Research Article

PINE-ZODIAC: Methods of Mastering Ray Diagrams for Convex Lens Among Students of Kolej Vokasional Seri Manjung

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Abstract: *This study was carried out due to the concern of the researchers after observing the students' poor performances in mastering the ray diagrams for convex lens involving various positions of objects and the impact on changes in the position of images, characteristics and examples of optical equipments. The objectives of the research are to increase students' performance in this topic, to attract students' interest in learning a difficult topic, and to develop interesting and effective Teaching Aids. The study was conducted on 40 students in the second year of the Sijil Vokasional Malaysia (SVM) at Kolej Vokasional Seri Manjung. This study involved the technique of drawing convex lens ray diagrams using the Pine- Zodiac (PZ) Technique as well as the use of PZ model. Research methodology used is the Kemmis & McTaggart model (1988) through Pre and Post-test instruments, interviews and surveys. The PZ Technique is used as an intervention. The findings were analysed using the method of finding mean and percentage. The findings showed an increment in students' achievement after implementing PZ Technique in lesson as they applied it in the Final Assessment, whereby students achieving excellent results increased from 1% to 93%. There was also an increase in students' interest towards the topic which is considered challenging, and interesting Teaching Aids for the Teaching and using PZ Technique that showed a mean of 4.58, which is at a fun level as the question asked to students is whether they enjoy using the PZ Technique. In conclusion, the PZ Technique is really beneficial for both students and teachers as students' achievement can be enhanced, students' confidence can be increased, and the Teaching Aids alternative. Hence, this technique can be developed through blended-learning involving face-to-face and virtual lesson in the future.*

Keywords: Pine-Zodiac, ray diagrams, convex lens

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1. INTRODUCTION

Light and Optics is the final topic in the SVM Science Semester 3 course which involves the formation of images by lenses and optical equipment. It is a crucial and critical topic because it is frequently asked in Final Assessment. According to years of experiences in marking students' answer

scripts, the researchers have found that most students commonly failed to answer questions from this topic appropriately, in fact many did not even answer the questions by leaving them blank. As a result, students tend to lose a lot of marks due to this issue. The question about ray diagram is included in Section B which is a compulsory part to be answered in the paper, where one question carries five (5) marks. This situation clearly shows that the students were not able to master Light and Optics topic appropriately.

The understanding of drawing ray diagrams and characterizing the formed images are among the issues in the sub-topic of image formation by lens (Mohd, 2019). Some of the problems arose are students were unable to accurately remember the steps of drawing a ray diagram for the lens and the students were confused to determine the characteristics of the image formed by the lens (Nur, 2023). The Teaching and Learning (T&L) process will be more fun and not dull. Fun learning is also related to the use of interesting Teaching Aids to create a conducive learning environment (Abdul & Hasmah, 2013). It is vital as body language plays an important role in conveying message, expressing emotions, and building relationships between teachers and students in the education process (Kucuk, 2023).

Teachers must be able to offers standards-based Science, Technology, Engineering, and Mathematics (STEM) programs that use innovative instructional tools (Kennedy & Odell, 2014). This is attributed to the fact that, lacking in variation of suitable methods and techniques will lead to a dull and ineffective lesson conducted by the teacher (Masyuniza, 2015). The error of choosing a method or technique of learning is the main factor influencing the failure of an individual to master a knowledge (Maizan, 2017). Teaching Aid for the students is needed to create an urge to learn and sustain their interest in learning, enable them to understand the most difficult and abstract concepts, and properly teaching aids can help retain concepts permanently (Kapur, 2018).

Based on the problem stated above, there are three research objectives established to achieve the aim of this study:

i. Improving students' achievement in mastering convex lens ray diagrams through the Pine-Zodiac method.

ii. Increasing students' participation during the Teaching and Learning process.

iii. Producing interesting Teaching Aids for Light and Optics module.

2. METHOD & MATERIAL

Researchers used the Kemmis and McTaggart (1988) model in this action research.

