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Teacher Utilization of Advanced Laboratory Equipment in Secondary Science Instruction: A Descriptive Qualitative Study

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Abstract — Science teachers lack advanced laboratory experience globally. I explored the perceptions of science teachers on their conditions in handling advanced laboratory equipment. I employed descriptive qualitative research design. Interviewing 11 purposively selected science teachers, and analyzing their data via thematic analysis, I found that science teachers experience emotional ambivalence and recognize instructional gaps and challenges in using advanced laboratory equipment, while emphasizing experiential learning, teacher transformation, and the adoption of improved, adaptive, and student-centered teaching strategies. School heads may allocate resources, provide training, mentorship, learning materials, collaboration, feedback, and professional development to support teachers in effectively implementing improved, student-centered, and experiential teaching strategies. Future research may further quantify these findings through multiple regression analysis and develop a validated survey instrument using exploratory factor analysis to establish a broader framework for understanding effective laboratory instruction.

Keywords: Utilization of advanced laboratory equipment, secondary science instruction, descriptive qualitative study

I. INTRODUCTION

In this chapter, I presented the problem and its scope, significance of the study, statement of the problem, assumptions, theoretical framework, and the paradigm.

The Problem and Its Scope

Poor experience in utilizing advanced laboratory equipment among science teachers is an educational concern in the global context. As science education increasingly integrates advanced technologies and laboratory tools, teachers are expected to demonstrate competence in using such equipment to support effective instruction. However, I learned that many science teachers worldwide still exhibit limited experience and proficiency in handling advanced laboratory equipment (Fischer et al., 2023).

This educational concern is also evident across various countries. In Kenya, science teachers have been observed to have limited experience in maximizing the use of advanced laboratory equipment in instructional settings (Odhiambo, 2024) Similarly, in India, studies highlight that teachers encounter difficulties in effectively utilizing laboratory tools in science teaching (Nuevo, 2024). In South Africa, the issue is likewise observed, where science teachers demonstrate challenges in engaging with laboratory equipment in classroom practice (Osaiyuwu, 2023). These international contexts show that the problem persists across different educational systems.

In the Philippines, science teachers have been observed to have limited experience in maximizing the use of advanced laboratory equipment in instructional settings (Perdio, 2023). Poor experience in utilizing advanced laboratory equipment among science teachers remains a significant educational concern. Despite efforts to enhance science education through the provision of laboratory resources, many teachers still demonstrate limited familiarity and engagement with advanced equipment in their teaching practices (Calzada, 2025).

The consequences of poor experience in utilizing advanced laboratory equipment among science teachers are considerable. With this, I agree that it can lead to ineffective science instruction, reduced opportunities for experiential and hands-on learning, and limited development of students' scientific skills and critical thinking abilities (Paglinawan, 2024). Additionally, it may negatively impact student engagement and learning outcomes, thereby affecting the overall quality of science education. These implications highlight the need to address this concern to ensure meaningful and effective teaching and learning in science classrooms. It is in this context that I conducted this study.

Significance of the Study

This study was important because it showed how hard it is for science teachers to work in the lab. Researchers often overlook the teacher's perspective, and I tried to make it right. I let my coworkers talk about their work and come up with ideas for how to make lab lessons more about discovery and deep thought. I linked my work to the United Nations Sustainable Development Goal 4, which calls for Quality Education for all. I think this study is my way of helping everyone get a better education. I also wanted to help school leaders and rule-makers understand what a teacher's day is really like. This helps them make better training and support for teachers so that they can give every student a great science education.

Statement of the Problem

In this study, I explored the perceptions of science teachers on their conditions in handling advanced laboratory equipment. Specifically, I sought answers to the following questions:

Specific Research Questions

1.What are the perceptions of science teachers on utilizing advanced laboratory equipment?

2.What are the reflections of science teachers on utilizing advanced laboratory equipment?

3.What are the emerging abstract concepts of science teachers on utilizing advanced laboratory equipment?

4.What are the perceptions of science teachers on applying new concepts in utilizing advanced laboratory equipment?

