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ANALYSIS OF STUDENTS' CRITICAL THINKING SKILLS ON THE MATERIAL OF VIRUSES AND THEIR ROLES

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ABSTRACT

Critical thinking skills are important for students in learning and real life to face the increasingly complex challenges of the 21st century, including those related to viruses. This study aims to analyze students' critical thinking skills on the material of viruses and their roles. This research is a quantitative descriptive research. The research subjects were 70 students from two grade X classes at a Karanganyar, Central Java school, comprising 35 students. The data collection method is done through a written test. The research instrument in the form of essay questions consists of 6 questions based on aspects of critical thinking skills. The data analysis technique used Rasch analysis through the Winsteps 3.73 program. The results of the study show that there are still many students who are unable to answer critical thinking skills questions as seen based on the Wright Map and the comparison of mean logit person (-0.77) < mean logit item (0.00) in the Winsteps output. In conclusion, students' critical thinking skills on virus material are still low. Therefore, further research is needed to improve students' critical thinking skills.

Keywords: *analysis, critical thinking skills, virus*

INTRODUCTION

The 21st century presents humanity with increasingly complex global challenges, fast-paced, potentially new problems and unpredictable future developments (Dishon & Gilead, 2020; Scott, 2015). Humans need to prepare themselves by mastering various skills that can keep them going and even innovate. Education plays a role in preparing students to become part of society

who must be ready for the challenges and changes in the 21st century. Learning must adapt to the era of globalization by practicing the needs of the 21st century (Anggraeni et al., 2023). Some of the skills that students need to have include critical thinking, collaboration, communication and creative thinking (Alabbasi et al., 2022; Thornhill-Miller et al., 2023). Critical thinking skills are important for students to manage and utilize information in conditions that are always changing and competitive (Amelia et al., 2022). Creative thinking has the potential to produce new ideas in problem-solving, while collaboration and communication are stimuli for creative thinking (Zubaidah, 2018).

Critical thinking skills are the process of analyzing and evaluating information collected through reflection, reasoning or communication to produce valid and strong conclusions and show evidence (Chusni et al., 2020). Critical thinking aims to prove something, interpret the meaning of something and solve a problem which includes aspects of interpretation, analysis, evaluation, inference, explanation and self-regulation (Facione, 2020). Critical thinking has a positive impact on learning effectiveness (Li, 2023), academic achievement (D'Alessio et al., 2019), problem-solving and appropriate decision-making processes (Özgenel, 2018; Silviariza et al., 2021), forming a systematic thinking process in everyday life applications (Pislae-ngam, 2018), and preparing students for the next level of education and career (Jafarigohar et al., 2016).

The implementation of the Merdeka curriculum is one of the government's policies to prepare students to become a generation that is ready to face global challenges with the provision of several 21st-century skills through the learning process, including critical thinking. Biology is important in the Merdeka curriculum because through biology subjects, students are expected to be able to understand natural resources so that they can protect and manage them and overcome various problems faced by society in the 21st century. Biology can also be used as a basis for students in making critical decisions about personal, local, and global issues in addition to providing understanding for further education at college and career levels (BSKAP, 2022).

One of the biology materials at the high school level is the virus material and its role. Learning the virus material includes the characteristics of viruses, replication and the role of viruses for life, both beneficial and detrimental. Students are expected to be able to identify the characteristics of viruses, understand their replication so that they can reason critically by linking how the virus transmission process is very fast, analyzing solutions as an effort to prevent and transmit diseases caused by viruses, both in humans, animals and plants.

Critical thinking skills will stimulate students' cognitive reasoning in gaining knowledge. Critical thinking skills are important for students to have in developing ideas for thinking about problems that occur in learning and everyday life and finding solutions (Diharjo et al., 2017). Critical thinking skills also train students to be objective so that they are open to differences of opinion,

not easily believe in things that are not certain, be careful in acting and making decisions. Students can find the right solution to a problem involving facts, data, and concepts through critical thinking (Wulandari & Warmi, 2022). Based on several research results, also show that critical thinking skills have a positive influence on student learning outcomes (Annisa et al., 2020; Egok, 2016; Husnah, 2018; Komariyah et al., 2018; Siburian et al., 2019). Efforts to empower critical thinking skills need to be made as alternative learning because they have a large contribution to cognitive learning outcomes (Siburian et al., 2019). This can be done by modifying models/methods, media, or learning evaluations that stimulate critical thinking skills.

