



BSED-SCIENCE STUDENTS' DIFFICULTIES IN LABORATORY EXPERIMENTS AND WAYS OF DEALING WITH THEM

Joseph Emmanuel S. Salazar
joseph.salazar1207@gmail.com

Jannelle S. Arellano
janelarellano6@gmail.com

Lor Jean A. Tomarong
lorjeantomarong@gmail.com

Mayranette F. Manayan
mfmanayan.cteas@sccpag.edu.ph

Genesis B. Naparan
genesisbnaparan@gmail.com

Angelina V. Villaver
angelinavillaver@sccpag.edu.ph

Daisy R. Catubig
daisycatubig@sccpag.edu.ph

ABSTRACT

Laboratory experiments have been a great asset to science education and the community, making them necessary. This study aimed to investigate the experiences of Bachelor of Secondary Education, major in Science students in conducting laboratory experiments during the academic year 2022-2023. The study utilized a qualitative research design, specifically the case study research model by Merriam. The researchers interviewed the 8 BSED–Science students enrolled in a private academic institution. Students shared their difficulties when performing laboratory experiments are lack of laboratory equipment, limited time given by the teacher, unachievable outcomes, difficulty in collecting samples, unfamiliarity with the laboratory equipment, difficulty in understanding the experiment procedures, difficulty in interpreting the results, unspecified instructions from the instructor, and inappropriate use of laboratory equipment. With that, referring to online sources, modifying the difficult parts of the experiment, accepting undesired outcomes, studying in advance, asking others for help, persisting in attaining success, and developing vital patience are ways to deal with difficulties. To address the lack of laboratory equipment, the researchers recommend allocating sufficient resources to ensure laboratories are well-equipped.

Keywords: science, BSED–science students, laboratory experiment, difficulties, experiences



INTRODUCTION

Laboratory experiments test hypotheses in a controlled environment or a laboratory (Pederson, 2017; Savage & Torgler, 2021). Laboratory experimentation is the foundation of science education, and managing these difficulties is important for providing meaningful and engaging learning experiences for BSED–Science students. It began many years ago and has significantly improved our lives and society, making life more accessible and convenient for everyone. Laboratory experiments have also enhanced students' abilities; they have become more attentive, fostered scientific reasoning, developed an interest in Science, and improved their collaboration with classmates (Putri et al., 2021). Laboratory activities also provide students with plenty of learning opportunities, which is crucial in fostering their continuing intellectual development across all academic levels (Sshana & Abulibdeh, 2020)

Laboratory experiments have played a big part in helping scientists, researchers, and students understand and solve problems around us. Due to its essential role in the science curriculum, it became required in science-related higher education programs such as biology and chemistry (Mojica & Upmacis, 2021). Although laboratory experiments are wonderful, they can sometimes be challenging to perform. Understanding these difficulties and how students deal with them can be essential to students' academic success (Kranz et al., 2022).

Moreover, the effectiveness of laboratory experimentation heavily relies on the instructor's skill and confidence (Sshana & Abulibdeh, 2020), as well as on identifying the difficulties students encountered and how they dealt with them, to enhance the quality of education. By also offering seminars on teaching, educational institutions can better prepare these teachers to deliver effective, engaging laboratory activities to students (Otero et al., 2006). This can contribute to a deep understanding and appreciation of laboratory experiments or the subject.

Furthermore, navigating the difficulties encountered during laboratory experimentation is essential for BSED–Science students. As these students engage in laboratory experiments, they often encounter various obstacles in the laboratory or during experimentation (Kranz et al., 2022). By understanding their resilience and problem-solving skills in encountering these difficulties, we can gain insights into their personal growth and development (Freire et al., 2020).

While the importance of laboratory experiments is widely recognized and their benefits are notable, there is a lack of literature on the specific challenges that Bachelor of Secondary Education major in Science students encounter during laboratory experiments (Sshana & Abulibdeh, 2020). Previous studies have centered on the advantages of laboratory experiments and the general challenges students face (Putri et al., 2021). However, the researchers found that a more detailed study is needed of the specific difficulties BSED–Science students encountered and how they dealt with them during laboratory experimentation (Freire et al., 2020; Kranz et al., 2022). Understanding these difficulties and how they are addressed is crucial to developing effective teaching strategies and improving the quality of science education (Vialle et al., 2021). This study aims to bridge this gap by investigating the challenges that Bachelor of Secondary Education, Major in Science, students encounter during their laboratory experiments and how they deal with these difficulties.



The researchers are motivated to pursue this study because laboratory experiments are important in science education, providing students with hands-on experiences to develop their scientific knowledge. Furthermore, the theoretical framework of this study is David Kolb's Experiential Learning Theory. This theory emphasizes engaging, stimulating activities grounded in real-world contexts, aligning with the laboratory experiments conducted by Bachelor of Secondary Education Major in Science students. More importantly, experiential learning is achieved through the transformation of experiences (Kolb, 1984).

Research Objectives

This study aimed to investigate the experiences of Bachelor of Secondary Education, major in Science students conducting laboratory experiments during the academic year 2022-2023. With this in mind, the study addressed the central question, "What challenges do BSED-Science students face during laboratory experiments, and how do they deal with these difficulties?" It also addressed the following sub-questions:

1. What are the difficulties that students of the Bachelor of Secondary Education Major in Science encounter during laboratory experimentation?
2. How do the Bachelor of Secondary Education Major in Science students deal with the difficulties they encounter?

