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# Student's Psychomotor Abilities in the Fundamental Physics Experiment of the Geometry Optic Topic during the COVID-19 Pandemic

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## Abstract

This research was conducted to study the student's psychomotor abilities in the fundamental physics experiment of the geometry optic topic during the COVID-19 pandemic. Type of research is descriptive quantitative. Data collection techniques were carried out by assesing students' practical skills who had participated in Geometry Optic experiment with observation sheet instrument. The research sample is Undergraduate Students in Physics Education Department UNM who programmed Fundamental Physics II for the 2020/2021 academic year totalling 113 students. The results of the research data show that the average student's psychomotor abilities in the fundamental physics experiment of the geometry optic topic was at a percentage of 83.79%. Thus, it can be said that the student's psychomotor abilities in the Fundamental Physics Experiment of the Geometry Optic Topic are in very high category.

Keywords: assessment; laboratory experiments; practical skills; psychomotor domain

## 1. Introduction

Education plays an important role and position in the development of advanced life as a society, nation and state. In addition, education also plays an important role as a provider of skilled and quality educators as well as in the development and management of human resources (HR) to advance the progress of human life [1]–[3]. To achieve this, the process of providing education must also be of quality such as curriculum, mastery of the material by teachers/lecturers [4]–[6], learning models (including strategies, approaches and methods), sufficient learning media and supporting facilities, as well as a conducive school/campus environment [7]–[9].

Physics is a science that studies symptoms through a scientific process that is based on a scientific attitude and is realized as a scientific product composed of the three most important components in the form of concepts, principles, and theories that are universally applicable [10]. Physics is one of the key disciplines in the development of technology or engineering, which plays an important role in understanding natural events in real life in the form of mathematical expressions using models, theories and laws [11]. In addition, physics basically aims to study and provide a quantitative understanding of various natural phenomena or processes, the properties of matter and their applications [12]. This view is reinforced that physics is the study of natural events that allows research through experiments, measuring what is obtained, presenting it systematically, and based on universal rules [13]. From some of these opinions it shows that physics describes and analyzes the structure and events or natural phenomena so that rules or laws are found in nature, which can explain the symptoms based on the logical structure between cause and effect.

Learning Physics is not enough just to study theory, but must be supported by experiments conducted in the laboratory. Experiments are one of the learning strategies that can attract students' interest in developing scientific concepts and applying scientific methods. Experiments provide knowledge and direct experience to students to observe a phenomenon that occurs so that students will better understand the concepts being taught [14]. Experiments carried out in the laboratory can make students understand better concepts and directly prove the results of research in the laboratory, so that students master the material better [15].

 

Laboratory experiments are very important in learning process. Laboratory experiment provides valuable opportunities for students to effectively build relationships between theories and real-world phenomena [16]. Hence, experiments are integrated in the curriculum to prepare students for practical experiences before their graduation [17], [18]. The most effective method of teaching students to do something is to ask them to do the task. Therefore, by conducting laboratory experiments, students learn by practicing skills that cannot be learned theoretically [19]. In addition, when conducting laboratory experiments, students have the opportunity to develop and practice their practical and hands-on skills [20]–[23].

Several previous research has studied student's psychomotor abilities in a laboratory experiment. However, there are still very few researches that studied specifically in Fundamental Physics experiments. This research will study the student's psychomotor abilities in the fundamental physics experiment of the geometry optic topic during the COVID-19 pandemic. This research is expected to be a consideration and input for lecturers, especially lecturers in basic physics courses. Thus, this research is expected to be an evaluation for the development of student quality through improving psychomotor abilities.

## 2. Psychomotor Domain

Learning outcomes in the psychomotor domain refer to the ability to physically manipulate a tool or instrument such as a hand or a hammer [24]. Psychomotor goals typically focus on changing and/or developing behaviors and/or skills. Thus, students' practical skills and hands-on experience in the laboratory are linked to the psychomotor domain [16], [18]. Students' experimental skills in the laboratory are associated with the psychomotor domain. There are many psychomotor domain that used. Among them the frequently discussed one is Simpson's categories. He categorized the progressive levels of behaviors from observation to Mastery of a skill [25].

