

STUDENT'S UNDERSTANDING OF IMAGE FORMATION BY PLANE MIRROR: A PHENOMENOLOGICAL STUDY

Swidin S. Husin

Western Mindanao State University, Zamboanga City, Philippines.

husinphysics@yahoo.com.ph

ABSTRACT: *The purpose of this study was to get an in-depth understanding of the lived experiences of university students about image formation by a plane mirror. Specifically, how do students experience a plane mirror? What are the experiences of the students about image formation by a plane mirror?*

A qualitative research design, known as phenomenology, was utilized in this study. A phenomenological approach provides a better understanding of the lived experiences about image formation of the students and how these experiences affect their conceptual understanding of the image formation by a plane mirror.

The results showed that the participants possessed preconceptions that are insufficient in the form to describe the image formation phenomenon. Participants' experiences affect their concept of image size with the distance of the object from the plane mirror. Moving towards the mirror, the image size increases, and away from it reduces image size. The image of an object can be seen in full if the mirror height is no less than the object's height. It is observed that students' lived experiences influence their thoughts on image formation.

Keywords –alternative conceptions, lived experiences, Phenomenology,

INTRODUCTION

In the classroom, physics teachers are faced with many challenges to educate students about physics, particularly image formation by plane mirrors [1]. Teachers are dealing with students who viewed physics concepts as abstract and difficult to understand. According to [2], general education student difficulties with physics content knowledge stems from inadequate scientific reasoning. Several studies [3,4,5] demonstrated the concept of the virtual image formed by a plane mirror. The results of these studies showed that students still hold on to their naïve conceptions. This is because college students have only developed expressive skills.

Physics concepts related to image formation in a plane mirror, which are common, present alternative conception to the students, and yet they are unattended.

According to [6]:

Looking at the reflection of our image in a mirror is so commonplace that most of us are unaware of the misconception we hold we respect to this phenomenon (p.25). Other researchers have also commented [7]:

Many students have difficulty linking the fundamentals of geometrical optics with images perceived in the laboratory or situations encountered in everyday life (p.420).

Several factors cause the hindrance to attaining meaningful learning on the part of the students. Amongst these factors is the lived experience of the students, which has accumulated through daily interactions with other people and nature. According to [8], in order for us to understand the lived experiences of the students, we must continue to discover new information about the way they think of learning.

Furthermore, [6] stress that students continue to hold the same alternative conception despite having seen their reflected image many times. It indicates that alternative conception is a severe problem that directly affects student's learning and must be a concern not only for the physics people but also for the researchers.

The reflection of an image from the mirror is a phenomenon familiar to students and teachers. However, several incorrect notions are still evident even after formal instructions.

Therefore, it is necessary to look into this account in order to address it meaningfully.

Exploring the lived experiences of the students provides information and, eventually, insights on the prior knowledge of the students about the plane mirror. This is because, according to [9], prior knowledge, which includes explicit, tacit knowledge, metacognitive, and conceptual knowledge derived from the individual's daily experiences, beliefs, and cultural backgrounds.

Students in the classroom come from different communities with varied ethnic and cultural backgrounds. Most of these students bring their culture and beliefs into the classroom. They make use of them to make sense of their learning. In a study conducted by [10], he found out that students accumulated funds of knowledge as a result of their lived experiences. Thus, teaching becomes a complicated activity because teachers have to accommodate these lived experiences for conceptual understanding [11,12] in the learning process. In essence, [13] urge that for the teaching of science to become meaningful and useful, science must be connected to the lived experiences of the students. Upadhyay [10] stresses that students' lived experiences can serve as a tool to enhance students learning of science. Therefore, understanding students lived experiences must be primarily considered before proper classroom instructions.

In order to interpret the lived experience of the students about image formation by a plane mirror, a phenomenological approach was utilized in this study. Phenomenology is a research method whose primary objective is to describe and explicate the meaning of a student's lived experiences around the specific phenomenon [14,15,16,17]. In other words, as a research method, it emphasizes the importance of personal views and interpretation of the specific phenomenon. The core purpose of phenomenological research methodology is to get into the experiences of the participant. In this way, the researcher would be able to arrive at the structure of the participant's experiences. It provides a new understanding of how these experiences can be described.

