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The Content of Scientific Explanations Aspect in The Junior High School Science Textbooks: An Analysis on Substance Pressure Topics

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ABSTRACT

The purpose of this research is to compare the aspects of scientific explanation and identify the patterns of scientific explanation in several books. The textbooks sampled in this study were (Sample 1) Science Textbooks for junior high school grade 8th Curriculum 2013 Revised Edition 2017 published by the Ministry of Education and Culture of the Republic of Indonesia, (Sample 2) Integrated Science Books for junior high school grade 8th Curriculum 2013 published by Yudhistira, (Sample 3) Science Books for junior high school grade 8th Curriculum 2013 published by Gramedia. This research uses a qualitative descriptive approach with content analysis. The data collection technique used a document content review technique in the sample book. The validity of the data used is a confidence test, a transferability test, a dependency test, and a certainty test. For data analysis using fixed comparison method which includes data reduction, organization, categorization, synthesis, and formulating working hypotheses. From this study, it was found that the scientific explanation can only be identified if it fulfills the three main components described, namely claim, evidence, and reasoning. The three book samples have uniformity in the content of scientific explanation aspects. The three all have categories of claim only (C), claim-evidence (C-E), and claim-evidence-reasoning (C-E-R). However, the sample 1 has the greatest level of density. Its mean that the sample 1 presents the most complete scientific explanation aspects when compared to the presentation of the claim aspects. The research show that in preparing junior high school science textbooks, it is necessary to pay careful attention to the completeness of the scientific explanation aspect. This is because it is very important to facilitate this for students.

Keywords: *scientific explanation, science textbooks, substance pressure.*

INTRODUCTION

The quality of human resources is closely related to the educational aspect. In educational aspect, scientific literacy is very important and needed by students. Scientific literacy is needed because according to the Program for International Student Assessment (PISA) Indonesia ranks at the bottom. Students in Indonesia are still ranked 62, 61, and 63 out of 69 countries in the achievement of science, reading, and mathematics (Pertiwi et al., 2018). Scientific literacy is the ability to use scientific knowledge, ask questions, and draw conclusions based on facts and accurate data to understand everything in the universe and make decisions about changes caused by human activities (Arohman et al., 2016). The construction scientific explanations about physical phenomena is an intrinsic part of scientific literacy skills. To be able to achieve this goal, it is necessary to have aspects that support learning, one of which is the science textbook used (Velentzas & Halkia, 2018). The importance of scientific literacy and the use of textbooks in

schools is also related to aspects contained in textbooks. One important component that is able to improve students' scientific literacy is through understanding scientific explanation which needs to be emphasized in science learning (Velentzas & Halkia, 2018). Scientific explanation is the ability to explain questions that require students to analyze data and interpret data scientifically based on existing evidence through a written or oral response (Muliardi et al., 2018). Based on interviews that have been conducted by the previous author, the material that is classified as difficult to be trained in the application of aspects of scientific explanation is the substance pressure material.

Considering the importance of scientific explanation for students and the fact that these aspects have not been identified in the textbooks used by teachers in Indonesia, it is necessary to conduct an analysis related to the content of the scientific explanation in the textbooks used. Therefore, in this study, research will be conducted on the analysis of junior high school science textbooks from the scientific explanation on the material pressure of substances.

METHODOLOGY

This research uses a qualitative descriptive approach with content analysis. Content analysis is a study of theory and methodology and utilizes library sources as study material (Ahmad, 2018). The focus of this research is to identify the content of scientific explanation in three sampel of Science Textbooks in Indonesia namely (sample 1) the science text book for junior high school students grade 8th Semester 2 Curriculum 2013 Revised Edition 2017 published by the Ministry of Education and Culture of the Republic of Indonesia, (sample 2) Integrated Science Text Books for junior high school students grade 8th Curriculum 2013 Revised Edition 2016 published by Yudhistira, (sample 3) Science Text Book for junior high school students grade 8th Curriculum 2013 Revised Edition published by Gramedia. This aspect is analyzed on the topic of substance pressure.