- Perception - Sensory cues guide motor activity.
- Set - Mental, physical, and emotional dispositions that make one respond in a certain way to a situation.
- Guided Response - First attempts at a physical skill. Trial and error coupled with practice lead to better performance.
- Mechanism - The intermediate stage in learning a physical skill. Responses are habitual with a medium level of assurance and proficiency.
- Complex Overt Response - Complex movements are possible with a minimum of wasted effort and a high level of assurance they will be successful.
- Adaptation - Movements can be modified for special situations.
- Origination - New movements can be created for special situations.

The other two popular versions are given by Dave in 1970 and Harrow in 1972.

## 3. Geometric Optic Topic

Optics and its application have seen a tremendous development in various fields of science. It has been an interesting research area for researchers in physics education [26], because, without understanding very well the fundamental concepts of light and its properties, students are not expected to fully grasp modern science [27]–[29]. However, students find the subject of optics to be obscure and difficult, and teachers help is often inadequate because of its complex and abstract relations [27], [29]–[31].

The field of geometric optics involves the study of the propagation of light. Geometric optics assumes light travels in a fixed direction in a straight line as it passes through a uniform medium and changes its direction when it meets the surface of a different medium or if the optical properties of the medium are not uniform in either space or time [32].

The Geometric Optic topic experiment was designed to enhance students' knowledge and practical skills in geometric optic material. The objective of this experiment are:

- Knowing the behavior of light in the event of reflection and refraction of light
- Determine the refractive index of the material
- Determine the focal length of a convex lens and a concave lens
- Plotting a graph of the relationship between the distance of the image and the distance of the object so that the value of the focal distance is obtained based on the graph
- Compare the theoretical value with the obtained lens focal distance graph plot

The experiment session was supervised by the laboratory assistant who was responsible to brief students on the experiments and assessing students' performance. For the experiment session, students were given a laboratory worksheet and a pre-formatted laboratory temporary report. The pre-formatted laboratory report consists of pre-formatted tables for students to fill in the measured values. At the end of the laboratory session, each group was required to submit their pre-formatted laboratory temporary report to the laboratory assistant. There is also Psychomotor Assessment Form that is used as a checklist for identifying students' practical skills while performing the laboratory practical test.

## 4. Methodology

This research was conducted to study the psychomotor abilities of students in the Fundamental Physics practicum for the 2020/2021 academic year during the COVID-19 pandemic at the Physics Department, Universitas Negeri Makassar. This research can be classified into quantitative descriptive research.

The population of the study are undergraduate students in Physiscs Department, Faculty of Mathematics and Science UNM Makassar who took the Fundamental Physics II course in the 2020/2021 academic year, amounted to 127 students. While sampling using purposive sampling method by determining the sample size using the Slovin's formula [33]. Obtained a minimum sample size of 96, but in this study, researchers took a sample size of 113 students, which means above the minimum sample required by Slovin's formula.

The data collected in this study is the psychomotor ability of students in Geometry Optics topic experiment. Data were collected through non-test instruments in the form of observation sheets given to laboratory assistants to measure students' psychomotor abilities. Psychomotor abilities that measured are identifying tools and materials, assembling, measuring, writing down measurement results. The data collected will be processed using descriptive analysis, namely to describe the characteristics of the distribution of scores from the variable. Descriptive statistics are used to present data that has been obtained from student learning outcomes in the form of tables containing the minimum value, maximum value, average, standard deviation, and variance. Data processing in this study was carried out by giving a score to each sub-skill performed by students to determine the percentage of students' abilities and determine categories. Very high, high, medium, low, very low categories with consecutive percentages (81-100%), (61-80%), (41-60%), (21-40%) dan (≤ 20%) [34].