RESEARCH METHOD

Research Design

The study utilized a qualitative research design to gain insights into the students' motivations, experiences, and contextual factors influencing their laboratory experiments. The case study research model by Merriam (1998) focused on BSED–Science students performing laboratory experiments. The model follows a systematic approach: it includes a thorough literature review, the selection of the best theoretical framework for the study, identification of the research problem, and formulation of research questions (Merriam, 1998). This study employed a multiple case study design, exploring diverse perspectives and providing extensive descriptions and explanations of the experiences of BSED students majoring in Science during laboratory activities. Biology was case 1, and Chemistry was case 2.

Research Environment & Participants

This study was conducted at a private institution in Pagadian City, Zamboanga del Sur, Philippines. Participants were selected through purposive sampling. Eight BSED-Science students were enrolled in the academic year of 2022 – 2023 as participants of this study. The participants were students in one of the private institutions enrolled in their second to fourth years in the department. Consent was obtained from the participants, and interviews were conducted. The data collected from the participants was carefully analyzed and interpreted. Transcriptions of participants' responses were validated for accuracy, ensuring that their intended meaning was captured.

Research Instruments

The researchers themselves served as the primary instrument in this study, using an interview guide to collect data from participants. Additional information was gathered



through field notes and data mining—the local vernacular. The research participants in this study are the eight selected BSED–Science students. Each participant is given codes to maintain anonymity. They are P1, P2, P3, P4, P5, P6, P7, and P8.

Data Analysis

Since the case study model used is Merriam's (1998), the researchers provided a holistic description, interpretation, and analysis of the results, including the experiences of a group within a social unit.

Ethical Consideration

The ethical principles observed in this study to protect the rights and well-being of participants were informed consent, confidentiality, respect for research participants, beneficence, nonmaleficence, and honesty.

RESULTS AND DISCUSSION

Difficulties Encountered By The BSED-Science Students During Laboratory Experimentation

The BSED–Science students shared their difficulties when performing laboratory experiments. The categories that emerged are *lack of laboratory equipment, limited time given by the teacher, unachievable outcomes, difficulty in collecting samples, unfamiliarity with the laboratory equipment, difficulty in understanding the experiment procedures, difficulty in interpreting the results, unspecified instructions from the instructor, and inappropriate use of laboratory equipment.*

Lack of Laboratory Equipment. A lack of laboratory equipment poses a significant obstacle to conducting experiments, hindering students' ability to collect accurate data and draw valid conclusions. This limitation can restrict students' opportunities to develop practical laboratory skills, hindering their learning. The following are the statements of the participants:

Case 1: Biology

“One of the main difficulties is the shortage of modern microscopes. Although plenty of microscopes are available, most are outdated and difficult to use.” P8

Case 2: Chemistry

“There was a lack of laboratory apparatus and the necessary materials for the experiment, like potassium salt. It is crucial to have the needed materials for better experiments in chemistry.” P4

“I encountered difficulties in chemistry due to incomplete equipment. I could not execute the experiment properly because the laboratory lacked the necessary equipment for that specific experiment, like a Bunsen burner.” P5

In both cases, the participants identified a lack of laboratory apparatus and equipment as a significant challenge for their experiments. In biology, the main issue is the need for more modern microscopes; the available ones need to be updated and easier to



use. Also, there is concern about the shortage of necessary materials and equipment in chemistry, such as potassium salt and a Bunsen burner. The lack of equipment/apparatus makes it difficult to perform the experiments and affects their outcomes and understanding.

The lack of laboratory equipment/apparatus can make it difficult to perform experiments. The insufficiency of equipment/apparatus in laboratories can lead to inaccurate results, delayed experiments, and reduced understanding of scientific concepts for students (Hadji Abas & Marasigan, 2020). A study also suggested that every educational institution must have a well-equipped experimental laboratory. It should be stocked with essential instruments and chemicals to guarantee that students can successfully conduct laboratory experiments (Zangele & Alemayehu, 2016).

Limited Time Given by the Teacher. It refers to when the teacher assigns the students an experiment to be conducted quickly. This can lead students to need more time to fully understand and learn from the experiment as they rush to complete it. The following are the statements of the participants:

Case 1: Biology

“We had a hard time accomplishing the experiment on time because the time given to us was insufficient.” P2

Case 2: Chemistry

“Another difficulty I encountered was the lack of time to complete an experiment. In chemistry, we had an experiment that required boiling bleach using an alcohol lamp. Thus, we needed a longer time to make it boil.” P3

“We needed extra time in our experiment because we ran out of time before the zonrox (bleach) could boil.” P8

In both cases, the participants reported difficulty during experimentation. Due to the limited time the teacher gave them, they struggled to complete the assigned experiment. In case 1, the participant reported difficulty completing the experiment due to insufficient information. In case 2, they explained that they needed more time to complete the experiment, specifically boiling the bleach. Their statements suggest that providing sufficient time during experiments is important.

According to the study by Zengele and Alemayehu (2016), insufficient time in the laboratory can significantly affect experimental activities. Enough time to experiment is important for enriching students' learning experience. When students face time constraints, the way they conduct experiments will be affected, potentially reducing the quality of the experiments. Additionally, time constraints can restrict the depth of understanding students acquire during their lab sessions (National Research Council, 2006).

