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Profile of Scientific Explanation of High School Students on Human Circulatory System Material

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Abstract: This study aims to determine the profile of scientific explanation ability of high school students, especially on the material of the human circulatory system. The type of research used is quantitative research with survey methods shared through google forms. The subjects of the study were high school students who had received human circulation system material in one of several schools in Central Java, the research sample was selected through random sampling techniques from the population. The research instrument used was adapted from McNeill, Lizotte, Krajcik, and Marx (2016) which consisted of 9 long answer questions to be able to determine the success of aspects of claim, evidence, and reasoning in scientific explanation. The instrument has been declared valid and reliable through Rasch Model testing. The research data is in the form of scores from student answers which are then processed through the Rasch Model to determine the level of difficulty and wright map person (students) to find out the profile of each student's scientific explanation ability. The results showed that 78% of students were still at the lower middle level in compiling the three aspects of scientific explanation, and only 12% of students were able to achieve maximum scores in the preparation of claims, evidence, and reasoning.

Keywords: Scientific explanantion; Claim; Evidence; Reasoning; Human circulatory system; Biology; Science

Introduction

High School Students in science education emphasizes developing students' abilities to explain scientific phenomena (McLure, 2023). This is reflected in the high school science curriculum which contains material on scientific methodologys and scientific communication (Çilekrenkli, 2023). The ability to explain scientific phenomena logically and accurately is one of the important skills in science (Gizaw & Sota, 2023). These skills allow students to understand scientific concepts better and apply them in everyday life (Rini & Aldila, 2023).

Current learning aims to develop students' abilities that are scientific, one of which is scientific explanation. Students' scientific explanations are often called scientific explanations in the learning process (Nasir & Nur, 2018). Scientific explanation has 3 components, namely claim, evidence, and reasoning (Osborne & Patterson, 2011). Scientific explanation describes the product of science in the form of a scientific explanation of the process, causes, and reasons for the occurrence of a phenomenon (McNeill & Krajcik, 2009).

Student activeness and participation in the classroom can be encouraged by preparing scientific explanations. Scientific explanation requires students to be able to understand statements, explore problems, provide evaluations of problems, and provide corrections to false statements (Mc. Neill & Krajcik, 2011). The fact that during initial observation of upper middle school students during the learning process shows that most students chat with their friends, play mobile phones, respond to teacher questions with simple answers, do not even respond to teacher

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questions, thus students do not respond to the ongoing learning process.

Science process skills are essential competencies for the 21st century (Kurniawan, 2023). These skills, which scientists use during investigations, involve a variety of complex abilities integral to the learning process (Dilek, 2020). According to Elfeky, (2020), science process skills are behaviors that facilitate the acquisition of knowledge. However, students today often struggle with these skills and tend to view science as difficult, theoretical, and unengaging (Keen & Sevian, 2022). Additionally, the use of uninspired teaching methods and media contributes to student disinterest in science (Ndlovu, 2020). Teachers also face hallenges in conveying abstract physics concepts and relating lessons to real-life applications due to the pressure of meeting curriculum targets (Stadermann, 2022). In laboratory settings, while students engage in practical activities to verify theories, they are often not encouraged to explore and discover independently (Howell, 2021).

Based on the results of initial observations of biology subject teachers, most teachers stated that the ability to provide scientific explanations for the reason is an ability that students must have, especially in biology learning. The results of observations show that some teachers do not know about the indicators of scientific explanation ability consisting of claims, evidence, and reasoning.

Facts found through several similar studies show that the level of scientific explanation is low, students' reasoning still cannot provide a real evidence in natural phenomena that strengthen claims (Duncan et al., 2018).

According to Wijayanto dan Singgih Bektiarso (2020) Students tend to be unclear in conveying the conclusions that have been obtained through the observation process. Scientific explanations compiled by students are not able to completely write claims, evidence, and reasoning (Laksmi et al., 2021) (Nasir et al., 2022). The ability of students to write scientific explanations without being accompanied by visualization of objects is lower than the treatment group accompanied by providing visualization of learning objects (Lestari et al., 2021).

Based on PISA scores in 2018, Indonesia occupies the low category for science (OECD, 2019). The average score of Indonesian students' science ability is 389 with an OECD average score of 489, Indonesian students who are able to achieve level 2 in science skills are approximately 40% while the OECD average is 78% (OECD, 2019). Level 2 in science skills includes, explanation of phenomena scientifically, being able to identify, and make conclusions based on data (OECD, 2019). The PISA results prove that most Indonesian students have not been able to write scientific explanations based on existing data or evidence.

The human circulatory system is an important material in high school biology subjects. Understanding this system comprehensively and accurately is crucial for students to understand the function of the human body and apply that knowledge in everyday life. This study aims to identify and describe the profile of the scientific explanation of high school students in the material of the human blood circulation system. A deep understanding of the profile of students 'scientific explanations is an important foundation for formulating effective learning strategies to improve students' abilities in explaining the scientific phenomenon of the material.