OBJECTIVES OF THE STUDY

The purpose of this study was to get an in-depth understanding of the lived experiences of university students about the plane mirror. Specifically, this study sought answers to the following questions:

1. How do students experience a plane mirror?
2. What are the experiences of the students around image formation by a plane mirror?

In other words, this study concerns life-world experiences from the student's perspective and interpretations of a specific phenomenon.

METHODS

In an attempt to obtain in-depth interpretations of the participants' experiences, qualitative research design, particularly the phenomenological approach, was utilized in this exploration study. It allowed the researcher to gain a better understanding of the lived experiences of the students about the plane mirror and how these experiences affect their conceptual understanding of the image formation by a plane mirror.

This approach was chosen because phenomenology emphasizes the importance of the precognition of the learners, including their sense of feeling, which is different from conceptual cognition [18]. The phenomenological methodology is effective at bringing to the fore these experiences and perceptions of the students from their point of view. Furthermore, as mentioned by Lester [17], this method is most potent when it is used to understand subjective experiences. Lin [19] recommends the phenomenological methodology for a study that aims to understand and explore the precognition of the students.

According to Creswell [20], phenomenological research considers only the building of understanding of the experiences from the point of view of the participants instead of focusing the specific theoretical orientations. Creswell [20] also emphasized that the phenomenological research question must be descriptive and be able to surface the meanings of the phenomenon in the experience of the participants.

Sampling procedure

Purposive sampling was used since it is considered to be the essential non-probabilistic procedure to identify the participants [21]. To carry out this sampling technique, the researcher sets two criteria to identify the representative participants. The criteria are 1) participants must not have taken optics as course subject in the classroom to ensure that their views of plane mirror come entirely from their daily experiences, and 2) they have seen their image in a plane mirror or used a plane mirror on a daily basis prior to the conduct of the study. With the first qualification, the participants must be students in tertiary education.

Using the first criterion as a basis, the researcher approached the Head of the Physics in one university in Mindanao, Philippines, considering that he manages BSBS Physics degree programs and has access to all students within the department. The department's approval was sought.

The participants

Students, who have met the first selection criterion, were the 26 first-year BSBS physics majors. Through the gatekeeper, they were invited, offering them the opportunity to participate in the study. The research established a good rapport with

them so that they would feel comfortable during the period of study.

After several friendly conversations with them, the researcher asked the students whether they had seen their image in a plane mirror or had used a mirror. With affirmative reply, the students have met the second selection criterion. Although there were 26 freshmen enrolled in the BSBS Physics degree program, only five were solicited in the study due to time constraints.

Data Collection Procedure

Six in-depth face-to-face interviews were conducted in order to gather the lived experiences of the students about image formation by the plane mirror in its entirety as a phenomenon. Participants were encouraged to talk freely and to tell stories using their own words and dialect.

Open-ended questions were asked to understand how participants experience image formation. For instance, questions such as "what are a plane mirror to you?" and "how do you feel upon seeing your image in a plane mirror?" prompted students to share their experiences. Subsequently, cues of the participants were followed by asking questions for clarification or elaboration. For example, "You mention reflection, please tell me more about reflection as what you have experienced" was followed up in order for the participants to elaborate further on the expressions of their experiences. These questions allowed the researcher to capture detailed descriptions and settings of the phenomenon. With permission from the participants, all the interviews were audiotaped. Each interview with every participant was coded as "participant number, interview sequence, date." At the end of the interview, the participants were reminded about the need for subsequent contact with them to discuss the study findings and to make sure that the study findings reflect their own experiences.

In this study, memo-writing as another necessary data gathering procedure was used. All the memos are dated so that they could be easily correlated with the data from the interview.