Unachievable Outcomes. It refers to targets or objectives that are impossible to achieve. These outcomes are often unrealistic, too complex, or beyond one's control. Setting unachievable outcomes can lead to frustration, disappointment, and demotivation. Setting achievable, challenging, realistic, specific, and measurable outcomes is essential. The following is the statement of the participant:

Case 1: Biology



“One of the difficulties I encountered is when I have a goal, but I just cannot see it. So, that is the case in the biology lab, where it is necessary to see something like an organism, but sometimes it is just not visible.” P4

Case 2: Chemistry

“We encountered difficulties when trying to boil the bleach as instructed by our teacher. She said the bleach should be boiling, yet our experiment never boiled.” P2

In both cases, participants have distinct yet interconnected challenges during laboratory experiments. In Case 1: Biology, the student highlights the difficulty of observing the microscopic organisms necessary for their experiment, emphasizing the inherent challenge of observing invisible entities. Conversely, in Case 2: Chemistry, students encounter issues when attempting to achieve a specific outcome—boiling bleach, per their teacher's guidance.

Establishing realistic, attainable outcomes that align with the laboratory's available resources and the time available is important. It is important to develop learning goals when conducting experiments, and setting challenging yet achievable outcomes is a crucial motivator for individuals, leading to increased performance and fulfillment (Holmes & Smith, 2019). However, when outcomes are set too high or unrealistic, this can result in frustration and hinder the progress of the experiment (Van Lent & Souverijn, 2020). Instructors should carefully consider the feasibility of the experiment and ensure that they are aligned with the laboratory's available resources and the students' expertise. By setting achievable goals, students are more likely to succeed in their lab experiments.

Difficulty in Collecting Samples. It refers to the difficulty faced when obtaining samples for an experiment. This problem is challenging because samples may need to be collected from an inaccessible location at times. However, more sampling can lead to complete data, compromising the experiment results. The following are the statements of the participants:

Case 1: Biology

“It is difficult to collect the needed samples for our experiment. For example, I have tried collecting samples many times but have not gotten the desired results, which is very challenging.” P3

“Collecting the needed samples was challenging on my part. For example, when I gathered the samples for an experiment we had, it was not just about gathering water from whichever part of the vicinity; if I needed a quality sample, I should collect it from the center of the vicinity or a part where with visible impurities, to ensure the presence of microorganisms.” P5

The participants' statements discuss the difficulties with collecting the needed experimental sample. P5 emphasizes the need to collect samples beyond simply obtaining water from whichever part; it is more beneficial to collect samples from the middle part or where the visible impurities are in a location to ensure the presence of microorganisms. Students must understand the experiment's objectives carefully to select suitable sampling



sites. On the contrary, P3's statement highlights the common issue of repeated sampling without achieving the desired outcomes.

Collecting samples for an experiment is important because it can yield accurate results and, more importantly, lay the foundation for the experiment. A study cited that collecting high-quality samples could be challenging (Baily, 2017). Various factors can contribute to the difficulty in collecting samples for the experiment. One area for improvement is the need to collect a wide range of samples. These difficulties can lead to inadequate sample collection, thus affecting the validity of the results (Raudino et al., 2019).

Unfamiliarity with the Laboratory Equipment. It refers to the need for more familiarity with the names of lab equipment or to inexperience with its use. This can pose difficulties in experiments, resulting in errors or inaccurate results. It can also harm the user or damage the equipment. The following are the statements of the participants:

Case 1: Biology

“I do not know how to use the microscope during our lab experiment. Also, it was hard when I asked the laboratory attendant for an apparatus I needed, and I did not know its name.” P6

“I find it hard to adjust the microscope, especially since it is my first time using it.” P7

The participants' statements highlight the challenges of using microscopes during laboratory experiments. P6 and P7 emphasized the difficulty of using a microscope. Moreover, the difficulty is added when P6 cannot request the apparatus they need from the laboratory attendants due to unfamiliarity with the names of the equipment/apparatuses.

Unfamiliarity with laboratory equipment and apparatus may result in improper handling, misuse, or even damage to the item. Moreover, difficulties may arise in experimenting if the user is unfamiliar with the equipment/apparatus they plan to use (Restiana & Djukri, 2021). Students should become familiar with the laboratory apparatus and equipment they will use, as this plays a significant role in their performance during laboratory experiments (Yahaya & Akanbi, 2023).

Difficulty in Understanding the Experiment Procedures. It refers to a difficulty students may encounter in performing laboratory experiments. This may be due to unfamiliar terms in laboratory handouts or to the need to clarify procedures. The following is the participant's statement:

Case 1: Biology

“The procedures of some experiments we had are hard to comprehend.” P1

According to P1, understanding the experimental procedures encountered in laboratory experiments is a challenge. Some experiments can be difficult to understand, indicating that students may struggle to comprehend the steps or techniques involved.

A detailed procedure is important when conducting lab experiments to reach the desired outcomes. Poor comprehension of the experiment procedure can lead to unclear and unsuccessful outcomes (Stiggins et al., 2004). To follow the given procedures correctly,



students must thoroughly understand the experimental steps, variables, and techniques involved (Kranz et al., 2022). Students can improve the quality of their lab experiments by ensuring the experimental procedures are clear and easy to understand.

Difficulty in Interpreting the Results. It refers to the data gathered from an experiment that needs a more straightforward interpretation. This difficulty may happen when there is an inconsistency in the experiment results. Interpreting the results of an experiment is a crucial step, as it enables students to draw conclusions from their findings. Please solve the results correctly to avoid incorrect conclusions. The following are the statements of the participants:

Case 2: Chemistry

“I had difficulty interpreting the results in one of our experiments. For example, it was confusing for me to understand how the change was made in the experiment.” P1

The participant discusses the challenge in interpreting experimental results in case 2. P1 mentioned that they needed clarification about how the change was made in the experiment. This suggests that the experiment results could have been easier to understand, and they needed help interpreting the data and drawing the correct conclusions.