Method

This research is a quantitative research using a survey method that focuses on knowing the scientific explanation profile of students of one of the high schools in Central Java. This study aims to find out the scientific explanation profile of students on the material of the human circulatory system. The procedure for preparing survey instruments has been validated with Winstep 3.73. The survey was distributed through a google form consisting of 9 questions to measure students' scientific explanation abilities. The test is given to students in the form of a long answer test (essay). The written test is in the form of nine cognitive questions with a maximum score of 2. The questions given are used to know. students' scientific explanation skills. The problem of scientific explanation ability is developed from the scientific explanation ability indicator adapted from Mcneill, Lizotte, Krajcik, & Marx (2006).

Instruments are tested for validity and reliability using the Rasch Model. Reliability is used to measure whether the questions on the evaluation tool get consistent results. This study used Alpha Cronbach reliability coefficient, person reliability, and item reliability. The categories of reliability coefficients can be seen in Table 1 and Table 2.

Table 1. Cronbach Alpha Reliability Coefficient Category

Reliability Coefficient	Criteria
> 0.8	Very good
0.7 – 0.8	Good
0.6 – 0.7	Enough
0.5 – 0.6	Bad
< 0.5	Very bad

Table 2. Categories of Coefficients of Person Reliability and Item Reliability

Reliability Coefficient	Criteria
> 0.94	Special
0.91 – 0.94	Very good
0.8 – 0.90	Enough
0.5 – 0.6	Bad
< 0.5	Very bad

In this study, the provisions used as a check on the alignment of question items are considered valid if the three criteria are met, namely:

- Accepted MNSQ Outfit Value: 0,5 < MNSQ < 1,5
- ZSTD Outfit value accepted: -2,0 < ZTSD < +2,0
- Accepted Pt Mean Corr value: 0,4 < Pt Measure Corr < 0,85 (or the value is not minus)

Question items are declared invalid if the criteria are not met. So that the measurements that occur in the analysis of question items require a replacement or improvement. Profile analysis of respondents' level of scientific explanation was tested through the distribution of Wright maps obtained from the Rasch Model.

Result and Discussion

Instrument Reliability Test Result of Scientific Explanation

The results of the reliability of the questions on the evaluation question instrument can be seen in Table 3.

Table 3. Results of Reliability Analysis of the Question

	Average Logit (SD)	Separation	Reliability	Alpha Cronbach
Person (Student)	1.31 (0.63)	1.23	0.60	0.94
Item (Question)	0.28 (0.01)	4.26	0.78	

The results of Cronbach's Alpha value show 0.94 which means that the reliability of the question instrument used has very good criteria. The value of person reliability and item reliability respectively obtained results of 0.60 and 0.78. This can be interpreted that the consistency of answers from respondents is quite good and the quality of the evaluation question instruments used is quite good as well. Based on the results of RASCH analysis on the reliability of the evaluation question instrument, it can be stated that the scientific explanation problem is reliable and suitable for use. This finding is in line with research conducted by Saraswati et al., (2021) reported a Cronbach's Alpha value above 0.9 for the instrument used. This shows that the instruments used in both studies have high reliability. However, study by Cordier et al., (2018) also reports test reliability range between 0.60 and 0.91. Although this value is in the quite good category Kennedy, (2022), it is slightly lower than Cronbach's Alpha. Base Taber, (2018) The differences may be in the test caused by several factors, such as the number of items used, the characteristics of respondents, or the complexity of the material being tested.

Instrument Validity Test Results of Scientific Explanation Questions

The validity of the question items tests the level of accuracy of the question items to measure students' scientific explanations. The results of the three criteria in the question item validity test have also been met, as shown in Table 4.

Table 4. Question Item Analysis Results

Number	MNSQ	ZSTD	CORR
1	1.00	0.07	0.83
2	0.84	0.58	0.81
3	0.73	-1.01	0.78
4	1.05	0.25	0.91
5	1.06	0.32	0.83
6	1.39	1.4	0.78
7	0.66	-1.41	0.89
8	1.40	1.25	0.64
9	0.97	-0.05	0.78

The results of the question item analysis show that the MNSQ outfit value of each question item is in the range of 0.5 – 1.5; the ZSTD outfit value of each question item is in the range of -2.0 – 2.0; and the point measure correlation (CORR) value of each question item is in the range of 0.4 - 0.85 except question number 7 with a value of 0.89; so that the results of the analysis of question items from the three aspects of Scientific Explanation meet three conditions and it can be stated that each question item has good quality.

Several other studies also used similar analyzes to assess instrument quality. Utari et al., (2021) that the study are consistent with the finding that the instruments used are of good quality. The results teh study consistent with the finding that the instruments used were of good quality (Utina et al., 2021). By measuring students 'abilities, there will be a picture of measuring students' abilities (Qomariyah et al., 2023).

