Study Of Concept Mastery Of Binocular K-11 Students Through The Implementation Of A Multi-Representative Approach

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ABSTRACT: Mastery of the concept becomes the basis for use in the process of solving problems in science learning today, such as scientific literacy and 21st-century skills. However, generally mastery of concepts only revolves around solving scientific issues associated with the use of binocular formulas. Therefore, research is conducted that aims to obtain mastery profiles of binocular ideas through the implementation of a multi-representation approach. Qualitative descriptive research uses a sample of 26 students from a population of 142 students of class XI in one of the public high schools in Bandung. The researchers did randomsampling. The instruments used were in the form of tests and non-tests with the validity of 27.1% (valid) and reliability of 0.70 based on Rasch analysis. The data obtained were presented in the form of a percentage for each Competency Achievement Indicator (CAI), by grouping student answers into three categories namely Novice, Intermediate and Advance. Each type of answers gets a score for later converted to value and analysis with SPSS 23. The results show that the highest percentage is in CAI 1 (explaining binocular function) by 58% in the Intermediate category and 42% in the Advance category, while the lowest rate found in CAI 3 (drawing sketches of shadow formation by two convex lenses) which is equal to 4% in the Advance category. Besides, the average value of students in binocular concepts is 65.77, which indicates that the mastery of binocular concepts is still low. Some suggestions for improving the learning process are also elaborated.

Keywords: Binocular, mastery of concepts, multi-representation approach

1. INTRODUCTION

Learning process becomes a crucial thing to produce a good understanding of a concept. Through a meaningful learning process, students can change their initial thoughts into scientific concepts [1-2]. Students who are actively involved with what they learn will tend to understand and remember moreand can more easily connect what has been discovered with the knowledge they already have [3-4]. Thus, students will be able to apply their expertise in the problem-solving process. However, often, the learning process ignores student activities and is still teacher-centered. Ceuppens et al. [1] stated that classical learning, especially in an optical material, is not always possible to turn the students' initial conceptions into scientific concepts. For example, students only observe images without knowing the process of forming shadows on mirrors and lenses. Besides, the learning process supported by textbooks can encourage students to understand concepts in optical material for simple physics problems. For example, in binoculars, students can mention binocular parts, calculate the magnificationand length of the binocular.But in general, the learning is only recalled and becomes less meaningful for students. Saputra et al. [5] suggested that Indonesian students only remember formulas, laws, and theories to solve problems, but do not use them in analyzing issues that occur in everyday life. The less meaningful learning process will lead to low mastery of students' concepts. This thing will have an impact on students' difficulties in solving more complex problems, and not enough as a foundation for scientific literacy and 21st-century skills. Besides, the possibility concepts accepted by the students are different from scientific theories that give rise to misconceptions. Misconceptions can occur because the learning methods used by the teacher, teacher's interpretations are different from the concepts, students' previous understanding, and learning resources such as books [6-9]. The misconception occurs in the binocular idea, one of which is that the image formed is real, upright, and enlarged.The misconception should not occur in visual concepts (primarily geometric optics) because it is essential for students to study physical optics and analyze the workings of optical devices. Besides, at present, optical applications in technology are increasing rapidly [1]. In the Indonesian curriculum, the competencies students must possess after studying geometric optics are being able to analyze the workings of optical devices using reflecting and refracting properties by mirrors and lenses and creating works that apply the principle of reflection and refraction to mirrors and lenses. Based on this, students are not only required to master visual concepts, but also must be able to do works that apply the principle of reflection and refraction. In doing tasks, for example, making simple binoculars, a good understanding is needed to determine the focus of two lenses that will produce maximum magnification, and knowledge of the placement of the two lenses (objective lens and ocular lens) to get a focused shadow. One way that can be done so that the learning process is more meaningful for students is by implementing a multi-representation approach. Representation is something that can represent, describe, or symbolize an object or process [10]. The description of a system or method with two or more forms is called multi representation [11-12]. A multi-representation approach is essential in physics learning, especially in helping students to understand more complex physics concepts [13-14]. Besides, the use of several representations can help students in solving physics problems [15-16]. Multi-representation can take the form of diagrams, tables, equations, graphics, videos, animations, and texts. Through changing information from one way to another (for example from equations to graphs), students will find it easier to understand concepts and the learning process will be more meaningful [14], [17]. Ainsworth [18] suggested the benefits of a multi-representation approach, namely as a complement to the information received, limiting interpretation, and building a

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good understanding. Based on these problems, a study was conducted that aims to obtain mastery profiles of binocular concepts in high school class XI students through the implementation of a multi-representation approach. The mastery profile of binocular concepts is expected to be an illustration to improve the learning process.