Interpreting the experiment's results is an important part of a laboratory experiment. According to Hoekstra et al. (2016), mistakes are often made when interpreting experimental results. The difficulty in interpreting results arises from various factors, including complex data from the experiment, experimental variables, and more. To overcome these difficulties, students should consult their instructors for support to understand the results (Hoekstra et al., 2006)

Unspecified Instructions from the Instructor. It refers to a situation in which the instructor did not provide specific instructions for the experiment. This can be a significant obstacle for students when completing the experiment. Instructors must provide clear, detailed, easy-to-follow instructions to help students complete their experiments. The following are the statements of the participants:

Case 2: Chemistry

“Last time in our experiment, our instructor asked us to bring salt. We brought salt, but the salt needed for the experiment was salt with no sodium content. Moreover, of course, we could not experiment” P6.

P6 in case 2 highlights the importance of clear communication between the instructor and students. The participant's experience was due to unspecified instructions from their instructor. This led to the wrong type of salt being brought, affecting the experiment.

Specific instructions provided by the instructor play an important role in making laboratory experiments successful. Unspecified instructions can cause confusion and misunderstandings among students, leading to inaccurate results or canceling the experiment altogether. Providing clear instructions is essential for effective learning and understanding the experiment quickly (Finster, 2017). Instructors who give clear



instructions to their students show higher levels of comprehension, improved experimental performance, and a better overall understanding of the experiment (Sowell, 2017). Therefore, instructors must provide clear, specific instructions to students to enhance their comprehension, minimize confusion, and enable them to perform their experiments smoothly.

Inappropriate Use of Laboratory Equipment. It refers to the improper handling or use of laboratory equipment. This difficulty can pose safety hazards in the laboratory, increase the risk of equipment damage, and lead to inaccurate results. It is important to follow proper procedures and instructions when using laboratory equipment to ensure safety and have accurate results for the experiment. The following is the statement of the participant:

Case 2: Chemistry

“In chemistry, when we tried to boil the Zonrox (bleach), it took a very long time to react, as it took us more than an hour, but still, it did not produce visible bubbles like when you boil water. We also suspect that the alcohol lamp we used may have contributed to the problem because it is unsuitable for that experiment.” P7

The P7 statement discusses a difficulty encountered during the experiment. It emphasizes the potential impact of using inappropriate laboratory equipment, like alcohol lamps, on the experiment's outcome. The suspicion about the alcohol lamp's suitability for the experiment underscores the importance of selecting appropriate, compatible equipment. This problem emphasizes the importance of using the right equipment and materials when doing experiments to acquire the desired results.

The inappropriate use of laboratory equipment can affect scientific experiments. Improper use of laboratory equipment can affect experimental results and often cause numerous accidents (National Research Council, 2011). Inappropriate use may also lead to equipment malfunction or damage, hindering the progress of experiments and incurring additional repair or replacement costs. It is essential to prioritize proper training and education on equipment usage and safety protocols (Hill & Finster, 2016). Students and researchers should be made aware of the potential risks of improper use of laboratory equipment and provided with comprehensive guidelines and instructions.

BSED – Science Students’ Way Of Dealing With The Difficulties Encountered

The Bachelor of Secondary Education Major in Science students shared how they handle difficulties when experimenting in Biology and Chemistry. The categories that emerged are *referring to online sources, modifying the difficult part of the experiment, accepting undesired outcomes, studying in advance, asking for help from others, persisting in attaining success, and developing vital patience.*

Referring to Online Sources. When encountering difficulties during laboratory experiments, referring to online sources can be very effective. Online platforms, such as scientific databases, research articles, and reputable educational websites, offer a wealth of information and resources. These sources provide detailed explanations, methodologies,



and tips for various experiments. By accessing online materials, researchers can expand their knowledge, clarify concepts, and find solutions to specific challenges they may encounter. The following are the statements of the participants:

Case 1: Biology

“I am very grateful for the internet. I watch YouTube or read explanations on Google to understand why and how something in an experiment was attained.” P1

“There are times that I will search for the description of the apparatus I need online, and then, knowing its name, I will go to the attendant to ask for it.” P6

Case 2: Chemistry

I searched for information and data online to understand the results better and to help me interpret them. There are many websites you can go to help you out.” P1

“Honestly, it was not our fault since our instructor did not give us the instructions. Since we brought an ordinary salt, it is the one we used for our experiment, and clearly, it was a failure. So, we just looked at the experiment on YouTube and tried to understand it. The learning might not be the same from doing it personally, but still, we learned something from it and answered the questions given to us.” P6

In both cases, the participants overcame the difficulties they encountered in doing laboratory experiments by resorting to online resources. In case 1, P1 expressed gratitude for the internet as a valuable learning material. Using platforms like YouTube and others helped P1 understand the experiment. The statement highlights the ability of each participant to adapt and seek alternative sources of information for enlightenment when faced with difficulties in their laboratory experiment.

With the rise of digital online information, science students often rely on online resources as their source of learning (Stansfield et al., 2016). Through online sources, students can explore a variety of learning materials beyond the resources available in their schools. Students who use the internet to support their learning may benefit greatly from online resources (Nortvig et al., 2018).

