Identifying scientific critical thinking skills of high school students on the static fluid

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Abstract. Students as future generations need to be equipped with high-level abilities, such as creative thinking and critical scientific thinking. The purpose of this research is to know how much creative thinking skills and scientific critical thinking are possessed by high school students in Bandung. In this research, the instrument used is a test-shaped essay as many as 12 questions about static fluid topic. The appreciation instruments used in this study were Critical Thinking (ACTA) type instruments. Tests of students’ critical thinking skills were analyzed using the Rasch model. The research population is a grade XI student in one high school in Bandung City. Research samples were selected with a random sampling technique of 32 students. Research results show that students have not been able to analyze the arguments, assess or evaluate, make decisions or solve problems, and make conclusions using inductive or deductive reasoning. It is shown by the low percentage of scientific critical thinking ability on every aspect, Critical thinking ability of 1 26.5%, Critical thinking ability of 2 23%, Critical thinking ability of 3 13%. It was concluded that the student's scientific critical thinking skill level in the static fluid is motionless very low.

1. Introduction
Scientifically critical thinking is defined as the process of self-assessment generated through interpretation, analysis, evaluation, and conclusion of a fact explanation, concept, and methodology [1]. Experts have conducted research on critical thinking and how to study it for more than 100 years. Even Socrates had used the approach of critical thinking in lessons almost 2000 years ago. But who is more widely known as the father of modern critical thinking is Jhon Dewey who is a philosopher, psychology, and education figure in America. Jhon Dewey calls critical thinking relativistic thinking. Jhon Dewey states that critical thinking is an active, accurate (and continuous) consideration of a belief or a form of knowledge that is taken for granted which is viewed from the point of reasons that support it and further conclusions that tend to be [2]. Various studies show that critical thinking is a high-level thinking skill and it is known that scientific role becomes a very important part in moral, social, mental, cognitive, and scientific development [3].

Critical thinking skills student’s area demand to be able to analyze the arguments, assess or evaluate, make decisions or solve problems, and make conclusions using inductive or deductive reasoning [4]. Critical thinking is also a thoughtful and reasoned thinking focusing on decision-making about what to believe [5]. Developed an instrument assessment of critical thinking skills (Assessment of Critical Thinking Ability, ACTA), a survey that can be easily implemented online or carried out in the ACTA class judging three critical thinking skills to evaluate some conflicting knowledge and to
propose a complete description of some of the skills interconnected with each other. The results of the research, ACTA, and available information on levels of students scientific critical thinking skills can be used to help students develop or improve skills [6].

The ACTA [7] survey assesses students in three of the most important and essential critical thinking skills: (1) Critical thinking ability 1, incorporate conflicting knowledge into an integrated conclusion; (2) Critical thinking ability 2, designing multiple experiments to solve ambiguity in certain knowledge; (3) Critical thinking ability 3, providing statements against other interpretations in certain knowledge.

ACTA evaluates these skills in three opposing parts of knowledge. The knowledge is chosen to be more comprehensive by students who do not have special scientific knowledge, then integrate it to assess the thinking skills needed. One of the main objectives of the ACTA survey is to present information about the student's competence in three critical thinking skills and with the skills at a certain level required for going up to the next level. In learning physics also requires critical thinking skills. Critical thinking is reflective thinking and which focuses on making decisions about what to believe or do [8]. State that critical thinking skills are needed to develop an educated society which involves knowledge that is seen from the way of thinking used. This critical thinking skill is needed in physics learning which involves in real and scientific life [9].

2. Methods
This article discusses the critical thinking ability of scientific tests students using the Rasch model to view reliability instruments, and the level of abilities (analysis of Map Wright). Rasch models use the principle of probability on all available options on classical test theory preferred on how high each student's level of critical thinking [9]. This article uses a Rasch model with winstep software to process data obtained from test results and exercises for students.