2 METHOD

The method used in the research is a qualitative descriptive method.

2.1 Participants

The research sample was a class XI student in one of the Public High Schools in Bandung. The sample consisted of 26 students (18 female students and eight male students) from a total population of 142 students. The sampling technique used is random sampling.

2.2 Learning Process

The applied learning is a multi-representation approach during one meeting. During the learning process; students are given Student Worksheets (SW) to support the learning process. The method used is in the form of demonstrations, discussions, and experiments. At the end of learning, students are given formative tests in the form of multiple-choice questions and descriptions.

2.3 Instruments

The assessment method used is in the way of tests (multiple-choice and description) and non-test (SW). The examples of multiple-choice tests are shown in Figure 1.

An astronomical binocular consists of two convex lenses. When observing with normal eyes, the two lenses are 650 mm apart. The focal length of the ocular lens used is 50 mm. Magnification of binoculars is…times.

A. 13

B. 12

C. 11

D. 10

E. 9

Figure 1. Example of multiple-choice question (MCQ)

Questions on SW and formative tests are used to measure mastery of student concepts that refer to Bloom's taxonomy in Anderson & Krathwohl (2010). The distribution of cognitive process dimensions and Competency Achievement Indicators (CAI) are shown in Table 1.

Furthermore, all students' answers are presented in the form of a percentage for each CAI, by grouping student answers into three categories namely Novice, Intermediate and Advance. These three categories refer to the detailed rubric for each CAI. Each percentage is analyzed to describe the learning process and results. Besides, all three classes were given scores. The scores for each category are indicated in Table 2.

Each student score is summed and then converted to a value. The value of students is then analyzed using SPSS 23 for testing descriptive statistics.In addition, each percentage is analyzed to describe the learning process and results. Validity and reliability test using Rasch analysis. Validity test results show the value of raw variance explained by measures higher than 20%, namely 27.1%. This thing means that the instruments used have fulfilled validity [19]. Furthermore, the reliability test results show that the value of item reliability is 0.70, which means that the items in the instrument are quite useful [19].

TABLE 1
DISTRIBUTION OF THE DIMENSION OF COGNITIVE PROCESS AND CAI

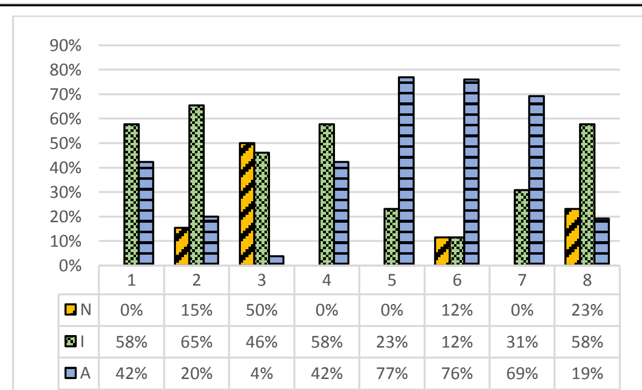
Dimension of Cognitive Process	Competency Achievement Indicators (CAI)
C1 Remember	CAI 1
C2 Understand	CAI 2 andCAI 3
C3 Apply	CAI 4 andCAI 5
C4 Analyze	CAI 6
C5 Evaluate	CAI 7
C6 Create	CAI 8

3 RESULT AND DISCUSSION

Based on the analysis of student responses from the SW and the questions test, an overview of the achievement of the CAI for each of the answer categories was obtained, as follows.

TABLE 2
SCORE FOR EACH ANSWER CATEGORY

Answer Category	Score
Novice	0
Intermediate	1
Advance	2



Note. N = Novice; I = Intermediate, A = Advance

Figure 2. The percentage of students' answers to each CAI for the three categories

The Competency Achievement Indicator (CAI) 1 is “explaining the function of binoculars”. Based on Figure 2, 58% of students are in the Intermediate category, and 42% of students are in the Advance category. The learning process in the classroom is that the teacher displays two pictures of the moon, which are observed using the eyes and by using a tool (binoculars). Questions on SWis:

Q (Question): “Based on the explanation that has been delivered, what is the function of binoculars?”

One of the students' answers is as follows.