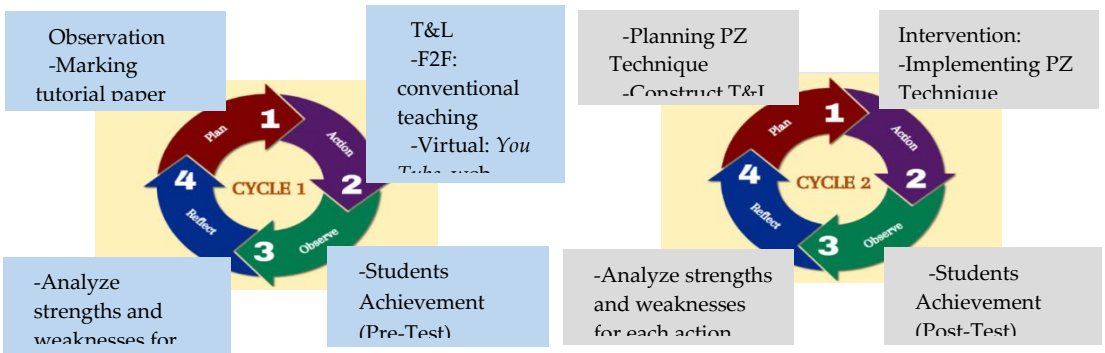


Figure 1. Kemmis and McTaggart Model (1988).

2.1 Methodology

The Kemmis and McTaggart (1988) model is selected for the innovation that involves four steps in each cycle which are planning, acting, observing, and reflecting. The study involves two cycles (Figure 1).

In cycle 1, the researchers started Step 1 (Planning) by observing students' answer patterns during the Final Assessment in previous years, then doing tutorial exercises for current students. The results of the scores proved a continuation of the alarming pattern of confusion among students in answering questions from the particular topic stated earlier and also supported by the results of interviews with students. Step 2 in Cycle 1 involves actions during face-to-face lesson by using conventional methods; and by implementing virtual learning with the aid of technology such as sharing of YouTube videos and web link in class Telegram group. Then, Step 3 involves the researchers observing students' performance and achievement in pre-test. The researchers also consider that methods and approaches of Teaching and Learning should be diversified (Asmazatul, 2023), hence step 4 is the reflective responses of every strength and weakness for the action taken. Accordingly, the suggested improvement proposed is intervention, which refers to a systematic activity that has a time limit and assessment is done at the end of the particular period (Noraishah & Isa, 2021). Intervention for this action research is a need of Cycle 2 through the creation of an efficient method to facilitate the students which is named Pine-Zodiac (PZ) Technique.

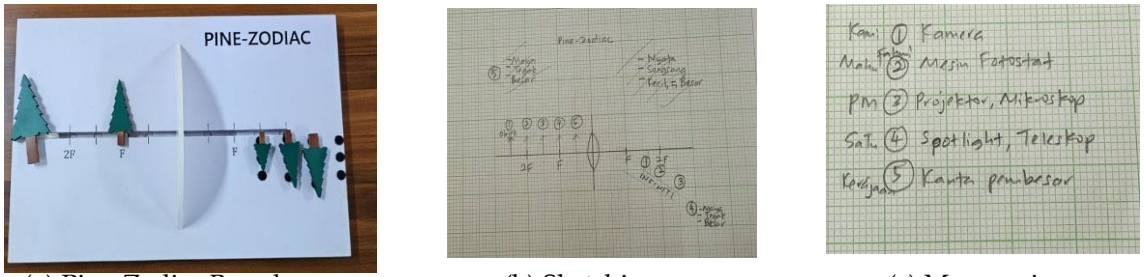
In Cycle 2, Step 1 includes the researchers planning the suitable PZ Technique to be applied for students during their Final Assessment and building a concrete model to enhance students' understanding during Teaching and Learning in the classroom. Step 2 is the implementation of intervention action which is introducing this technique to the students, followed by step 3 which is observing and analyzing students' achievement (Post-test). Step 4 involves the researchers reflecting the strengths and weaknesses after the implementation of the PZ Technique. Some suggested improvements are also discussed so that this technique could be widely-used to enhance students' performance for all the current semesters students and for the future ones.