Theoretical Lens

I anchored this study on David A. Kolb's Experiential Learning Theory (1984). Learning is an ongoing process in which knowledge is generated through the transformation of experience. Kolb's main point is that learning isn't just about getting information; it's also about doing things, reflecting, thinking, and applying what you've learned. He suggested that learning works best when it goes through four steps in a circle: Concrete Experience (doing something new), Reflective Observation (thinking about and reflecting on that experience), Abstract Conceptualization (coming up with theories or generalizations), and Active Experimentation (putting what was learned into practice in new situations).

Conceptual Lens

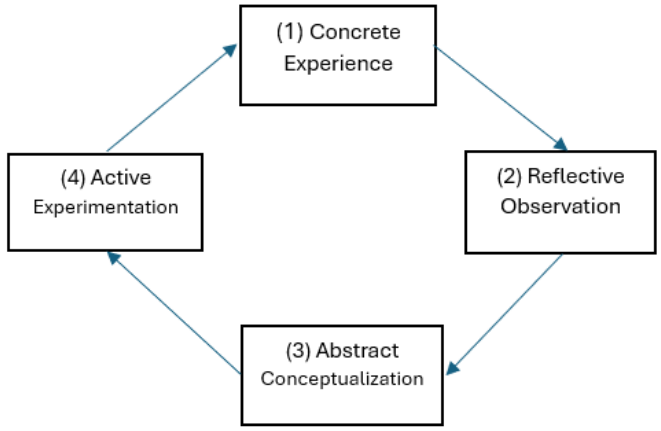

FIGURE 1
PARADIGM OF THE STUDY ON KOLB'S EXPERIENTIAL LEARNING THEORY

Assumptions

In this study, I assumed that learning is something that happens all the time and that people learn by doing things, not just by listening. I assumed that teachers and students learned by doing real lab work and then really thinking about what happened. They were able to better understand their work and come up with new ideas for how to teach by thinking about these times. This made a cycle where they used what they learned to make their next lessons better. This follows what Kolb calls the four stages of experiencing, reflecting, thinking, and testing.

II. METHODOLOGY

In this chapter, I presented the methodologies of the study. In consists of the research design, locale of the study, sample and sampling technique, data gathering technique, data analysis, trustworthiness of the study.

Research Design

I used a descriptive qualitative design for this study because I believe that the best way to understand the laboratory environment is from the teachers' points of view. Descriptive qualitative design is a way of doing research that tries to give a full and clear picture of a perceptions of the people about the events they encounter. It does this by focusing on "what" and "how" questions and staying close to the participants' own words while avoiding deep theoretical interpretation. I used it when I want to learn more about topics that haven't been studied enough, understand perceptions of the people in natural settings, or come up with useful ideas for fields like education. Some of its benefits are that it produces rich and detailed data, allows for flexible data collection and analysis, and produces results that are easy to understand and put into practice (Margarete Sandelowski, 2000; Sally Thorne, 2016).

Locale of the study

The study took place in a few secondary schools in Cluster 9 of the Baguio District, Division of Davao City, where science was a key part of the curriculum. Cluster 9 has eight schools, but I only pick three that have working labs. These schools were chosen because they were typical classrooms where teachers were expected to use laboratory-based instruction even though they didn't have enough resources, training, or help with managing the lab. The setting was important because many of the teachers in these schools were expected to have trouble using lab equipment, which could have made the science lessons less effective.

By placing the study in this setting, I was able to record the experiences of science teachers as they used laboratory techniques, which gave me insights into the strengths and weaknesses of everyday science classrooms.

Sample and Sampling Technique

In this study, I included 11 licensed high school science teachers who had worked in a lab at least for one year. I wanted to be sure that the people I talked to had real, firsthand information to share. I selected teacher participant that rendered their services from school year 2018 and above to ensure that they possessed sufficient exposure to laboratory techniques and classroom-based science instruction.