S21 (21st student answer): “Binocular function is to see objects that are very far away so that they can be seen clearly." (Advance)

S25: "The function of binoculars is to see objects that are very far away that cannot be seen by the eye." (Intermediate)

In the Intermediate answer category, students do not accurately explain the function of binoculars, but already know that binoculars are used to observe objects that are located very far away. Through the learning process that presents a comparison of observations of objects that are located very far away, students can make comparisons to obtain the function of the use of binoculars.The CAI 2 is "estimating the shadow formed by a convex lens". As many as 15% of students are in the Novice category, 65% of students in the Intermediate class and 20% of students are in the Advance category. As many as 15% of students cannot estimate the location of the shadows formed by a convex lens when objects are infinitely far away. Questions on SWis:

Q: "Describe the process of forming shadows on a convex lens when objects are infinitely far away!"

Student answers are as follows.

S22:

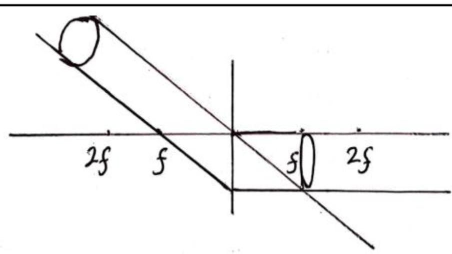


Figure 3. Example of student' answer in Advance category

S13:

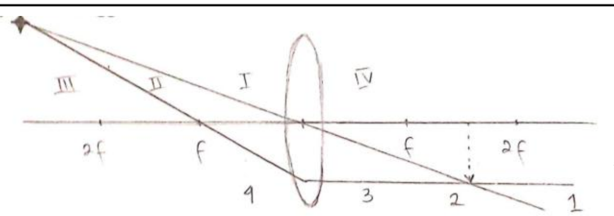


Figure 4. Example of student' answer in Intermediate category

S20:

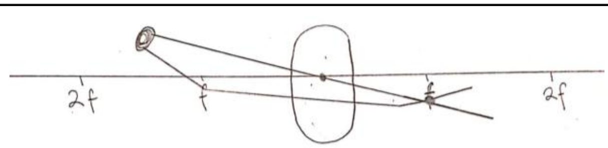


Figure 5. Example of student' answer in Novice category

The answer S13 in the Intermediate category is not quite right in drawing a convex lens and where the shadow is formed, but S13 has correctly described the first rays. S20 in the Novice category does not use individual beams correctly, so that the image formed is also not illustrated. Students answer wrong can occur for several reasons. First, the teacher assumes that students have studied shadow formation using individual rays in middle school. With this assumption, in the learning process, the teacher only reminds about the three first rays and gives an example of how shadows form when an object is between the focal point and the radius of the lens. But in reality, students are still having difficulty in sketching the formation of shadows when objects are infinitely far away. This thing is consistent with Ceuppens' research, et al. [1] and Goldberg & McDermott [20] which state that students have difficulty in determining shadows by convex lenses, both before and after the learning process. Second, when analyzed from the answer S13, students consider objects far away to be in room III so that the shadow must be in place II. So, the term 'infinitely far' becomes an obstacle for students to determine the sketch of shadow formation. Third, the plans made by some student's lack precision between one ray and the other so that the intersection of light is not right at the focal point. This thing is also following the Ceuppens study, et al. [1], which states that ray diagrams are essential concepts to describe the formation of shadows. However, students often have difficulty using individual rays, especially in the extension of the beam behind the mirror or lens.

The CAI 3 is "estimating shadows formed by two convex lenses in binoculars". As many as 50% of students are in the Novice category, 46% of students are in the Intermediate class, and only 4% of students are in the Advance category. As much as 4% of students can estimate shadows formed by two convex lenses on binoculars with assessment rubrics on designing, drawing, and products. Questions on SWis:

Q: "Describe the shadow formation process formed by two convex lenses when objects are infinitely far away!"

Further analysis for CAI 3 in the Advance category is by the rubric, producing profiles such as Figure 6.

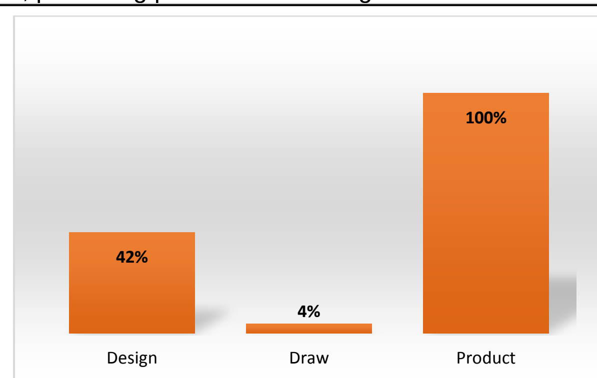


Figure 6. Percentage of answers to CAI 3 students for the Advance

Based on Figure 6, 42% of students can design (calculate the magnification value and the distance between two convex lenses), while the other 58% do not include calculations on the SW because of the questions on the SW focus on making a shadow formation sketch. Student answers are shown in Figure 7 below.

