

Paper Conceptions and Misconceptions of Pre-Service Teacher about Light

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Abstract—The purpose of this study is to define a description of the various conceptions and misconceptions of pre-service physics teacher about the concept of light in basic physics courses. This research was conducted on 96 students of a pre-service physics teacher in one of the state universities (PTN) in Makassar. The mixed method was used in this study. Data collection in this research is through observation, test, analysis of test results, limited interviews, and analysis of data by quantitative and qualitative. The result of this research is found the misconception of pre-service physics teacher about the concepts of physics, especially about the concept of light. This shows that the low understanding of the concept of pre-service physics teacher to the basic concepts of physics, causing misconception. Therefore, that misconceptions are defined an information to develop a continuous research that can contribute to improving the quality of teachers candidates, especially physics teachers who will give a positive impact on improving the quality of education, especially in Indonesia by developing a programming of basic physics course oriented conceptual change to eliminate a misconceptions on pre-service physics teacher).

Keywords—conceptions, misconception, light

I. INTRODUCTION

Until now, physics is still a material that is considered difficult and unpleasant to learn, both for students at the elementary, middle to university level [1]–[3]. The factor behind the students' difficulties in understanding physical material is the lack of understanding of the concept due to the poor quality of teaching and learning [4]–[8]. Lack of understanding of concepts supported by poor quality teaching and learning leads to misconceptions of the material being studied [9]–[11]. This is because each student already has a previous conception related to a particular material. Those responsible for the quality of teaching and learning are teachers. Teachers as educators are graduates from teacher training colleges who must have competence as professional teachers, one of which is pedagogic competence [12], [13].

Pedagogic competence is the ability of a teacher's knowledge, including an understanding of students, designing and implementing of learning, evaluating learning outcomes and developing students to actualize their various potentials. Pedagogic competence referred to in the Law of Teachers and Lecturers UU No.14 Year 2005 article 10

paragraph 1, is the ability to manage student learning. The most important thing to create an effective teaching and learning process is that the teacher must have the correct understanding of the concept and of course, must be in accordance with the scientific concept. However, in reality, there are still physics teachers who have misconceptions about certain material. The teacher's misconception is most likely to occur when the teacher is still a student teacher candidate in college. Thus, it is very important to provide conceptual understanding to the pre-service teacher to prepare professional teacher candidates, especially for physics teachers. Understanding students as prospective teachers in mastering the concepts of physics will influence the achievement of educational goals in the teaching and learning process. As a teacher, it is important to understand concepts that are in accordance with scientific concepts. The basic concept that is very important for a pre-service teacher is the concepts discussed in the basic physics course.

Basic Physics is one of the compulsory subjects for pre-service physics teacher at the LPTK and courses are given in the first semester because these courses are a requirement for the next course [14] and basic material to be taught at junior high school and school level upper middle class. Basic physics courses also underlie the development of engineering, design, planning, technology and have an important role in various disciplines as well as developing human thinking power. The purpose of holding Basic Physics II lectures in the physics education study program curriculum at the physical education department at one of the LPTK in Makassar is to explain the basic concepts related to the subject matter, develop the concept of the concept as the basis for the next concept, and apply it in daily life. To achieve this goal, one of the competencies that must be developed in the basic physics lectures is understanding the concept (understanding concept). The National Research Council (1996) describes the implementation of the NSES (National Science Education Standards) which confirms the acquisition of scientific knowledge and the development of understanding. Scientific knowledge includes facts, concepts, principles, laws, theories, models and which can be obtained in many ways.

Understanding includes the ability to use knowledge, and understanding requires the ability to distinguish between

those which include scientific ideas and those that are not scientific ideas. Developing understanding means that students can relate scientific ideas and experiences that are shared with the surrounding natural environment. It can be said that learning should move and focus on understanding concepts. However, in reality, Basic Physics is one of the subjects that students find difficult. This is because in certain concepts on Basic Physics involves complicated mathematics [15], [16]; too much material, depends on textbooks, abstracts, and complexes; requires laboratory activities; and frequent misconceptions [17]–[19].

