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A Phenomenological Study on the Lived Experiences of Physics Students in Laboratory Classes

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ABSTRACT

Classes in higher education often consist of both lecture and laboratory time for the subject of physics. An example of experience-based learning would be doing experiments in the classroom. Kolb's theory of experiential learning posits that learning is a process that involves the generation of knowledge via the accumulation of experience. However, due to the fact that doing experiments in a laboratory takes much more time and money than other methods of instruction, the usage of labs in the classroom has become a contentious topic. The primary objective of this research was to report on the activities that students of physics participated in during their physics laboratory lessons. Interviews with four different individuals were conducted utilizing a semi-structured format. Giorgi's descriptive phenomenological method was used, and the findings revealed the following constituents: (1) the clarification, visualization, and retention of concepts; (2) the application of learnings acquired from the laboratory; (3) involvement, cooperation, and interaction; (4) laboratory manuals and equipment; and (5) challenges. Recommendations were formulated to improve the Physics laboratory.

Keywords: Phenomenological, Physics laboratory, laboratory experiences, higher education, experienced-based learning

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ORIGINAL ARTICLE

INTRODUCTION

A quote attributed to Confucius states, "I hear and I forget. I can see and I have a memory of it. I agree, and I do get it." Some people have also cited Sophocles, who lived about 400 B.C., saying that "one must learn by doing the thing," since even if you believe you already know it, you won't for sure unless you attempt it. Or, one may use "The Great Difficulty of Education" by George Santayana, which states that the challenge of education is to "extract experience out of ideas." It would be difficult to argue against and communicate the idea that experience would not lead to learning under the appropriate circumstances if one were to use these well-known statements. There are a variety of words that may be used to describe the process of gaining knowledge through experience.

While John Dewey is credited with coining the phrase "learning by doing" (Dewey & Dewey, 1915), Wolfe and Byrne (Wolfe & Byrne, 1975) were the ones who popularized the term "experienced-based learning." Nevertheless, David Kolb, a psychologist, came up with the experiential learning theory. Kolb followed in the footsteps of other theorists, such as John Dewey, Kurt Lewin, and Jean Piaget, when he came up with the idea. Kolb defined this kind of learning as a process in which new information is created via the transformation of previous experience. The knowledge that we use as the foundation for our reflection comes to us mostly from our experiences. Following this step, we integrate the new knowledge and use these reflections to develop abstract conceptions. After then, we make use of these notions to develop new hypotheses, which we then put to rigorous testing. In order to go back to the beginning of the process, we analyze our thoughts and then go back to the way we gathered knowledge in the first place, which is by experience.

Despite the fact that experience is not necessary required to start the process, every individual is responsible for determining which learning strategy would be most successful in a given circumstance. Many educators have had their imaginations sparked by the creation of the experiential learning cycle, which serves as a helpful method of articulating the process of learning via direct experience. The controlled experience that serves as the basis for learning that may then be presented, researched, evaluated, and reassessed is the primary focus of this argument. The learner's experiences continue to be the source of new knowledge and serve as a testing ground for that knowledge. This is a logical conclusion that may be drawn from Dewey's theory of continuity of experience, which states that each new experience both retains some aspect of the experiences that came before it and alters in some manner the characteristics of the experiences that will follow it (Kolb, Boyatzis, & Mainemelis, 1999).

The university level study of physics often consists of both lectures and laboratory work. If the course is worth a total of 4 units, then it will consist of 3 lecture units and 1 laboratory unit. There is just one meeting each week, however there are three hours devoted to lectures and three hours devoted to the laboratory each week. Sometimes the same people teach the lecture and the laboratory, but more often than not they are different. The lecture portion of the class is often held at a different time than the lab portions of the session. Students are given the opportunity to get practical knowledge of the topics covered in lectures by participation in lab classes. The use of labs as a teaching strategy for subjects like science has been the subject of much discussion due to the fact that laboratory work is both time-consuming and expensive in comparison to other instructional methods. It is necessary that the procedure be successful in order to justify the greater investment of time and money required to use it. It simply implies that the increase in the budget allocation for employing labs as a strategy in teaching must be competent in reaching the goals of teaching Science in a manner that is more competent than other methods of instruction (Sabri & Emuas, 1999).

The primary objective of this research is to analyze and characterize the laboratory experiences that students have had in the physics laboratory courses that they have taken. This would give birth to suggestions that would enhance the laboratory and would offer ideas on how to effectively employ lab courses as a technique in teaching Physics. This would give rise to recommendations that would enhance the laboratory and give ideas on how to improve the laboratory.