Treatment of Data

The audio recordings were converted into a text-based form by listening to the recorded voice and typed them verbatim. During data exploitation, the researcher bracketed his predispositions and interpretations of the data. The qualitative data were processed systematically. To validate explication, the following measures were observed:

First, the working space (in landscape format) was divided into three columns. One column is for the transcript, second for the message units, and finally for the codes and categories. The transcripts were read and re-read many times in order to get a sense of the full content. For each transcript, significant ideas were delineated (second step). Statements in the form of message units that are seen to answer the research questions were extracted. These message units were separated and recorded in the second column. Meanings were formulated from these significant message units.

Third, the formulated meanings were grouped into categories that reflect the unique cluster of themes. After that, the distinctive construct of the theme, which reflects particular experiences of the participants, was formed.

Fourth, to provide a holistic context, every participant's transcripts, which are related to the themes, were summarized. When all emergent themes were defined and the whole structure of the phenomenon had been extracted, the findings were presented to peers for review and confirmation in terms of its richness to provide sufficient descriptions of participants' experiences about the phenomenon.

Fifth, when all the steps mentioned above were completed for all the interviews, the central theme that captures the entirety of the phenomenon was identified using the coaxial coding process. Finally, explication procedures were concluded by writing a composite summary reflecting the contextual emergence of the themes.

At this step, the researcher conducted a member check with the participants in order to determine whether the meanings and interpretations of the transcripts correctly capture the participants' experiences. Suggestions and comments from the participants, which are deemed necessary, were incorporated into the set of data as a form of modifications.

Validity and Ethical Considerations

In order to enhance the dependability of the study, repeated readings on the transcripts and rechecking of the themes as recommended by krefting [22] were applied. Dependability is also addressed through detailed descriptions of the analysis and results. The researcher continuously bracketed his engagement and contributions to the study and regularly consulted his peers who were experts in qualitative research to ensure the conformability of the study. Finally, member checks and peer reviews were done to validate information derived in the study.

The data were interpreted, and the understandings of the participants about image formation were drawn. Overall understanding revealed through the collection of stories, instances, and themes.

Before collecting data, the participants were given written instructions and notified of their voluntary participation in the research and right to refusal, as reflected in the consent form. Confidentiality was observed and maintained by calling the participants as student1, student2, and so on, instead of their real name. Each participant signed the consent form with provisions about the research study and their freedom not to continue participating at any time without prejudices to them in terms of their academic grades, school performance, and relation to school where they are enrolled. All recorded data were kept confidentially.

Informed consent signed by the participants and the approval of the Physics Department to conduct the study upholds the research ethics.

RESULTS AND DISCUSSION

All the transcripts were read several times to gain a concrete understanding of the entire contents. At the same time, all the thoughts, feelings, and ideas that spontaneously surfaced due to the previous experiences of the researcher as a teacher were bracketed.

Four themes emerged and were explicitly expressed in order to gain a real understanding of the lived experiences of students who used plane mirrors. Those themes were:

Description of Plane mirror

When asked about their views of a plane mirror, all of the participants considered a plane mirror as a reflecting surface, where the image of an object can be formed. Also, student1 described a plane mirror as follows:

"Plane mirror is the mirror we usually used. There are different kinds of plane mirrors. A plane mirror is thin. It reflects what is there".

For this participant, the plane mirror is a material thing that is considered as basic stuff that people use it every day. Student1 also believed that there are varieties of plane mirrors. This belief is similar to the belief of student5, except that student5 compared plane mirror to other kinds of mirror. For instance, student5 believed that

"for me, a plane mirror as what I have known is different from a concave and convex mirror. So the plane mirror is a mirror in which you can see the object in front of it as what it is. You put something in it, and it will reflect on what the object is".

This participant understands that the plane mirror is different from the spherical mirrors such as a concave and convex mirror. When asked about its difference to spherical mirrors, student5 attributed it to the flat surface of the plane mirror.

The understanding of the participants how the plane mirror is related to image formation is inconsonant with the results of the researches in physics education literature, particularly that of [23].

Processes of Reflection

The group talked about how the reflection of light takes place on the interface. They believed that the occurrence of reflection of light would depend on whether the surface is shiny or smooth. Student3 thought of reflection of light as follows,

"It depends if the surface is shiny or smooth, then the light will be reflected, for example, a concrete wall that is not smooth, then light will not be reflected. However, if the object is like glass, which is smooth, the light will be reflected".

