Structure analysis of Indonesian mathematics textbooks in the topic of relation and function for junior high school

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Abstract. The development and interest in mathematics textbooks in Indonesia have a considerable increase in the last decade. In this study, we discuss on structure analysis of Indonesian mathematics textbooks in Relation and Function Topics. We focused structure analysis of mathematics textbooks for 8th-grade students. Three Indonesian mathematics textbooks were analyzed for this study. An analysis framework was developed to investigate the characteristics of the structure in the textbooks from three perspectives: the physical features, the schematic of the math contents in the textbooks, and the patterns in the sequencing of content. We counted the distribution of block types, contents and performance expectation types to help us in examining and analyzing the structure of textbooks in relation and function topics for 8th grade. Our analysis showed that the three textbooks generally have a common structure. Firstly, the textbook A has more pages than the others. Mostly the textbook provided many learning activities with a scientific approach. Secondly, the schematics showed that the brief of structure of the three textbooks which have a common structure: 1) illustration about relation and function; 2) a concept map; 3) a set of narrations, learning activities, worked examples, and exercise to help students in understanding the topics; and 4) a competency test to examine whether students have achieved the aims of learning or not. Lastly, the patterns in sequencing content of the three textbooks showed that they have different patterns. Based on the results, recommendations are given for investigating the linkage between the structure of textbook and performance expectation in order to do further research on these topics.

1. Introduction
If many mathematics education researchers have a concern in how learning works in the classroom, we prefer the source used in the classroom while learning process happens, which is textbook, the main source. The role of textbooks in education is textbooks translate what the aims of the national curriculum for a particular course in detail and structurally. Mathematics textbooks have bridged national curriculum and classroom in order to achieve the aims of learning by how the mathematical concept would be conveyed, the sequencing of contents, the examples, types of questions, and opportunities to learn for students [1,2,3,4,5].

The importance of research about textbook analysis is the result of the studies could supply references for official reviewer of textbooks which would be published nationally. Research about mathematics textbooks in Indonesia increased considerably in the last decade, the focus of the previous studies was about types of questions in textbooks based on distinct views such as TIMSS, PISA, or opportunities-to-learn [3,6,7]. What is different from previous studies is that this study focuses on structural analysis in textbooks.
The structure of the textbook will affect how certain mathematical material sequences are delivered. Even though they have the same learning objectives, each mathematics textbook has its own uniqueness to translate and achieve the goals compiled by the national curriculum. It could influence how effectively students will learn the mathematics contents [2]. In this study, we focused on the topics of relation and function for 8th-grade students. The aim of this study was to investigate the characteristics of the structure in the textbooks from three perspectives: the physical features, the schematic of the math contents in the textbooks, and the patterns in the sequencing of content. Other fascinating findings also would be given in this study.

To reach the aims of this study, these research questions were:
1. How is the physical features of textbooks which presented the topics of relation and function?
2. How are the schematics of the relation and function in the textbooks?
3. How are the patterns in the sequencing of mathematics contents in the topic of relation and function?

2. Methods
The research method used in this study is qualitative research method. Three Indonesian mathematics textbooks were analyzed for this study. The textbooks are one from government and two from private publishers. Next, the three textbooks consecutively would be called by Book A, Book B, and Book C to make reading easier. An analysis framework was developed to investigate the characteristics of the structure in the textbooks from three perspectives: the physical features, the schematic of the math contents in the textbooks, and the patterns in the sequencing of content.

To collect the data of the study, we carried out:
1. Physical features: we measured the length and width of the three textbooks, the number of pages, font type and size, and the colors used in discussing the topics
2. The schematic of the math contents in textbooks: counting block types. There were twelve block types:
   1. Narrative
   2. Related narrative
   3. Unrelated narrative
   4. Related graphic/table/diagram
   5. Unrelated graphic/table/diagram
   6. Exercise set
   7. Competence test
   8. Students’ homework
   9. Unrelated exercise
   10. Activity
   11. Worked example
   12. Illustration/Photo
3. The sequencing of contents: counting various contents. There were fifteen mathematics contents in the topics of relation and function which are:
   1. Definition of relation
   2. How to present relation
   3. Definition of function
   4. How to present function
   5. How many distinct functions can be defined from set A to B
   6. Definition of one-to-one function
   7. How many distinct one-to-one functions can be defined from set A to B
   8. How to formulate function
   9. Dependent and independent variables
   10. How to find the value of function
   11. How to formulate linear function
   12. Function graphic
   13. Application of relation and function
   14. Summary
   15. Definition of domain, codomain, and range