One material that is difficult to understand in basic physics is the concept of light. This is found in several studies conducted in science education that both students, teachers, and prospective teachers have the wrong conception of the concept of light. Based on the results of the preliminary study of the conceptions of physics teacher prospective students related to the concept of light by using Three Tier Test found a lack of understanding of the concept of physics teacher candidate students on light topics as follows: 1) the concept of a large angle of reflection equal to the angle of arrival; 2) the concept of the procedure of using a comparison of shadows to the distance from the point of the light source; 3) the concept of the procedure for using the angle of incidence ratio is the same as the angle of reflection of the beam; 4) the concept of forming shadows on flat mirrors; 5) the concept of the shadow properties of objects on a flat mirror [20], [21]; 6) the Law's concept of reflection, as found in previous studies that most students have a hierarchy of knowledge that is wrong in the concept of reflection and dispersion of light [22]; 7) determine the critical angle based on the total internal reflection characteristics using Snellius law; 8) the concept of light propagation in different mediums and refractive indices based on Snellius's Law [23]; 9) the concept of refraction [24]; 10) critical angle; 11) formation of shadows on the lens; and 12) the properties of shadows on the lens.

In addition, teachers who teach optical materials are found to use traditional models still. Traditional learning processes are considered ineffective in learning physics concepts. Active learning that involves the active role of students in learning stimulates students' ability to think in gaining knowledge compared to traditional learning [25] and to help cognitive processes during knowledge acquisition (especially learning the concepts of light and optics) required learning designs that effective learning that involves students directly in the learning process [26]. Thus, it is necessary to take preventive measures to overcome the lack of knowledge and understanding of concepts or improve the misconceptions of prospective teachers, especially the concept of light before carrying out teaching.

Based on the introduction that has been described, the problem in this study was what is the description of the prospective teacher's conception of the concept of light in the basic physics course. The objective of this study is to describe the conceptions and misconceptions of the students of Pre-service physics teacher about the light concept.

II. RESEARCH METHOD

The approach used in this study is a quantitative-qualitative approach. The subject of research is students of pre-service physics teacher who a student's of basic physics II courses at one of the University in Makassar City.

Procedures of this study there are preliminary information obtained; there were problems related to the conception and misconception of students in higher education. Based on the problems found in the field, the Three Tier Test diagnostic test instrument that is tier1 is the answer choice, tier 2 is the confidence scale in selecting answer choices, and tier 3 is an explanation in the reason for choosing answers. After the test is carried out, the test results will be analyzed quantitatively and qualitatively. For tier 1 will be given a score of 1 for the correct answer and a score of 0 for the wrong answer. Then the results data will be analyzed descriptively. Next is tier 2, namely the confidence scale using a scale of 1-6 will be analyzed using the Certainty of Response Index (CRI) criteria. After that, it will be categorized into three categories: understanding the concept (P), not understanding the concept (TP), and misconception (M). Whereas for tier 3, the explanation in the reason for choosing answers will be analyzed by coding. This coding system consists of five categories including Scientific Correct (SC), Partially Correct (PC), Misconception (M), Uncodeable (U) and No Explain (NE) categories.

The conceptions of the pre-service teacher about Light who understand concepts, misconceptions, and do not understand the concept by using CRI (Certainty of Response Index) criteria. CRI (Certainty of Response Index) method is a measure of the level of confidence or certainty of respondents in answering each test question given. CRI is based on a scale and is given along with each answer to a problem. In this study, researchers used a scale of CRI scale 6. The CRI criteria for scale 6 can be seen in table 1.

TABLE I. TABLE CRI SCALE 6 AND ITS QUALITATIVE MEANINGS

Scale	Qualitative Meaning
1	Predicted
2	Almost predictable
3	Not sure
4	Almost Sure
5	Sure
6	Very Sure

Bunawan:2015, [27]

The operationalization of CRI criteria stated by the presentation of the element of guessing in answering a question that is in table 2.

TABLE II. THE CRI PROVISIONS TO DISTINGUISH BETWEEN KNOW CONCEPTS, MISCONCEPTIONS, AND NOT KNOWING CONCEPTS

Criteria Answer	Low CRI (<3)	High CRI (> 3)
Correct answer	Correct answer but low CRI means no understanding concept (lucky guess)	Correct answer and high CRI means an understanding of the concept.
Wrong answers	Wrong answers and low CRI means no understanding concept (lucky guess)	Wrong answers and high CRI means misconceptions

Tayubi:2005(8), [28]

III. THE RESULT AND DISCUSSION

Recapitulation of student candidates' answers about light which is categorized into 3 categories: understanding

categories (P), not understanding concepts (TP), and misconceptions (M) categories.