Their thoughts of the reflection of light are the descriptions of one type of reflection. According to Young and Freedman [24], there are two types of reflection of light, namely specular reflection, and diffuse reflection. The difference between the two types is related to the reflecting surfaces. Specular reflection occurs on shiny and smooth surfaces, such as a mirror while diffuse reflection happens in rough surfaces.

It appears that the participants have experiences about specular reflection but not the other type of reflection.

Furthermore, during the second interview, when asked why not all instances, a person can see his image in a plane mirror. Student5 shared with the researcher that it is about the reflection of light in a mirror. Student5 even talked further by considering the location of the person to the mirror in terms of its angle. This was student5's reply in their local dialect:

"kay tungod ra pud sa reflection sa mirror sir..... Ginahanglan man gud nga makita nimo, equal ang angle of incidence sa angle of reflection [because of the reflection in the mirror, you can see yourself with the angle of incidence equal to the angle of reflection]".

The argument of student5 is conceptually correct for the fact that the law of reflection dictates that angle of incidence is

always equal to the angle of reflection whether the reflection of light is specular or diffused.

Considering the thought of student5, when asked how he acquired his thought about the angle, student5 replied, I had learned it during my high school days.

Characteristics of Image

Most of the participants described the image formed in a plane mirror by relating the inversion of the right hand and the left-hand scenario. For instance, a participant described the image as "it is like, right appears left", the right hand is reflected as left hand." My conversation with the participants reached to the point when one participant talked about the word "AMBULANCE."

"The word ambulance is written in a reversed manner on the front of a vehicle. This is because when you look at the word ambulance from the mirror, it reads as ambulance, the proper way. However, if you look at it directly, it is not readable".

For this participant, the word "AMBULANCE," which is written in a reversed manner on the front of a vehicle, when reading from the plane mirror, appears in the same way how words are correctly written.

The participants continued to share their experiences about the image by telling the researcher that there is no difference between the image and the object in front of a plane mirror when compared according to their sizes. This implies that the image formed by the plane mirror is as big as the object in front of it.

However, this was contradicted by student5. Student5 demonstrated that the size of the image is related to how far the person is situated in the mirror. For example, when a person moves away from the mirror, the size of his image decreases, which eventually fits within the mirror. Consider student5's lines in Filipino:

'for example sir, kung sakto lang talaga sa akin ang mirror, mas malapit talaga ako. Example, kung mas maliit yung mirror mas lalayo ako [if the mirror's size adequately fits my image, then I am nearer to the mirror. However, if the mirror does not fit my image, I will move further from it]"

The experience of student5 about the size of an image is related to the distance of a person to the mirror is an example of an alternative conception. This experience is not far beyond what [25] had realized in their study entitled "Establishment for Misconceptions that Science Teacher candidates have about Geometric Optics." The results of their interview showed that when the participants were asked if moving away or toward the plane mirror the image of an object (pencil) in front of the mirror would change, seven of the participants said that moving away from the plane mirror the image of the object (pencil) becomes smaller.

Student3 had a different experience with that of student5. This is what student3 said:

"Kay if layo mi sa mirror, mas dili jud maklaro imong self. For example, kanang sa babay-i mamulbos. mas closer to the mirror kay maklaro jud nimo [If we are far from the mirror, we can barely see our image. For example a lady applying face power must be closer to the mirror in order for her image (face) becomes distinct.]"

Student3 considered the distance of a person to mirror as a measure of sharpness and distinctiveness of the image.

Student3 believed that moving away from the mirror, the image would appear fuzzy or blurred compared when the person is nearer to the mirror.