This framework was developed from the TIMSS Framework for analyzing mathematics textbooks used 4th and 8th-grade students [2]. The procedures to investigate the structure of textbooks were [5]:
1. Collecting all pages what discussed the topics in the textbooks
2. Read the data, marking entries related to block and content type codes
3. Read entries by the block and type codes, recording the main ideas on a summary sheet
4. Look for patterns, relationships, and themes within block and content types
5. Decide if the patterns are supported by the data, and search the data
6. Look for relationships among the patterns identified
7. Write your patterns as one-sentence generalizations
8. Select data excerpts that support your generalizations

We counted the distribution of block types, contents and performance expectation types to help us in examining and analyzing the structure of textbooks in relation and function topics for 8th grade.

3. Result and Discussion
3.1. Physical Features
Based on Table 1, Book A and Book B have the same paper size which 17.6 × 25 cm. But they pose a different writing style. Book A has font size greater than Book B and the number of pages which discussed the relation and function in Book A is more than other books. Book C is the biggest textbook with paper size 20 × 26.5 cm. Book A has 64 pages, Book B 31 pages, and Book C 29 pages. The quiet difference is that Book A give more learning activities than other textbooks which caused thicker than others.

|                          | Book A   | Book B   | Book C   |
|--------------------------|----------|----------|----------|
| **Paper Size**           | 17.6 × 25 cm | 17.6 × 25 cm | 20 × 26.5 cm |
| **Pages**                | 64       | 31       | 29       |
| **Font Type and Size**   | Times New Roman | Times New Roman | Times New Roman |
|                          | 12       | 11/10    | 12       |
| **Colours**              | Black, yellow, green, green mint, orange, pink, purple | Blue, black | Saphire, black |

3.2. The Schematic of The Textbooks
The schematics showed that the brief illustration of the structure of the three textbooks have a common structure: 1) illustration about relation and function; 2) a concept map; 3) a set of narrations, learning activities, worked examples, and exercise to help students in understanding the topics; and 4) a competency test to examine whether students have achieved the aims of learning or not.

The way to read the schematics (Figure 1) is the first column means block types and the first and second rows means pages. For example, in Figure 1, in the first page of Book A, there were narrative block and illustration in that page. We counted and examined the distribution of block types which appears on each page in the topic of relation and function of the three textbooks. After that, we could see the schematic of each textbook. In the first pages, the textbooks gave a general illustration, concept map, and the aims of learning the topics of relation and function. After that, students would be introduced to the definition of relation, how to present relation, and etc.

From Figure 1, it shows that the topic of relation and function was presented by narrative blocks and related graphic/table/diagram. It probably because the aims of learning of this topics are how students could describe and present relation and function by using various representation (words, tables, graphics, diagrams, and equations) [8]. 31 of 64 pages from Book A showed related graphics of certain mathematics contents discussed on one page. The fewest block types which were used for presenting the topic of relation and function in Book A was illustration/photo and competency test. Besides, that Book A provided learning activities and competence test more pages than other textbooks. Another interesting finding is that in Book A, there was a graph not related with context. This finding has to investigate further if it gives impacts to students’ understanding or not. But we need further research to examine whether this would influence teacher or student in the learning process.

Book B also used narrative blocks and related graphics/tables/diagrams to present the topics of relation and function. Narrative blocks appeared in 20 of 31 pages and related graphics/tables/diagrams appeared in 26 of 31 pages. The fewest block types which were used in this textbook were activities and competence test, 2 pages respectively. It caused Book B was the textbook
which gave textbooks that provide the least competency test places. But we need further research to examine opportunity-to-learn the three textbooks from types of question set and competence test [3].