To know the critical thinking ability through scientific tests forms the essay, the percentage of each indicator needs to be calculated. The equation to determine the percentage of student scientific literacy:

\[
\text{percentage average score} = \frac{\text{score obtained}}{\text{maximum score}} \times 100\% \tag{1}
\]

| Range Percentage Score | Description |
|------------------------|-------------|
| 80 – 100               | Very High   |
| 66 – 79                | High        |
| 56 – 65                | Pass        |
| 40 – 55                | Low         |
| 0-39                   | Very Low    |

2.1 Reliability Instrument
The criterion of reliability uses Cronbach alpha value instruments. The following is a description of the instrument reliability criteria. Rasch analysis with modelling is applied to the data obtained from the tests and now student response [11].

| Interval         | Criteria |
|------------------|----------|
| KR-20 < 0.67     | Weakness |
| 0.67 < KR-20 < 0.8| Pass    |
| 0.8 < KR-20 < 0.9| Good     |
| 0.91 < KR-20 < 0.94| Excellent |
| KR-20 > 0.94    | Exceptional |
Through analysis using the Rasch model, it was obtained that the results of reliability i.e. 0.52 person and item reliability i.e. 0.82. It can be concluded that the consistency of the answers of the students is weak, but the exercise questions’ quality in the instrument of the reliability is good. Grade from Cronbach alpha to determine reliability interactions between the person and the details of the question of the overall results obtained is 0.53. The value of the alpha test reliability is shown figure 1, in general, is still not satisfactory and could be categorized as bad.

![Figure 1. Reliability person and item](image)

### 2.2 Analysis Map of Wright (Person-Item Map) Politomi Data
Wright maps for polytomy data describe the distribution of students’ ability and the distribution of items’ difficulties. Wright's map is able to analyze students who have the highest to the lowest levels of ability, and are also able to analyze parts of the questions answered by students.

| Problem Different Index | Criteria |
|-------------------------|----------|
| 0.00 – 0.20             | Bad      |
| 0.20 - 0.40             | Pass     |
| 0.40 – 0.70             | Good     |
| 0.70 – 1.00             | Excellent|
| Minus                   | Very Bad |

Figure 2 is a wright map analysis, from this figure the distribution of person is seen on the left while the items on the right. That way the distribution of the ability of the highest to lowest students can be analyzed. The distribution of questions is according to the level of difficulty. Low ability students consist of 3 people with 0D, 0G, and 0Y person codes. High-ability students with OJ person codes.

### 2.3 Research Instrument
Data from scientific critical thinking skill are used to identify the scientific critical thinking skills of students. The technique of collecting data on students' scientific critical thinking skills was done by
giving test instruments in the form of essay questions. Because the test instrument in the form of essays, then scoring rubric is required. Scoring rubrics can be seen in table 4.

![Wright map Analysis (Person-Item Map) Politomi Data](image)

**Figure 2.** Wright map Analysis *(Person-Item Map)* Politomi Data

**Table 4.** Scoring rubric test scientific critical thinking skills *(A Novel Instrument For Assessing Student's Critical Thinking Ability)*

| No. | Critical Thinking Ability 1 | Critical Thinking Ability 2 | Critical Thinking Ability 3 |
|-----|-----------------------------|-----------------------------|-----------------------------|
| 4   | Provide an explanation of all concepts or knowledge of physics that are related to each other to build an opinion | Describes an experiment based on knowledge related to the opinions believed | Explain all concepts or knowledge of physics that are related to the conclusions produced |
| 3   | Mention explanations alternatives to concepts or knowledge of physics to build opinions | Elaborate specific knowledge related to the opinions believed | Mention concepts or knowledge of physics by considering possible concepts or other physical knowledge that are also related |
| 2   | Mention the concepts or knowledge of physics, but the explanation of the concepts or knowledge of physics mentioned is not very clear | Explain knowledge specifically but not related to the opinions believed | Mention concepts or knowledge of physics by considering possible concepts or other physical knowledge that are also related |
| 1   | Do not mention any concepts or knowledge of physics in opinion | Not able to explain knowledge specifically about the opinions believed | Not mentioning concepts or knowledge of physics in the conclusions produced |
| 0   | No answer | | |
3. Results and Discussion

3.1. Analysis from Critical Thinking Skills on Every Aspect

This research acts to study the level of thinking of eleventh grade students in high school. Before conducting this research, the previous researcher conducted a preliminary study using items which can be seen in Figure 3.