When asked about how they feel seeing their image in a plane mirror, they felt either sad or happy. The researcher continued to ask why the participants experienced such feelings. Moreover, this is what one of them said:

"Nafefeel ko yung , example kung ano yung itsura ko ngayon nasasad ako kung pangit yung attire ko, parang ganun. Sabihin na natin na happy din. Example, yung damit na nabili mo hindi maganda tapos sinukat mo, tapos nakita mo nandun sa mirror. Nakikita mo talaga sa mirror na hindi ganun kaganda yung damit. So, masasad ka kasi nakita mo dun eh, nakita mo na kaagad [I, sometimes feel sad whenever I see myself wearing odd clothes, something like that. Let's say I am also happy. However, if the clothe that you have bought is not that elegant, then you see yourself in front of the mirror wearing it. So, you really feel sad because it is not as elegant as you see it in the mirror.]"

Meaning of Light

Some of the participants talked about street lights, fluorescent lights, and other human-made lights. These experiences are associated with electricity. This is because electricity is basic stuff in their lives. However, the participants considered the sun as the primary source of light. Two of the participants considered light as a form of energy, just like mechanical energy, while one participant (student5) relate light to seeing. He said, during darkness, there is no light, and people will not be able to see.

Though student3 thought of light as a mean for people to see, he shared different views with that of student5. For student3, light bounces when it strikes an object.

"First of all, light is something that is coming from the sun, our first source of light. Light bounces through objects which enable us to see those objects. Moreover, light is also.. a.. can be made by man".

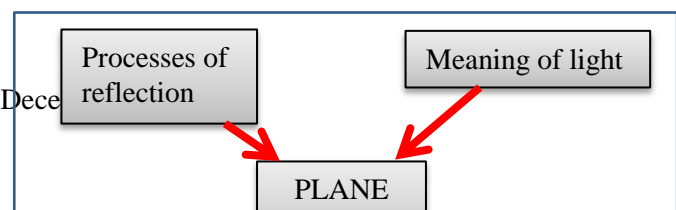
The participants' experiences about light confirmed the results of the research of [26]. The ideas that the sun gives light and light enlighten dark places are the student's light concept definitions, as shown in the results of their study of student's understanding of light concepts across ages (4th, 6th, and 8th graders).

CONCLUSION AND RECOMMENDATION

After using axial coding, where the plane mirror is considered as the central phenomenon, four themes emerged, as shown in Figure 1. The four themes, which are related to the central phenomenon, form parts of the processes when the mirror forms images of an object in front of it.

The reflection of light occurs when light hits the mirror. It is said that the incident light rays hit the mirror at the same angle as it leaves the mirror in the opposite direction. Light, which is mainly coming from the sun and as a form of energy, is involved because we could not see the image without it.

The image formed by the plane mirror is of the same shape and size as that of the object. However, it is laterally inverted when compared with an object.



The size of the image changes depending on the distance of the object from the mirror. Moving away from the mirror makes the image smaller. Image size increases when the object is moved closer to the mirror. Furthermore, the size of the mirror affects also the image size. For instance, if we want to see the whole body of our image in a mirror, the height of the mirror must be at least equal to the person's height standing in front of it.

The participants possessed preconceptions that are insufficient in the form to describe the image formation phenomenon. While listening to their conversations, the researcher noticed two dominant unscientific preconceptions. First, participants' experiences affect their concept of image size with the distance of the object from the mirror. This notion held by the participants is contrary to the generally accepted idea [1]. Finally, the image can be seen in full if the mirror height is no less than the man's height, when, in fact, one needs only a mirror of half his height.