Modifying the Difficult Part of the Experiment. It refers to a strategy in which, when students face difficulties with their experiment, they modify the part they find difficult. This involves determining the part of the experiment causing the difficulty and adjusting to overcome it. Students can brainstorm ways to replace the part they find challenging with a more suitable one. The following are the statements of the participants:

Case 1: Biology

“I will find another sample to look at or change the microscope. Sometimes, the problem may come from the sample or the equipment I use.” P4

"We will just modify it by looking for another experiment with the same objectives as our first plan to achieve our objectives still." P8



Case 2: Chemistry

“Same with biology, we modify it and ensure it is right. So, we look for other laboratory activities that align with the learning objectives. Because if we do not do it, we will still be unable to act out the activity.” P4

“We modified the experiment by finding alternative equipment to use. Since the laboratory has no Bunsen burners, we just brought our portable butane stove and used it for our experiments. The experiment's outcome from using the Bunsen burner and butane gas stove is the same.” P5

In both cases, participants show adaptability and resourcefulness in addressing the difficulties they encounter in their laboratory experiments. They can flexibly modify their experimental approaches by finding alternative samples, adjusting the experiment, or changing the equipment. Their statements highlight how resourceful they can be when solving problems to enhance their laboratory experiences.

Modifying difficult parts of an experiment is a common technique used in the laboratory. Creating a new experiment can take time and resources, thus forcing one to modify the existing ones (Rodriguez & Towns, 2021). However, modifying the experiment can alter the results. Thus, it is essential to be aware and understand how these modifications can affect the outcome of an experiment (Price et al., 2015). Modifying the experiment can also suggest that the equipment or materials used are causing the problem; hence, upgrading or adding more equipment or materials to the laboratory.

Accepting Undesired Outcomes refers to students encountering difficulties during laboratory experiments and accepting whatever the outcomes of their experiment are. It is helpful when students recognize that experiments may only sometimes yield the desired results, reducing their frustration and stress. The following are the statements of the participants.

Case 1: Biology

“I can only make a little progress on our experiment, considering the lack of time. So, I just accepted my progress even if it was lacking.” P2

Case 2: Chemistry

“I could not get the expected outcome of the experiment. I did trial and error many times, and the result remained the same. I just accepted the result and made peace with it.” P2

“I could not produce the desired result because our equipment was unsuitable for our experiment. So, I just accepted the outcome and moved on.” P3

“I just accepted the progress I have made and moved on. Progress is progress, and I think our instructor understands our situation since no one in the class could produce the expected outcome of that experiment.” P8

Participants in both cases demonstrate acceptance and resilience when faced with difficulties during their lab experiments. They also recognized the limitation of being provided with a short time to perform the experiment and the shortcomings of their



equipment. The participants accepted the outcomes they had achieved rather than fixate on difficult-to-achieve goals. Their statements describe how important it is to develop resilience, foster a practical mindset in addressing difficulties, and recognize the value of effort when anticipated outcomes are unachievable.

It is important to recognize that experiments will not always go as planned, as they often yield unpredictable outcomes. Hence, it is important to accept undesired outcomes (Lawal, 2014). Students can develop resilience to overcome difficulties during lab experiments by accepting undesired outcomes. This acceptance can also nurture a growth mindset, which involves acknowledging and using the situation as a learning opportunity (Spiegel, 2019).

Studying in Advance. It refers to another effective strategy for overcoming difficulties encountered during lab experiments: studying in advance. Preparing in advance by studying the experiment can greatly enhance understanding and execution. When studying in advance, students can confidently approach the experiment and make informed decisions when problems arise. The following are the statements of the participants:

Case 1: Biology

“I always assume that it will be quite difficult when doing experiments, especially if what we will experiment with is unfamiliar to me. So, I will study the experiment in advance to perform better and avoid struggling when the time comes to experiment.” P1

“I studied and familiarized myself with the other apparatus and equipment needed for the next experiment, so it will be easy for me to ask what I need next time.” P6

Case 2: Chemistry

“To deal with my difficulties, I studied the experiment in advance. For example, when the teacher provides the experiment you will perform in advance, you should study it. Once you have studied the experiment you will perform, interpreting the data will become easier because you have studied it thoroughly, allowing you to understand the experiment better.” P1

In both cases, the participants acknowledged the potential difficulties of working with unfamiliar experiments or materials and showed a positive approach by preparing beforehand. They emphasize the importance of studying in advance for an upcoming laboratory experiment. This approach of dealing with their difficulties enhances their understanding and enables them to perform the experiments more easily, ultimately contributing to the success of their laboratory experiments.

Effective study habits are critical for academic success. Students who began studying earlier tended to perform better (Walck-Shannon et al., 2021). A goal should be set, items should be prioritized, and an effective study plan should be drawn. Regarding laboratory experiments, science students need to use their time effectively. Planning a study schedule, studying every day, creating a quiet study environment, and taking regular breaks are key habits contributing to academic success. Most science students are guilty of waiting until the last minute for their laboratory experiments. However, cramming adds pressure



and stress, which can be avoided if they start preparing for their laboratory experiments (Ebele & Olofu, 2017).

Asking for Help from Others. It refers to an approach in which students ask others for help when faced with difficulties. Asking others for help allows the student to seek guidance and knowledge, thereby gaining new insights and potential solutions to their difficulties. Solving problems with others can lead to a better understanding of the experiment and to learning from each other. The following are the statements of the participants:

Case 1: Biology

Whenever I have difficulties with the experiment, I ask my groupmates for help. If they cannot help me, I will approach my other classmates for help. Moreover, if I still cannot find an answer, I will directly approach our instructor and ask for answers to my questions." P1

"I asked for help from my friends or other groupmates. Usually, in experiments, we are grouped so that I will ask them for help collecting samples. Perhaps they have collected better samples for that experiment." P3

During the experiment, some of my classmates saw microorganisms in their samples. I do not know where they got their samples, but it was a quality sample. So, I asked for some of their samples and used them to observe under my microscope." P5

"I asked for assistance from my classmates who know how to use the equipment and apparatus. However, if my classmates are preoccupied, I ask our instructor for guidance." P6

"I asked our instructor for help since it is best to be guided by someone knowledgeable enough about microscopes." P7

The participants' statements in case 1 show students' strategies when confronted with challenges during laboratory experiments. It shows the importance of seeking assistance and guidance from various people, including friends, groupmates, and instructors. Whether the challenges involve understanding procedures, collecting samples, or operating laboratory equipment, these participants prefer reaching out to knowledgeable individuals to overcome obstacles and enhance their learning.

