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Revealing Physical Education Students' Misconception in Sport Biomechanics Linear Motion

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***Abstract*— The aim of this research is reveal misconception in Sport Biomechanics Linear Motion. The Data of misconception collected by standard question of diagnostic test that given to students of Physical Education, Faculty of Sport Science, State University of Surabaya. The samples choose using simple random sampling method. Diagnostic Test completed with open reasoning and CRI (Certainty of Response Index). Students' answer combined with graph of CRI right, CRI wrong and right fraction in every single question to observe the exist of misconception than categorized into four quadrants, these: correct concepts, lucky guess, misconception, and lack of knowledge. Open reasoning of diagnostic test used to analyzed kind of misconception that arise in linear motion concept. The result of students' answer showed that kind of misconception arise in linear motion concept are differences distance and displacement, differences velocity and acceleration, and free fall motion. Results of t-test in diagnostic test categorize misconception showed that percentage of misconception arise is very high.**

Keywords*— *Misconception, Sport Biomechanics, Linear Motion

I. INTRODUCTION

Humans have a structure of knowledge in the brain like boxes containing meaningful information that is different [1]. Especially, students present at school with diverse experiences and ideas or thoughts on learning materials based on natural behavior everyday [2]. The breadth of the idea differs from the background of the student and is usually different from the ideas the scientist has. The differences in the frame of mind have been described as misconceptions [3], alternative conceptions [4], preconceptions [5], alternative thinking frameworks [6], false ideas [7], and children's science [8]. To simplify the discussion, we use the term "misconception" to express ideas or thoughts that students have that are inconsistent or conflict with the generalization of ideas received by scientists [9]. Misconception is an interpretation of concepts in an unacceptable statement [10]. Brown states that misconceptions are a false explanation and an idea that is inconsistent with the scientific understanding that experts accept [11].

Sport biomechanics is one of the study in sports education that emphasizes mechanical approaches in analyzing the movement of a professional athlete to get maximum movement. General understanding Biomechanics has been defined as the study of the movement of living things using the science of mechanics [12]. Some important mechanical concept approaches in sports biomechanics are the concept of friction, distance and displacement, speed and acceleration, and free fall motion. The wrong concept if owned by the student will lead to errors in the analysis of sports movement. Students in sports education majors are also prospective sports teachers, if the wrong concept is left then it is feared will be a source of new misconceptions in the future when working in the field of sport biomechanics.

Sport science undergraduate education, one of which purposes is to produce an analyst in sport [13]. However, generally misconception of Sport Biomechanics is still relatively very high [14]. The background of Sports Education students which 60% from high school with Social Sciences contributes to the maturity of biomechanics materials held by students. Many students' preconceptions are not appropriate and only on the wrong assumption. Here is the background of previous education from students majoring in Physical Education Department:

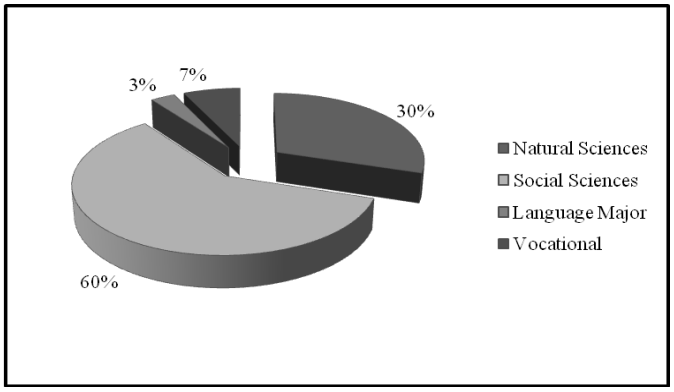

Fig. 1. Distribution of previous education background from sports education students.

Several previous studies relevant to this research include Suana [15] which concludes that as many as 36% of prospective students have mechanical misconceptions. Tunc found that as many as 301 prospective teachers from various universities in Turkey experienced misconceptions on some Mechanics topics [16]. Bayraktar also found that the misconception of a potential physics teacher in Turkey is very strong (high) against the material of force and motion [17].

Lawrenz found that only 50% of prospective teachers answered the 11 questions correctly of the 31 questions tested [18]. Finegold states that student misconceptions are very much present in the material of Force [19].

Based on the background, the researchers took the initiative to reveal misconceptions that emerged in the students of the Department of Sport Education on concepts of sports biomechanics linear motion.

