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Development of Numerical Logic Textbook Containing Characters through Elementary School Students' Thinking Analysis

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Abstract. This study aims to develop a numerical logic textbook through elementary school students' thinking analysis and containing character education. Numerical Logic is one of the required competencies in mathematics that must be mastered by the pre-service teacher of elementary school. This subject is intended to see various points of view of students in the process and solving mathematical problems. Nowadays no teaching material model explains the numerical logic of elementary school students, so in the end, the teacher will teach mathematics according to the teachers' point of view. Besides, they are required to be good role models for their students with character education. This study used the 4D Model where consist of four stages, namely define, design, develop, and disseminate. Method of collecting and analyzing data used was documentation method to get textbook data and observation to analyze elementary students' thinking data before textbooks developed, the questionnaire to get expert validation data and readability by the students of the pre-service teacher of elementary school as well as a test to obtain data on the eligibility of test instrument. The validation results show that the textbook is feasible to use even though there are some improvements however not change the concept. The readability test result shows that some words need to be revised. It can be concluded that the textbook is effective and readable to be used in a class.

Keywords: numerical, logic, textbook, character, thinking

INTRODUCTION ~ Mathematics is one of the compulsory competency fields that must be mastered by prospective elementary school teachers because one indicator of competency that must be mastered by elementary students is numeracy competency. This competency is in the field of mathematics. To be able to understand and use mathematics in problem solving requires a good mastery of concepts(Winarni & Harmini, 2017).Before students could mastered well, the teacher must mastered it well first.

So that in the education of elementary school teacher department curriculum at STKIP Al Hikmah Surabaya there are compulsory subjects related to mathematics, including counting logic, numeracy art, and elementary mathematics which in each of these courses have special identifiers. Count logic is an opening course for prospective elementary teacher students in mastering concepts and learning of mathematics in elementary schools, especially related to the concepts of numbers and reasoning of elementary school children in understanding basic mathematical concepts.

The learning achievement of this course is to make college students are able to see various points of view of students in the process and solving mathematical problems. Prospective elementary school teachers in understanding elementary school mathematics are not enough to understand the material alone, but there needs to be an understanding of how the students' thinking plot in mathematics before they develop more abstract

mathematical concepts. Educators must be able to see how students develop. Teaching everything according to his nature is the main point so that we do not damage the creativity of students in exploring their abilities(Santosa, 2018).

The plot of thinking of elementary students, in this case, is how elementary students learn about numbers and arithmetic with a high level of meaningfulness for students. Students will follow the logic of the nature of the mind that is natural, no longer on a particular algorithm. If the teacher is able to maximize the nature of the child's reasoning, they will find answers to the various mathematical problems given. So students no longer need to memorize certain algorithms, but they can find their own algorithms with a deep understanding of concepts. the most important thing is students understand the concept first after that students will be able to formulate their own findings into a particular algorithm. Analysis of the thinking plot is the basis for the development of numeracy logic textbooks in this study.

The material raised is low grade and high-grade elementary school mathematics material in accordance with 2017 revised 2017 curriculum. To get information and so on about how elementary students solve mathematical problems, the researcher plunges directly or indirectly to be able to see how elementary students currently operating mathematical problems. Furthermore, variations in the methods obtained in the field are synchronized with the reference sources that are then listed and arranged according to elementary school mathematics material.

By studying the course of numerical logic through elementary school students' thinking plot analysis, the understanding of prospective teacher candidates will be more intact in understanding how elementary students can absorb learning optimally and not make mathematics a scary thing anymore. In addition, the professional competence of students as teacher candidates will also increase.

College students learn how elementary school students understand mathematics in their own way so that in the end mathematics is no longer the field most students avoid. Strengthening the correct numeracy logic for students will have an extraordinary impact related to how students can later solve various mathematical problems encountered without busy memorizing the algorithm. So this numeracy logic course becomes very important to be mastered by prospective elementary school teachers.

In the process of increasing understanding of mathematical concepts, students could interact directly with students to find out how students solve mathematical problems. Students can also explore themselves about how students solve mathematical problems without memorizing algorithms, which will emerge many possible answers. So this numeracy logic course becomes very important to be mastered by prospective elementary

school teachers. This is very important for prospective elementary school teachers to look for various learning resources in improving understanding of mathematical concepts.

This numeracy logic course does not yet have a special textbook that can be used as the main reference in lectures. During this time the lecturer only uses elementary mathematics material books or for the education of elementary school teacher department which is then self-developed in the implementation of learning. So it is necessary to develop a learning resource for these lectures.

