



Profile Analysis of Critical Thinking Ability of Science Education Study Program Students

^{1*}Ita Ainun Jariyah, ²H. Husamah

¹Department of Science Education, Faculty of Tarbiyah and Teacher Training, Sunan Ampel State Islamic University Surabaya, J. A. Yani 117, Surabaya 60237, Indonesia

²Department of Biology Education, Faculty of Teacher Training and Education, University of Muhammadiyah Malang, Jl. Raya Tlogomas No. 246 Malang 65144, Indonesia

*Corresponding Author e-mail: itaainunjariyah@gmail.com

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Abstract

In order to produce superior human resources according to the demands of 21st-century competence and be resilient in facing global challenges in the era of society 5.0, the ability to think critically must be mastered. Critical thinking is a key competency needed by university graduates and most universities have determined this ability as one of the attributes that must be supplied to their graduates. This study aims to analyze the profile of critical thinking skills of Science Education Study Program students. The subjects in this study were 147 students of the Science Education Study Program, Faculty of Tarbiyah and Teacher Training UINSA, class of 2020, 2021, and 2022, totaling 147 students. Critical thinking skills are measured using a critical thinking question instrument consisting of 10 essay questions with 10 indicators of critical thinking skills. The questions tested are questions that have been revised and declared valid by expert validators. The results of the critical thinking ability test are analyzed descriptively to see the category of critical thinking skills in students and each indicator. This study revealed that the critical thinking ability profile of the students of the Science Education Study Program was dominated by the low category, which was 32.3%. Critical thinking indicators that get high categories are indicators of analyzing conclusions, logic classes, and definitions; obtain medium categories on indicators of problem formulation, reasoning ability, and short intervals between observation and report; Getting a low category on indicators assesses the correctness of assumptions, makes and considers decisions, as well as formulates alternative solutions.

Keywords: critical thinking, student, science education study program

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INTRODUCTION

In order to produce excellent human resources, universities must be able to produce graduates who are competent according with the expectations of 21st-century competency (Astriyana et al., 2019). The learning context of 21st-century is known as 4C (Communication, Collaboration, Critical Thinking and Problem Solving, and Creativity and Innovation) (Prayogi, 2020). The ability to think critically is one of the qualities expected in accordance with the needs of the 21st-century. To deal with various complex challenges and demands in the era of society 5.0, critical thinking abilities should be mastered. According to Ennis (2015), critical thinking is reasonable reflective thinking that focuses on deciding whether to believe or do anything.

Critical thinking is a cognitive activity related to the use of mind or reason. Critical thinking, analytical, and evaluative, are the ways to use mental processes such as focusing on categories, selection, and decisions (Cottrell, 2005). Critical thinking can be defined as a

process where we evaluate a claim and argument to determine what is right and what is not. In other words, critical thinking is the act of looking for solutions (Ruggiero, 2012). Critical thinking refers to the mental processes or strategies that students use to analyze, evaluate, and select a certain idea or concept (Borich, 2006). According to Ennis (2015), there are eighteen indicators of critical thinking, i.e (a) Basic clarification (simple explanation) consists of: 1) formulating problems, 2) analyzing argument, 3) asking and answering clarifying questions, 4) reading graphs and tables; (b) Bases for decision (the basis for making decisions) consists of: 5) ability to give reasons, 6) observing and assessing observation reports, 7) using existing knowledge in a situation; (c) Inference consists of: 8) inferring and considering conclusions, 9) making and assessing conclusions and inductive arguments, 10) evaluating; (d) Advanced clarification (further clarification) consists of: 11) defining and assessing definitions, 12) dealing with appropriate rationales, 13) identifying assumptions, 14) making and considering decisions, 15) dealing with erroneous opinions, 16) being careful, and examining the quality of their thinking (metacognition), 17) dealing with things in an orderly; and (e) Not constitutive, but often helpful if not misused with the indicator of 18) using a rhetorical strategy.

The relevance of critical thinking for a person is that it causes someone to reconsider the beliefs, ideologies, assumptions, and realities he/she faces, as well as her/his aspirations. Someone who can think critically will seek the truth in the information he/she receives, use his/her thinking processes to analyze current assumptions, and then develop conclusions based on the findings of the studies. Someone who thinks critically will research anything before answering and interpreting the response for him/herself. The existence of this ability will lead someone to see his/her positive and negative sides of everything he/she faces before accepting or rejecting it (Sihotang, 2017). The research results of Fitriani et al. (2019) indicate that teaching the critical thinking ability to the prospective teacher is an important thing because of the many positive implications that will be obtained by linking critical thinking abilities and critical analysis to the construction of independent thinking processes in accordance with the demands of the 21st-century.