Collaborating with others not only enhances outcomes but also optimizes resource utilization. The act of sharing information not only fosters a positive impression but also contributes to a collective pool of knowledge. Students perceived asking questions as helpful because other students' questions could clarify their thinking (Nadile et al., 2021). Seeking assistance empowers science students to immerse themselves in a supportive network, promoting a conducive environment for mutual growth and advancement in laboratory experiments. Suppose they can ask for help and obtain feedback. In that case, they can overcome setbacks and grow the traits needed to enhance their resilience in their laboratory experiments (De Witte, 2022).

Persisting in Attaining Success. When the BSED-Science encountered difficulties in a laboratory experiment, one practical approach was to persevere until success. To



implement this approach, students should approach the difficulty with a positive attitude and a belief in their ability to overcome obstacles. It is important to remain patient and not give up easily, as perseverance often leads to valuable learning experiences and breakthroughs in understanding. The following are the statements of the participants:

Case 1: Biology

“Even though I encountered difficulties, I overcame them by trying repeatedly. I do not like giving up after the first or second try.” P3

“I just kept trying until I achieved it. I would not say I like giving up easily when faced with such difficulties. So, I will persevere and not be discouraged easily.” P5

The statements from participants P3 and P5 emphasize a typical attitude of persistence and determination in the face of difficulties encountered during laboratory experiments. Both participants were reluctant to give up easily when confronted with challenges. They highlight their willingness to make repeated attempts and put in persistent effort to overcome obstacles. It highlights the importance of resilience and a determined mindset in navigating and successfully resolving the difficulties that may arise during laboratory experiments.

Persistence is crucial in predicting high achievement among students, especially when performing laboratory experiments. Problems are inevitable when doing laboratory experiments. Each problem they face in experiments may seem like a failure, but they are necessary. Because the failures they encounter represent their success, it shows how successfully they recover and persevere (Khindri & Rangnekar, 2022). Unforeseen problems must be anticipated, and as a science student, skills will allow these obstacles to be overcome, and the research to continue their laboratory experiments is needed (Blades, 2018).

Developing Strong Patience. Having strong patience is crucial when facing difficulties during laboratory experiments. The gathered data shows that experiments often involve complex procedures and unexpected challenges, which can test one's patience. Maintaining a calm and composed mindset is essential, allowing time for troubleshooting, observation, and analysis. Patience enables researchers to persevere through setbacks, trial and error, and the iterative nature of experiments. The following is the statement of the participant:

Case 2: Chemistry

Having strong patience. The laboratory experiment we performed required a lot of patience from me. While using the alcohol lamp to boil the bleach, I patiently waited several hours to make it boil, yet it never did." P7.

The P7 statement shows the importance of strong patience when conducting laboratory experiments. The participant's statement highlights the recognition that strong patience is an essential characteristic for dealing with the difficulties encountered in laboratory experiments. The statement also suggests that the experiment was time-consuming and required extensive waiting, which was challenging. Despite waiting patiently for the bleach to boil, it did not reach the expected outcome.



It has been recognized that patience is a highly valued characteristic that fosters the growth and overall welfare of each individual (Bülbül & Izgar, 2018). It is when they show self-control rather than lashing out and complaining about the experiment (Bülbül & Arslan, 2017). Patience is crucial when performing an experiment, waiting for its results, and dealing with the challenges you may encounter. It may be taxing to navigate the complexities of laboratory experiments, but patience pays off (Bülbül & Izgar, 2018).

CONCLUSION

Laboratory experiments help students understand and solve the lesson, making them crucial in science education. However, students can also encounter difficulties when performing lab experiments. Thus, the data gathered in this study revealed the various difficulties BSED–Science students face during laboratory experiments. These difficulties include the lack of laboratory equipment, limitations imposed by the teacher, unattainable outcomes, difficulty collecting samples, unfamiliarity with the laboratory equipment/apparatus, difficulty understanding the experimental procedures, difficulty interpreting the results, unspecified instructions from the instructor, and inappropriate use of laboratory equipment.

Moreover, the data revealed effective ways they used to deal with the difficulties they encountered. They referred to online sources and modified the difficult part of the experiment. Accepted undesired outcomes, studied in advance, asked for help from others, persisted in attaining success, and developed strong patience. This approach has demonstrated its ability to adapt and enhance its laboratory experience when faced with difficulties. The participants also hope to have some development in the science laboratory to improve their laboratory experiences.

RECOMMENDATION

1. To address the lack of laboratory equipment, administrators may enhance laboratory resources. The researchers recommend allocating sufficient resources and funding to ensure that the laboratories are well-equipped with the necessary apparatus, instruments, and materials, such as up-to-date microscopes, Bunsen burners, potassium salt, and other resources requested by the laboratory in charge or instructors. This will enable students to conduct experiments effectively and accurately.
2. Instructors and teachers may engage in continuous professional development to enhance their instructional skills and knowledge in laboratory management. This will enable them to effectively guide students, provide clear instructions, and address the challenges encountered during laboratory experimentation.
3. For future researchers, research the other branch of Science and conduct new research that explores the laboratory experiences of the BSED–Science students in physics, since this study is limited to the two branches of Science: biology and chemistry. This will contribute to a more holistic understanding of the overall science laboratory experiences of BSED-Science students.