The data collection technique used in this study was a study of the document content in each textbook. The document review or document content review is a method of collecting data or information needed by researchers by reading letters, announcements, meeting summaries, written statements of certain policies and other written materials (Nilamsari, 2014). To make it easier to analyze aspects of scientific explanation in the contents of the textbook, several questions are assisted, including:

a) What is the main topic/statement from the author? (*to identify claims*).
b) What evidence or facts can justify the claim? (*to identify evidence*).
c) What are the guarantees that substantiate and link the claim with the evidence? (*to identify reasoning*).

The data validity technique used in this research is the reliability test or the consistency and stability test of the data or findings. Good data will point to the actual conclusion (Yusup, 2018). Research can be said to be reliable if the research process can be repeated or applied by other people in other studies (Sugiyono, 2013). The reliability test in this study involved two raters or experts called Inter-rater reliability (IRR) which gave a score of the level of agreement given using the Cohen Kappa agreement coefficient (Widhiarso, 2010). In Widhiarso (2010), the categorization of Cohen kappa coefficient values can be seen Table 1. To find the Cohen Kappa coefficient, the formula:

$$K = \frac{P_a - P_c}{1 - P_c} \quad (1)$$

Information:
K = Cohen Kappa coefficient
1 = Constant
P_a = Proportion of observed agreement
P_c = Proportion of expected agreement

Table 1. Cohen Kappa Coefficient Value Category According

k < 0.00	Poor agreement
0.00 < k < 0.20	Slight
0.21 < k < 0.40	Fair
0.41 < k < 0.60	Moderate
0.61 < k < 0.80	Good
0.81 < k < 1.00	Very good

In this research, Inter-rater reliability (IRR) were used by taking 25% of the data that had been analyzed by the researcher (Cetin, 2014). In the sample 1, there are a total of 32 claims, so 8 claims which are tested on the validity of this data. In the sample 2, 10 out of 43 total claims, while in the sample 3, 10 out of 41 total claims were taken. Table 2 presents the results of Inter-rater reliability analysis by two experts.

Table 2. Calculation of Agreement from Inter-Rater Test

Rater	Sample 1		Sample 2		Sample 3	
	Agree	Disagree	Agree	Disagree	Agree	Disagree
Expert 1	8	-	10	-	10	-
Expert 2	7	1	7	3	7	3

The results of the cohen kappa coefficient can be seen in the Table 3.

Table 3. Categories of Agreement Value of Inter-Rater Test Results

Sample	Cohen Kappa Coefficient Value	Category
1	0.875	Almost Perfect Agreement
2	0.7	Substantial Agreement
3	0.7	Substantial Agreement

In the column for the Cohen Kappa coefficient value category, the agreement between the two raters/experts is included in the good and very good category. So that, the data that has been analyzed in this study can be said to be consistent/stable data. As stated by Yusup (2018) in his research that consistent data can show conclusions that are in accordance with the actual situation.

Analysis of the data in this study using a fixed appeal method. The fixed comparison method by Moleong (2014) analyzes data constantly comparing categories with other categories. The analysis process carried out includes data reduction, organization, categorization, synthesis, and formulating working hypotheses. Data reduction, namely identifying the existence of scientific explanation by analyzing 3 main components, namely claims, evidence, and reasoning (Langae, 2011) in each book that has been obtained on the material pressure of substances. Organizing, which is looking back at the results of data reduction so that they are in accordance with the similarities in aspects of scientific explanation , namely containing claims, evidence, and reasoning. Categorization of data is done by categorizing according to the pattern of aspects of scientific explanation, namely C, C–E, C–E–R.