There are several indicators of critical thinking abilities. Nuraini discovers that the critical thinking abilities of biology teacher candidates have various scores and criteria for each ability or indicator, according to her research. The interpretation ability is (78,18), concluding is (84,17), and evaluating is (84,29), those are in a good category. The analysis ability is (66,06), and explaining is (57,78), in which it is in moderate criteria, while self-regulation abilities get a score of 42,78 with very low criteria. Furthermore, Nuraini asserts that critical thinking abilities are very essential for biology prospective teachers as a provision to face the 21st-century generation so that they are able to be competitive and respond to various challenges in the future (Nuraini & Yani, 2017). Kirana & Kusairi (2019) conduct a test of critical thinking abilities for the students of Science Education Study Program, particularly in the case of one-dimensional kinematics graphs with the results of students' critical thinking skills are still in the low category, in which the average final semester student score slightly higher than the initial semester student average score. Learning that focuses on problem-solving can help to strengthen critical thinking abilities. It will be able to increase critical thinking abilities with a lot of training to solve problems in the lecture process.

Increasing critical thinking ability as a provision for competency in entering the 21st-century is a crucial issue for the government to develop human resources. Improving the quality of education that focuses on developing critical thinking abilities is one effort that can be addressed. Mastery of critical thinking ability will strengthen students so that they are accustomed to facing challenges and solving problems by analyzing their mindset to make choices and draw conclusions, forming strong individuals who can act based on logical, rational, careful, critical, effective, and efficient thinking (Agustina, 2019).

The world of education is one of the vehicles for responding to the worldwide demands that are being confronted in the era of society 5.0; therefore, students must be supplied with the

ability to think critically as one of the focuses of the competencies required in tackling these global difficulties. Thus, the Science Education Study Program of Tarbiyah and Teacher Training Faculty of UIN Sunan Ampel Surabaya as a Human Resource maker, especially prospective teachers, contributes to efforts to produce superior prospective teachers, especially by improving students' critical thinking abilities. These efforts cannot be carried out instantly but must be carried out gradually in order to attain the desired outcomes.

Students' critical thinking abilities are still weak in Indonesia, especially for those who are prospective teachers. This happens to prospective elementary school teachers (Wibowo, 2022), prospective mathematics teachers, (Kurniati et al., 2022), and also a prospective biology teacher (Apriliani et al., 2023; Suyatman & Chusni, 2022). This happens on several campuses in Indonesia. Of course, a solution needs to be found for this, but first, it is specifically necessary to know the profile on a narrow scale. In this case, we focus on the Science Education Study Program, Tarbiyah and Teacher Training Faculty, UIN Sunan Ampel Surabaya, something that has never been done by previous researchers. To improve students' critical thinking abilities, the first effort to be carried out is analyzing the extent of the critical thinking abilities of science education study program students. This stage is a preliminary study in order to continue broader stages forward as an effort to improve critical thinking abilities. Therefore, it is important to do a profile analysis of the critical thinking abilities of students of the Science Education Study Program, Tarbiyah and Teacher Training Faculty, UIN Sunan Ampel Surabaya.

METHOD

This research was descriptive research. This research was carried out by describing the characteristics of a situation with actual facts based on descriptive observations which meant making a thorough observation of something that was in the research setting. This research aimed at analyzing and describing the profile of students' critical thinking ability. This research was conducted at Science Education Study Program of Tarbiyah and Teacher Training Faculty of UIN Sunan Ampel Surabaya. The subject of this research was students of Science Education Study Program of Tarbiyah and Teacher Training Faculty of UIN Sunan Ampel Surabaya in the class of 2022, 2021, and 2020 (totaling 147 students). This research was conducted during the even semester of the 2022/2023 academic year.

Data collection method was carried out by distributing item instrument of critical thinking which was developed and adapted from Ennis (2015). Critical thinking abilities were measured using 5 aspects and 10 indicators. The instrument consisted of 10 essay questions that were devised and validated by education professionals in the fields of biology, physics, and chemistry (100% of validators have declared it valid), all of whom hold at least the functional position of lecturer. Table 1 revealed indicators of critical thinking ability.

