

# Analysis of students critical thinking skills in junior high school on natural sciences based on the difference of learning styles

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**Abstract.** Natural Science is a learning related to everything around us. One of the subject matter in natural science is the motion system that often occurs in daily life. However, some of the students have misconceptions about the motion system. It required the critical thinking skills of the students in understanding the concept to resolve a problem in society. Critical thinking skills is one of the skills that must be possessed by students because of the demands in the 2013 curriculum. Critical thinking skills can be influenced by several factors, one of them is students' learning style. This study aimed to analyze the critical thinking skills of junior high school on natural sciences based on the differences in learning styles. This study took sample of students in the first, second and third grade of junior high school. In this research, the researcher uses descriptive method. To analyze the data, the researcher used mix methods (qualitative and quantitative). The technique of collecting data uses observation and tests. Observation is used to find out the types of the students' learning styles, while tests to measure student's critical thinking skills. The results showed that there were verbal-linguistic learning style (73.0%), logic-mathematic (67.6%), kinesthetic (60.0%), visual-spatial (60.2%), music (62.0%), and interpersonal (61.1%). So, the verbal-linguistic learning style was better than critical thinking skills.

## 1. Introduction

Natural Sciences is learning related to everything in nature. Natural Sciences is the branch of science for some field of knowledge such as biology, the physics, of chemical science, the science of geology, the science of astronomy and others [1]. One of the sciences that studies about life and organisms including the structure, function, growth, evolution, distribution, and taxonomy is the science of biology [2]. The motion system is one of the chapters in the study of biology in junior high school. In the motion system sub-chapter there are structures, functions and mechanisms in moving [3]. In addition, there is also a count in determining the movement of an object. Based on sub-chapters that students must understand, to make it easier for students the teacher can provide a problem that often occurs in daily life. So students can analyze problems and find solutions or answers to these problems.

Activities done by these students require to be able critical thinking. This is appropriate with the assessment in the 2013 Curriculum which is closely related to critical thinking skills [4]. Critical thinking is the way of thinking about any subject, content or problem where thinkers improve the quality of their thinking by skillfully taking more than the structure inherent in thought and imposing intellectual standards in themselves [5]. Through critical thinking, students can learn to be more critical in examining perspectives on issues about the impact of science and technology in daily life, and evaluating these to get solutions or solve problems [6]. Critical thinking also allows the students to study problems systematically, deal with many obstacles in an organized manner, formulate innovative questions, and design appropriate solutions to the problems faced [7]. Besides that critical



thinking is one of the skills needed in 21st century learning [8]. Students' critical thinking skills will appear when the teacher applies the problem-based learning, and the problem-based assessment using essay tests was used to measure them.

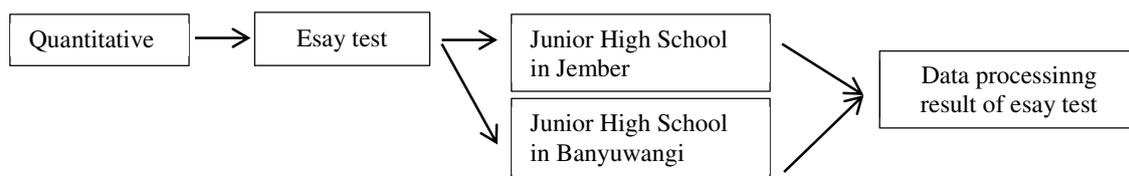
Essay tests can be used as an assessment to measure critical thinking skills [9]. Using essay tests, students can write the solutions or results of the problem solve based on the cognitive abilities of the students to synthesize knowledge, explore relationships and describe the information that students have gotten [10]. The use of essay tests will practice the students' thinking skills by requiring students to write down ideas what they are thinking about [11]. An essay test is used to assess students' critical thinking levels which are adjusted to the indicators of critical thinking based on Ennis. There are 12 indicators of critical thinking skills, namely formulating questions, analyzing arguments, asking and answering questions, assessing credibility resources consider membership, observing and assessing reports the results of observations, making deduction and assessing deduction, making induction and assessing the induction, evaluating, defining and assessing the definition, identifying assumptions, guessing, and integrating [12].