S23:

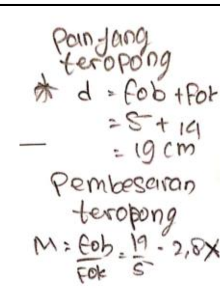


Figure 7. Student' answer in Advance category

Only 4% of students can draw sketches of shadow formation on two convex lenses. This thing is because the learning process lacks training in how to form shadows at each stage. After student's description shadow formation, not all images made by students can be examined during the learning process so that there are still many students who are mistaken in sketching the creation of shadows. Besides, the learning process is also less stressful to interpret the image until it has an extended formulation and magnification of binoculars. The examples of student answers are as follows.

S26:

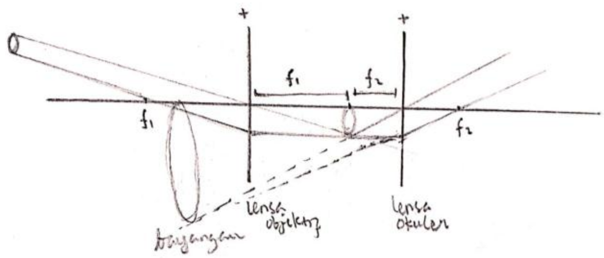


Figure 8. Example of student' answer in Advance category

S7:

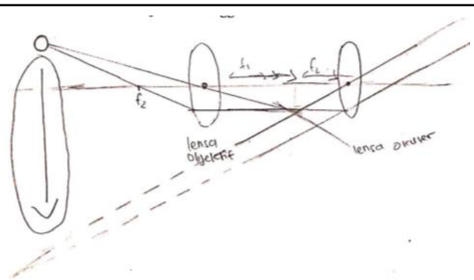


Figure 9. Example of student' answer in Intermediate category

S22:

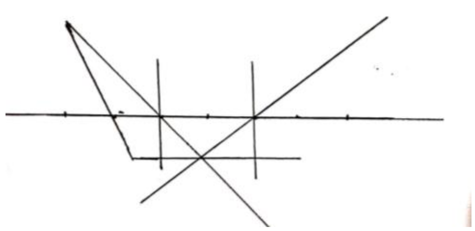


Figure 10. Example of student' answer in Novice category

In the Intermediate category, the S7 is less precise in describing convex lenses (thin lenses) and shadows that are formed. However, the S7 has correctly described the first rays. In the Novice category, S22 cannot describe shadows formed by special rays. As much as 100% of students can observe shadows created on two convex lenses, which are upside down and enlarged. The CAI 4 is "determining the magnification of binoculars" in MCQs. Based on Figure 2, 58% of students are in the Intermediate category, and 42% of students are in the Advance category. As many as 58% of students in the Intermediate class because students immediately, use the numbers listed in the question without reading and matching the formulations that will be used. However, students are right in using binocular magnification formulations. Besides, the learning process does not train students to do calculations with various numerical manipulations or formulations so that students are not used to determining the magnification of binoculars when combined with the drafting of the length of binoculars. The learning process that occurs is also not enough to interpret the shadow formation sketches that have been made by students, so students also lack the meaning of the formulation used (only memorization).

The CAI 5 is "determining the length of binoculars" on MCQs. 23% of students are in the Intermediate category, and 77% are in the Advance category. As many as 23% in the Intermediate class because students are less careful in converting units from mm to cm. However, students are right in using the formulation of the length of binoculars.

The CAI 6 is "choosing two convex lenses that will produce maximum magnification". Questions on SWis:

Q: "Search for information on the internet regarding the focus value of the convex lens available! Record some of the focus values of the lens! Which pair of lenses focus values will produce maximum magnification?"

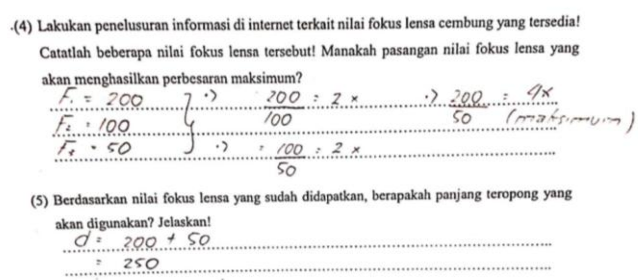
The 12% of students are in the Novice category, 12% in the Intermediate class, and 76% in the Advance category. Students can choose two convex lenses, which will produce maximum magnification. The rest, students only write the lens focus values without calculating the maximum magnification and determine the pair of two lens focus. In the Intermediate category, students only count one magnification of various possibilities.