![Figure 3. Results of Scientific Critical Thinking Skills on Each Aspect](image)

Table 5 shows the critical thinking test scores of students in every aspect, on the Critical 1 none of the students were able to provide an explanation of the whole concept or knowledge of physics that are associated with each other to build an opinion. In the critical 2 only 2 students are able to describe an experiment upon the knowledge that is associated with the opinion that believed, then on 3 critical aspects of none of the students were able to explain the whole concept or knowledge of physics related to the resulting conclusions.

Table 5. Profile of Scientific Critical Thinking Skills for each aspect

| Indicator of scientific critical thinking | Casting per aspect |
|------------------------------------------|--------------------|
|                                          | 4 | 3 | 2 | 1 | 0 |
| Critical 1                              |   |   |   |   | 0 |
| Critical 2                              | 2 | 2 | 9 | 20| 21|
| Critical 3                              | 0 | 0 | 6 | 25| 33|

Table 6. Reliability of Scientific Critical Thinking

| Reliability | Critical 1 | Critical 2 |
|-------------|------------|------------|
| QUESTION    | 0.96       | 0.81       |
| STUDENTS    | 0.30       | 0.45       |

Table 7 shows the response of the students in doing some questions to get the value of Cronbach Alpha. On a matter of critical thinking, scientific research in critical thinking question 1 gets 0.96 for Item reliability, which is very satisfactory. For the person Reliability of 0.30 is categorized as not satisfactory. Then the results of scientific critical thinking question 2 for item reliability reached 0.81 which is very satisfactory and the person. Reliability reaches 0.30 which is not satisfactory.
3.2. Wright Critical Map Analysis Scientific

Results from Wright's map analysis shows that critical scientific question with the highest level of difficulty in number 14 and only 3 students was able to answer the question (with no serial number 10, 13, 14, 15, 26) as shown in table 7.

| Critical | Students with high ability | Students with low ability | Question with the highest level of difficulty | Question with the lowest level of difficulty |
|----------|---------------------------|--------------------------|---------------------------------------------|-------------------------------------------|
| 1        | 10.13, 14, 15, 26         | 03, 20, 01, 02, 05, 11, 19 | 7k, 6k                                      | 5k                                        |
| 2        | 10.13, 14, 15, 26         | 02, 04, 09               | 14k                                        | 11k, 13k                                  |

Based on the graph, it can be seen that the average score of critical thinking of students in each aspect is very low, this occurs due to the rarity of challenges during learning that trains students' critical thinking, this is also in line with the research of [9]. Which states that students' low thinking skills with an average value of 46.1 occur because students are only trained in the explanation of physics material with lectures and discussions and the teacher gives questions and solutions to the problem based on the material taught. In addition, physics practicum in the laboratory is also rarely used and students receive more physics concepts from the teacher than in the process of discovering their own concepts from the practicum they do. Also, the research conducted by [10] states the average value of critical thinking skills is 29, 39. Due to the weak ability of students to analyze events or events, students tend to memorize and quickly forget. Therefore, learning physics only focuses on emphasizing the concept alone without applying the concept, students only use mathematical calculations. According to [11], researchers critical thinking skills such as [12], Hendri (1991), Waston and Glazer (1980) and Missimer (1990) have the same understanding that critical thinking skills involve the continuation of thinking processes that include focusing and observation on a question or problem, scoring, and understanding problem situations, analyzing problems, making and evaluating decisions or solutions and finally deciding on an action.

4. Conclusion

This research was conducted to identify critical thinking scientifically developed to implement the use of Critical Thinking Ability, (ACTA). Critical scientific thinking ability in every aspect with the percentage, Critical thinking ability 1 26.5%, Critical thinking ability 2 23%, Critical thinking ability 3 13%. It was concluded that the level of critical thinking skills of students’ in the scientific content of static fluid is still very low. Based on the findings of the research, to implement instruments of Critical Thinking Ability, (ACTA) could be developed to identify students’ scientific critical thinking. This research can be a reference for researchers to further research and learning activities to prepare teachers who are able to increase the ability of students’ scientific critical thinking.

5. References

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