Students' critical thinking skills are different to one another, this can be influenced by several factors, and one of them is students' difference learning styles [13]. Learning style is a characteristic style of someone in obtaining, using information in learning and solving problems [14]. According to [27], learning styles are divided into 9 namely (1) verbal-linguistic, (2) logical-mathematical, (3) bodily-kinesthetic, (4) visual-spatial, (5) musical, (6) intrapersonal, (7) interpersonal, (8) natural, and (9) existence [15].

Verbal linguistic learning styles are learning styles with words, both written and oral along with the rules. Logical-mathematics is intelligence in the use of numbers, causal relations, and problem-solving. Body-kinesthetic is a learning style with body movements. Visual-spatial is a learning style with the ability to accurately capture color, direction, and space and transform catches into other forms such as decoration, architecture, painting, sculpture. The musical is a learning style with the ability to capture sound, distinguish, change, and express yourself through sound. Intrapersonal is a learning style with the ability to understand oneself and responsibilities in one's own life. Interpersonal is a style of learning by understanding and working with others. Natural intelligence to recognize, distinguish, classify, and make categories from what is found in nature and the environment. Existence relates to someone to put themselves in range

## 2. Method

The type of research was a descriptive research. To collect the data, the researcher did test and observation. The test was used to measure critical thinking skills and observation was done to determine the learning styles. This research was conducted in junior high schools in the semester II of academic years 2018/ 2019. The sample was 123 students on 8 SMP. The research did in 2 junior high schools in different districts. The aim was to determine differences of the critical thinking's level between the 2 districts. Analyzing the data used a mix of methods (qualitative and quantitative). Quantitative data are generated from tests of critical thinking skills that are presented based on the results of scoring rubrics of the Finken & Ennis assessment with different learning styles. The qualitative data generated the form of descriptive high, medium and low level critical thinking skills. In addition, a difference test used SPSS is the T test. In this study, quantitative and qualitative methods are carried out and that can be seen in Figure 1 and Figure 2 modification from [16].



**Figure 1.** The Quantitative Method

Based on Figure 1. The quantitative method is carried out at different districts with essay test. The researcher took 2 districts to find out the differences on students' critical thinking skills.

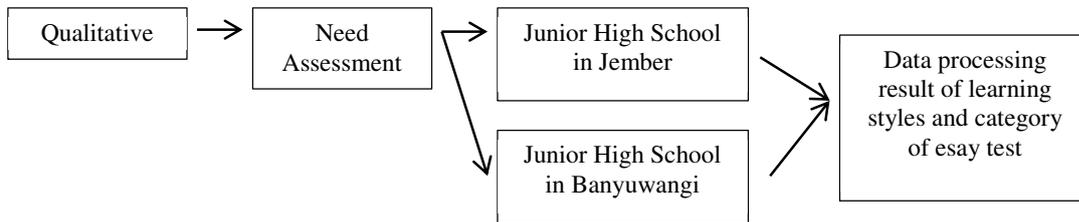


Figure 2. The Qualitative Method

Based on Figure2. The qualitative method result consists of essay test and learning styles. The essay will be categorized as low, medium or high category. Then, the learning styles are used as a cause of students' level of critical thinking skills.

The subject matter used for the critical thinking essay test is the Chapter of the motion system. There are 5 indicators used to make an essay test in accordance with critical thinking indicators according to Ennis, namely (1) analyzing arguments, (2) integrating, (3) observation & assessing reports the results of observation, (4) guessing, and (5) evaluating. This research took 5 indicators from 12 indicators was adjusted to the purpose of the research. Essay test results will be assessed using scoring instructions according to Finken and Ennis [17]. The scoring instructs function to determine students' critical thinking and writing skills. The scoring guide consists of 6 components, namely (1) focus, (2) supporting reason, (3) reason, (4) organization, (5) conventions, and (6) integration. In this research only used 4 components that were adjusted to the purpose of the study and the desired data. There were 5 questions about the concept of the motion system. The scoring rubric for critical thinking essay tests can be seen in Table 1.