After categorizing the data, then calculate the average percentage of presentation of scientific explanation aspects from each book per level. We call it percentage density ($\boldsymbol{\partial}$) of the scientific explanation. The density of scientific explanation is comparison of the number of scientific explanation formulas per level presented by the book with the total claims presented. The formula of percentage density:

$$\boldsymbol{\partial} = \frac{\text{Number of patterns of scientific explanation}}{\text{total claim}} \times 100\%. \quad (2)$$

Synthesis is carried out by connecting the scientific explanation patterns that have been found with the scientific argumentation level categories. Claim only (C) is categorized as level 1, claim-evidence (C-E) is categorized as level 2, and claim-evidence-reasoning (C-R-E) is categorized as level 3. Each book sample analyzed is compared with one another to enter the scientific

explanation level category. Compiling working hypotheses related to the data obtained from the synthesis stage to compare levels scientific explanation and to answer research questions.

RESULT AND DISCUSSION

The results of the analysis of scientific explanation in science textbooks for junior high school students grade 8th Semester 2 Curriculum 2013 Revised 2017 Edition published by the Ministry of Education and Culture of the Republic of Indonesia, Integrated Science books for junior high school students grade 8th Curriculum 2013 Revised Edition 2016 published by Yudhistira, and science books for junior high school students grade 8th Curriculum 2013 Revised Edition published by Gramedia on substance pressure material identified 3 elements of scientific argumentation that are interconnected to form a scientific explanation. The first pattern is C, only the claim (C) is identified without being supported by evidence (E) and reasoning (R). The second pattern is C–E, the claim (C) is identified and is supported by evidence (E) but is not explained further because there is no reasoning in it. The third pattern is C–E–R, the claim (C) is identified which is supported by evidence (E) and explained by reasoning (R). The pattern of scientific explanation can be seen in the Table 4.

Table 4. Number of Availability of Scientific Explanation Aspects in Each Sample

Sample	Number of claim	Pattern		
		C	C–E	C–E–R
1	32	5	9	18
2	43	9	12	22
3	41	11	9	21

Explanation:

C	:	Claim
C–E	:	Claim – Evidence
C–E–R	:	Claim – Evidence – Reasoning
Sample 1	:	Science textbooks for junior high school students grade 8th Semester 2 2013 Curriculum Revised Edition 2017 published by the Ministry of Education and Culture of the Republic of Indonesia
Sample 2	:	Integrated science book for junior high school students grade 8th Curriculum 2013 Revised Edition 2016 published by Yudhistira
Sample 3	:	Science book for junior high school students grade 8th Curriculum 2013 Revised Edition published by Gramedia

Based on the Table 4, it is known that the books with the most claims are The Integrated Science book for junior high school students grade 8th Curriculum 2013 Revised 2016 Edition published by Yudhistira (43 claims). Compared with the science books for junior high school students grade 8th Curriculum 2013 Revised Edition published by Gramedia found fewer claims (41) and science textbooks for junior high school students grade 8th Semester 2 Curriculum 2013 Revised Edition 2017 published by the Ministry of Education and Culture of the Republic of Indonesia identified 32 claims.

From the number of available aspects of scientific explanation in the sample book, it is categorized according to the analytical framework to determine the level of scientific explanation. Based on the calculation of the average percentage of each scientific explanation, the results obtained can be seen in the Table 5.

Table 5. Percentage of Scientific Explanation Level of Three Sample Books

Scientific Explanation Pattern	Scientific Explanation Level	∂		
		Sample Book 1	Sample Book 2	Sample Book 3
C	Level 1	15,6%	20,9%	26,8%

Scientific Explanation Pattern	Scientific Explanation Level	∂		
		Sample Book 1	Sample Book 2	Sample Book 3
C-E	Level 2	28,1%	27,9%	23%
C-E-R	Level 3	56,3%	51,2%	51,2%

Based on the Table 5, it can be seen that the majority claim of the three sample books that have been analyzed occupies level 3 which have a percentage above 50% with the order of the highest to lowest percentage being sample 1 of 56.3%, sample 3 of 51.2%, and sample 2 of 51.2%. Level 3 is a pattern of scientific explanation that describes the existence of claim that is supported by evidence and reasoning (C-E-R). Based on research findings, scientific explanation patterns found in textbooks are presented with supporting evidence in the form of data experiments, observations in daily life, or in the form of factual images. Next, based on this evidence, reasoning is presented in the form of sentences that connect the statement with existing evidence in the form of cause and effect, supporting formulas, and applications in daily life. The relationship between Claims – Evidence – Reasoning can be seen in the Figure 1.