I used purposive sampling to choose specific people who had the right knowledge and experience. The goal was to get detailed and useful information from these individuals, rather than just getting a general overview from a random group. This method worked well because I was studying a specific group of people who had lived through the situations I was researching. It allowed me to find the right participants to provide the detailed facts and insights needed to truly understand the problem (Patton, 2015; Creswell, 2018).

Data Gathering Technique

I used IDI (In-Depth Interview) and FGD (Focus Group Discussion) to get qualitative data that helped me learn more about how people think, feel, and act. An IDI is a one-on-one interview that lets people really talk about their ideas. A structured group discussion called a FGD helps people share their thoughts and come up with new ideas and different points of view. I used these methods to learn more about difficult social issues, figure out why people act the way they do, and get a lot of qualitative data from specific groups or communities. These methods have their pros and cons. IDI gives me detailed and context-rich data, FGD encourages interaction and idea generation, and I can get both individual and group perspectives (Kvale, 2007; Morgan, 2019).

Data Analysis

I employed thematic analysis based on the framework established by Braun and Clarke (2006). This process involved getting to know the data, coding it, and carefully developing themes. It wasn't just a technical job for me; it was a process that required me to fully understand the data. I read each transcript over and over again, paying close attention to the details of each conversation until I could clearly see important events and patterns in their lives. I then put these results into groups based on common themes that showed how teachers used lab equipment. I did more than just write a report; I did a lot of research and compared different sources of data. I was able to present a clear and honest picture of the problems these teachers had to deal with and the smart ways they found to fix them.

I used a method called triangulation to make sure that the stories I told were true and honest. This meant that I thought about the teachers' experiences in a number of different ways. I put together the personal stories I heard in my interviews with the ideas that came up in the group discussions and compared them to school documents. I was able to confirm the main patterns I saw and keep my own opinions from affecting the results by comparing these different sources. This step of double-checking the data was more than just a research step; it was my way of making sure I really told the stories of these teachers and their lives as they really were.

Trustworthiness

To ensure trustworthiness in this study, I established credibility, transferability, dependability, and confirmability as key standards throughout the research process (Lincoln & Guba, 1985; Korstjens & Moser, 2018). I ensured credibility through triangulation and member checking by comparing interview data with focus group responses, while transferability was achieved by providing thick descriptions of participants and research settings; dependability was ensured through an audit trail of all research procedures, and confirmability was established through reflexivity and cross-checking of interviews, FGDs, and documents to minimize bias.

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III. RESULTS AND DISCUSSIONS

In this section, I discussed the findings of my study, future direction and implication for practice.