## 5. Result and Discussion

### *5.1 Result*

The psychomotor abilities of students in the Fundamental Physics experiment of Geometry Optics topic are presented in the following table.

Table 1. Descriptive analysis results

| Descriptive statistics | Score | | | | |
|---|---|---|---|---|---|
| | Psychomotor Ability | Identifying Tools and Materials | Assembling | Measuring | Writing Measurement Results |
| Sample Size | 113 | 113 | 113 | 113 | 113 |
| Mean | 83.79 | 83.98 | 82.76 | 82.43 | 85.99 |
| Standard Deviation | 6.06 | 7.14 | 8.88 | 8.64 | 8.52 |
| Variance | 36.77 | 50.91 | 78.83 | 74.60 | 72.65 |
| Score Range | 40 | 40 | 60 | 60 | 40 |
| Lowest Score | 55 | 60 | 40 | 40 | 60 |
| Highest Score | 95 | 100 | 100 | 100 | 100 |

The psychomotor abilities of students are then grouped based on the categorization that has been made. The categorization of students' psychomotor abilities can be seen in Table 2.

Table 2. Categorization of student psychomotor abilities

| Interval | Category | Distribution | |
|---|---|---|---|
| | | ∑ | % |
| 81-100 | Very High | 94 | 83.19% |
| 61-80 | High | 16 | 14.16% |
| 41-60 | Medium | 3 | 2.65% |
| 21-40 | Low | 0 | 0.00% |
| 0-20 | Very Low | 0 | 0.00% |
| Total | | 113 | 100.00% |

The categorization of the sub-ability to identify tools and materials can be seen in Table 3.

Table 3. Categorization of the identifying tools and materials sub-ability

| Interval | Category | Distribution | |
|---|---|---|---|
| | | ∑ | % |
| 81-100 | Very Good | 62 | 54.87% |
| 61-80 | Good | 48 | 42.48% |
| 41-60 | Fair | 3 | 2.65% |
| 21-40 | Poor | 0 | 0.00% |
| 0-20 | Very Poor | 0 | 0.00% |
| Total | | 113 | 100.00% |

For the categorization of the assembling sub-ability it can be seen in Table 4.

Table 4. Categorization of the assembling sub-ability

| Interval | Category | Distribution | |
|---|---|---|---|
| | | ∑ | % |
| 81-100 | Very Good | 61 | 53.98% |
| 61-80 | Good | 49 | 43.36% |
| 41-60 | Fair | 0 | 0.00% |
| 21-40 | Poor | 3 | 2.65% |
| 0-20 | Very Poor | 0 | 0.00% |
| Total | | 113 | 100.00% |

For the measuring sub-ability, the categorization can be seen in Table 5

Table 5. Categorization of measuring sub-ability

| Interval | Category | Distribution | |
|---|---|---|---|
| | | ∑ | % |
| 81-100 | Very Good | 70 | 61.95% |
| 61-80 | Good | 37 | 32.74% |
| 41-60 | Fair | 4 | 3.54% |
| 21-40 | Poor | 2 | 1.77% |
| 0-20 | Very Poor | 0 | 0.00% |
| Total | | 113 | 100.00% |

The categorization of the sub-ability to write down the measurement results can be seen in Table 6.

Table 6. Categorization of writing the measurement results sub-ability

| Interval | Category | Distribution | |
|---|---|---|---|
| | | ∑ | % |
| 81-100 | Very Good | 87 | 76.99% |
| 61-80 | Good | 19 | 16.81% |
| 41-60 | Fair | 7 | 6.19% |
| 21-40 | Poor | 0 | 0.00% |
| 0-20 | Very Poor | 0 | 0.00% |
| Total | | 113 | 100.00% |

### *5.2 Discussion*

Based on the analysis, it can be seen in Table 2 that 94 students with a percentage of 83.19% are in the very high category, 16 students with a percentage of 14.16% are in the high category, 3 students with a percentage of 2.65% are in the medium category, and there are no students in the low and very low category. The results of the analysis of student acquisition scores showed that on average, the psychomotor abilities of students in the Geometry Optics experiment were in the "very high" category.