METHODOLOGY

Research Design

In order to successfully traverse the investigational endeavor, a qualitative method was used. In particular, Giorgi's descriptive phenomenological approach was used in this investigation. It achieves it by concentrating on the participants' points of view and supplying the lived context of the participants without resorting to any kind of deception. In addition, the researcher is able to preserve the voices of the participants in the study without having to abstract the perspective at any point throughout the analysis since this approach was used. The participant's subjective and psychological point of view is what piques the researcher's attention, so they can better understand them (Giorgi, 2009).

Research Locale and Participants

This study was conducted in one of the universities in the Visayas. The participants of this study were major and non-major Physics students. The four participants were interviewed about their experiences in the Physics laboratory who passed the course in one take.

Table 1. Demographic Profile of the Participants.

Participants	Course, Year & Major	Gender	Physics undertaken
P1	BSEd-III PhySci	Male	Phys14 – College Physics II
P2	BSEd-III PhySci	Female	Phys14 – College Physics II
P3	BSA-III Horticulture	Female	Phys11 – General Physics I
P4	BSAB-III	Female	Phys11 – General Physics I

Procedure

A formal letter of consent was given to the target participants before the interview transpired and the researcher waited for their response (verbal and written) on the participation of the interview. Also, a semi-structured interview with the four participants was conducted in such a manner that allowed the participants to openly discuss their experiences without being distracted by anybody else in the area. In addition to this, it was made certain that they were able to freely express themselves once it was made clear to them that the anonymity of their identities would be maintained at a high level. The interview most likely took about 30 minutes to complete. The interview with P2 took place in the evening, whilst the interviews with the other participants took place in the afternoon of the following day.

Data Analysis

Giorgi's modified Husserlian approach was the only one used in the analysis of these data. This method detailed and explained the context of doing psychological research on the participants' actual experiences, and it was the only method that was used in the study. Giorgi's steps are as follows: (1) assume a phenomenological attitude; (2) read the entire written account to get a sense of the whole; (3) delineate meaning units; (4) transform meaning units into psychologically sensitive statements of their lived-meanings; and (5) synthesize a general psychological structure of the experience based on the constituents of the experience. Giorgi's steps are as follows: (1) assume a phenomenological attitude; (2) read the entire written account for It is a psychological viewpoint taken from the first-person point of view. The lived experiences of the students who participated in this inquiry were used to give light on the phenomena that was being investigated, therefore their voices were an essential part of this investigation. Following the completion of the interview, the audio tape was transcribed, carefully studied, and reread before the meaning units were explained. In the end, a synthesis was performed to determine the psychological importance of the meaning units that were based on the components of the experience. Tabulations of the analyses were performed on each of the four transcripts separately; however, the presentation of the summary results was carried out using a text format.

RESEARCH FINDINGS AND DISCUSSION

The analyses of the transcripts were looked at in great detail, and the results of those studies led to the discovery of the following constituents. This section discusses every component that makes up the whole.

Application of Learnings Acquired from the Laboratory

All the participants of this study has verified that the knowledge they have acquired from the laboratory was applied in real life situations, though, in different cases and scenario. P1 and P2 have used their learnings from the specific heat experiment in different ways. P1 applied his knowledge to evaluating which material to use in roofing considering the material's specific heat capacity while P2 applied her knowledge in decision-making on which pan to buy, considering its specific heat capacity. P1 added that with his knowledge in resistor's color code, he could calculate the resistor's resistance himself as he buys a resistor from the market. P2 also integrated her learnings in specific heat capacity's experiment in cooking rice. As she cooks rice, she would avoid the steam for she knew that its burn is more painful than boiling water's. On the other hand, both P3 and P4 has applied their knowledge from vector quantity's experiment in their own different ways. P4 has used short cuts (*resultant or the sum in adding vectors*) while walking around the wide university while P3 incorporated her knowledge in vectors to her sport – athletics. According to P3,

> *Useful sad siya (knowledge in vector quantities) labi na dire sa athletics kay instead nga modagan ko ani dapita ba (pointing the curve area in the oval), sa athletics di man jud mi pwede mo cross ug lane, pero ug long distance na gani nay time nga pwede mi mu-cross, so instead nga mo run ka sa whole nga area, gamit tong distance versus displacement, instead nga mo follow ko sa actual path, pa slant nalang akong dagan, which is a lot better and easier. Makasave pajud kog energy ug time pud. Of course, it's a race gud, papaspasay, paunahanay. So, dako jud siyag gamit.*