Analysis of Student Scientific Explanation Ability Profile

In tests using the Rasch Model, the difficulty level of the question item is a comparison between the number of correct answers and the total number of questions. The difference in item difficulty is in the probability value section based on a logarithmic function called logit. A good instrument must have various levels of difficulty, this is so that each level of student ability can be represented through the existing

question items. The difficulty level of the instruments used can be seen in Table 5.

Table 5. Difficulty of the Question

Entry Number	Total Score	Total Count	Measure
4	113	84	1.42
5	127	84	0.28
7	129	84	0.14
6	131	84	0.00
1	132	84	-0.07
2	132	84	-0.07
9	134	84	-0.22
3	138	84	-0.51
8	144	84	-0.97
Mean	131.1	84.0	0.28
P.SD	8.0	0.0	0.01

Table 5 shows the logit value of each item sorted from largest to smallest, mapping the difficulty of the problem based on standard deviation and the average value obtained from the output of table 13. Item: measure (Winstep). The profile of the scientific explanation ability of high school students who have been studied can be seen on the Wright map obtained through the Winstep Output Table. The distribution mapping of students can be seen in Figure 1.

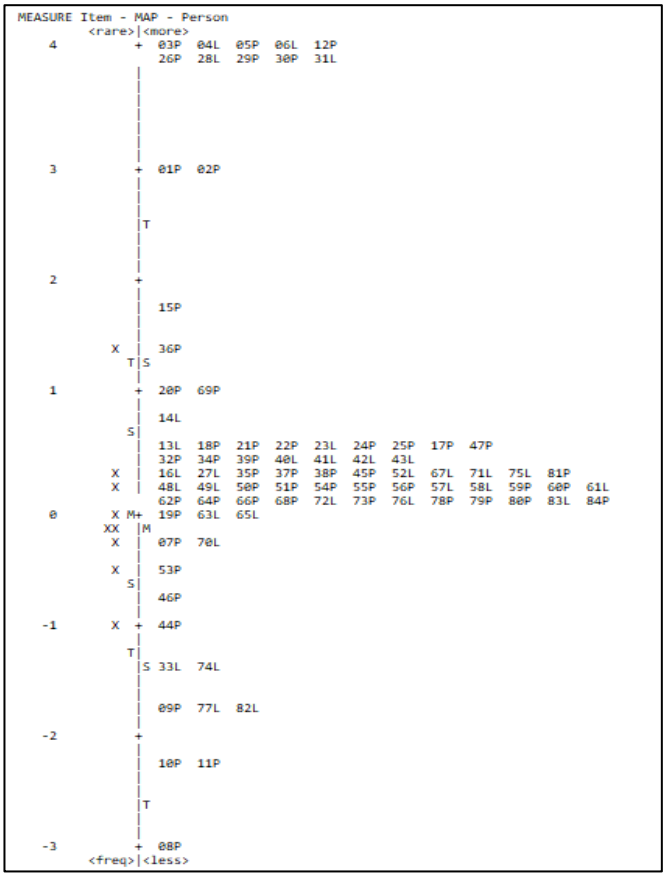

Figure 1. Wright Map Person (Students)

Based on Figure 1, it can be seen that the distribution of students who have the highest logit scores and are at the top is only 12%, while students with middle to lower accents reach 78%. This states that the profile of the scientific explanation ability of high school students is still below, or students have not been able to compile claims, evidence, and reasoning in sequence.

Students have difficulty when it comes to mentioning data as supporting evidence in compiling scientific explanations. Students have not been able to make a correct reason to connect the statements that students have written with data as existing evidence.

The low profile of students' scientific explanation abilities is caused by the passivity of student responses. Minimal student response in the learning process results in low student understanding (Stevanović et al., 2021). Low student understanding affects students' answers regarding the explanation of a phenomenon (Rohwer & Rice, 2015). Explanation of the reason or cause of a phenomenon is an activity in the preparation of a scientific explanation (Colaço, 2020), Thus, students' ability to provide scientific explanations is less than optimal.

Conclusion

Based on the results and discussion, It can be concluded that high school students already have scientific explanation skills. However, not all students are able to achieve all three aspects of scientific explanation, namely compiling claims, evidence, and reasoning. The follow-up of this study is to analyze the aspects of scientific explanation that are most difficult for students and review appropriate learning innovations to be able to improve the scientific explanation ability of high school students.

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Conceptualization, L.V.W.W., B.A.P., and B.S.; methodology, L.V.W.W.; validation, L.V.W.W., and B.S..; formal analysis, L.V.W.W.; writing—original draft preparation, L.V.W.W.; writing—review and editing, L.V.W.W., B.A.P., and B.S.

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The authors declare that there is no conflict of interest regarding the publication of this paper

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