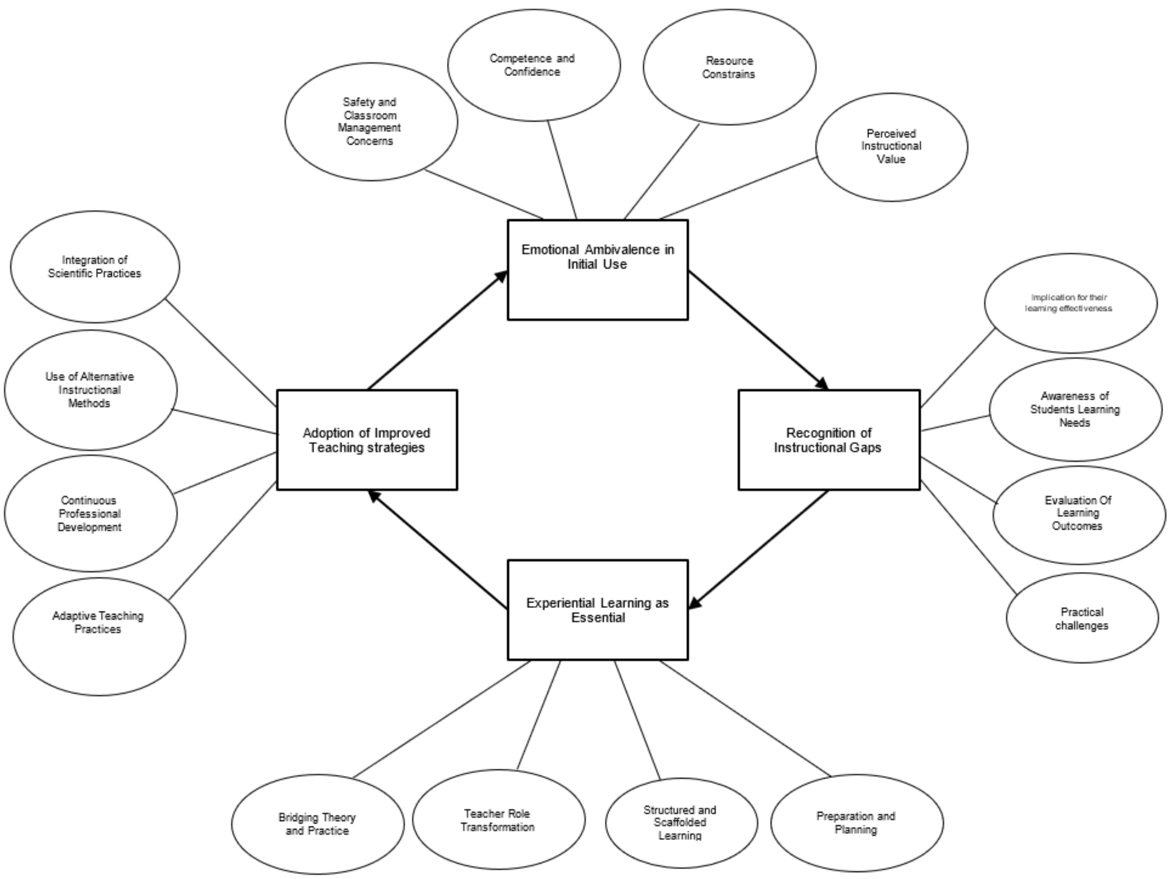

FIGURE 2: MODIFIED PARADIGM
EMERGING THEMES ON THE PERCEPTION OF SCIENCE TEACHERS IN UTILIZING ADVANCE LABORATORY EQUIPMENT

Perceptions of Science Teachers on Utilizing Advanced Laboratory Equipment

In this study, I found that science teacher perceived that when using advanced laboratory equipment, emotional ambivalence is felt. It is important to ensure safety and proper management, consider the need for competence and confidence, be mindful of resource constraints, and recognize its instructional value.

My finding supports the work of Loughran, John, and Berry, Amanda (2022), which showed that teachers' beliefs, feelings, and limitations in the classroom have a big impact on how well they teach science, especially in labs. It also agrees with Fischer, Christian et al. (2023), who found that the availability of school resources and teacher confidence have a big effect on how well practical science activities are done.

In contrast, I opposed the study of Willingham (2023), who argued that effective learning is best achieved through structured, cognitively clear instruction rather than relying heavily on experiential or discovery-based approaches. While this perspective emphasizes clarity and cognitive efficiency, my findings showed that science teacher perceived that when using advanced laboratory equipment, emotional ambivalence is felt. It is important to ensure safety and proper management, consider the need for competence and confidence, be mindful of resource constraints, and recognize its instructional value. I observed that teachers viewed effective instruction as a balance of clear guidance and hands-on engagement, suggesting that laboratory-based learning becomes more meaningful when emotional, practical, and experiential factors are also considered alongside structured teaching.

Reflections of Science Teachers on Utilizing Advanced Laboratory Equipment

In this study, I found that science teachers reflected that the use of advanced laboratory equipment helped them recognize instructional gaps, understand the implications for their teaching effectiveness, develop awareness of students' learning needs, evaluate learning outcomes, and identify practical challenges.

My finding supports the claims made by Darling-Hammond, Linda, and Hyler, Melissa (2022), who said that reflective teaching practice improves the quality of instruction and helps teachers make better decisions in the classroom. It also supports with Korthagen (2023), who found that structured reflection makes teachers much more aware of their teaching and more effective in the classroom.