The continuity of an experience and the amount of interaction between participants are the two primary factors that should be used to evaluate the significance of an experience for educational purposes. The learner need to be capable of associating features of the new experience to what it is that he already knows, putting the lessons that were created in that setting to the test (Dewey & Dewey, 1915). In addition, Kolb, Boyatzis, and Mainemelis (1999) suggested that students should be able to generate concepts that integrate their observations into rationally consistent theories, and that they should be able to use these theories to both make decisions and solve problems. This ability to generate concepts is essential for students to have in order to be successful. According to Kolb's model, experiential learning places a strong emphasis on reflecting on experiences that are immediate and tangible. During the course of an event, there should be times set aside for reflection. This will enable the participant to make connections between the actual experience and the information gained from the experience. As a result, the central tenet of his model of experiential learning is a straightforward explanation of a learning cycle that details the process by which one's experiences are transformed into ideas, which are then used as criteria for selecting other experiences.

Visualization, Clarification and Retention of Concepts

The participants positively showed developments in their learning through laboratories. P1 can picture out concepts and be amazed by the happenings in the lab. He also shared that because of the experiments in the laboratory, he has finally visualized and clarified some concepts which he had difficulty in connecting before such as the concept in electricity-magnetism. P2 also has stated that despite of conducting the experiments long time ago, she could still recall the details, thus, the retention is high. In addition, P4 said that it's better to learn through experience and that she could move a lot. P3 could probably learn from lectures but as she stepped outside the room, she easily forgot about it, unlike in laboratories, though 3 semesters have passed, she could still recall the concepts. P1 stated,

> *Also, another experiment is about the DC motor. I was amazed when I discovered that DC motor works by reversing the current. I could not imagine it very well because how could you reverse the current? And then I have found out that it's not literally reversing the current. It is actually the position of your conductor that actually reverses. That is why the flow of your current would seem to reverse. So, that was a mind-opening experiment.*

According to (Mba & Uba, 2012), activities in laboratories increase students' learning, positive attitudes towards physics and permanence of knowledge or retention.

Involvement to Experiments, Cooperation and Interaction among Students

Everyone who took part in the experiment acknowledged that in order for them to learn, they needed to take part in the actual experiment and participate in its execution. P2 continued by saying that in order to better remember the principles they noticed, they take turns doing the experiments. According to Cox (2017), doing experiments with one's hands is not only enjoyable but also keeps pupils actively engaged. Students will become more effective and efficient learners if they combine hands-on activities with active learning. This will allow them to more precisely recall the concepts that they have learned. Hands-on activities are only one component that will assist students enhance their learnings. P4 said that she had not been a member of the block section first, but that she has now adjusted to the situation and is delighted to be the head of the group now that everyone is working together. P3 was doing well with her groupmates despite the fact that they lack initiative, and she was also participating in doing tests despite her disdain for her classmate. P3 was doing well with her groupmates despite the fact that her groupmates lacked initiative. On the other side, P4 said that following the midterm, her classmates' levels of interest and collaboration dropped, which was a disappointment to her. P1 said,

> *Ang laboratory pud kay maka increase sa interaction sa imong classmates. Magtinabangay mo sa imong classmates kay maka-increase na syag interaction between nimo ug sa imong classmates. Tungod ana, mabuild nimo imong personality ug ma-build imong relationship with other people.*

According to Balkcom (1992), cooperative learning is an effective teaching approach in which small teams of students, each of which include students of diverse levels of aptitude, collaborate with one other to better their comprehension of a subject. Because each participant is accountable not only for his or her own education but also for that of his or her fellow members, an environment of success is fostered as a result. Better academic success, improved conduct and attendance, enhanced self-confidence and drive, and increased like of school and peers are some of the documented effects. Additionally, Gentry (1990) emphasized that in order for experiential learning to be considered successful, it must be a participatory process, and that the students must be active in the process. Learning through experience is an active process rather than a passive one.

Lab Manuals and Lab Equipment

Lab manuals. P3 specified that though she was asleep during the pre-lab, she was still involved in conducting the experiment by the use of the lab guide. Meanwhile, P1 stated that some procedure parts should be revisited as other discrepancies may affect the results of their experiment.

Lab equipment. P1 indicated and specified that equipment in the lab should be updated for better results.