Virus material is considered difficult by students in biology learning (Agustine et al., 2020; Etobro & Fabinu, 2017; Fauzi & Mitalistiani, 2018; Sari et al., 2022) because it is abstract and predominantly uses complex concepts (Hasibuan & Djulia, 2017; Yuniarti et al., 2012). Students are not motivated and less interested in doing difficult tasks on virus material (Asriani et al., 2020; Wakhidah, 2021) so that their understanding and learning outcomes are low (Hasibuan & Djulia, 2017) and they have difficulty understanding the role of viruses in life (Firmanshah et al., 2020). The material about viruses and their roles is one of the materials that is closely related to life and daily problems faced by students. After studying the virus material, students are expected to be able to understand the concept of viruses related to structure, replication, distribution and diseases caused to participate in overcoming problems caused by viruses (Fariroh & Anggraito, 2015; Wakhidah, 2021). In addition, students are also expected to be able to think critically about various information related to viruses and have awareness and concern for problems related to viruses.

Based on this, this study aims to analyze students' critical thinking skills on the material of viruses and their roles. The results of the analysis are expected to provide an overview/information related to students' critical thinking skills, especially on virus material, so that further efforts can be made to improve or empower students' critical thinking skills, both in terms of media and learning methods.

METHODS

This type of research is descriptive research with a quantitative approach. The research procedure includes the preliminary study stage, compiling critical thinking questions, testing questions, collecting data, analyzing data and drawing conclusions. **Figure 1** shows the procedure chart in this study. The population in this study was all grade X students at one of the high schools in Karanganyar, Central Java. The sample selection technique is cluster sampling, namely the subjects selected are a group of individuals who are naturally together (Ary et al., 2010). The research subjects consisted of 35 students from class X.7 while during the test the question instrument consisted of 35 students from class X.6. The data collection method used a written test. The research

instrument is in the form of essay questions that refer to aspects of critical thinking skills according to Facione (2020), namely interpretation, analysis, evaluation, inference, explanation and self-regulation. This question consists of 6 questions about virus material including virus characteristics, virus replication and the role of viruses in life. The assessment score uses a Likert scale with an interval of 0-3.

The preliminary study stage was carried out by searching for information related to critical thinking skills, for example aspects and indicators of critical thinking skills. Then compiling questions about the virus material according to the learning achievements of the Merdeka curriculum which refers to aspects and indicators of critical thinking skills Facione (2020). Before being used for collecting critical thinking skills data, the questions were first tested to determine their validity and reliability using Rasch analysis with the Winstep 3.73 program. The next stage is data collection through critical thinking skills essay tests for students. The research data in the form of critical thinking skills data were then analyzed using the Rasch model through the Winstep 3.73 application. Students' critical thinking skills on virus material can be known through the Wright Map distribution obtained from the Rasch model analysis output. Rasch analysis can provide overall information and interactions between respondents and question items. The results of the interpretation of the statistical analysis of the Rasch model are more effective, accurate and detailed because data calibration is carried out on the measurement scale, respondents and items simultaneously (Fitriati, 2013; Risdianto et al., 2021).

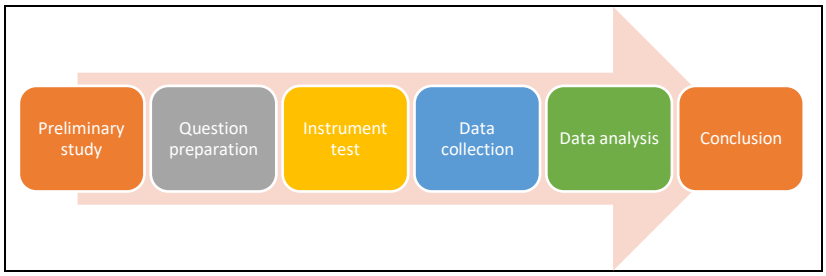

Figure 1. Research procedure chart

The validity of the test items shows the ability of the test to measure what should be measured, in this case the critical thinking skills of students on the topic of virus material. **Table 1** below shows the criteria for the validity of test items using the Rasch model.