REFERENCES

- [1] Goldberg, F. and McDermott, L. C. "Student's difficulties in understanding image formation by a plane mirror." *The Physics Teacher*, **24**(11):472-480(1986)
- [2] Moore C.J., and Rubbo, L.J., "Scientific reasoning abilities of non-science majors in physics-based courses." *Physical Review Special Topics-Physics Education Research*. **8**(1):010106(2012)
- [3] Singer D. "The location of virtual images in plane and curved mirrors." *The Physics Teacher*. **17**(8):534(1979)
- [4] Mansell, P. "Where is the Reflection." *The Physics Teacher*. **45**(2), 119(2007)
- [5] Greenslade, T. B. "Virtual Mirrors." *The Physics Teacher*. **48**(1):26(2010)
- [6] DiBiase, W. J., Mahler, J., Melton, B. "Reflecting on misconception." *The Science Teacher*, **69**(2):24-27(2002)
- [7] Salinas, J., and Sandoval, J. "Geometrical optics and visual perception." *The Physics Teacher*, **39**(7):420-423(2001)
- [8] Chick, N., Poole, G. "Exploring the Lived Experiences of Our Students." *Teaching and Learning Inquiry*, **2**(2):1-2(2014)
- [9] Dochy, FJRCFJRC, Alexander, P.A. "Mapping Prior knowledge: A Framework for Discussion among Researchers." *European Journal of Psychology of Education*, **10**(3):225-242(1995)
- [10] Upadhyay, B. R. "Using students' lived experiences in an urban science classroom: An elementary school teacher's thinking." *Science Education*. **90**(1):94-110(2005)
- [11] McCarty, T. L., Wallace, S., Lynch, R. H., Benally, A. "Classroom inquiry and Navajo learning styles: A call for reassessment." *Anthropology & Education Quarterly*, **22**(1):42-59 (1991)
- [12] Daniel A. "Teachers' curriculum agency in teaching a standards-based curriculum." *The Curriculum Journal*, **29**(4):479-498, DOI: [10.1080/09585176.2018.1486721](https://doi.org/10.1080/09585176.2018.1486721) (2018)
- [13] Bouillion, L. M., Gomez, L. M. "Connecting school and community with science learning: Real-world problems and school-community partnerships as contextual scaffold." *Journal of Research in Science Teaching*, **38**(8):878-898(2001).
- [14] Christensen, L. B., Johnson, R. B., Turner, L. A. *Research methods, design and analysis* (11th ed.). Boston, MA: Allyn & Bacon (2010).
- [15] Englander, M. "The Interview: Data Collection in Descriptive Phenomenological Human Scientific Research." *Journal of Phenomenological Psychology*, **43**:13-35(2012)
- [16] Groenewald, T. "A phenomenological research design illustrated." *International Journal of Qualitative Methods*, **3**(1). Article 4. Retrieved from http://www.ualberta.ca/~iiqm/backissues/3_1/pdf/groenewald.pdf(2016)
- [17] Lester, S "An introduction to phenomenological research." Taunton UK, Stan Lester Developments. Retrieved from www.sld.demon.co.uk/resmethy.pdf(2014)
- [18] Østergaard, E., Dahlin, B., Hugo, A. "Doing phenomenology in science education: a research review." *Studies in Science Education*, **44**(2):93 - 121(2008)
- [19] Lin, C-S. "Revealing the "Essence" of Things: Using Phenomenology in LISLIS Research." *Qualitative and Quantitative Methods in Libraries*, **4**:469-478(2013)
- [20] Creswell, J.W. "Research design: qualitative, quantitative, and mixed methods approaches" (3rd ed.). Thousand Oaks, CA: Sage Publications (2009)
- [21] Welman, C., Kruger, S. J., Kruger, F. *Research Methodology for the Business and Administrative Sciences*. Oxford University Press (2001)
- [22] Krefting, L. "Rigor of Qualitative Research: The assessment of trustworthiness." *American journal of Occupational Therapy*, **45**(3):214-222(1991)
- [23] John, M., Molepo, M., Chirwa, M. "How Do Learners Conceptualize Plane Mirror Reflection? A Case Study of Grade 11 South African Learners". *International Journal of Educational Sciences*. **13**:221-230. [10.1080/09751122.2016.11890456](https://doi.org/10.1080/09751122.2016.11890456) (2016)
- [24] Young, H., Freedman, R. "Sears and Zemansky's University Physics: with modern physics" (13th ed.) Pearson Education, Inc., publishing as Addison-Wesley, USA USA (2012)
- [25] Aydin, S., Ural Keles, P., Hasioglu, M. A. "Establishment for misconceptions that science teacher candidates have about geometric optics." *The Online Journal of New Horizons in Education*, **2**:7-15(2012).

- [26] Sahin, C., Ipek, H., Ayas, A. "Student's understanding of light concepts primary school. A cross-age study". *Asia-Pacific Forum on Science Learning and Teaching*, **9**(1):1-19(2008)