In contrast, I opposed the study of Hattie (2023), who claimed that visible teaching strategies and direct instruction are superior predictors of student achievement compared to reflective practice alone. While this perspective emphasizes structured instruction and measurable outcomes, my findings showed that in science laboratory instruction, reflection is equally significant in enhancing teaching effectiveness. I observed that science teachers used advanced laboratory equipment as a basis for recognizing instructional gaps, understanding implications for their teaching, identifying students' learning needs, evaluating learning outcomes, and addressing practical challenges. This suggests that effective teaching is not only driven by visible instruction but also by reflective practice that strengthens pedagogical awareness and improves classroom decision-making.

Emerging Abstract Concepts of Science Teachers on Utilizing Advanced Laboratory Equipment

In this study, I identified the emerging abstract concepts in utilizing advanced laboratory equipment are experiential learning as essential, the bridging of theory and practice, the teacher role transformation, structured and scaffolded learning, and preparation and planning.

My finding confirms Bybee, Rodger W. (2022), who pointed out that inquiry-based science education is crucial for fostering scientific literacy and conceptual comprehension. It also corroborates with Taber (2023), who found that scaffolded learning helps students link abstract scientific ideas to things that happen in the real world.

However, I opposed the study of Kirschner et al. (2022), who argued that minimally guided discovery learning is less effective than structured direct instruction in achieving learning outcomes. While this emphasizes efficiency and structured teaching, my findings showed that science teachers highly valued experiential learning as essential, the bridging of theory and practice, the teacher role transformation, structured and scaffolded learning, and preparation and planning. I observed that teachers perceived effective learning as active student engagement supported by guided instruction, suggesting that meaningful understanding is strengthened when experiential activities are combined with appropriate teacher support.

Application of New Concepts on Utilizing Advanced Laboratory Equipment

My exploration reaches the point of seeing how science teacher perceived their application of new concepts in utilizing advanced laboratory equipment. Indeed, they made it clear that it includes adoption of improved teaching strategies, integration of scientific practices, use of alternative instructional methods, continuous professional development, and adaptive teaching practices.

This claim that I have developed throughout the process, supports Darling-Hammond, Linda et al. (2022), who emphasized that sustained professional learning leads to instructional improvement and effective classroom adaptation. In support, according to Desimone, Laura M. (2022), who found that effective professional development promotes long-term changes in teaching practice.

Conversely, I opposed the study of Hattie (2023), who argued that consistency in instructional strategies is more effective than frequent adaptation in achieving learning outcomes. While this emphasizes stability in teaching, my findings showed that science teacher perceptions on applying new concepts in utilizing advanced laboratory equipment include adoption of improved teaching strategies, integration of scientific practices, use of alternative instructional methods, continuous professional development, and adaptive teaching practices. I observed that teachers viewed effective laboratory instruction as a flexible process that responds to classroom conditions and resource limitations, suggesting that meaningful teaching is strengthened through adaptation and continuous improvement rather than rigid consistency.

Future Direction of my Study

My journey has reached the end of the tunnel. And I saw ahead potential research that may be focused on after my conversations with the science teachers. I am convinced that conducting multiple regression analysis, to assess the predictive validity of the identified themes, including emotional ambivalence, safety and classroom management issues, competence and confidence, resource limitations, and perceived instructional value, along with other relevant sub-themes as indicators of effective science laboratory instruction. I also considered the use of exploratory factor analysis (EFA) to develop and validate a standardized survey instrument grounded in the sub-themes that emerged from this qualitative study. I believed that these future studies could help transform the qualitative findings into a validated framework applicable to larger populations and useful for comparing different educational contexts.

Implications for Practice

School heads may allocate resources intended to relevant activities such as orientation workshop and seminars that help develop the confidence of the teacher in using advance laboratory equipment; may offer mentorship programs and technical assistance to support teachers in their instructional effectiveness; may provide appropriate learning resources, strengthen collaboration among teachers, and implement continuous feedback to ensure its effective implementation as an essential approach in teaching and learning; and may engage in relevant practices such as being open to innovation, participating in continuous professional development, and applying student-centered and reflective teaching strategies in the classroom to effectively support the implementation of improved teaching strategies.

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