Table 1. Question item validity criteria

No.	*Indicator*	*Criteria*
1	Outfit Mean Square (MNSQ)	0,5 < MNSQ < 1,5
2	Outfit Z-Standard (ZSTD)	-2,0 < ZTSD < +2,0
3	Point Measure Correlation (Pt Mean Corr)	0,4 < Pt Mean Corr < 0,85

(Sumintono & Widhiarso, 2015)

Non-conformity to these criteria ensures that the test items are not good enough and need to be improved or replaced (Ramadhani et al., 2024). However, test items are still declared valid if they meet at least 2 indicators, especially the MNSQ outfit and the ZSTD outfit (Jumini et al., 2023). PT Measure Corr is accepted if the value is not negative (Widiana et al., 2024). PT Measure Corr is used as an additional threshold to confirm the suitability of the item (Soeharto & Csapó, 2022) so that if it is positive it can still be accepted (Bond et al., 2020).

Reliability indicates the stability of the instrument in assessing what it assesses. The overall reliability of the instrument is based on Cronbach's Alpha value, while the reliability of students/respondents is based on person reliability and the reliability of questions is based on item reliability which is seen through Summary Statistics in the Winstep program (Muntazhimah et al., 2020; Prasetya & Pratama, 2023; Sumintono & Widhiarso, 2015). The categorization of student reliability and question reliability and instrument reliability are shown in **Table 2** and **Table 3** below:

Table 2. Categorization of student reliability and question reliability

No.	*Person reliability and item reliability values*	*Category*
1	> 0,94	Excellent
2	0,91 - 0,94	Very Good
3	0,81 - 0,90	Good
4	0,67 - 0,80	Quite
5	< 0,67	Weak

(Sumintono & Widhiarso, 2015)

Table 3. Categorization of instrument reliability

No.	*Cronbach's Alpha Value*	*Category*
1	$\alpha > 0,8$	Very Good
2	$0,7 < \alpha \leq 0,8$	Good
3	$0,6 < \alpha \leq 0,7$	Fair
4	$0,5 < \alpha \leq 0,6$	Bad
5	$\alpha < 0,5$	Very bad

(Sumintono & Widhiarso, 2015)

RESULTS AND DISCUSSION

Based on the results of the research at the instrument testing stage that has been conducted on 35 students, it can be seen the quality of the instrument used for the analysis of students' critical thinking skills on the virus material. The results of the validity test are shown in **Table 4** below:

Table 4. Results of the validity test of question items

Question Number	*Outfit MNSQ*	*Outfit ZSTD*	*PT Mean Corr.*	*Conclusion*
5 (Explanation)	0,98	0,00	0,48	Valid
6 (Self regulation)	1,05	0,30	0,67	Valid
3 (Evaluation)	0,67	-1,50	0,61	Valid
2 (Analysis)	1,19	0,90	0,70	Valid
4 (Inference)	1,10	0,50	0,63	Valid
1 (Interpretation)	0,92	-0,30	0,54	Valid

Based on **Table 4** above, each question item has met the criteria of MNSQ outfit, ZSTD outfit and Pt Mean Corr so that all questions are declared valid. This ensures that the test instrument is truly tested through the right and quality question items (Ramadhani et al., 2024). Therefore, these questions are expected to be able to accurately and precisely measure students' critical thinking skills on virus material.