TABLE III. PERCENTAGE OF STUDENTS BASED ON ANSWERS AND LEVEL OF TRUST ON LIGHT CONCEPT

No	Sub Topic of Discussion	Total of Percentage (%)		
		P	TP	M
1	The monochromatic nature of light in the phenomenon of two-slit interference	40.58	40.58	18.84
2	Application of the concept of light on the phenomenon of interference in everyday life	31.88	28.99	39.13
3	The application of the concept of light on the diffraction phenomenon in the color spectrum	31.88	27.54	40.58
4	Application of a polychromatic concept of light on dispersion phenomenon	72.46	27.54	0.00
5	Characteristics of monochromatic light	7.25	56.52	36.23
6	The concept of the phenomenon of interference in Young Experiments	49.28	49.28	1.45
7	Light bending on the lattice and the sequence of the color spectrum in light	23.19	42.03	34.78
8	Physical characteristics of light	55.07	37.68	7.25
9	The characteristics of light as electromagnetic waves	5.80	46.38	47.83
10	Characteristics of light as a wave	28.99	50.72	20.29
11	Characteristics of monochromatic light on the concept of refraction	8.70	65.22	26.09
12	The nature of light as a wave in its application to the concept of interference phenomenon.	24.64	47.83	27.54
13	Physical characteristics of light	10.14	57.97	31.88
14	The characteristics of light in the concept of reflection	50.72	43.48	5.80
15	Light characteristics that show the physical nature of light	39.13	39.13	21.74
16	Light characteristics in the application of the reflection concept	26.09	39.13	34.78
17	The characteristics of light in the application on a plane mirror	10.14	72.46	17.39
18	The characteristics of light in the application on a convex mirror	8.70	71.01	20.29
19	The characteristics of light in the application are concave mirrors	0.00	59.42	40.58
20	The characteristics of light in its application to the concave lens	18.84	59.42	21.74
21	Light characteristics on the concept of total internal reflection	1.45	78.26	20.29
22	Light characteristics in prisms	14.49	52.17	33.33
23	Light characteristics in planparal glass	31.88	40.58	27.54
24	Light characteristics in refraction	15.94	37.68	46.38
25	Color spectrum on the prism	31.88	43.48	24.64
26	Light characteristics on the prism color spectrum	7.25	59.42	33.33
27	Application of the concept of refraction	21.74	42.03	36.23
28	Characteristics of Light in optics	24.64	57.97	17.39
29	Characteristics of reflected light	4.35	52.17	43.48
30	The concept of Snellius Law's	59.42	30.43	10.14

Based on table 3, it can be seen that students of pre-service physics teacher experience misconceptions about the concept of Light. The misconceptions of the pre-service teacher about the concept of light are found in almost all subtopics of the concept of light, namely on the subject matter of the monochromatic nature of light in the two-slit

interference characteristics of 18.84%. Moreover, the application of the concept of light to the characteristics of interference in daily life is 39.13%, the application of the concept of light on diffraction characteristics in the color spectrum is 40.58%, the characteristics of monochromatic light is 36.23%, the concept of interference characteristics in Young Experiment is 1.45%, the bending of light on the lattice and the order of the color spectrum in light of 34.78%, physical properties of light of 7.25%, properties of light as electromagnetic waves of 47.83%, characteristics of light as a wave of 20.29%, characteristics of monochromatic light on the concept of refraction of 26.09%, the properties of light as a wave in its application to the concept of interference characteristics by 27.54%, the physical properties of light in its application a daily life of 31.88%, the properties of light on the reflection concept of 5.80%, the characteristics of the light that shows the physical properties of light as much as 21.74%, the characteristics of light in the application of reflecting concepts of 34.78%, properties light properties in the application on a flat mirror of 17.39%, the properties of light in its application to a convex mirror of 20.29%, the properties of light in its application to a concave mirror of 40.58%, the properties of light in its application the concave lens is 21.74%, the light characteristics on the concept of total internal reflection is 20.29%, the characteristics of light in the prism is 33.33%, the characteristics of light in the planparalel glass are 27.54%, the characteristics of light in refraction events are 46 , 38%, the color spectrum of the prism of 24.64%, the characteristics of light on the prism color spectrum of 33.33%, the application of the refraction concept of 36.23%, the properties of light in optics at 17.39%, the characteristics of c the reflected light is 43.48%, and Snellius's Law's concept is 10.14%. In addition, there is one sub-subject of the concept of light which has absolutely no misconception on prospective teacher students, namely the sub-subject matter of the application of the concept of polychromatic light in the dispersion characteristics of 0%.