Table 1. Item Indicators of Critical Thinking Ability

No.	Aspects	Indicators
1	Basic Clarification	1. Formulating the problems 2. Analyzing the conclusion
2	Bases for a decision	3. The ability to provide reasons 4. Short interval between observation and report
3	Inference	5. Logic class 6. Consequences of accepting or rejecting a decision
4	Advanced Clarification	7. Defining 8. Assessing the correctness of the assumptions 9. Making and considering decisions
5	Employ rhetorical strategies	10. Formulating alternative solutions

The test instrument used had been reviewed and declared valid by the expert validator. Each critical thinking item had rubrics with categories of correct answers (score 3), comparatively correct answers (scoring 2), incorrect answers (score 1), and wrong answers

(score 0). The findings of the responses to questions concerning critical thinking skills were then descriptively assessed depending on the achievement of each critical thinking indicator. The following formula was used to calculate the percentage of student critical thinking abilities test results in each indicator:

$$\text{Percentage of critical thinking abilities} = \frac{\sum \text{obtained score}}{\sum \text{maximum score}} \times 100\%$$

Percentage results of critical thinking abilities, moreover, would be grouped based on the following criteria in Table 2 (Setyowati & Subali, 2011):

Table 2. Criteria for Students Critical Thinking Ability

No.	Percentage	Category
1	81,25 < X < 100	Very High
2	71,50 < X < 81,25	High
3	62,50 < X < 71,50	Moderate
4	43,75 < X < 62,50	Low
5	0 < X < 43,75	Very Low

RESULTS AND DISCUSSION

Respondent Profile

This research aims to measure the students' critical thinking abilities of Science Education Study Program, Tarbiyah and Teacher Training Faculty of FTK UIN Sunan Ampel Surabaya by means of distributing the instruments of critical thinking abilities in the form of an essay questionnaire covering 10 items of gform. Figure 1 depicts the profiles of the respondents who completed the questionnaire:

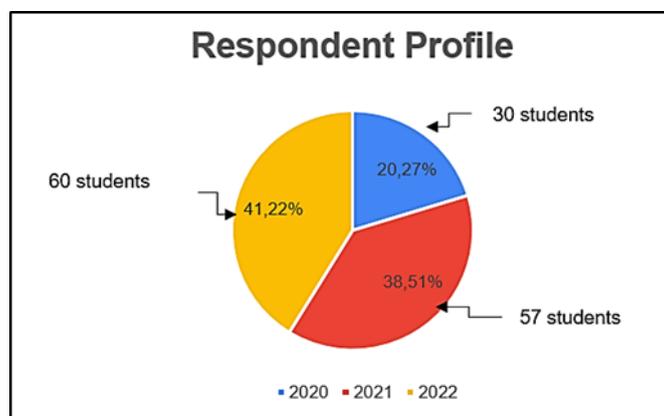


Figure 1. Respondent Profile

The overall number of respondents is 147, including 20,27% or 30 students from class 2020, 38,51% or 57 students from class 2021, and 41,22% or 60 students from class 2022. The Science Education Study Program's Class of 2020 is currently enrolled in semester 6. There is only one class in the 2020 class. The student classes of 2021 and 2022 are grouped into two classes, which are taking semester 4 and semester 2 lectures at the time of the research.

Results of Students' Critical Thinking Ability

The findings of critical thinking ability instruments completed by students are used to assess students' critical thinking abilities. Figure 2 demonstrates the outcomes of students' critical thinking abilities:

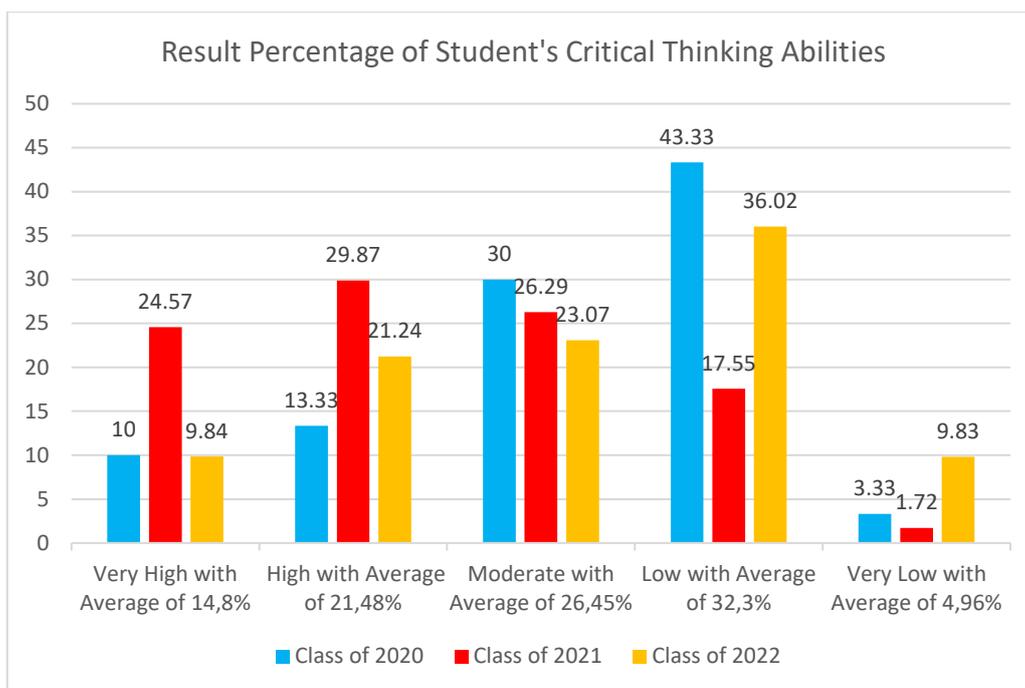


Figure 2. Result Percentage of Student's Critical Thinking Ability

According to Figure 4.2, it is known that the most average percentage of students' critical thinking ability of Science Education Study Program in Tarbiyah and Teacher Training Faculty of UIN Sunan Ampel Surabaya is 32,3%, in the low category. The remaining percentage is divided into four categories: moderate (26,45%), high (21,48%), very high (14,8%), and very low (4,96%). According to data on critical thinking ability scores, the students with the best critical thinking abilities are in the class of 2021. Whereas the very high category for students in the class of 2021 receives a percentage of 24,57% and the high category receives a percentage of 29,87%.

Based on the above results, it can be concluded that the students' critical thinking abilities should be enhanced. The students should be provided with critical thinking abilities so that the students think carefully to prepare for the world of work. The habit of critical thinking will enable them to solve the problems they face carefully so that they can solve problems better than solving them without thinking critically (Arsanti et al., 2021).

The importance of critical thinking for someone is not to easily accept a belief, assumption, ideology, desire or even a reality they face. Someone who thinks critically will first seek the reality of the information gained, then assess the assumptions gathered using existing thinking processes, and finally develop conclusions based on the study's findings. Based on this ability, a person will be guided toward an in-depth evaluation from both positive and negative perspectives before accepting or rejecting something (Sihotang, 2017). It is crucial for prospective science teachers to develop critical thinking abilities so that they can overcome any problems or challenges that arise while carrying out learning assignments at school.

Students' critical thinking abilities are categorized as low, based on the research of Sulistyanningrum et al. (2019), in which it indicates that the average critical thinking ability of elementary school students and teachers is less than 30%, meaning that they are in the low category so that further efforts are needed to do learning that can improve their critical thinking abilities. Low critical thinking ability can have a detrimental impact on academic and professional abilities in the future, so it must be developed. Critical thinking abilities can be developed by training thinking skill indicators and involving them in learning activities (Agnafia, 2019). Sternberg (1990) in Behar-Horenstein & Niu (2011) recommend the ways to develop critical thinking abilities, where the instructors should focus on the strengthening

students' intellectual functions in meta-components, performance components, and knowledge acquisition strategies. Meta-components are high-level mental processes that necessitate individual action planning, monitoring, and evaluation. The actual procedures taken while implementing a knowledge acquisition strategy are referred to as the manner in which individuals connect old material with new material and apply new material. Critical thinking abilities can be developed and trained throughout the lecture process by employing suitable learning methods and models, utilizing lecture material, and practicing questions based on high-order thinking skills. This is a cooperative effort of the Science Education Study Program, specifically to increase students' critical thinking abilities.

Students from the class of 2021 have the best critical thinking abilities. One of the reasons for this is that class 2020 is one of the batches of students who suffered during the Covid-19 pandemic, when all learning was done online. This appears to have an effect on the acquisition of suboptimal learning outcomes. Students in the Class of 2021 have entered the new normal period, in which learning is gradually being carried out ordinarily or offline. Of course, face-to-face offline learning produces greater results. This is because students receive an explanation and can directly ask the lecturer questions. It is evident that communication that occurs immediately throughout the learning process is better than the use of online lectures. Aside from that, one disadvantage of online learning is that practicum activities cannot be carried out directly in the laboratory. Students in the class of 2021 also have better critical thinking abilities than students in the class of 2022. This may have occurred because students in class 2021 took and received more lecture content than students in class 2022. Based on this, students in class 2021 should have stronger academic ability than students in class 2022.

