze real-world events, behaviors, or perceptions without altering the environment in which they occur (Elliott, 2025).

The interviewer with the interviewee during the interview were allowed to sit together in a distance and to think about the series of questions about a certain issue. The aim is to get the main or the necessary views of the participants in a certain issue in a social context through the responses of the participants to the questions.

## Research Design

The study used phenomenological research design. Phenomenology can be considered a philosophical approach to undertaking qualitative research. The goal of phenomenology is to understand how others view the world, and how this view may vary from commonly held views by focusing on a person's subjective interpretations of what she experiences. Phenomenology is done by interviewing the subjects to learn their impressions, and is frequently used in such fields as psychology, sociology, and social work.

Phenomenology focuses on the study of structures of consciousness as experienced from a first-person perspective. The central aim of phenomenology is to investigate and describe phenomena as they are consciously experienced, without resorting to theories about their causal explanations or being influenced by unexamined preconceptions (Biemel and Spiegelberg, 2024).

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## Participants of the Study

The participants of this study were twelve (12) junior high school science teachers from Oton National High School. The selection of participants was guided by specific inclusion criteria to ensure that they possess the necessary qualifications and relevant experiences for the conduct of the study.

To be included, participants must be currently teaching science in the Junior High School level, have actively utilized virtual laboratory platforms such as PHET, Labster, Gizmos, or other similar tools as part of their instructional practices, hold a regular permanent teaching appointment in the school; and have completed at least one full academic year of teaching experience in Oton National High School.

These criteria were established to ensure that the participants have sufficient exposure, familiarity, and practical experience in integrating virtual laboratories into science instruction, thereby enabling them to provide rich, relevant, and reliable insights for the study.

## Sampling Design

Purposive sampling design was used in the study. Purposive sampling according to Nikolopoulou (2023) refers to a group of non-probability sampling techniques in which units are selected because they have characteristics that you need in your sample. In other words, units are selected "on purpose" in purposive sampling. This is also called judgmental sampling, this sampling method relies on the researcher's judgment when identifying and selecting the individuals, cases, or events that can provide the best information to achieve the study's objectives.

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## Research Instrument

The research instrument utilized in the study was a researcher-made interview schedule.

An interview schedule in research methodology is a written list of pre-planned questions (either structured, semi-structured, or open-ended) prepared to guide an interviewer in collecting information consistently from participants. It functions as a standardized tool for data collection, ensuring that the same topics and questions are addressed across interviews to support systematic comparison and analysis. The interviewer follows the schedule during face-to-face, telephone, or electronic interviews, asking each participants the predetermined items and recording their responses (Socio.health, 2024).

The interview schedule has four (4) major questions focusing on the lived experiences of teachers in using virtual laboratories in terms of lesson preparation, classroom facilitation and student assessment, the challenges or barriers teachers encounter during integration, and the benefits that the teachers observed in student engagement and conceptual understanding.

Voice and video recorders were also used for data gathering and documentation depending upon the permission of the participants.

## Validity of the Research Instrument

Prior to the determination of the validity of the interview schedule made by the researcher, the adviser, Dean of the Graduate School then a panel of jurors who were

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considered for their expertise in the field of research, testing and assessment, and English, were requested to validate each question for review and modification.

Validity refers to the extent to which the findings, interpretations, and conclusions derived from a study are accurate, meaningful, and appropriate in representing the concept being examined. It ensures that the research instrument truly measures what it is intended to measure and that the results are credible reflections of reality. In establishing content validity, the questions and format of the instrument must align with the study's defined variables and objectives to guarantee that each item accurately reflects the construction under investigation. This process often involves expert review to determine whether the items are relevant, clear, and representative of the concepts being studied. By ensuring that the content and structure of the instrument are consistent with the study's framework, researchers enhance the accuracy and usefulness of the data collected in relation to the research objective (Creswell & Creswell, 2022).

Comments, corrections, and suggestions of the panel of validators regarding the interview schedule were considered using the appropriate form of Good and Scates (1972) as cited by Soqueña (2021).

### Data Gathering Procedures

Permits from the adviser, Dean of the Graduate School, Office of the Schools Division Superintendent, Office of the District Supervisors, School Heads, and individual participants were obtained to allow the researcher to conduct the study. The researcher personally went

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to the schools/community/place convenient on the part of the participants to conduct the interview.

The researcher encouraged the participants to sign a waiver or permission relative to the conduct of the study.

Using in-depth interview, a voice and video recorder were also be provided to completely capture the interviewee's words. The researcher consolidated all collected data after series of interviews.

### Data Analyses

The gathered information was analyzed using thematic approach.

Thematic analysis is the process of identifying patterns or themes within qualitative data. According to Maguire & Delahunt (2017), the aim of a thematic analysis is to identify themes, such as patterns in the data that are important or interesting and use these themes to address the research or say something about an issue. This is summarizing, analyzing, and interpreting the data gathered and making sense of it.

## RESULTS AND DISCUSSIONS

This study was conducted to explore the experiences of science teachers in integrating virtual laboratories in schools as bases for a program enhancement in Oton National High School during the School Year 2025-2026.

The research method utilized in the study was descriptive using in-depth interview.

The study used phenomenology under qualitative research design.

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The participants of the study were 12 junior high school science teachers from Oton National High School in the Schools District of Oton, Schools Division of Iloilo.