Misconception by some experts is defined in different terms. Some use the term misunderstanding, misinterpretation of fact, and naïve believe [29]. There are also those who use the terms alternative concepts and native conception [30], [31] and use the terms alternative frameworks, intuitive beliefs, and pre-conceptions. The number of terms used is due to the lack of definitions that can best represent in explaining related misconceptions. But there are at least a few points which are the meeting points of the differences in defining this term, namely that misconception is a natural phenomenon that occurs in almost every student where there are differences in students' ideas or understanding with the basic concepts of science.

In general, the misconception is defined as a difference in a concept or idea that is built by students' own way of thinking with the ideas of teachers and scientists working in understanding scientific concepts [32], [33]. In building their understanding of the concept of science, students sometimes only think simply while the concept of science that wants to be understood as far more complex characteristics. The misconception is also defined as an idea or understanding of a concept that is not based on a basic understanding of science. Misconception in the form of ideas that are not easily removed. He is resistant and needs serious effort to change it [34], [35].

Misconceptions are defined by some people as concepts or ideas that are different from current scientific thinking — every conceptual idea whose meaning deviates from what is commonly accepted by scientific consensus. Student conception produces a systematic pattern of errors. Students' conception is very different from their teacher "or scientist and is resistant to change even in the face of the most solid effort. They are not mistakes or wrong answers caused by lack of knowledge. All definitions of the term misunderstanding agree that students have the wrong ideas or beliefs about scientific concepts and such ideas or beliefs are often held firm, resistant to change, and inhibits further learning [36], [37].

Misconceptions have some of the same characteristics as the strength of misunderstandings embedded in students' cognitive structures, the concepts that are different from the concepts of experts. This misconception will affect how students understand natural phenomena and provide an explanation of the phenomenon, and the problem of misconceptions must be immediately overcome, avoided or eliminated to achieve an understanding of the concept that is appropriate or the same as understood by experts [38], [39].

Misconception as a misunderstanding of concepts caused by students' cognitive construction errors is one of the factors causing low learning achievement [40]. But if explored further, misconceptions can be caused by many things. Broadly speaking there are five groups of sources of misconceptions in students, namely (1) students, (2) teachers, (3) textbooks, (4) context, and (5) teaching methods.

Misconceptions sourced from students. The philosophy of constructivism states that knowledge is constructed by students themselves when dealing with the environment, challenges, and material learned. Because the students are constructing their own knowledge, it is possible that a construction error may occur because they do not have sufficient provisions related to the concept being constructed or do not have a scientific framework that can be used as a reference in constructing the right knowledge. Some things that can cause misconceptions that come from students include (1) preconception or initial concept of students; (2) associative thinking of students; (3) humanistic thinking; (4) incomplete reasoning; (5) wrong intuition; (6) stages of cognitive development of students; (7) student ability; and (8) interest in learning.

Misconceptions sourced from the teacher. Verbal communication that occurs when a teacher applies the lecture method in the learning process has a weakness that students cannot comprehensively capture the material presented by the teacher. This is because verbal communication has many weaknesses, including teacher perceptions with different students because each has a different world and language, different experiences and knowledge [41], [42]. The results of research conducted show that one of the causes of students is difficult to grasp the lesson, which is due to the language used by the teacher in teaching is confusing, so that students have difficulty connecting between the concepts they receive. It may be that students' cognitive constructs change [43]. Specific causes that might make students experience misconceptions originating from teachers are: (1) the teacher does not master the material / material well, intact, and correctly (does not have professional and pedagogical competence); (2) teachers are not undergraduate background in the field of science taught, for example, undergraduate

mathematics education but teach chemistry; (3) rarely do learning activities that provide opportunities for students to express ideas / ideas, so they cannot detect the occurrence of misconception early; and (4) teacher relations with students are not well established, so that when students experience difficulties in understanding a concept do not dare to ask.