Table 1. The scoring rubric of critical thinking for minimal structures according to Finken & Ennis (1993)

Component	Score					
Focus	1	2	3	4	5	6
Degree to which main idea/ theme or point of view is clear and maintained	Unclear; absent; insufficient length to ascertain maintenance	Confusing; attempted; main point of shifts	Underpromise, overdeliver; overpromise; underdeliver; infer; two/+ positions w/o unifying statement	Bare bones; position clear; main point previewed	Position clear; generally previewed	All main points are specified and maintained
Reason	1	2	3	4	5	6
Degree to which conclusion supported by reason / evidence; alternatives addressed; and argument clear	Conclusions unsupported; no reasoning attempted; insufficient	Conclusions minimally supported; alternatives unmentioned; muddled confused	Some insufficient support; alternative prejudicially mentioned, key terms undefined	Moderate support; alternatives mentioned fairly; some vagueness	Conclusions well supported; alternatives well recognized; clear	Strong support; alternatives thoroughly addressed; clear
Organization	1	2	3	4	5	6
Degree to which logical flow of ideas and exploitiveness of the plan are clear and connected	No plan; insufficient length to ascertain maintenance	Attempted; plan is noticeable	Not knowledgeable in paragraphing	Some cohesion and coherence from relating to topic; plan is clear	Most point connected; coherent; cohesive, using various methods	All points connected, signaled with transitions/ other cohesive devices
Integration	1	2	3	4	5	6
	Doesn't present most	Attempts to address	Partly developed;	Essentials present	Features present, but	All features

featurest; in suff, length	assignment; conclusion	one / > features not developed	not all equal	evident and aqually well developed
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Scoring results based on the critical thinking rubric according to Finken and Ennis are further grouped based on the same learning style. Then determine the average value for each learning style using the following formula:

$$X = \frac{\sum n}{N}$$

Descriptions:

- X : Average
- $\sum n$  : Score obtained
- N : Total Score

Then, the average results of each learning style is converted into percentages using the following formula.

$$\% = \frac{\sum n}{N} \times 100\%$$

Descriptions:

- % : Percentage
- $\sum n$  : Score obtained
- N : Total Score

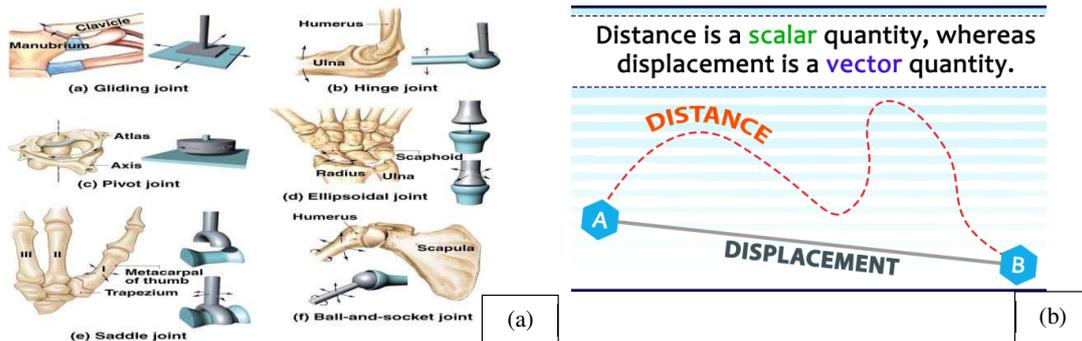
The percentage results of each learning style are categorized based on the Mardapin categorization in Table 2. [18]

**Table 2** Tabel of critical thinking skills categories

No.	Percentage	Categories
1	Score $\geq 73\%$	High
2	$73\% < \text{Score} \leq 47\%$	Medium
3	Score $< 47\%$	Low

**3. Result**

The following description of the motion system that students learn is presented in Figure 3 below.



**Figure 3.** The motion system (a) types of joints, (b) distance and displacement (Source: ScienceStruck.com)

The scores of students' answers for each indicator of critical thinking skills are presented in Table 3

**Table 3.** Percentage of student answers for each indicators

Indicator	The result of percentage	Categories
Analyzing argument	86,0%	High
Integrating	46,7%	Low
Observation & assessing reports the result of observations	55,6%	Medium
Guessing	72,9%	Medium
Evaluating	74,7%	High

The following answers to students in the low category of integrate in Figure 4.

2. Fahmi is a very active child. He likes running everywhere without tireless. If he runs to the east over 100 m, then turn to the south over 40 m, and go back to the west over 101 m. Fahmi's movement can have a movement, so how much Fahmi's movement?

Answer:  $\sqrt{101} + \sqrt{100} + \sqrt{40}$   
 $= \sqrt{2191}$   
 $= 13398$

Figure 4. Student answer in the low category of integrate

The following answers to students in the high category in Figure 5.

2. Fahmi is a very active child. He likes running everywhere without tireless. If he runs to the east over 100 m, then turn to the south over 40 m, and go back to the west over 101 m. Fahmi's movement can have a movement, so how much Fahmi's movement?

