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Description of Students' Critical Thinking Skills in Integrated PjBL STEM Learning Environmental Change Material

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Abstract

Critical thinking skills are important skills in the 21st century, therefore their attainment needs to be measured to determine future steps in the learning process so that they can be improved. This study aims to describe the critical thinking skills of students after learning with Project Based Learning (PjBL) integrated Science, Technology, Engineering and Mathematic (STEM). This research was conducted with a mix-method approach and a concurrent triangulation strategy. Data collection uses test essay to measure aspects of critical thinking skills including aspects of elementary clarification, basic support, inference, advanced clarification, and aspect strategy and tactics. Furthermore, the results were analyzed by descriptive analysis. The results showed that the achievement of each aspect of critical thinking skills showed variations. The aspect of elementary clarification score 71.01 in high category, basic support score 72.54 in high category, the inference score 74.65 in high category, advanced clarification score 58.49 in moderate category, and the aspect of strategy and tactics scored 82.83 in very high category. These results indicate the average critical thinking skills of students in PjBL STEM learning environmental change material on high category.

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INTRODUCTION

One of competency that always known as 21st century competence is critical thinking skills. Critical thinking skills includes the ability to access, analyze, and synthesize information that can learned, trained and mastered (Redecker et al., 2011). Critical thinking skills can becomes provision valuable face technological and information developments so rapidly.

According to Ennis (1985), critical thinking is think reasonably and reflectively with emphasizes on making decisions about what to believe or do. Besides, Facione & Facione (2013) stated that critical thinking as deep self-regulation decide something that results interpretation, analysis, evaluation, and inference, as well as presentation using evidence, concept, methodology, criteria, or consideration contextual on which to make it decision. It can be concluded critical thinking skills are the process of observing, analyze and evaluate obtained information to make a decision.

Ennis (1985) classifies indicators of critical thinking skills into the top five activites. These activities are in practice can unite to form an activity or broken down into several indicators. Aspects and indicators of critical thinking skills can be seen in Table 1.

Tabel 1. Aspects and Indicators of Critical Thinking Skills

Aspect	Indicator
Elementary Clarification	Focusing on a question
	Analyzing arguments
	Asking and answering question of crarification
Basic Support	Judging credibility of a source
	Observing and judging observation report
Inference	Deducing and judging deductions
	Inducing and judging inductions
	Making and judging value judgments
Adavanced Clarification	Defining terms and judging definitions three dimentions
	Identifying assumptions
Strategy and Tactics	Deciding on an actions
	Interacting with others

Study result of PISA (the Program for International Student Assessment) in 2018 shows the level of scientific skills of Indonesian students at a score of 396 are at ranked 70 out of 78 countries tested (OECD, 2019). PISA categorizes science skills of students in Indonesia at level 1a where students are described only can identify a simple explanation of scientific phenomena. The questions are contained in PISA in the form of questions with high levels thinking that requires not only the ability to memorize, but also requires critical thinking skills. The low PISA results are indicative that critical thinking skills of students in Indonesia is still low.

Learning in schools is expect to improve students' critical thinking skills. The learning model could used to develop critical thinking skills of students is Project Based Learning (PjBL). Short et al. (2008) stated project-based learning has some deep fundamental features the learning process includes several stages starting from the stage of asking, appreciating, analyze, associate and conclude. Furthermore, Rosiyanah et al. (2019), and Sularmi et al. (2018) in his research reveal the Project Based Learning model can improve critical thinking skills.

Apart from using the PjBL model, current learning needs to integrate Science, Technology, Engineering, and Mathematics (STEM) following the times in the globalization era. The relationship between science and technology or other cannot separated in science learning. Breiner et al. (2012) explained that the STEM integration approach is an approach combines all the STEM fields in one teaching subject. STEM integration learning is expect to produce meaningful learning for students through the integration of knowledge, concepts, and skills systematically.