2.2 Material

Figure 2. Set of Pine-Zodiac Model

The product is made from polyvinyl chloride (PVC), which is strong, resistant to falling, match the parts to the particular position to enhance students' understanding. The design has smooth surfaced, every detail has been processed manually, machine, and polished, so it friendly-used. The

color of the product is painted with water-resistant paint. Velcro in built for students to match the image position. Pine-tree shape is designated, make it like a real tree exactly like people have in real life. Finally, the product is covered with wooden box for its safety.



(a) Pine-Zodiac Board (b) Sketching (c) Mnemonic

Figure 3. Pine-Zodiac Teaching Aid.

Pine-Zodiac Version 2.0 (PZV2.0) is a method of teaching by implementing the use of Pine-Zodiac Model (Figure 2) during Teaching and Learning session. Through the PZ model, students will look directly and be able to use the PZ model as an exercise and revision with their friends. By using Teaching Aids, all forms of symbol and abstract concepts can be explained concretely (Nur & Mohd, 2021). The knowledge delivered is quite clear-cut which is when light rays exiting the convex lens converge, they form a real image. We can use the standard rays to find the location of that image. To explain these concretely, pine trees are used in the model [Figure 3(a)] that will change from one position to another. Thus, students need to determine the correct position of the pine tree image. The set of sketches [Figure 3(b)] together with the interesting mnemonic type acrostic technique [Figure 3(c)] is very practical to facilitate students recalling this technique while answering their Final Assessment. The word mnemonic comes from a Greek word which means 'to remember' and the memory of the selected information of the acrostic type which is in the form of a specific word or phrase (Maizan, 2017).

For the sampling, the target group of this study is the 2SVMETE2 and 2SVMETN1 students, representing Semester 3 SVM students for 2023/2024 Session from the Electrical Technology and Electronic Technology programs at Kolej Vokasional Seri Manjung, Perak. The 40 research samples chosen consist of 15 students of Electrical Technology and 25 students of Electronic Technology program. The selection of classes is random.

While for the research instrument to collect data of students' achievement is in the form of a test to compare their achievement before and after the PZ Technique is introduced. Pre-test is conducted in Cycle 1, which is after face-to-face and virtual Teaching and Learning session (before the PZ Technique was introduced). While, the Post-test is conducted in Cycle 2 after the students are introduced to the PZ Technique as an intervention.

The research instrument used to measure the effectiveness of the PZ Technique was a Questionnaire created in the Google Form by including a 5-points Likert scale adapted from the Salwati study (2008) which are 1 (Strongly Disagree), 2 (Disagree), 3 (Neither Agree nor Disagree), 4 (Agree), and 5 (Strongly Agree).

3. FINDINGS

Students' achievement analysis (Table 1) uses percentage to analyze the exam grade throughout the action research.

Table 1. Comparison of Students' Achievement.

Students Marks	Level	Quantity and Percentage of Students (%)			
		Tutorial Question (Preliminary)	Pre-Test	Post-Test	Differentiate of Pre- and Post-Test
80 -100	A (Excellent)	1 (3%)	1(2.5%)	37(92.5%)	+36 (+90%)
60-79	B (Good)	6(15%)	5(12.5%)	2(5.0%)	-3 (-7.5%)
40-59	C (Average)	8 (20%)	11(27.5%)	-	-11(-27.5%)
0-39	D (Poor)	25(63%)	23(57.5%)	1(2.5%)	-22 (-55%)

Analysis of efficiency PZ Technique (Table 2) consists of 10 items using the 5-points Likert's Scale.

Table 2. Analysis of efficiency PZ Technique.