II. MATERIALS AND METHODS

This research is a descriptive qualitative research. The sample chooses using simple random sampling method [20]. It's used 30 students Physical Education Department year 2017/2018 Faculty of Sport Science, State University of Surabaya. The instrument used is a multiple choice Diagnostic Test equipped with the reason for the answer and Certainty of Response Index (CRI) scale. The number of questions tested is 10 questions including the concept of linear motion. The question of diagnostic tests used is a matter of standard mechanics developed by Chee [21], Suana [15], and Blazevich [22] to determine the misconceptions used in CRI scales developed by Hassan [23] completed with open reason in order to understand students' answer [24]. The answers of diagnostic test are categorized in the following four quadrants: (1) Know the concept, if the answer is correct and the CRI scale is high (3, 4, or 5), (2) Lucky Guess, if the answer is correct and the CRI scale is low (0.1 , or (2), (3) Lack of Knowledge, if the answer is wrong and the CRI scale is low (0.1, or 2), (4) misconception, if the answer is wrong and CRI scale is high (3.4, or 5)[23].

The analytical data were obtained from the diagnostic test to produce Correct CRI chart and Wrong CRI along with correct fraction of student's answer. The CRI is correctly obtained based on the average CRI value for the correct answer, whereas CRI is incorrectly obtained based on the average CRI value for the wrong answer. Correct answer a fraction of total is obtained based on the results for students who correctly answer the total number of students. Analysis of Diagnostic Test answers followed by categorization of student answers based on 4 categories. Non-parametric statistical analysis of t-tests was then performed to determine the level of misconceptions in students [25]. The paired t-test is performed after the assumption of sample normality is met. The diagnostic test data of misconception category through t-tested to get general conclusion of misconception rate that happened to student above 50%. Each misconception is assigned a value of 1 and other than the misconception category is given a value of 0, so the high value indicates high misconception and otherwise.

III. RESULTS AND DISCUSSIONS

From the previous studies, Suana [15], Tunc [16], Bayraktar [17], Lawrenz [18] and Finegold [19] shown that misconception emerge in prospective student and several concept, not exception in Physical Education students. In order to decrease number of misconception, first find out the number of misconception and how far its level in every single concept of sport biomechanics Linear Motion.

A. Curiosity of Response Index (CRI)

The results of the diagnostic test which consists of 10 questions covering several concepts in sports biomechanics linear motion are expressed in graphical form between correct CRI, wrong CRI, and correct answer fraction of total student obtained as follow:

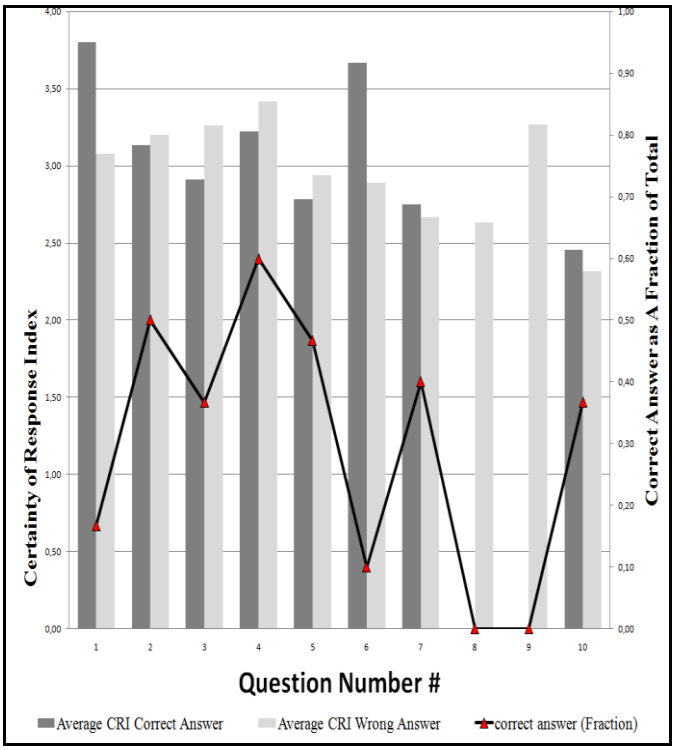

Fig. 2. Chart based on the results of 30 physical education students who took the diagnostic test. the bar graph shows the values of the average CRI for correct and wrong answers, for each question. Question numbers are shown on the horizontal axis.

Based on Figure 2, the CRI chart is correct, CRI is wrong, and the Correct Answer Fraction of Total shows that in the case of numbers 1 to 6 CRI is very high with a low true fraction (the number of students is very high) indicates that there are many misconceptions which occurred in the span of the problem. In problem 7 (the question of distance and displacement) and 8 (the question of speed and acceleration) shows the same thing that is wrong CRI is high and the true fraction is low even the absolute number 8 all students answer the wrong answer, it shows the existence of misconception on college student. In the case of numbers 9 and 10 (the question of free fall motion) also shows the existence of misconceptions even in question number 9, all students absolutely answer the wrong answer.