The combination of PjBL STEM can make the better learning. Research result of Tseng et al. (2013) revealed that PjBL STEM could increase students' learning interest, learning becomes more meaningful, help students in solve problems in real life, and support future careers. Use of the PjBL model with STEM also can improve students' critical thinking skills (Furi et al., 2018; Mutakinati et al., 2018; Sumardiana, 2019; Triana et al., 2020).

Based on field observations, critical thinking skills never been measured specifically. The teacher does not know much about the critical thinking skills profile of students. According to York et al. (2015), critical thinking skills need to be measured

because it is an essential skill that can be used as an indicator success learn. Condition level critical thinking skills of students actually need to be known so it can be develop and increased. Research it aims to find an overview the profile critical thinking skills of students on PjBL STEM learning environmental change material.

METHODS

The research was conducted at MA Tahfizhul Qur'an As Surkati Salatiga on the Environmental changes material. The research was carried out with a mix method approach and concurrent triangulation strategy. Research design used is one group postest only design. The study population was all students of class X MA Tahfizhul Qur'an As Surkatiga Salatiga year 2019/2020 lessons. Samples were taken with saturated sample technique where all the members population as the research sample. There is two classes to be examined in this study.

Data was collected by an essay test. Test which was used consists of 20 items refers to the aspects and indicators of critical thinking skills according to Ennis (1985) as well refers to environmental change material. The test was used has been tested the validity and reliability to be used as a measuring tool.

The collected data was analysed statistically with concurrent triangulation strategy to know the description. The research data were processed using the percentage formula and so on conducted interpretation of critical thinking skills (CTS) all students by category interpretation of the score (very high, high, moderate, bad, and very bad) (Riduwan, 2013: 41).

Table 2. Category Score Percentage of Students' Critical Thinking Skills

Score Percentage (%)	Category
80 < CTS ≤ 100	Very High
60 < CTS ≤ 80	High
40 < CTS ≤ 60	Moderate
20 < CTS ≤ 40	Bad
0 < CTS ≤ 20	Very Bad

RESULTS AND DISCUSSION

The research results shows the average students' critical thinking skills get a score 71.91. Students' critical thinking skills that learning with the PjBL STEM model indicates the high category. The whole students already have the good critical thinking skills. Next, the spread of students' level critical thinking skill category can be seen in Table 3.

Table 3. Distribution of Students' Level Critical Thinking Skills Categories

Categories Students' Critical Thinking Skills	Amount Students	Percentage (%)
Very High	12	22.64
High	31	58.49
Moderate	10	18.87
Bad	0	0
Very Bad	0	0

The majority students' critical thinking skills who have carried out learning activities of PjBL STEM are in high category. Learning with using PjBL STEM delivers opportunities for students to maximize ability to think so students' critical thinking skills can be honed. As is delivered by Murnawianto et al. (2017) that STEM-based education has comprehensive characteristics (problem solving and critical analysis) in providing opportunities for students to practice their thinking skills solve a problem. PjBL STEM also makes students not only memorizing the concept, but also making students can know and understand scientific concepts and their relationship in daily life (Sumarni et al., 2019).

Susilo et al. (2012) explain learning that involves students for solving problems will improve critical thinking skills. Research that conducted by Afifah et al. (2019) shows that learning with the PjBL STEM model able to improve thinking skills critical students. Pratama et al. (2019) states when students get used to solve existing contextual problems around them then the critical thinking skills will increase. Students who have been trained to think to finish problems with PjBL-STEM learning have good critical thinking skills.

In this research, there are five aspects critical thinking skills under study. That aspect are elementary clarification, basic support, inference, adavanced clarification, and strategy and tactics. Each aspects shown the variation results. Assess each aspect and category of critical thinking can be seen in Table 4.