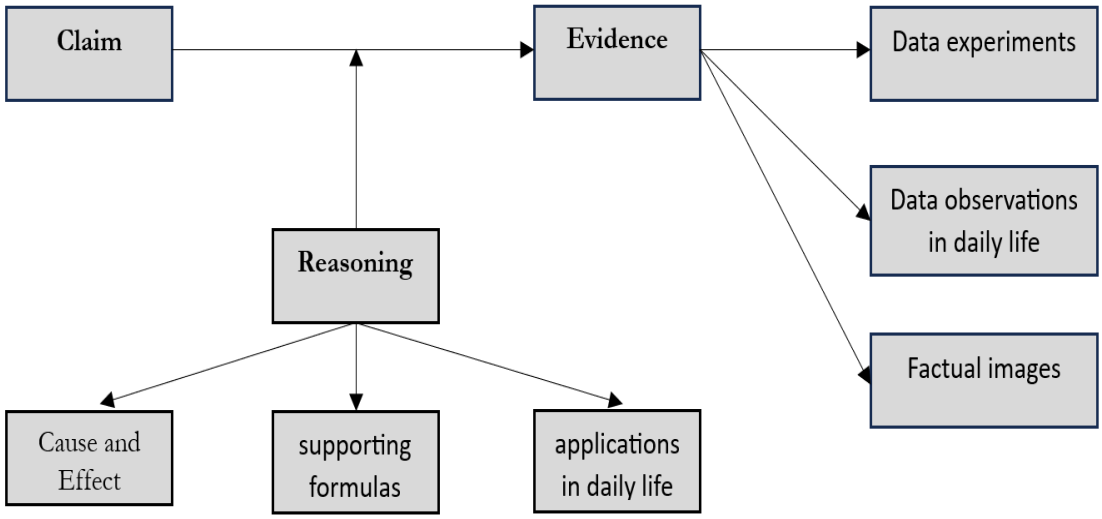

Figure 1 Claim-Evidence-Reasoning

For level 2 in the analysis of Table 5, the scientific explanation with the highest percentage is found in sample 1 as much as 28.1%, then the second is sample 2, which is 27.9 % and the last is sample 3 as much as 22%. In this pattern, the content in the sample book only shows the author's statement accompanied by evidence in the form of understanding, types, or processes. For the lowest level, namely level 1 in the analysis of Table 5, the pattern of scientific explanation C with the highest percentage is found in sample 3 as much as 26.8%, then the second is sample 2 which is 20.9% and the last is sample 1 as much as 15.6%. In this pattern, the content in the sample book only shows the author's statement without any evidence or reasoning, the statement can be an example of a case in life or the application of a concept.

From the explanation that has been submitted, it can be seen that sample 1 is the Science Textbook for junior high school students grade 8th Semester 2 Curriculum 2013 Revised Edition 2017 published by the Ministry of Education and Culture of the Republic of Indonesia in Chapter 7 with the material "Substance Pressure and Its Application in Daily Life", there is a discussion of 32 pages consisting of 6 subchapters and 27 material concepts with 32 claims. From all claims, there are 3 patterns of scientific explanation. Level 1 with pattern C (Claim) has 5 claims with a percentage of 15.6%, for level 2 with pattern C–E (Claim - Evidence) has 9 claims with a percentage of 28.1%, and for level 3 with pattern C– E–R (Claim – Evidence - Reasoning) has 18