Item	Subject	Percentage (%) / Quantity					Mean
		1 SD	2 D	3 NAD	4 A	5 SA*	
1	Science is an easy subject.	-	-	5% (2)	72.5% (29)	22.5% (9)	4.18
2	I prefer to use other techniques other than PZ Technique.	20% (8)	30% (12)	17.5% (7)	10% (4)	22.5% (9)	2.85
3	Light and Optics appears to be an easy topic even without Pine-Zodiac Technique.	10% (4)	25% (10)	32.5% (13)	20% (8)	12.5% (5)	3.00
4	I easily understood ray diagram after the teacher introduced Pine-Zodiac Technique.	-	-	2.5% (1)	32.5% (13)	65% (26)	4.63
5	I easily memorized the ray diagram after the teacher introduced Pine-Zodiac Technique.	-	-	7.5% (3)	40% (16)	52.5% (21)	4.45
6	I feel interested in drawing ray diagram using the Pine-Zodiac Technique.	-	-	-	42.5% (17)	57.5% (23)	4.58
7	I was able to redraw the ray diagram using the Pine-Zodiac Technique.	-	-	-	50% (20)	50% (20)	4.50
8	I was confident to guide my friends to draw ray diagram using the Pine-Zodiac Technique.	-	-	17.5% (7)	47.5% (19)	35% (14)	4.18
9	The Pine-Zodiac Technique helped me in answering the Light and Optics questions in the examination.	-	-	-	40%	60%	4.60

					(16)	(24)	
10	I was certain to answer all questions about ray diagrams in the examination.	-	-	5% (2)	47.5% (19)	47.5% (19)	4.43

*1 (Strongly Disagree/SD), 2 (Disagree/D), 3 (Neither Agree nor Disagree/NAD), 4 (Agree/A), and 5 (Strongly Agree/SA).

4. DISCUSSION

4.1 Discussion of Research Objective 1

Improving students' achievement in mastering convex lens ray diagrams through the Pine-Zodiac method.

Findings were measured from a comparative analysis of students' achievement (Figure 4) during the Pre-test and the Post-test (before and after the PZ Technique was introduced).

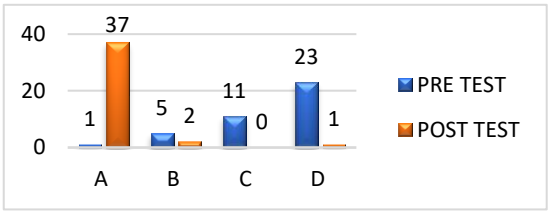


Figure 4. Analysis on the Difference of Students' Performance in Pre- and Post-test

The PZ Technique in Cycle 2 has shown an impressive increase in students' achievement with an increment of 37 (93%) students getting an A (Excellent) in the Post-test compared to just 1 (3%) student in the Pre-test. The percentage of students at level D (Weak) was drastically reduced when there is only 1(3%) student left in the Post-test compared to 23 (58%) students during the Pre-test. Therefore, the research objective 1 which is to increase the achievement of the students in mastering convex lens ray diagrams through PZ method has been achieved.

Students were able to accumulate the movement of object's position and how to gradually relate the resulting image. Thus, this will resolve the students' confusion about the formed image criteria that consists of three aspects which are size, position and characteristics (Nur, 2023). Image formation by lens is a sub-topic that requires teachers to use their own skills to deliver appropriate understanding about the topic among the students (Ramzi, 2022) prompting the construction of PZ Technique which is proven its ability to increase students' achievement. It becomes very important in geometric optics by mastery the representation diagrams. Thus, the laws of physics will be delivered correctly when using the correct picture representation (Poluakan, 2019).

4.2 Discussion of Research Objective 2

Increasing students' participation during the Teaching and Learning Process.

Findings were measured from responses for item 6. 7, and 8 in questionnaire instruments distributed to the students.