In the Rasch model, reliability can be seen based on the Summary Statistics output table through the Winstep program. The results of the reliability test are shown in **Table 5** below:

Table 5. Reliability test results

Indicator	*Value*	*Category*
Person Reliability	0,67	Enough
Item Reliability	0,87	Good
Alpha Cronbach's	0,66	Enough

Based on **Table 5**, the person reliability value is 0.67 indicating that the consistency of the respondents' answers is included in the "sufficient" category in answering the questions. The item reliability value is 0.87 meaning that the quality of the items used in this instrument is "good". If the validity analysis is carried out on each test item, but the reliability analysis is carried out on some test items as a whole (Son, 2019). Therefore, the main reliability indicator is the Cronbach's Alpha value. The Cronbach's Alpha value shows the interaction between respondents and items. In this study, the Cronbach's Alpha value was 0.66 which is included in the "sufficient" category, meaning that this question instrument is reliable enough to measure students' critical thinking skills on virus material. Several factors that can influence the Cronbach's Alpha value include the number of questions used, respondent characteristics, or the complexity of the material being tested (Widiana et al., 2024).

In addition to validity and reliability, the Rasch model can also be used to determine the difficulty level of the test items. This can be seen based on the logit measure and the Standard Deviation (SD) value of the logit items (Sumintono & Widhiarso, 2015). The results of the level of difficulty of the test items are shown in **Table 6** below:

Table 6. Level of difficulty of test items

Entry Number	*Total Score*	*Total Count*	*Measure*	*Items*
5	27	35	0,61	Explanation
6	27	35	0,61	Self-regulation
3	28	35	0,52	Evaluation
2	33	35	0,11	Analysis
4	35	35	-0,05	Inference
1	57	35	-1,80	Interpretation
Mean	34,5	35,5	0,00	
S.D.	10,5	0,0	0,84	

Table 6 shows the logit values of the items sorted from the largest to the smallest, meaning from the most difficult to the easiest. The logit of the difficulty items ranges from -1.80 to +0.61. The mean value of the logit items obtained is 0.00, and the SD is 0.84. Based on the logit value, the instrument questions can be categorized in **Table 7** below:

Table 7. Recapitulation of the level of difficulty of question items

Mark	*Category*	*Question Item Number*
Measure logit > 0,84	Very difficult	-
0 ≤ Measure logit ≤ 0,84	Difficult	2, 3, 6, 5
- 0,84 ≤ Measure logit ≤ 0	Easy	4
Measure logit < - 0,84	Very Easy	1

Based on **Table 7** above, the distribution of questions is not even for the very easy, easy, difficult and very difficult categories. There are no questions included in the very difficult category but the largest percentage of questions are in the difficult category (4 items). A good question is a question that is not too easy but also not too difficult (Boopathiraj & Chellamani, 2013; Erfan et al., 2020). In this case, it means that the question items are in the medium category with the criteria of -SD logit ≤ Measure logit ≤ SD logit. Therefore, this test instrument meets the criteria for questions with a good level of difficulty because there is a large percentage of questions in the medium category.

The results of the analysis of students' critical thinking skills on the virus material can be seen through the Winstep output table in the form of a Wright Map shown in **Figure 2** below:

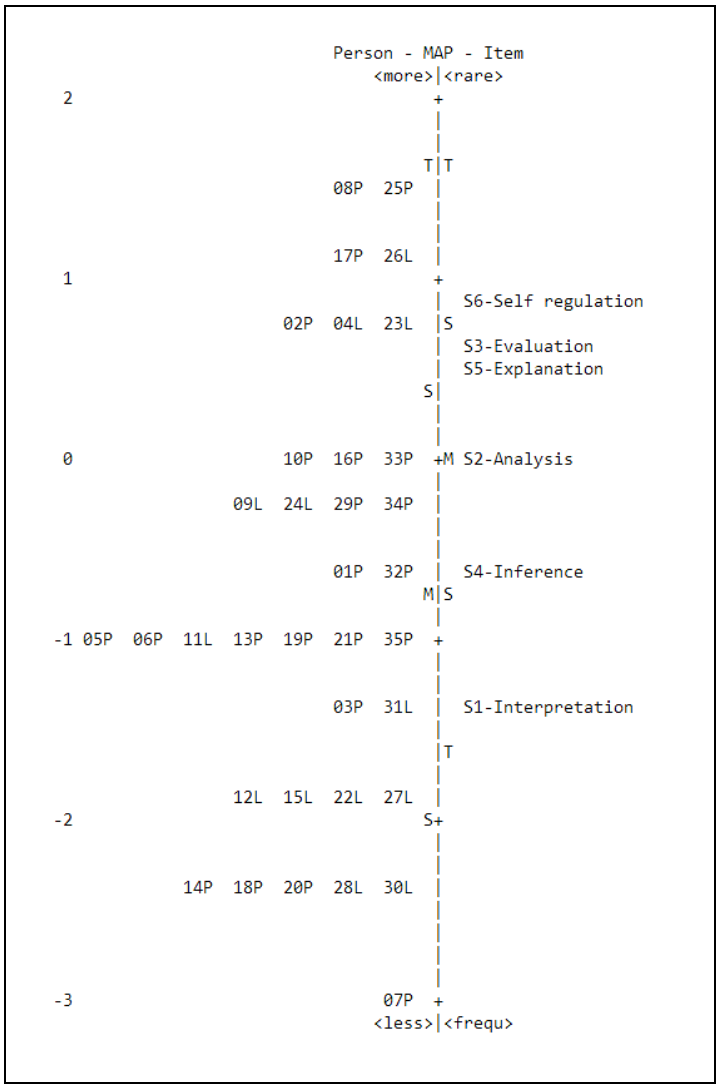

Figure 2. Wright Map

Wright Map provides information about the ability level of each student to answer questions and the difficulty level of the question items. The left side of the logit ruler shows the ability level of the student while the right side shows the difficulty level of the questions. The higher the logit value, the higher the level of critical thinking skills of students and the difficulty level of the questions. Conversely, the lower the logit value, the lower the critical thinking skills of students and the difficulty level of the questions.

Question number 1, which is the easiest question, could not be answered by students 12L, 15L, 22L, 27L, 14P, 18P, 20P, 28L, 30L and 07P. This question was answered by 25 other students whose positions were higher than question

number 1 on the logit ruler. Students 05P, 06P, 11L, 13P, 19P, 21P, 35P, 03P and 31L were able to answer question number 1 but were unable to answer question number 4. In the Rasch model analysis, students with a logit value higher than the question logit value were able to answer the question. Students 02P, 04L and 23L were able to answer questions number 3, 5, 2, 4 and 1 but were unable to answer question number 6. Students 10P, 16P and 33P were able to answer questions number 2, 4 and 1 but were unable to answer questions number 5, 3 and 6. So, students/respondents can answer questions with lower logit values but cannot answer questions with higher logit values than their logit values. For example, student 23L (0.74) can answer question S3 (0.67) but is unable to answer question S6 (0.83).

The most difficult question (number 6) in this test was only able to be answered by students 08P, 25P, 17P and 26L. Therefore, these four students were able to answer other questions with a lower weight than question number 6, namely questions number 3, 5, 2, 4, and 1. This means that these four students have higher abilities than the weight/difficulty level of the questions. This is indicated by their position being higher than the position of the questions on the logit ruler. Meanwhile, 31 other students were unable to answer question number 6. This means that these students have lower abilities than the weight of question number 6. In addition, based on the output of the person measure, the average logit value is -0.77, lower than the average logit value of the item measure of 0.00. The large number of students who are still unable to answer these test questions means that students' critical thinking skills on virus material are still low.

Several other studies also stated that the critical thinking skills of high school students in biology subjects are still low (Agustine et al., 2020; Nugroho et al., 2022; Nurliana et al., 2023; Suharyani et al., 2023; Susilowati et al., 2017), even biology education students (Nursyamsi et al., 2023). Factors that can cause students' low critical thinking skills include mindset, motivation, student misconceptions and learning models used by teachers (Endang et al., 2021; Sarwanto et al., 2021), the lack of learning and assessment instruments that empower critical thinking skills so that students are not used to being trained in questions with indicators of critical thinking skills (Agnafia, 2019; Agustine et al., 2020; Noris et al., 2024).

CONCLUSION

Based on the results of the research and discussion, it can be concluded that students' critical thinking skills on the material of viruses and their roles are still low. The results of this study can provide information to students, educators and schools so that educators are expected to be able to develop learning models and assessment instruments to stimulate and empower students' critical thinking skills.

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