Answer:  $c^2 = a^2 + b^2$   
 $= 1^2 + 40^2$   
 $= 1 + 1600$   
 $c = \sqrt{1601} \text{ m}$

3. Based on the second question, why do you choose the procedure of answering the question using that kind of formula? Explain!

Answer: because the movement is a short distance between the first place and the last place. The experiment above number of movement is taken from the size of line that relates with the first and the last place.

5. Ica always wakes up in the morning to take a walk with her grandfather. Morning mood in the village is very pleasant, the cool air and the expanse of green rice field. The activities of ica's and his grandfather, what joints are used? Explain!

Answer: The motions of the joints of the hinge between the thigh bone and the bones of the lower limb, the joint of the saddle on the bone of the thumb, the joints of the bullet on the thigh bone and the pelvis, sliding joints in the spine, joints when running and at the sight of the expanse of rice fields using rotary joint.

Figure 5. Student answer in the high category of critical thinking

Based on observations from 123 students, the percentage of students based on student learning styles is presented in Figure 6 below.

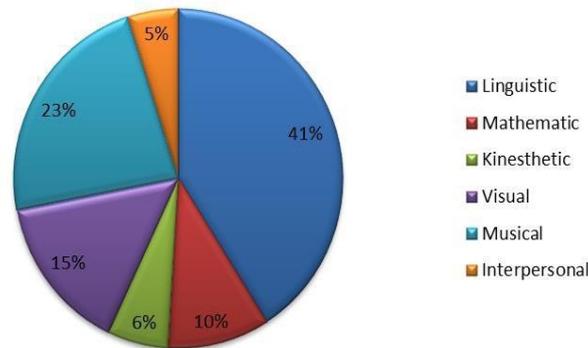


Figure 6. Percentage of students based on differences in learning styles

The following percentage of students' critical thinking skills based on differences in learning styles is presented in Figure 7.

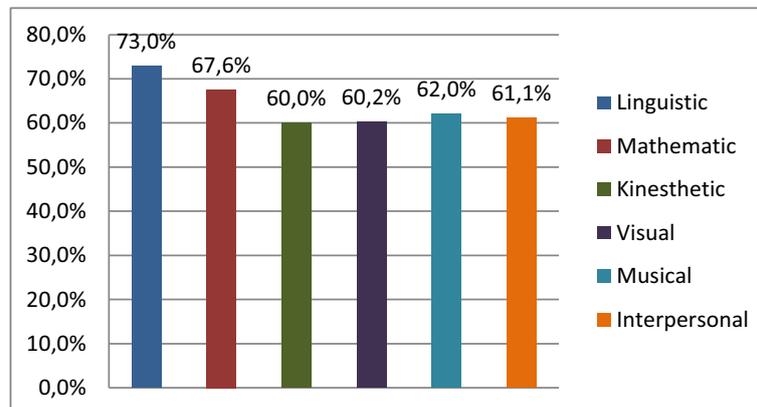


Figure 7. Percentage of Critical Thinking Skills Based on Differences in Student Learning Styles

The results of data analysis using the T-test are presented in Table 4.

Table 4 T-test  
Paired Samples Test

	Paired Differences	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Jmbr - BWI	9,984	20,512	2,605	4,775	15,193	3,833	61	,000

4. Discussion

4.1. Analysis of each indicator of critical thinking skills

The subject matter used on the essay test sheet is the motion system. This is because motion material often occurs in daily life, but students still often experience misunderstandings and difficulties in understanding the material of the motion system [19]. Material motion system has the characteristics of conceptual analysis that is associated with phenomena in daily life [20]. So students are required to be able to analyze and solve problems that occur. For this reason students must have critical thinking skills in solving these problems.

According to Figure 1., (a) shows the type of joints that exist in the human body. With this picture, students will be able to answer problems in essay tests related to daily life. If in the learning process, students are able to understand the concept of the function and location of joints in the human body, so when there are problems students will be able to answer tests easily. Figure 1. (b) shows the calculated formula to find out the distance and displacement. Distance is total of the track traveled,

while displacement is the resultant from the initial position to the final position. The difference lies in the direction, if the distance does not depend on the direction of motion objects, while the displacement is influenced by the direction of motion objects. From these two pictures, of course students must be able to master the concepts given. And to answer essay tests correctly requires the ability to critical thinking of the students, so can be provide answers that correspond to the questions asked.