The research instrument utilized in the study was a researcher-made interview schedule. Voice and video recorder were also used for data gathering and documentation depending upon the permission of the participants.

A panel of experts validated the interview schedule and considered all comments and suggestions relative to the validation of the tool.

Permits from the individual participants were obtained to allow the researcher to conduct the study. The researcher personally went to the schools/community/place convenient on the part of the participants to conduct the interview and virtual instruction was done prior to the interview.

Using in-depth interview, voice and video recorders were provided to completely capture the interviewee's words or responses. The researcher consolidated all the collected data after series of interviews.

The information gathered was analyzed using thematic approach.

The following are the findings of the study:

Based on the results of the in-depth interview with the participants, it was found out that the experiences of teachers in integrating virtual laboratories in classroom facilitation include increasing lesson engagement, providing accessibility and convenience, and providing enjoyment to learners.

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One of the participants revealed that using virtual laboratories really help in making learners engaged in the lesson through attractive graphics. The participant all also added that learners tend to understand the concept better because they themselves manipulate the variables and be able to see the result immediately.

I also found out that teachers have observed an increase in learners' curiosity, particularly when they get to interact with simulations.

When it comes to accessibility and convenience, several participants declared that due to lack of stable internet connection in schools, they often opt into virtual laboratories as a supplementary learning material. Teachers provide links of the simulations and ask learners to explore them at home in their most convenient time.

Based on an interview, it was found out that teachers witnessed their learners enjoying ICT or virtual lab integration in class.

Based on the results of the in-depth interview with the participants, it was found that teachers' observed benefits on student engagement and conceptual understanding in integrating virtual laboratories are to increase learner engagement, boost learner motivation, enable direct observation, and provide learning flexibility.

According to the result, having learners engaged in virtual laboratories increases their curiosity and motivation to learn as they are free to explore scientific ideas on their own. Learners are more relaxed because they are not afraid to make mistakes given that the experiment can be done as much as they want.

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However, based on the results of the in-depth interview with the participants, it was found out that the teachers' challenges encountered during integration of virtual laboratories include limited access to technology, unstable internet connectivity, inadequate hands-on experience, and lack of time and verification.

The result also revealed that the coping strategies employed by teachers to overcome challenges on the integration of virtual laboratories are to provide backup plans and activities, group learners by needs and encourage teamwork, maintain flexibility and creativity, and utilize personal laptops and alternative technologies.

Based on the result of the study, the proposed program enhancement is titled, "Program Enhancement for Effective Integration of Virtual Laboratories in Classroom Instruction".

This program aims to strengthen the use of virtual laboratories in classroom teaching by addressing existing challenges and maximizing their educational benefits. While virtual laboratories have been shown to increase student engagement, motivation, and conceptual understanding, limitations such as insufficient devices, unstable internet connectivity, lack of hands-on practice, and difficulties in monitoring student learning have hindered their full potential. The program focuses on improving access to technology, supporting teachers, enhancing practical learning opportunities, and fostering collaborative and flexible teaching approaches.

Based on the findings, the following insights were drawn:

Teachers perceive that incorporating virtual laboratories into their teaching not only

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captures students' interest but also simplifies the learning process, making it easier for learners to follow and interact with the material, while creating a more positive and enjoyable classroom experience overall.

Teachers observed that integrating virtual laboratories encourages students to participate more actively, enhances their enthusiasm for learning, provides opportunities for hands-on exploration and experimentation, and supports a more adaptable and personalized approach to understanding scientific concepts.

Teachers faced difficulties in implementing virtual laboratories due to insufficient technological resources, unreliable online access, restricted practical experimentation opportunities, and constraints in managing and monitoring student learning effectively.

Teachers addressed the difficulties of using virtual laboratories by preparing alternative instructional approaches, organizing students to support each other, adapting their teaching methods creatively, and leveraging their own devices and tools to ensure learning continued smoothly.

## CONCLUSION

In the light of the findings and insights arrived in this study, the following recommendations are highlighted:

Science teachers should continue integrating virtual laboratories into their instruction while providing structured guidance and blending these simulations with interactive, hands-on activities to promote active participation and practical skill development.

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Furthermore, educators should remain adaptive by employing flexible teaching strategies and leveraging both school-based and personal technological resources to ensure instructional continuity.

Learners should have proactive engagement with virtual simulations as tools for independent inquiry and collaborative problem-solving, alongside the development of the digital literacy and self-discipline necessary to navigate these environments effectively.

School heads are encouraged to strengthen technological infrastructure and provide the administrative support required to eliminate technical barriers and monitor implementation effectively. This includes institutionalizing professional development programs that prioritize pedagogical integration over basic technical skills.

Similarly, Department of Education (DepEd) officials should adopt a phased implementation approach for virtual laboratory programs, supported by adequate funding and national guidelines that address both hardware maintenance and the psychological well-being of teachers. Prioritizing resource allocation for rural and underserved schools is essential to bridge the digital divide and ensure equitable access to quality science education.

Curriculum planners and instructional designers should focus on aligning and localizing the Most Essential Learning Competencies (MELCs) to explicitly include virtual simulations that are both offline-capable and mobile-friendly.

Future researchers should conduct longitudinal studies to explore the long-term impact of these tools on students' critical thinking and practical skills. Further investigation into innovative strategies to overcome persistent technological challenges and an evaluation

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of training models for improving Technological Pedagogical Content Knowledge (TPACK) will remain critical for sustaining the evolution of science education in the Philippines.



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