claims with a percentage of 56.3%. Then sample 2, namely the Integrated Science Book for junior high school students grade 8th Curriculum 2013 Revised Edition 2016 published by Yudhistira in Chapter 8 with the material "Substance Pressure", there is a discussion of 28 pages consisting of 6 subchapters and 38 material concepts with 43 claims. From all claims, there are 3 patterns of scientific explanation. Level 1 with pattern C (Claim) has 9 claims with a percentage of 20.9%, for level 2 with pattern C–E (Claim - Evidence) has 12 claims with a percentage of 27.9%, and for level 3 with pattern C– E–R (Claim – Evidence - Reasoning) has 22 claims with a percentage of 51.2%. Furthermore, sample 3 is the Science Book for junior high school students grade 8th Curriculum 2013 Revised Edition published by Gramedia in Chapter IX with the material "Substance Pressure", there is a discussion of 21 pages consisting of 5 subchapters and 36 material concepts with 41 claims. From all claims, there are 3 patterns of scientific explanation. Level 1 with pattern C (Claim) has 11 claims with a percentage of 26.8%, for level 2 with pattern C–E (Claim - Evidence) has 9 claims with a percentage of 22%, and for level 3 with pattern C–E– R (Claim – Evidence - Reasoning) has 21 claims with a percentage of 51.2%.

The percentage of scientific explanation written in Table 5 shows the average density of the number of scientific explanation in the number of claims. The highest percentage of the scientific explanation pattern is the C–E–R (Claim – Evidence – Reasoning) pattern which occupies level 3 when compared to all claims found, then the highest density of scientific explanations of the three sample books that have been analyzed is found in sample 1, namely Science textbooks for junior high school students grade 8th Semester 2 Curriculum 2013 Revised 2017 Edition published by the Ministry of Education and Culture of the Republic of Indonesia with a percentage of 56.25% but have the claims least claims. In contrast to other sample books which have a C–E–R (Claim – Evidence - Reasoning) pattern percentage at level 3 below sample 1, namely sample 2, which has a percentage of 51.2% of 43 claims and sample 3 which has a percentage of 51.2% of 41 claims.

After analyzing the three samples of junior high school science textbooks, we categorize the description of the scientific explanation for each pattern. From each pattern occupying a different level, a description of the scientific explanation from the analysis of the sample book can be seen in the following Table 6.

The main purpose of science education is to help students find evidence and reasons for ideas or knowledge claims described in science (Driver et al., 2000). Scientific explanation tries to answer three questions, namely: what we know (the ontological question), why it happened (the causal question), and how do we know (the epistemic question). Explanation means the answer to a question from "an explanation that describes how this fact can occur", it explains that the explanation consists of a causal explanation (Osborne, 2011). College Based Science Standards in Osborne (2011) also explains that scientific explanation is defined as "a statement consisting of at least one claim, evidence related to the claim, and reasons that clarify both". Thus, it can be said that a scientific explanation or fulfills the objectives of science education must at least contain claims, evidence, and reasoning. In the analysis of the sample book that has been carried out, it was found that the existing explanations have fulfilled the common usage of "explanation" that has been described by Velentzas & Halkia (2018), namely explanation as explication, explanation as causation, and explanation as justification.

Table 6. Description of Scientific Explanation

Level	Pattern	Description
1	C	Provide only statements/facts without being explained with supporting sentences to prove the truth of the sentence
2	C–E	Claims supported by evidence form of: a) Experimental data b) Observations in life daily life c) Illustrations or explanation pictures

Level	Pattern	Description
3	C–E–R	Claims supported by evidence are then explained by reasoning form of: a) Cause-effect relationships b) Supporting formulas c) Application in life

From the analysis of the three sample books that have been carried out, it was found that all sample books contain 3 elements of scientific explanation, namely claim, evidence, and reasoning. With this analysis, it can be seen that the book has fulfilled the main components of scientific explanation or scientific explanation (Langae, 2011; McNeill & Krajcik, 2008). From the elements of scientific explanation, it was also found 3 patterns that are interconnected from one element to another. The patterns are C (Claim/claim), C–E (Claim/claim – Evidence/evidence), and C–E–R (Claim/claim – Evidence/evidence – Reasoning). The three sample books contain 3 patterns of scientific explanation with the most patterns found in the C–E–R pattern in each sample book. From this statement, it can be seen that all sample books meet the highest level of scientific explanation aspect scientific explanation a fairly strongavailability of scientific explanation the highest level of claims that are not accompanied by evidence and reasoning.