The CAI 7 is "predicting binocular length according to the lens focus value". Only 69% of students can predict the length of binoculars according to the focus value of the lens, which is in the Advance category. This thing happens not because students do not know the formulation used, but only students misunderstand the meaning of the questions in the SW. Students use the focus of the lens that they have used in the experiment, while the issue on the SW asks the length of the binoculars used to focus the value of the lens whose value has been traced on the internet. The questions on SWis:

Q: "Based on the focus value of the lens that has been obtained, what length of binoculars will be used?"

Examples of student answers to the Advance and Intermediate categories are shown in the following figure.

S4:



(4) Lakukan penelusuran informasi di internet terkait nilai fokus lensa cembung yang tersedia! Catatlah beberapa nilai fokus lensa tersebut! Manakah pasangan nilai fokus lensa yang akan menghasilkan perbesaran maksimum?

F₁ = 200 → 200/100 = 2× → 200/50 = 4× (maksimum)
F₂ = 100
F₃ = 50 → 100/50 = 2×

(5) Berdasarkan nilai fokus lensa yang sudah didapatkan, berapakah panjang teropong yang akan digunakan? Jelaskan!

d = 200 + 50
= 250

Figure 11. Example of student' answer in Advance category

S10:

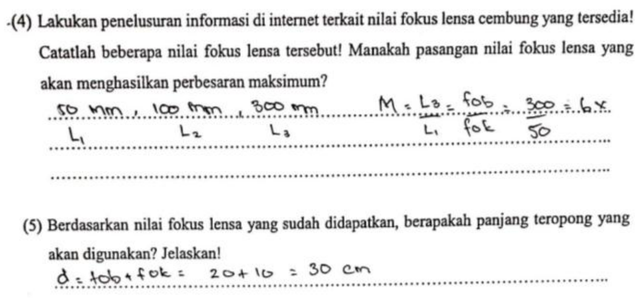


Figure 12. Example of student' answer in Intermediate category

The CAI 8 is "designing the manufacture of star binoculars using the lens refraction properties". 23% of students are in the Novice category, 58% in the Intermediate class, and 19% in the Advance category. The learning process has facilitated students to design binoculars, such as selecting two lens focus, calculating the magnification and the length of the binoculars that will be used. However, there are still students who answer incorrectly because of the lack of emphasis at the end of learning about the binocular manufacturing process.
Based on the processing of student grades, the results are as shown in Table 3.
From Table 3, it can be seen that the average value of students in the binocular concept is 65.77 with a value range of 0-100. The minimum amount of students is 44, while the maximum value is 94. When viewed from the average amount of students, the mastery of students' concepts on binocular concepts is still relatively low. This thing is consistent with Tural's research [21], which states that students still experience difficulties in an optical material, especially lenses, even though students have learned it.

4 CONCLUSION AND SUGGESTION

Based on the analysis of students' answers for each CAI, it can be concluded that the highest percentage is in CAI 1 which explains the function of binoculars by 58% in the Intermediate category and 42% in the Advance category, while the lowest rate is in CAI 3 for drawing sketches forming shadows by two lenses convex on binoculars which are 4% in the Advance category. Based on the processing of descriptive statistics, the average value of students in binocular concepts was 65.77. This case shows that the mastery of binocular concepts is still low.
Based on the conclusions that have been obtained, there are some suggestions for improvement, especially in the learning process for binocular concepts, namely:
1. Ensure that students are not mistaken when sketching the shadows on a convex lens by giving a few examples of shadow formation.
2. Guiding students to describe shadow formation by two convex lenses at each stage. Besides, the learning process must also be emphasized on the meaning of the shadow formation sketch that has been made.
3. Train students to determine the magnification of binoculars with different numbers or formulations (combined with the drafting of binoculars length).
4. Remind students about the importance of unit conversion.
5. Guiding each student's activities when filling in questions on Student Worksheets (SW). Besides, items on SW should be able to be emphasized, more detailed, and improved so that students are more easily understood.
6. The product produced cannot be measured because it is only in the form of student observation, preferably the images observed by two convex lenses can be photographed by students as evidence.
7. Reinforce the end of learning about the process of making binoculars in general so that students can design binoculars.

TABEL 3
RESULT OF STATISTIC DESCRIPTIVE USING SPSS 23

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Nilai Siswa	26	50	44	94	1710	65.77	2.607	13.292
Valid N (listwise)	26							

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