REFERENCES

- Adams, C. R., Barrio Minton, C. A., Hightower, J., & Blount, A. J. (2022). A Systematic Approach to Multiple Case Study Design in Professional Counseling and Counselor Education. *Journal of Counselor Preparation and Supervision, 15*(2). Retrieved from <https://digitalcommons.sacredheart.edu/jcps/vol15/iss2/24>
- Baily, J. (2017). Challenges relating to the collection of high-quality field samples and how to overcome them. In *Game meat hygiene: Food safety and security. Wageningen Academic Publishers*, pp. 195–210. https://doi.org/10.3920/978-90-8686-840-7_10
- Blades, I. A. B. (2018). Perseverance in Science Education: A Longitudinal Study on the Academic Journeys of Eight Female Students [Doctoral dissertation, Curtin University]. Curtin Theses. <https://core.ac.uk/download/pdf/195696533.pdf>
- Bülbül, A. E., & Arslan, C. (2017). Investigating Patience Tendency Levels in Terms of Self-Determination, Self-Compassion, and Personality Features. *Universal Journal of Educational Research, 5*(9), 1632-1645. <https://files.eric.ed.gov/fulltext/EJ1170094.pdf>
- Bülbül, A. E., & Izgar, G. (2018). Effects of the Patience Training Program on Patience and Well-Being Levels of University Students. *Journal of Education and Training Studies, 6*(1), 159-168. <https://doi.org/10.11114/jets.v6i1.2900>
- De Witte, M. (2022). Asking For Help is Hard, But People Want to Help More Than We Realize, Stanford Scholar Says. *Stanford News*. <https://news.stanford.edu/2022/09/08/asking-help-hard-people-want-help-realize/>
- Ebele, U. F., & Olofu, P. A. (2017). Study Habits and Their Impact on Secondary School Students' Academic Performance in Biology in the Federal Capital Territory, Abuja. *Educational Research and Reviews, 12*(10), 583–588. <https://files.eric.ed.gov/fulltext/EJ1143649.pdf>
- Finster, D. C. (Ed.). (2017). Safety In Academic Chemistry Laboratories: Best Practices for First- and Second-Year University Students. *American Chemical Society, Joint Board-Council Committee on Chemical Safety, 1*. <https://bit.ly/3WmphGk>
- Freire, C., Ferradás, M. D. M., Regueiro, B., Rodríguez, S., Valle, A., & Núñez, J. C. (2020). Coping strategies and self-efficacy in university students: A person-centered approach. *Frontiers in Psychology, 11*, 841. <https://doi.org/10.3389/fpsyg.2020.00841>
- Hadji Abas, H. T., & Marasigan, A. P. (2020). Readiness of Science Laboratory Facilities of the Public Junior High School in Lanao Del Sur, Philippines. *IOER International Multidisciplinary Research Journal, 2*(2). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3606078
- Hill Jr, R. H., & Finster, D. C. (2016). Laboratory safety for chemistry students. *John Wiley & Sons*. <https://bit.ly/41YbSFQ>
- Hoekstra, R., Kiers, H. A., Johnson, A., & Groenier, M. (2006). Problems when interpreting research results using only the p-value and sample size. *In Proceedings of the 7th International Conference on Teaching Statistics (ICOTS-7)*. <https://iase-web.org/documents/papers/icots7/C437.pdf?1402524968>



- Holmes, N. G., & Smith, E. M. (2019). Operationalizing the AAPT Learning Goals for The Lab. *The Physics Teacher*, 57(5), 296–299. <https://arxiv.org/ftp/arxiv/papers/1809/1809.00059.pdf>
- Khindri, A., & Rangnekar, S. (2022). The Trait of Perseverance: A Literature Review and Future Research Directions. *The American Journal of Psychology*, 135(3), 271–285. <https://doi.org/10.5406/19398298.135.3.02>
- Kolb, D. A. (1984). *Experiential Learning: Experience as The Source of Learning and Development*. Prentice Hall. bit.ly/3kwZZH3
- Kranz, J., Baur, A., & Möller, A. (2022). Learners' challenges in understanding and performing experiments: a systematic literature review. *Studies in Science Education*, 1-47. <https://doi.org/10.1080/03057267.2022.2138151>
- Lawal, B. (2014). Probability and probability distributions. In *Applied Statistical Methods in Agriculture, Health and Life Sciences* (pp. 59–113). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-05555-8_4
- Lê, J. K., & Schmid, T. (2022). The Practice of Innovating Research Methods. *Organizational Research Methods*, 25(2), 308–336. <https://doi.org/10.1177/1094428120935498>
- Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education*. Revised and expanded from "Case Study Research in Education.". Jossey-Bass Publishers, 350 Sansome St, San Francisco, CA 94104
- Mojica, E. R. E., & Upmacis, R. K. (2021). Challenges encountered and students' reactions to practices utilized in a general chemistry laboratory course during the COVID-19 pandemic. *Journal of Chemical Education*, 99(2), 1053–1059. <https://doi.org/10.1021/acs.jchemed.1c00838>
- Nadile, E. M., Alfonso, E., Barreiros, B. M., Bevan-Thomas, W. D., Brownell, S. E., Chin, M. R., ... & Cooper, K. M. (2021). Call on me! Undergraduates' perceptions of voluntarily asking and answering questions in front of large-enrollment science classes. *PLoS One*, 16(1). <https://doi.org/10.1371/journal.pone.0243731>
- National Research Council. (2006). *America's lab report: Investigations in High School Science*. The National Academies Press. <https://doi.org/10.17226/11311>.
- National Research Council. (2011). *Working with Laboratory Equipment*. In *Prudent Practices in The Laboratory: Handling and Management of Chemical Hazards*, Updated Version. <https://www.ncbi.nlm.nih.gov/books/NBK55884/>
- Nortvig, A. M., Petersen, A. K., & Balle, S. H. (2018). A Literature Review of The Factors Influencing E-Learning and Blended Learning about Learning Outcome, Student Satisfaction, and Engagement. *Electronic Journal of E-learning*, 16(1), pp. 46- 55. <https://files.eric.ed.gov/fulltext/EJ1175336.pdf>
- Otero, V., Pollock, S., McCray, R., & Finkelstein, N. (2006). Who is responsible for preparing science teachers? *Science*, 313(5786), 445–446. <http://dx.doi.org/10.1126/science.1129648>
- Pederson, J. (2017). Laboratory Experiments. In M. Allen (Ed.), *The SAGE Encyclopedia of Communication Research Methods*. SAGE Publications. <https://dx.doi.org/10.4135/9781483381411>