Critical thinking abilities should be trained thru student-centered learning. This training should be done intensively. In this case, the students should repeat the exercises, even though these abilities are already part of his/her way of thinking. Exercises performed on a regular basis can improve the efficiency and automation of students existing thinking abilities. The lecturer should include new thinking abilities into the learning process and apply them to a variety of courses so that students have a larger variety of critical thinking abilities (Zubaidah, 2010).

Results of Critical Thinking Ability for Each Indicator

The proportion of critical thinking abilities for each indicator is calculated from the results of measuring critical thinking abilities, as shown in Table 3.

Table 3. Average Percentage of Students' Critical Thinking Ability Indicator Score

Indicators of Critical Thinking	Average Percentage Score	Category
Formulating the problems	64,04 %	Moderate
Analyzing the conclusion	75,61 %	High
The ability to provide reasons	47,29 %	Low
Short interval between observation and report	65,91 %	Moderate
Logic class	72,5 %	High
Consequences of accepting or rejecting a decision	64,87 %	Moderate
Defining	79,97 %	High
Assessing the correctness of the assumptions	53,11 %	Low
Making and considering decisions	60,15 %	Low
Formulating alternative solutions	59,74 %	Low

According to Table 3, at least three indicators are in the high category. Conclusions, logic classes, and definitions are being examined by the indicators. Another indicator specifically three, falls into the medium category. These indicators include the problem formulation, the short interval between observation and report, and the consequences of accepting or rejecting a decision. The ability to explain explanations, assess the accuracy of assumptions, develop

and examine decisions, and formulate alternative solutions are the next four indicators in the low category.

The definition indicator (79,97%) receives the highest percentage score of the ten indicators examined, followed by the analysis conclusion indicator (75,61%), and the logic class indicator (72,5%). Meanwhile, the indicator with the lowest score (47,29%) is the ability to explain the reason. Based on the findings of analyzing critical thinking ability for each of these indicators, it is clear that there is a need to improve critical thinking abilities, particularly for those indicators that earn a low category.

Recognizing a problem is one of the first steps in critical thinking. Recognizing this difficulty, it is further subdivided into many sub-indicators, which include: identifying significant concerns or problems; comparing similarities and contrasts; selecting relevant information; and presenting or formulating the problem (Zubaidah, 2010). Considering that one of the initial steps in critical thinking abilities is problem formulation, this ability is crucial to master. Students must be able to develop the correct problem formulation in the form of a question while formulating this problem. The questions must be structured in accordance with the problem's focus and include a relationship between the two study variables. The formulation of the problem should be a testable research question. Furthermore, a good problem formulation includes aspects of the solution to the challenges given.

Students' critical thinking abilities in analyzing conclusion indicator is categorized as high with a percentage average of 75,61%. The ability to assess these findings is critical for students to understand in order to think rationally about the varied data they receive. Students must be able to derive the correct conclusions from these numerous sources in order to use them as a basis for making a decision. Angelo (1995) in Zubaidah (2010) postulates that concluding skills are mental actions that are founded on knowledge (truth) and can lead to new knowledge (truth). This ability demands readers to understand and describe many features on a continuous basis in order to arrive at a new formula, essentially a conclusion.

The findings of this study show that students' capacity to give arguments is still weak in expertise. The majority of the students' answers are incorrect; however, there are few who are correct but do not provide adequate justification. The questions in this indication need relatively complicated skills, such as observation, analyzing the accuracy of opinions based on the results of observations, and then providing good reasoning for the replies. If one of the three skills is not fully mastered, the written response will undoubtedly be incorrect. This may clarify why this indicator has a lower average percentage, namely 47,29% in the moderate category. When compared to the results on other critical thinking indicators, this is the lowest percentage average result. As a result, major efforts to increase critical thinking abilities, particularly the ability to offer reasons, are required.

In the medium category, measurement of the indicator "short interval between observations and reports" reveals an average percentage of 65,91%. Students are requested to produce a short report based on the data from the water purification practicum arising from the observation of the images given in the issue for this indicator. The most challenging part of writing the report is writing the discussion, as evidenced by the number of right responses obtained. According to the research of Nuryanti et al. (2018), answers in the incorrect category dominate students abilities in the short interval indicators between observations and reporting. This is due to students' misunderstanding of the time interval. Making a report takes longer in general since there are numerous components that must be written in a report. Someone who can think critically will be able to produce good reports at frequent intervals based on observations.