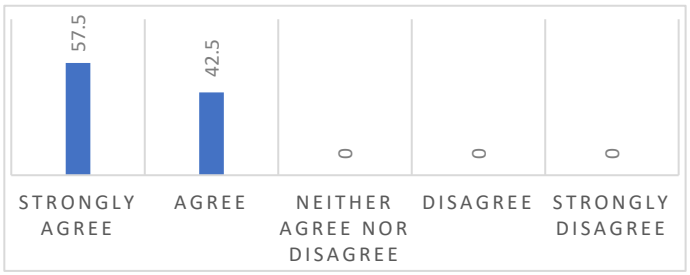


Figure 5. Findings of Questionnaire Analysis (Item 6).

Based on Figure 5, item 6 *"I feel interested in drawing ray diagram using the Pine-Zodiac Technique."*, 57.5% of the students chose Strongly Agree scale and 42.5% chose Agree. These findings showed that all students enjoyed drawing ray diagrams using the PZ Technique. Thus, the mean is 4.58 (Table 2) indicating that students were actively and positively involved in the Teaching and Learning Process.

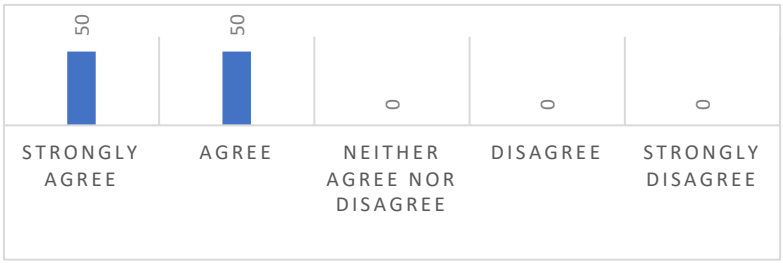


Figure 6. Findings of Questionnaire Analysis (Item 7)

Based on Figure 6, item 7 *"I was able to redraw the ray diagram using the Pine-Zodiac Technique."*, same value obtained for both Strongly Agree and Agree scale; 50%. The findings showed that students were able to redraw the ray diagram after sketching the PZ. Thus, the mean is 4.50 (Table 2) indicating that the cognitive aspect (knowledge) of the students has increased and they were confident to answer this type of question.

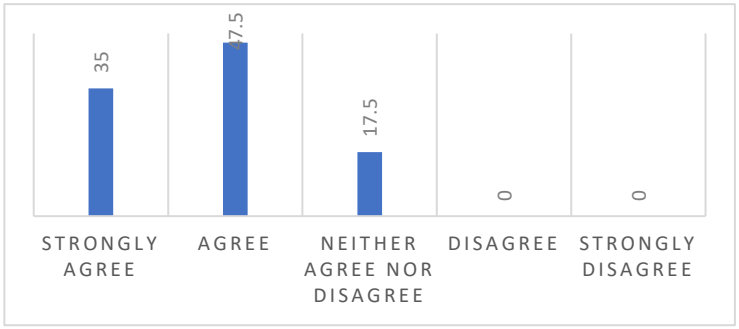


Figure 7. Findings of Questionnaire Analysis (Item 8)

Based on Figure 7, item 8 *"I was confident to guide my friends to draw ray diagram using the Pine-Zodiac Technique."*, 35% of the students chose Strongly Agree scale, 47.5% Agree. The findings

showed that the students have mastered the ray diagrams and were able to teach other classmates. Thus, the mean is 4.18 (Table 2) showing that the majority of students were emotionally positive and ready for peers-to-peers learning so that knowledge can be shared together.

The findings proved that students with positive emotions will be more mentally prepared to face Final Assessment. Emotional intelligence in the field of education consistently shows a positive relationship between emotional intelligence and academic performance (Alifah, 2012). They enjoy an exciting learning environment with their friends, achieve learning objectives for self-improvement and are willing to share with friends, as well as being able to apply PZ Technique to answer questions related to Light and Optics. One of three representations that physics educators agree is correct drawing of light rays through lenses such as the ray diagram, other than conceptual knowledge and mathematical understanding (Danilo & Junehee, 2022).