- Price, P. C., Jhangiani, R., & Chiang, I. C. A. (2015). Research Methods in Psychology. BCCampus. <https://arcabc.ca/islandora/object/kora%3A384/datastream/PDF/view>
- Putri, L. A., Permanasari, A., Winarno, N., & Ahmad, N. J. (2021). Enhancing Students' Scientific Literacy Using Virtual Lab Activity with Inquiry-Based Learning. *Journal of Science Learning*, 4(2), 173-184. <https://files.eric.ed.gov/fulltext/EJ1292932.pdf>
- Raudino, H. C., Tyne, J. A., Smith, A., Ottewell, K., McArthur, S., Kopps, A. M., Chabanne, D., Harcourt, R. G., Pirotta, V., & Waples, K. (2019). Challenges Of Collecting Blow from Small Cetaceans. *Ecosphere*, 10(10). <https://doi.org/10.1002/ecs2.2901>
- Restiana, & Djukri. (2021). Students' Level of Knowledge of Laboratory Equipment and Materials. *Journal of Physics: Conference Series*. <https://doi.org/10.1088/1742-6596/1842/1/012022>
- Rodriguez, J. M. G., & Towns, M. H. (2018). Modifying Laboratory Experiments to Promote Engagement in Critical Thinking by Reframing Prelab and Postlab Questions. *Journal of Chemical Education*, 95(12), 2141-2147. <https://doi.org/10.1021/acs.jchemed.8b00683>
- Savage, D. A., & Torgler, B. (2021). Methods and Insights on How to Explore Human Behavior in the Disaster Environment. In T. Chaiechi (Ed.), In Economic Effects of Natural Disasters. *Academic Press*, 191-209. <https://doi.org/10.1016/B978-0-12-817465-4.00013-3>
- Sowell, J. (2017). Good Instruction-Giving in the Second-Language Classroom. *In English Teaching Forum*, pp. 3, 10–19. <https://files.eric.ed.gov/fulltext/EJ1156495.pdf>
- Spiegel, M. (2019). Unknown outcomes, no guarantees: Lawrence Grossberg and experimentation. *Cultural Studies*, 33(1), 57–67. <https://doi.org/10.1080/09502386.2018.1543336>
- Sshana, Z.J., & Abulibdeh, E.S. (2020). Science Practical Work and Its Impact on Students' Science Achievement. *Journal of Technology and Science Education*, 10(2), 199-215. <https://doi.org/10.3926/jotse.888>
- Stansfield, C., Dickson, K., & Bangpan, M. (2016). Exploring Issues in Website Searching and Other Online Sources for Systematic Reviews: How Can We Be Systematic? *Systematic Reviews*, 5(1), 1–9. <https://doi.org/10.1186/s13643-016-0371-9>
- Stiggins, R. J., Arter, J. A., Chappuis, J., & Chappuis, S. (2004). Classroom assessment for student learning: Doing it right, using it well. *Assessment Training Institute*. <https://bit.ly/3MBq5nv>
- Van Lent, M., & Souverijn, M. (2020). Goal Setting and Raising The Bar: A Field Experiment. *Journal of Behavioral and Experimental Economics*, 87, 101570. <https://doi.org/10.1016/j.socec.2020.101570>
- Vialle, W., Stoeger, H., & Ziegler, A. (2021). Editorial: Advanced Learning. *Front. Psychol.* 12: 712661. doi: 10.3389/fpsyg. <https://doi.org/10.3389/fpsyg.2021.712661>
- Walck-Shannon, E. M., Rowell, S. F., & Frey, R. F. (2021). To What Extent Do Study Habits Relate To Performance? *CBE—Life Sciences Education*, 20(1), ar6. <https://doi.org/10.1187/cbe.20-05-0091>



- Yahaya, W. O., & Akanbi, A. O. (2023). Students' knowledge of identifying and using physics laboratory apparatus in post-basic schools in Ilorin, Nigeria. *International Journal of Educational Innovation and Research*, 2(1), 82-89. <https://doi.org/10.31949/ijeir.v2i1.4100>
- Zengele, A. G., & Alemayehu, B. (2016). The Status of Secondary School Science Laboratory Activities for Quality Education in the Case of Wolaita Zone, Southern Ethiopia. *Journal of Education and Practice*, 7(31), 1-11. <https://files.eric.ed.gov/fulltext/EJ1122534.pdf>