Table 4. Score of Aspects Student's Critical Thinking Skills

Aspects of Critical Thinking Skills	Score (%)	Category
Elementary Clarification	71.01	High
Basic Support	72.54	High
Inference	74.65	High
Adavanced Clarification	58.49	Moderate
Strategy and Tactics	82.83	Very High

Elementary Clarification

Students' skills in aspect of elementary clarification in high category. In this aspect, there are three indicator, focusing on a question, analyzing arguments, asking and answering question of clarification. Students show high category for each indicator (Figure 1). Overall students are capable to understand what is being asked in the questions and able to explain answers according to the questions asked. Next, on test questions where students were asked to formulate questions, students already able to ask the right questions according to the facts presented. Surya (2013: 169) explains that critical thinking allows someone to analyze, assess, explain, and restructure his thoughts.

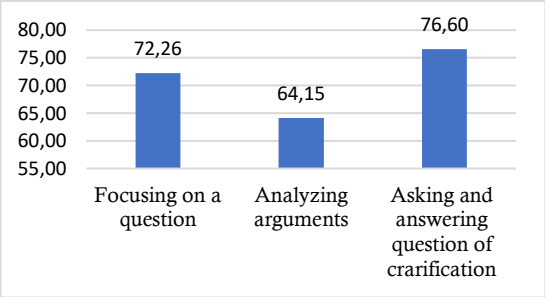

Figure 1. Score of Indicator in Aspect Elementary Clarification

In PjBL STEM learning, students have been trained to formulate problems or questions for which solutions will be sought through a project. The formulation of the problem submitted by students comes from facts found in the neighborhood. Nugraha et al. (2017) stated when students solve existing contextual problems around them, it will further improve critical thinking skills.

Basic Support

Aspects of basic support of students' skills are in high category. On this aspect, there are two indicators, namely judging credibility of a source, observing and judging observation report. Students have high category on both indicators.

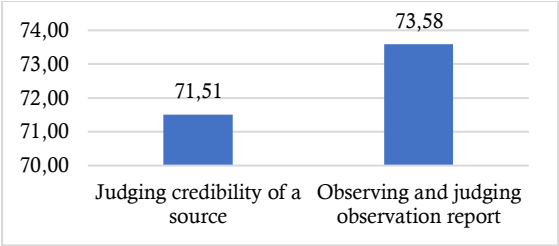

Figure 2. Score of Indicator in Aspect Basic Support

Students seem capable sorting out the information obtained. On the question test students are given information and then students are asked to consider the content of the information. In general, students are capable judge the correctness of an information that is be delivered. This shows that students already have high critical thinking skills. Surya (2013:165) states that a critical person is people who are quick to identify information relevant and separate it from the information which is irrelevant.

Students have been trained to consider information that obtained in PjBL STEM learning activities. In PjBL STEM learning activities students carry out the research stage and discovery. At this stage there are many students looking for information to design projects and trained to recognize information as well consider truth and suitability information with the problem that face it. Linanti et al. (2021) reveal activities read, collect analyze and evaluate information can build students' critical thinking skills.

Inference

The skills of students in aspects inference to be in high category. On this aspect, there are three measured indicators namely deducing and judging deductions, inducing and judging inductions, and making and judging value judgments. Students have high categories concluded on all indicators.

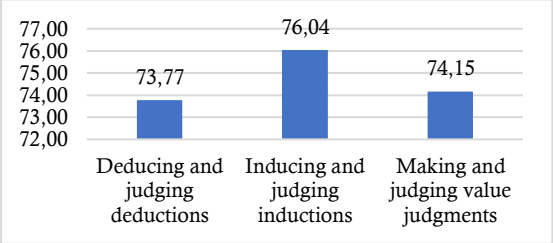

Figure 3. Score of Indicator in Aspect Inference

Students are able to make well general conclusions from the facts shown. In the questions test students are asked to conclude from an experiment that is compare the amount of soil dissolved by water when the land is planted with grass and soil without planting grass doused with water. Students able to conclude that the role of plants it is very important to keep the soil from erosion occurs.