The sub-ability to identifying tools and materials sub-ability is assessed by seeing whether students can recognize what tools and materials are used in geometric optic experiment.

Table 7. List of Components

| No | Components |
|---|---|
| 1 | Optical Bench |
| 2 | Precision Optical Rail |
| 3 | Diaphragm and slide holder |
| 4 | Cables |
| 5 | Plastic Ruler |
| 6 | Concave Lens |
| 7 | Convex Lens |
| 8 | Power Supply 10 A, 12 V AC/DC |
| 9 | Light Box |
| 10 | Flat Mirror |
| 11 | Plan Parallel Glass |
| 12 | Rhombus |
| 13 | Straight Pin and Paper |
| 14 | Receiving Screen |
| 15 | Light Blub 12 V, 18 W |
| 16 | Arrow Diaphragm |
| 17 | Protractor |
| 18 | Stem Lamp |

Table 7 shows what tools and materials are used and must be identified by students. For the sub-ability to identify tools and materials, it can be seen in Table 3 as many as 62 students with a percentage of 54.87% are in the very good category, 48 students with a percentage of 42.48% are in a good category, 3 students with a percentage of 2.65% are in the fair category, and there are no students in the poor and very poor categories. The results of the analysis of student acquisition scores show that on average the students' sub-ability to identifying tools and materials is in the "very good" category.

Students' assembling sub-ability is assessed by seeing whether students are able to assemble tools into a series used for geometric optic experiment. For the assembling sub-ability, it can be seen in Table 4 as many as 61 students with a percentage of 53.98% in the very good category, 49 students with a percentage of 43.36% in the good category, 3 students with a percentage of 2.65% in the less category, and there are no students in the fair and very poor categories. The results of the analysis of student acquisition scores showed that on average the students' assembling sub-ability were in the "very good" category.

Students' measuring sub-ability is assessed by seeing whether students are able to measure quantities in geometric optic experiment.

Table 8. List of Measuring Items

| No | Item |
|---|---|
| 1 | Measuring angles |
| 2 | Measuring the focal length of the lens |
| 3 | Measuring the image distance |

Table 8 shows what was measured by students. For the measuring sub-ability, it can be seen in Table 5 as many as 70 students with a percentage of 61.95% in the very good category, 37 students with a percentage of 32.74% in the good category, 4 students with a percentage of 3.54% in the fair category, 2 students with a percentage of 1.77% in the poor category, and there are no students in the very poor category. The results of the analysis of student acquisition scores show that on average the students' measuring sub-ability are in the "very good" category.

Students' sub-ability to writing the measurement results was assessed by seeing whether students are able to correctly write down the measurement results obtained in geometric optic experiment. For the writing ability sub, the measurement results can be seen in Table 6 as many as 87 students with a percentage of 76.99% in the very good category, 19 students with a percentage of 16.81% in the good category, 7 students with a percentage of 6.19% were in the fair category, and there were no students in the poor and very poor category. The results of the analysis of student acquisition scores showed that on average the students' sub-ability to writing the measurement results were in the "very good" category.

## 6. Conclusion

Based on analysis of the research that has been carried out, it can be concluded that the student's psychomotor abilities in the Fundamental Physics Experiment of the Geometry Optic Topic are in 83.79% or in very high category with distribution of 83.19%. As for all sub-abilities that were observed, they were in the very good category with consecutive percentages of distribution are 54.87% for identifying tools and materials sub-ability, 53.98% for assembling sub-ability, 61.95% for measuring sub-ability, and 76.99% for writing the measurement result sub-ability.

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