Based on the mapping of diagnostic test results 30 students also found the category in 4 quadrants with category of misconceptions, correct concepts, lucky guess, and lack of knowledge as follow:

TABLE I. RESULT DIAGNOSTIC TEST CATEGORIZED IN 4 CATEGORY

Categorize	Question Number									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
misconception	20	14	17	11	11	22	11	17	25	7
correct concept	5	13	8	15	11	3	5	0	0	6
lucky guess	0	2	3	3	3	0	7	0	0	5
lack of knowledge	5	1	2	1	5	5	7	13	5	12

Based on the distribution of data in Table I it can be seen that the category of misconception are dominant in every aspect of test diagnostic tested. From data, the largest misconceptions students found in questions 1, 6, and 9 each more than equal to 20 students. The least number of misconceptions is found in question number 10 is 7 students.

B. *Analysis of Students' Open Reasons*

Students' answer completed with open reasons to understand way of thinking in every part of concept [24]. From this open reasons, researcher analyzed and took several misconception of linear motion that occurred.

1) *Distinguish Acceleration and Velocity*

First misconceptions arises about acceleration and velocity concept. It is analyzed from question number 7 of diagnostic test with screenshot as follow:

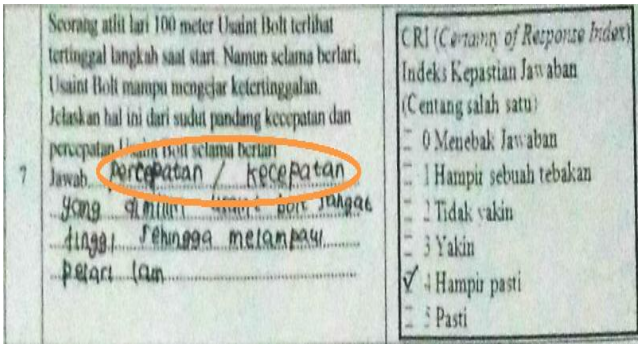

Fig. 3. Sample of student' answer question #7.

Based from Figure 3, student thinking that acceleration and velocity are same concept. Student couldn't distinguish both concepts. It is strengthened with high level number of CRI in that question. The conclusion that student couldn't distinguish both concepts also showed in figure 4 as follow:

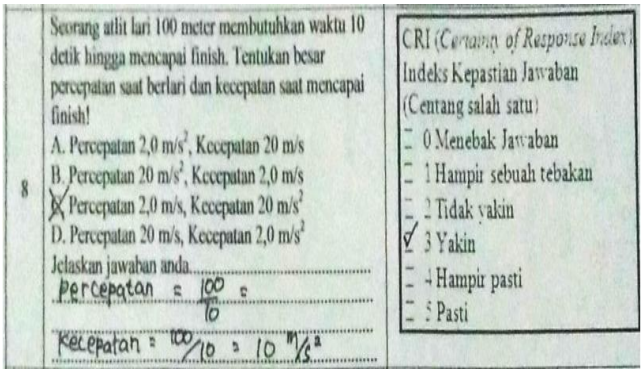

Fig. 4. Sample of student' answer question #8.

2) *Distinguish Distance and Displacement*

Second misconception arises about distance and displacement concept. It is analyzed from question number 10 of diagnostic test with screenshot as follow:

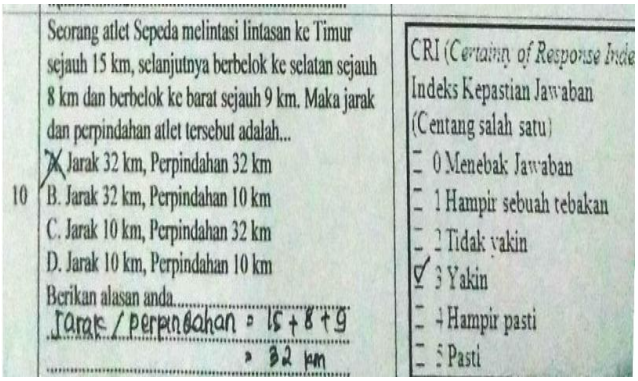

Fig. 5. Sample of student' answer question #10.

Student couldn't distinguished between both concept distance and displacement. Student considered that both of them is same concept. It is strengthened with high level number of CRI in that question number 10 in figure 5.