Misconception Sourced from Textbooks. Textbooks are learning resources for students who are passive, meaning that students only communicate with the writings and pictures in the book and cannot ask directly if there are sentences that are unclear and not understood. All sentences in the book are tried to be understood by the students themselves, so sometimes the imposition of this understanding can result in misconceptions. Some studies show that there are misconceptions caused by textbooks read by students [44]. Research conducted shows students' misconceptions about electrochemical material caused by textbooks used in learning. Similar research was carried out by [45] which states that most of the misconceptions students have comes from the books used. The number of books that have inadequate representation in explaining a concept contributes to the emergence of misconceptions in students. Illustration of images included in the textbooks is possible for the emergence of misconceptions because images are concrete manifestations that are easily captured and understood by students. Therefore, an illustration of a concept is very important to be noticed by the teacher so that when found illustrations the wrong image can be straightened out immediately, so misconception can be avoided. According to Suparno [40], specific causes of misconceptions originating from textbooks include: (1) wrong explanation in the book; (2) writing errors that are not accompanied by errata (in chemistry formula writing errors are fatal); (3) language usage that is too high for the level of the intended student; (4) there are many students who read textbooks (not intact) so that they give a less correct / correct understanding; (5) giving illustrations taken in daily life that are not in accordance with the true meaning of the concept; and (6) use of cartoon images that often contain misconceptions.

Misconception Sourced from Context. The context of subject matter can be understood differently by students and teachers. This is due to differences in experience, knowledge, goals, needs, and motivation. Therefore, to understand students' difficulties, the teacher must first understand that the perceptions that students have are often not the same as the teacher's perception, because students have different worlds and languages. Some things that can cause misconceptions that come from context include (1) experience; (2) everyday language; (3) friends; and (4) religion.

The misconception is sourced from the Teaching Method. In particular the way teachers teach that is realized in the form of learning methods can lead to misconceptions if the teacher (1) only uses the lecture and writing methods without trying to find feedback mastered or the material presented before; (2) does not explain the decline of the formula from the initial concept, so that students only memorize and are not adaptive to the application of the formula in the calculation of various situations; (3) does not convey the occurrence of misconceptions experienced by some students, so that students who are not detected are likely to experience misconceptions; (4) does not provide final conclusions after applying the question and answer

method, discussion, or recitation (assignment); (5) giving the wrong analogy at the time of the lecture, (6) not testing the demonstration beforehand; and (7) does not explain the existence of symptom irregularities or chemical reactions.

Characteristics of the level developed by Küçüközer [46] about several categories that will be obtained through a coding system from several responses by classifying several categories and meanings at each level based on the students' physics teacher's reasoning displayed below this: A-Scientifically Correct: Scientifically correct and complete explanations; B- Partially Correct: Responses contain / involve truth, but the explanations are incomplete; C- Incorrect 1 (Error 1): Ideas contain partial truths, and incorrect sentences / statements are still contained in them. In general, statements in this group are considered incorrect; D- Incorrect 2 (Errors 2): Ideas related to the concept under study and explanations are too minimal, and the majority of answers are wrong; E-Incorrect 3: Ideas related to several concepts and parts of explanations of related concepts that are correlated; F- Uncodeable: It is a difficult explanation to understand what is stated indirectly or the answer has no relation to the question; G-No Explanation (No explanation): Respondents who did not make some explanations about the questions and wrote the same responses / answers.

IV. CONCLUSIONS

Based on the results and discussion that has been described, it can be concluded that pre-service teacher still has misconceptions about the concept of light in almost all sub-subjects about light. there are twenty-nine subtopics about light which are misconceptions. While the other one subtopics are a subtopic of the concept of light which is not understood by all pre-service teacher who is respondents. It is about The characteristics of light in the application are concave mirrors.

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