Critical thinking skills in solving problems about motion systems are by identifying problems and determining information on problem situations, analyzing problems, providing strategies to solve problems and evaluating [21]. The scores of students' answers for each indicator of critical thinking skills are presented in Table 3. Table 3. Shows that the percentage of students' critical thinking skills for indicators integrate in the low category (47%). This indicator tend to the ability to take and make decisions in mathematics. Mathematics is closely related to calculations and formulas. In this case, students not only memorizing concepts and formulas but also solving the problems that they must understand to find solutions of those problems [22]. In this case, students don't answer or answer the questions but the answers do not match to the questions. The following answers to students in Figure 2.

Figure 2. Shows that the answers of students do not understand the concept of displacement in the motion system, so students cannot determine the magnitude of the displacement that occurs. Lack of student understanding due to student misunderstanding between distance and displacement. The matter of desired answer is displacement, so the direction of motion of an object / person influence the outcome [23]. From the answers, students have devised a strategy in solving the problem by drawing in the direction that described in the problem. So that the observing and assessing the results based on observations included in the medium category that is 55.6%. In addition, students can also make hypothesis or estimate to solve the problems which certainly based on the concepts and facts, so that the guessing indicator is (72.9%) in the medium category. For the analyzing argument category (86.0%) and evaluating (74.7%) are in the high category. This can be seen from the students' answers in Figure 3.

According to Figure 3., the students can use analyze the problem well and use a solution to the strategy using the Pythagoras formula, and provide arguments inappropriate with the correct concept. Question 5 shows that students are also able to analyze problems correctly and use logic and facts to solve the problems. If students are able to answer correctly, then the concepts that the teacher gives by practicing or showing pictures according to the location of the joints, with any problem students will be able to answer according to the concepts they have obtained.

#### 4.2. Analysis of critical thinking skills based on learning styles

The students' level understanding is different from one to another, one of the factors that influence student is learning styles. Students have different characteristics learning style. Learning style is one of the factors that determine the level of critical thinking skills of students [24]. If the learning style used by the teacher, it will not match the learning style of the student. And then, there are many possibility of students that are not able to understand the material that the teacher conveys. So that some students will have difficulty in determining the concepts that must be used to overcome the problem given. The student learning styles are divided into 9 according to Gardener, namely (1) verbal-linguistic, (2) logical-mathematical, (3) bodily-kinesthetic, (4) visual-spatial, (5) musical, (6) intrapersonal, (7) interpersonal, (8) natural, and (9) existence. Learning styles obtained after observing, there are 6 from 9 learning styles who described by Gardner (1983). The learning styles are (1) verbal-linguistic, (2) logical-mathematical, (3) bodily-kinesthetic, (4) visual-spatial, (5) musical, and (6) interpersonal. Based on observations from 123 students, the percentage of students based on student learning styles is presented in Figure 4.

Figure 4. Shows that 41% of students have verbal-linguistic learning styles, 10% of students have logical-mathematical learning styles, 6% of students have kinesthetic learning styles, 15% of students have visual-spatial learning styles, 23% of students have musical learning styles, and 5% of students have interpersonal learning styles. The different learning styles between students will also affect the level of critical thinking skills of students. The following percentage of students' critical thinking skills based on differences in learning styles is presented in Figure 5.

Figure 5. shows that the verbal-linguistic learning style gets better results than other learning styles that is equal to 73.0%. This result is included in the high category, while other learning styles are included in the medium category.

#### 4.2.1. Verbal linguistic

Verbal linguistic is included in high category. This is because in verbal linguistic learning styles students tend to like to read, write and tell stories. The perseverance in reading will expand student knowledge and can strengthen the concepts that the students get. The other thing that causes verbal linguistic learning style is able to show a high level of critical thinking ability, namely learning style that the area of the brain that is used in the left temporal lobe and frontal lobe. The frontal lobe is closely related in students' creativity to solve problems [25]. So students will be able to think of a high level to solve problems with the type HOT (High Order Thinking). Critical and creative thinking skills in students are interrelated to find solutions to the problems that they face latter [26].

#### 4.2.2. Logical-mathematic

Logical-mathematic learning styles is (67.6%) that included in the medium category, it is because students tend to feel difficulty when they are looking at numbers, and they must analyze numbers to solve a problem. Logical-mathematical learning styles possesses sensitivity in understanding logical or numerical patterns and the ability to process long lines of thought in solving problems. Areas of the brain used in this learning style are the left frontal lobe and the right parietal lobe [27].