**Figure 1** The Schematics of Book A (up), Book B (middle), Book C (down)
Book C has a common schematic as Book A and B. This textbook also used narrative blocks and related graphics/tables/diagrams. Narrative blocks and related graphics/table/diagram appeared on 16 of 29 pages. The fewest block types which appeared in the topic of relation and function is illustration or photo, only one page in the first page.

Another finding from the three schematics is that there were no unrelated narrative blocks, graphics, and unrelated exercise. It would minimize misconception or mistake happens. As said before, the schematics revealed that the most block type which appeared in the topics of relation and function was related graphics/table/diagram. The graph used was coordinate graphs and the diagram was arrow diagrams. It probably aims to achieve the goal of learning the topics of relation and function for 8-grade students [8].

3.3. The Patterns of The Sequencing of The Contents
There are three categories of patterns of the sequencing of the contents [2]. The three textbooks in this study fulfill the category of textbooks with sequential themes reflecting the progression of sequential themes. This is because the three textbooks represented the topics with interconnected between contents. There are three types of sequential textbooks: multiple topics, single topics, and recursive single topics. The definition of multiple topic themes is a book with sequential content themes that have several different topics and will form one big theme. Recursive theme type is a book that has the theme of sequential and multiple contents, but some contents reappear after being discussed previously. The last type of theme is a textbook with single-topic themes is a book with the theme of content that does not repeat the content that has been discussed.

In this study, we examined one topic, the relation and function. Because of that, we used the term of multiple or single content themes, which means the mathematics contents in the topic relation and function. Book A and C were categorized as textbooks with sequential themes with multiple content themes. It means that the textbooks had multiple contents which were given many pages than other contents. For example, Book A started from the definition of relation and then have 13 pages to discuss how to present relation (Figure 2). Book A discussed definition of function and how to present function in 11 and 8 pages respectively. Book C has 6 pages to discuss how to present relation and 7 pages for how to present function. It quite far than other contents if we see from Figure 2. Because of that, we characterize these two textbooks with sequential themes (multiple contents) to form the topic of relation and function.

Based on Figure 2, Book B represented as a textbook with sequential themes with single-content themes. It is because the textbook did not revisit the content have been discussed previously. Even there were happened in three contents, but this can be ignored because the rest of the contents did not been discussed. Besides that, the proportion of each content has no considerable pages than others. This is why Book C was characterized as a textbook with sequential themes with single-content themes.

3.4. Other Findings
Book A and Book B provided distinct mathematicians who were Galileo and Rene Descartes respectively in order to motivate student could imitate their good behaviors. Book A has some interesting learning activities such as Let’s Observe, Let’s Ask, Let’s Try, Let’s Find Out, and Let’s Share Together. Book C is the thinnest book than others, only 29 pages. Moreover, there are some unique features in the textbook. First, the exercise set was presented structurally by the level of difficulty. Lamp icon means understanding concept who discussed paragraphs before. Mouse icon means using application and communication skill to solve the problems. Brain means problem-solving skill for addressing the problem. It facilitated students to evaluate themselves how far they understand the topics of relation and function and also to improve their math skills. Another finding in this study is that Book C did not comprise an explanation of one-to-one function in the topics of relation and function, besides other books, did. In fact, a one-to-one function is called by one-to-one correspondence for 8th-grade students. Book C has a particular block to discuss how to make a table for finding the value of a function.
Figure 2 The sequencing of contents in Book A (up), C (middle), and B (down)
4. Conclusion
From the results and discussion session, we can conclude that the physical features of the three textbooks have common features. The difference between the textbook is Book A is the thickest which has 64 pages and Book C is the thinnest which has 29 pages. Secondly, the schematics showed that the brief of structure of the three textbooks which have a common structure: 1) illustration about relation and function; 2) a concept map; 3) a set of narrations, learning activities, worked examples, and exercise to help students in understanding the topics; and 4) a competency test to examine whether students have achieved the aims of learning or not. Lastly, the patterns in sequencing content of the three textbooks showed that they have different patterns. In this study, we could not investigate the influence of the structure of textbook and performance expectation. Based on the results, recommendations are given for investigating the linkage between the structure of textbook and performance expectation in order to do further research on these topics.

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