P4 also said, *there are some equipment that are not really, somehow, in a business way, it reached its depreciation already. It needs to be changed na.*

The findings of a study conducted by Mba and Uba (Mba & Uba, 2012) in North, Anambra State showed that teaching and learning are more likely to be quicker and easier when adequate facilities are provided. Despite this, a greater number of schools have physics laboratories, but they are not provided with enough and variety of equipment, seats, and benches that make laboratory work comfortable. In addition, as part of a thorough review of Australia's scientific education curriculum, the government conducted a poll of educators about laboratory facilities as well as students' views of the learning settings in which they are placed. The findings revealed that more hands-on approaches to education were related with higher quality scientific resources (Ainley, 1978, 1990). Also, Gentry (1990) defined that experiential learning encompasses contact that extends beyond the traditional dyad of teacher and student. Interaction between students and their surroundings is also essential. Therefore, learning is facilitated by contact between students and the facilities.

Class size

Both P1 and P2 expressed that they have problems with the number of students in their class. P2 said that they have to hurry in conducting the experiment so others could use the materials after them. P1 even stated,

> *Regarding with the class size, dili mayo tong ingato kadaghan nga students. I think we are 42? Yes, 42. So ang uban kay magtinanga nalang, di na mutabang. Igo nalang sila magstorya-storya. That would mean nga wala silay malearn. Usahay sad kay maghuna-huna*

sila nga di nalang mutabang kay masayop unya naa may kagrupo nga mas maayo. However, kung pagamyan siguro ang number of students, bisan pag maghuna-huna sila ug ingato, tungod kay gamay raman, they don't have a choice. So they would probably conduct the experiment. Kay ug di sila muconduct, wala silay data. Kung wala silay data, di sila kahimo ug lab report. Kung di sila kapass ug lab report, wa silay grado, hagbong. So mao to, dapat siguro nga mas pagamyan ang number of students aron tanan makaexecute ug tanan makalearn.

Because of the large number of class, others would no longer be involved in conducting the experiment and would not have access to the equipment.

There has been a significant amount of study carried out in the United States on the topic of class size, as stated in an article published by the Alberta Teachers' Association (What is the Effect of Class size on Student Learning, 2018). Although the majority of the studies have sought to merely utilize test scores as a measure of the efficacy of class size, it does seem that there is some agreement on the following three points: Class size may have a greater impact on students' attitudes than it does on their academic performance if the following three conditions are met: (1) students from low-income families have higher rates of academic success; (2) students with lower levels of academic ability perform better when they are in smaller classes; and (3) the first two conditions are met when class sizes are smaller. The Tennessee STAR Project is the research of the impact of class size that has the most supporting documentation (Student Teacher Achievement Ratio). According to the findings of this research, the optimal student-to-teacher ratio for classrooms is less than 17 individuals. Also, kids who are enrolled in classrooms that are smaller than their classmates' are more successful academically. According to the findings of a research that spanned ten years in Tennessee, kids in grades 13 to 17 had higher graduation rates, better grades, and a greater likelihood of enrolling in college.

CONCLUSION

Students who have enrolled for Physics classes are obligated to participate in both the lecture and laboratory portions of such sessions. Students are given the opportunity to participate in hands-on learning through the laboratory activities, during which they are actively involved in the process of carrying out laboratory experiments. Experiments performed in the laboratory make use of several pieces of laboratory equipment, and students are provided with laboratory manuals in addition to guidance from the lab teacher and lab technician. Students are able to experience the fulfillment of objectives that were set for them in which they could clarify the concept, get a visual representation of the concept, achieve permanent or higher retention of the concept, and apply this concept in real life situations in which Physics concepts were relevant. This is made possible by commendable support facilities and services that are provided to students. The large number of students in the class was one difficulty that the students faced in the laboratory, which had an effect on how well they performed there. The greater the number of students in a class, the lower the probability that all of them will participate in the experiments and have access to the laboratory's supplies and equipment. The pupils' low performance is also caused by a lack of motivation on their part. Better academic success corresponds to higher levels of student motivation.

RECOMMENDATIONS

Based on the findings of this study, students learn the concepts more if they could visualize the concepts and acquire direct experience through laboratory experiments. It is recommended that in order to have greater chance for students to be involved in experiments, the class size must be minimized in such a way that in every group, there should be less members so that the equipment could accommodate every student. Also, since poor facilities and support services highly affect the results of experiments and students' learnings, it is highly recommended for the administration to allocate enough budget to purchase advanced equipment. Lastly, as much as possible, laboratory and lecture instructors must be the same to have coherence between both classes. In such way, the concepts taught in lecture would be easily shown and proven through laboratory exercises.

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