#### 4.2.3. Kinesthetic

Kinesthetic learning styles is (60.0%) that included in the medium category. This learning style is related to the ability of body movements to express ideas and feelings. In the process of learning to understand concepts, students tend to more quickly understand if the material presented is done directly or by practical methods. This intelligence resides in the cerebellum, basal ganglia, cortex in both hemispheres. If related to the results, the acquisition in the medium category is in accordance with the facts, because in some sub-systems the motion system can be done by practicing and touching limbs or practicing various joints in the body.

#### 4.2.4. Visual-spatial

Visual-spatial learning styles is (60.2%) that included in the medium category. This learning style is closely related to art such as the ability to capture color, direction and space accurately and change the capture into other forms such as decoration, architecture, and painting and sculpture [28]. If it is associated with motion material, this learning style will support the development of students' critical thinking. The motion system will be a lot of pictures such as illustrations from the complete skeletal system, joint shape and color difference between joints and bones. By looking the images, students will be able to imagine things and come up with ideas visually and spatially. The area of the brain used in the visual-spatial learning style is the back of the right hemisphere, the occipital lobe, and the posterior part of the right hemisphere. If this related to the results, this moderates gain that is consistent with the fact that in the material of the motion system there are images that will be easily remembered by the occipital lobes through vision. So that, this learning style will be able to deviate the concept in accordant based on what they see.

#### 4.2.5. Music

Music learning style is (62.0%) that included in the medium category. This learning style is closely related to students' listening abilities. Students with this learning style will tend to quickly understand if listening to an explanation from someone or the teacher. The area of the brain in this learning style is the right temporal lobe. This lobe functions as a memory or memory and hearing, so students will easily remember something through listening [29]. But if the atmosphere of learning or in the process of understanding the concept is not conducive or noisy and noisy atmosphere. Then it will affect students with music learning styles. Students with this learning style emphasize the process of hearing, so that with noise that will make the concentration of students become divided. And understanding the concepts obtained is less than the maximum.

#### 4.2.6 Interpersonal

Interpersonal learning style is (61.1%) that included in the medium category. This learning style tends to students who are actively socializing. Students will understand quickly the concept if it is given a task or problem that must be solved by group discussion. The areas of the brain in this learning style are in the frontal lobe, temporal lobe, right hemisphere and limbic system. If it related to the results, it is in accordance with the fact that this learning style will be easy to remember and understand the concept because the frontal lobe is closely related to one's cognitive and this lobe

serves to store students' memories, as well as bring up students' critical thinking skills in solving problems [30]. Based on the results of the analyze, it can be seen that the verbal-linguistic learning style is better than other learning styles.

#### 4.3. Analysis of critical thinking skills based on differences of district

The data collection was carried out on 2 junior high schools with different districts, namely Jember regency and Banyuwangi regency. The scoring data of each student based on the regency was analyzed using the T-test to determine differences in the level of students' critical thinking. The results of data analysis using the T-test are presented in Table 4. In Table 1.4 it can be seen that the critical thinking skills of Jember and Banyuwangi districts differ significantly ( $p = 0,000$ ) with the average difference of 9.984 with the results of critical thinking skills in Jember Regency higher than the results of critical thinking skills in Banyuwangi. One reason for this difference is that the facilities at each school are different.

### 5. Conclusion

The conclusion based on the results and discussion found that students' critical thinking skills in solving motion system problems are included in the moderate category. The percentage of critical thinking skills for indicators analyzing the argument (86.0%), integrating (26.7%), observing & assessing reports the results of observations (55.6%), guessing (72.9%), and evaluating (74.7%). The different levels of students' critical thinking skills in solving problems are caused by the students' different learning styles. Percentage of indicator's critical thinking skills of students with verbal-linguistic learning styles (73.0%), logic-mathematic (67.6%), kinesthetic (60.0%), visual- spatial (60.2%), music (62, 0%), and interpersonal (61.1%). From these results it can be seen that the verbal-linguistic learning style is a better learning style compared to other learning styles. The achievement of students' critical thinking skills of two districts also showed a significant difference ( $p = 0,000$ ) with the results of the critical thinking skills of students in Jember Regency higher than students in Banyuwangi District.

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