Implementation of project-based learning able to train students to can conclude. Thomas (2000) explains project based learning supported by the activity of asking which questions requires students to be able to provide arguments against the questions and give that conclusion deductive or inductive in a problem given. Next is Fakhriyah (2014) reveal ability concluded can be trained in a way apply concepts, principles and skills they have learned to solve problem that they facing or summed it up.

Adavanced Clarification

In aspects of adavanced clarification, students show moderate category. In this aspect, there are two indicators, defining terms and judging definitions three dimentions, and identifying assumptions. Students show have moderate category in both indicators. Students have not been able to make a complete definition and according to the things faced with using their own thinking.

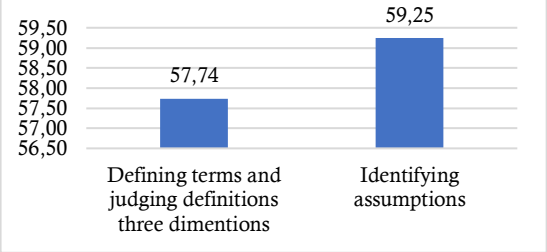

Figure 4. Score of Indicator in Aspect Adavanced Clarification

On the questions test, students are asked to explain the definition of water pollution after previously presented data on a river condition that is polluted. Students answer with provide general definitions as they are read on books. There are still many students use rote to answer the question without relating the concept under the circumstances faced. Carson (2007) explains a lot student who have not been able to explain a phenomenon even though they already know a concept. In Luzyawati's research (2017) shows the ability to provide further explanation of students is still lacking. If students learn accustomed just memorize the information from the teacher then they will find it difficult to explain continuation of a problem.

Strategy and Tactics

The skills of students in aspects strategy and tactics are in very high category. In this aspect, there are two observed indicators, namely deciding on an action, and interacting with others. Students have a very high category on both indicators. Students are able to consider what actions need to be done in accordance with problems faced.

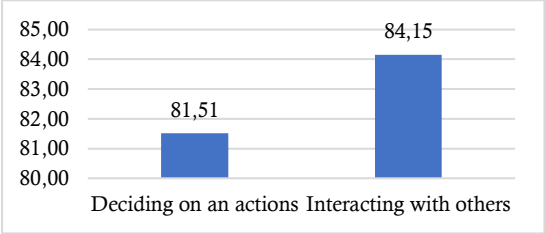

Figure 5. Score of Indicator in Aspect Strategy and Tactics

PjBL STEM learning activities train students to work together in making project to solve a problem. Students have been trained to be able determine a good course of action for solving problem. Apart from that in activities learning active students working together with a group of friends. Fujika et al. (2015) in his research explained when work together in groups, students discuss together to determine action in solving problems, this can practice critical thinking skills in particular related to strategy and tactics.

Critical thinking skills are always necessary attempt to be improved continuously. As stated by Redhana (2012) that critical thinking skills require learning and continuous exercise. Critical thinking skills need to always be trained continuously. Snyder & Snyder (2008) stated that such a skill on generally, critical thinking skills takes training, practice and patience to grow. Syahfitri et al. (2019) research results shows that critical thinking will always increase as it goes time during the learning process. Role learning activities at school are very important to help improve critical thinking skills.

Teachers need to choose right learning activities to help students improve critical thinking skills. Critical thinking skills can be improved by apply a strategy that has characteristics involves

active interaction from students to use deep cognitive abilities apply concepts and solve problem (Agboze et al, 2013). PjBL STEM learning is considered appropriate to be one the learning model can used by the teacher in teaching and learning activities.

CONCLUSION

From the research results is known that every aspect of the participant's critical thinking skills students show variety. Aspect set strategy and tactics have very high category. Aspects elementary clarification, basic support, inference, to be in high category. Aspects advanced clarification in medium category. Average of students' critical thinking skills on PjBL STEM learning environmental change material are in high category.

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