From the results of the analysis and comparison of the density of scientific explanation from all junior high school science textbooks that were used as research samples, the three sample books already presented quite a number of aspects of scientific explanation that met the main components of scientific explanation itself. This is evidenced by the percentage of the C–E–R pattern which is more than 50% of the total claims found in each sample book. This statement is directly proportional to previous research regarding the 2013 Curriculum Middle School Science textbooks in Indonesia which stated that the direction of textbook development in Indonesia puts forward an integrated, experimental-based, and scientific attitude model (Fitriani et al., 2019; Hakim, 2019; Wahyu RN et al., 2020). However, this research does not only identify the existence of aspects of scientific explanation, but also explains and compares the patterns of scientific explanation contained in each book that is used as the research sample.

Aspects of scientific explanation that meet the categories mentioned by McNeill & Krajcik (2012), must contain the main components of scientific explanation, namely claims, evidence, and reasoning. The following is an example of a paragraph that fulfills the scientific explanation.

> Jika kalian menjatuhkan sebuah balok pada tanah yang lembek, balok tersebut akan meninggalkan bekas di tanah. Bekas tersebut menunjukkan bahwa tanah tertekan oleh balok yang jatuh (***claim***). Tekanan tersebut makin besar jika balok dijatuhkan dari tempat yang lebih tinggi. Tekanan balok penampang kecil lebih besar daripada balok penampang besar. Dengan demikian dapat dikatakan bahwa besar tekanan suatu benda berbanding terbalik dengan luas penampangnya. Hal tersebut membuktikan bahwa luas penampang yang kecil akan memperbesar tekanan suatu benda (***evidence***). Dengan demikian dapat disimpulkan bahwa tekanan suatu benda merupakan hasil bagi gaya tekan dengan luas permukaan tempat gaya tersebut bekerja.
>
> Pernyataan itu dapat dirumuskan sebagai berikut.
>
> $$P = \frac{F}{A}$$
>
> Dengan
>
> P = Tekanan (N/m^2 atau pascal = pa)
>
> F = Gaya tekan (N)
>
> A = Luas permukaan tempat gaya bekerja (m^2) (***reasoning***)

The paragraph presents claims in the form of simple activities that are often carried out in daily activities related to material concepts. Then displayed evidence in the form of cause and effect of the occurrence of events on the claim. Furthermore, reasoning is givenin the form of the formulation of theevidencethat has been mentioned. So, this paragraph is a paragraph that fulfills the scientific explanation.

CONCLUSION

From this research, it was found that the scientific explanation can only be identified if it fulfills the three main components that have been described, namely claim, evidence, and reasoning. The science text book for junior high school students grade 8th Semester 2 Curriculum 2013 Revised Edition 2017 published by the Ministry of Education and Culture of the Republic of Indonesia (sample 1) has the greatest level of density. Its mean that the sample 1 presents the most complete scientific explanation aspects when compared to the presentation of the claim aspects. The Integrated Science Text Books for junior high school students grade 8th Curriculum 2013 Revised Edition 2016 published by Yudhistira (sample 2) and the Science Text Book for junior high school students grade 8th Curriculum 2013 Revised Edition published by Gramedia (sample 3) have more scientific explanations presented than sample 1, but when compared to the number of claims presented, sample 1 is more complete in presenting scientific explanations. The pattern scientific explanation obtained in this study is C (claim), C-E (claim-evidence), C-E-R (claim-evidence-reasoning). Based on this research, it is necessary to pay careful attention to present the completeness of the scientific explanation aspect. It is very important to facilitate scientific explanation for students.

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