3) *Free Fall Motion*

Third misconception arises about free fall motion concept. It is analyzed from question number 9 of diagnostic test with screenshot as follow:

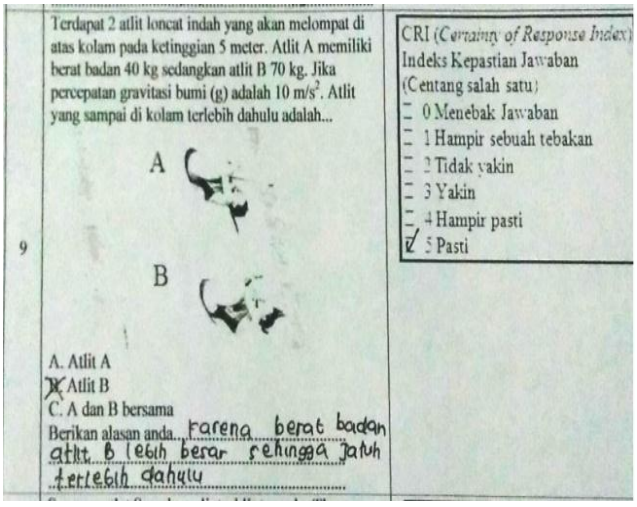

Fig. 6. Sample of student' answer question #9.

Based on the sample answer Figure 6, it could analyzed that student considered something bigger would falling down the stair first. The fact, in case of free fall motion quantity of mass doesn't influence time to fall [11].

Based on data spread of student misconception could be determined the percentage of 3 misconceptions that occurred in Linear Motion concept as follow:

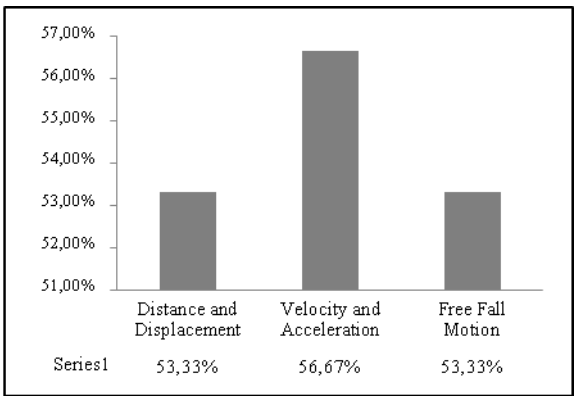

Fig. 7. Graph of percentage misconceptions in linear motion concept

Based on figure 7 it can be seen that there are quite high misconceptions in every category of sports biomechanics concepts tested. The highest misconception occurred on the concept of distance and displacement 53.33%, velocity and acceleration of 56.67% and followed by consecutive free fall motion concept of 53.33%. Generally, the percentage of misconceptions high enough indicates that there is still need for further individual improvement to overcome or reduce the misconceptions that occur in the students of sports teacher candidates in the field of sports biomechanics, especially linear motion concept.

Furthermore, based on the results of diagnostic tests mapped also misconceptions of each individual and then tested statistically parametric extent of the misconception that occurred in the classroom.

TABLE II. DISTRIBUTION MISCONCEPTIONS IN EACH STUDENT

Name	Misconceptions	Name	Misconceptions
A	5	P	7
B	6	Q	3
C	5	R	5
D	7	S	5
E	7	T	4
F	2	U	3
G	0	V	4
H	5	W	10
I	3	X	5
J	8	Y	5
K	6	Z	6
L	5	AA	7
M	4	AB	2
N	8	AC	7
O	8	AD	3

After passing the normality test and the data stated Normal then subsequent data based on the spread of misconception in each individual hypothesis test and obtained data t_{count} 0,042 $<t_{table}$ 1.699 so H_0 accepted that misconception that occurs in each student is above 50%.

Based on Figure 2 and Table 1, indicate that misconception arise in sport Biomechanics concept especially in linear motion. It's highly relevant to some of previous studies Suana [15], Tunc [16], Bayraktar [17], Lawrenz [18] and Finegold [19] also Kartiko [14]. In the study generally address the misconceptions that appear in each individual prospective teacher in their respective fields. The kind of misconception arise in linear motion concept based on Figure 3 until Figure 6 as evidences qualitatively that student of physical education cannot distinguish velocity and acceleration and consider both of them are same, distance and displacement, and the last considered that something bigger mass will be arrive first in free fall motion. By the emergence of misconceptions it is expected that there is a grand formulation of instructional design in sports majors, especially the right sport biomechanics course to reduce the consistency of misconception in order to produce an analyst in sport especially using sport biomechanics.

IV. CONCLUSIONS

Based on the results of the Diagnostic Test of Sport Biomechanics Linear Motion, the conclusion of misconceptions occurred in Physical Education Student with the percentage of distinguish concept distance and displacement 53.33%; distinguish concept of velocity and acceleration 56.67%; and the concept of free fall motion 53.33%. T-Test Result on Diagnostic Test of percentage of misconception category shows the percentage of misconception that happened in every student above 50%.

Subsequent research of these findings is expected to develop appropriate methods or models including grand formulation of instructional design to reduce misconceptions that appear in Physical Education students or at least analyze the determinants of the emergence of misconception in order to decrease the misconception in Sport Biomechanics.

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