With an average acquisition percentage of 72,5%, students' abilities in logic class indicator are generally in the high category. This demonstrates that students can think rationally and provide an adequate explanation for an issue that has been presented. Kurniawati et al. (2018) propose that logical thinking is a process to operate the mind consistently to come to a conclusion. Logical thinking involves problems that require understandable structures and

relationships between facts, arguments, and logical series. Wayudi et al., (2020) clarify that it has been acknowledged in general that critical a logical thinking abilities is a competency that is increasingly important to master as part of supporting success in life in line with the ever-increasing pace of change and increasing complexity and interdependence. Education is the primary means of training students to be engaged citizens and responsible citizens in a society that is increasingly based on modern technologies. As a result, schools and academic institutions at all levels must focus on critical thinking development. Problem-based learning models, guided discovery learning models, and project-based learning models are some of the models that can be used to build critical and logical thinking abilities.

In the moderate category, the average percentage of critical thinking abilities indicators of accepting or rejecting decisions is 64,87%. According to Nuryanti's research, et al., the good category dominates the aspect of accepting or rejecting decisions, implying that students can provide justifications for making or rejecting decisions. According to the findings of this study, the indicator of the consequences of accepting or rejecting a decision falls into the moderate category, indicating that it still need improvement. In line with Thomas (2011) who thinks that critical thinking is identified as one of the key competencies of university graduates and most universities determine the ability to think critically or use high-level abilities as a desirable attribute of their graduates. Critical thinking abilities must be integrated into curriculum content, and each of the indicator must be developed in every lecture process.

The ability to think critically on the definition indicator has the greatest average percentage of any indicator of critical thinking ability, 79,97% in the high category. In general, students can make good definitions. This shows that human can use their critical thinking abilities to define a term. This result is better than the research results of Nuryanti et al. (2018) which get the results that definition aspect of students is in the moderate category.

In the poor category, the capacity to analyze the truth of assumptions receives an average percentage of 53.11%. Based on these findings, students' ability to appraise the reality of assumptions requires further development. Students who do not comprehend the concepts offered in the questions may be unable to determine the credibility of the assumptions, or they may be able to judge the correctness of the assumptions but cannot provide detailed reasons. Rasmawan (2017) also reveals that students' critical thinking on analyzing argument indicators, interpretation of information, and making assumption are in the less skilled category. This indicate that students cannot determine the argument as the basis to support a statement. Students have also struggled to find the proper and relevant material to utilize as a foundation for making assumptions.

The low category dominates students' ability to make and consider decisions, with an average percentage of 60,15%. Students' ability to make and consider decisions is still low and has to be improved. This suggests that students are still unable to create and consider decisions using critical thinking abilities. According to a research of Fernanda et al. (2019), the indicator findings for making low decisions are due to difficulty in processing information or data from observations, making them less capable of making correct decisions. This can also be caused by a failure to apply logical analysis as the foundation for decision making.

With an average percentage of 59,74%, students' ability to formulate alternative solutions is still dominated by the low category. One possible explanation for this low ability is that students' alternate answers are less relevant to the context of the challenges presented and are more difficult to implement. Students are regarded capable of providing alternative answers if they can propose alternative solutions that are simple and straightforward to implement, and rely on suitable theory, and also relevant to the challenges presented.

Generally, to enhance critical thinking ability, teachers' creativity in planning and developing learning media is required so that it can develop the students' critical thinking as a habit. Through various active learning methods, teachers must engage students in learning situations which foster critical thinking abilities (Nuryanti et al., 2018). Critical thinking ability is an ability to comprehend a complex problem, connect various information, until in the end

appear various perspectives, and find a solution to a problem (Agustina, 2019). Critical thinking abilities can be enhanced during the learning process using numerous strategies such as debate, group discussion, and solving numerical problems or puzzles (Agboeze et al., 2013)

CONCLUSION

This research concludes that students' critical thinking ability of Science Education Study Program in Tarbiyah and Teacher Training Faculty of UINSA is dominated by low category, as much as 32,3%. Students' critical thinking abilities get a high category on indicators of analyzing conclusions, logic classes, and definitions; get a moderate category on the indicator of formulating problems, and short intervals between observations and reports; get a low category on the ability to give reasons, assess the truth of assumptions, make and consider decisions, and formulate alternative solutions.

RECOMMENDATION

Further research can be done by conducting research on efforts to improve students' critical thinking skills. Further research can also be done by comparing students' critical thinking skills in various science education study programs at other universities by utilizing validated critical thinking skills instruments for science education student study programs

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