4.3 Discussion of Research Objective 3

Producing Interesting Teaching Aids for Light and Optics module.

Findings were measured from the responses for item 4 and 5 in questionnaire instruments distributed to the students.

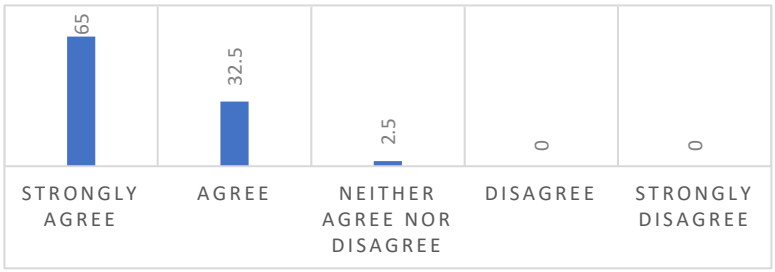


Figure 8. Findings of Questionnaire Analysis (Item 4).

Based on Figure 8, item 4 *"I easily understand the ray diagram after the teacher introduced the Pine-Zodiac Technique."*, 65% of the students chose Strongly Agree scale and 32.5% chose Agree. The findings showed that students easily understood the ray diagrams after using the PZ Technique. Thus, the mean is 4.63 (Table 2) showing that students liked the Teaching Aids used in this technique and were able to understand the ray diagrams easily.

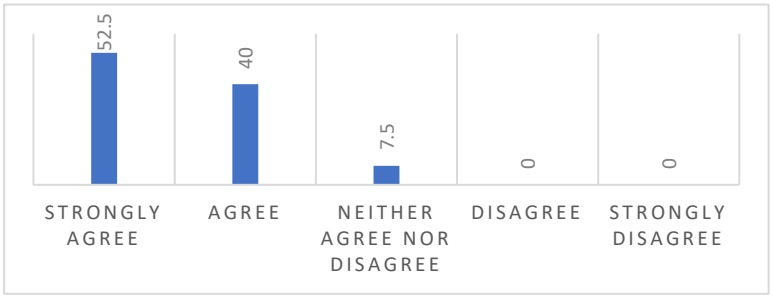


Figure 9. Findings of Questionnaire Analysis (Item 5).

Based on Figure 9, Item 5 *"I easily memorized the ray diagram after the teacher introduced Pine-Zodiac Technique."*, 52.5% of the students chose Strongly Agree scale and 40% chose Agree. The

findings showed that students' ability to remember the ray diagrams increased after using the PZ Technique. Thus, the mean is 4.45 (Table 2) showing the Teaching Aids used in this technique made it easier for the students to remember the correct ray diagram.

The shape of the Teaching Aids turned out to have a great positive impact on the students because through them, students were able to draw ray diagrams, images, and state the characteristics of the resulting image (Azif, 2019; Omar, 2019; Nur, 2023). Teaching Aids used in the PZ Technique also support differentiated pedagogy as researchers emphasize four main elements, contents, processes, products and environment. These elements are combined according to the diversity of pupils in terms of readiness, interest and learning profile (Zurina et al., 2021). It indicated that this Teaching Aids product facilitated the students in answering their Final Assessment, attracted their interest in learning difficult topics, and created a positive learning profile which refers to the most effective learning style among the students to the extent they were capable to teach their friends regarding the topic.

5. CONCLUSION

The researchers hope that the PZ built will be able to facilitate students in understanding and mastering this Light and Optics topic. This research confirms the effectiveness of the PZ Technique in improving students' achievement in mastering the ray diagrams of convex lenses. It is highly recommended to implement this technique in Teaching and Learning session to improve students' understanding and to increase their ability to remember for Light and Optics topic. It is believed that students will have the ability to answer this topic well in their Final Assessment.

The recommendation of further research is to make the PZ Technique as a teaching material for blended-learning. Thus, students can get the advantange of learning this technique not only in physical classroom, but also be able to browse it at any time virtually in line with the latest technological developments.

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