The role of learning resources is very important in the course of learning. Mulyasa(Mulyasa, 2017)states that the low quality of a learning activity is the low frequency of the use of learning resources that are used by teachers and students. One example of learning resources such as textbooks. This textbook is one of the references used by teachers and students in learning(Suwarni, 2015).

According to the Complete Dictionary of Indonesian Language, the book has a meaning as a book that functions as a provider of the learning process in class. If seen from its understanding, the textbooks should be arranged in accordance with the learning objectives that have been set in the subject matter. While development is a systematic process to be able to produce a design, method, or device that has a value of usefulness and meets certain requirements(Putra, 2012).

Based on these two definitions, it can be concluded that the development of textbooks is a systematic process in producing textbooks that are in line with learning objectives and meet the requirements of textbooks. Today, textbooks that have been developed are numerical logic textbooks through analysis of elementary school students' thinking paths with character education. The hope, this textbook is able to provide benefits for prospective elementary teacher candidates in mastering elementary school material from the perspective of students. It is also expected that there is a match between the contents and the learning objectives of the numerical logic courses to be achieved.

In addition, there is one important component in ongoing education, namely the teacher. Teachers have a very large contribution to the educational process. The teacher is also one of the agents of change in which everything the teacher does becomes an imitation magnet for the students, especially for elementary school teachers. Elementary school students are individuals who emulate their teachers. Therefore, the teacher must have good character so that later students could emulate it.

Character is defined as individual characteristics in thinking and behaving to live in the community. In addition, character is also interpreted as a good typical value in a person and reflected in his behaviour(Kementrian Pendidikan

Nasional, 2010). This character can be grown through systematic character educationwhere among the strategies is integration in learning with character education to support the internalization without being aware of the students.

This character education could help students to be successful in school and in their lives(Schwartz, 2008). Personal with good character will be able to respond to everything well and wisely. The characters that can be grown in relation to the logic of arithmetic are skilful, empathetic, loyal, enthusiastic, disciplined, appreciative, and nationalist.

This is in line with what is applied at STKIP Al Hikmah. Which one of the curriculums applied in teacher training schools is the cultivation of character in students. These characters are disciplined, honest, smart, tough, and caring.

Based on this background, research was conducted on the development of numerical logic textbooks through elementary school students' thinking plot analysis and character education. Textbooks that examine in-depth about the way of thinking of elementary school students in every detail of the material areas of mathematics competency in elementary school Numerical Logic while simultaneously instilling character education to students

METHOD

This research is using a numerical logic textbook as development object trough analysis elementary school thinking plot with the integration of character education. This development research using 4D (four-D model) which was initiated by Sivasailam Thiagarajan, Dorothy S. Semmel(Thiagarajan, Semmel, & Semmel, 1976). This 4D model consists of four stages define, design, development, and disseminate.

Research Subject

this research subject is lower elementary students class and collage student of Al Hikmah education of elementary school teacher Departement second semester and fourth semester. Elementary students whoare involved in this research are students of Al Hikmah elementary school Surabaya, UNESA laboratory elementary school, and elementary Labschool UNESA. they are students who have been chosen by the teacher at the school based on their ability namely, low,intermediate, and upper. These students are used to know how the elementary students thinking plot is related to numerical logic at the define stage.

Furthermore, the selected college students are the students who have obtain Numerical Logic course, with total number of 15 students. 5 students for limited trials and 10 students for final trials.These college students are subjected to textbook trials to be able to find out whether textbooks can be effectively used in lectures and readability of textbooks.

Research Stages

The research procedure used is as mentioned before, with four stages.The first stage is defined which consists of literature study and planning. Where in this stage consists of a preliminary analysis of the numerical logic of elementary students school as welland perspective of the needs of students of education ofelementary school teacher department of STKIP Al Hikmah.

In addition, an analysis of the tasks and concept of the material will be written in the textbook.

In the second stage, the design consists of determining the design and template of books and compiling books that are tailored to the thinking path of elementary school students with the integration of character education.The overall layout is also carried out at this stage.

The next stage is the development stage which consists of developing books which are then reviewed and validated by material experts and linguists,The results of improvements from experts then called the revision draft. After stated valid, a limited trial and final trial are conducted on elementary student teacher candidates at STKIP Al Hikmah Surabaya.The strengths and weaknesses found during the limited and final trials are used to make further revisions

The final stage of this development is dissemination. This disseminationis conducted with two events, namely providing textbooks to students and libraries and disseminating research results through scientific publications. (See Figure 1).

Data Collection and Analysis Techniques

Data collection conducted in this research is by validating textbooks by material and language experts using validation sheets. It also uses a questionnaire instrument that is filled out by college students after a limited and final trial and an interview sheet is also conducted on college students regarding college student responses to textbooks. Students in this case also have the opportunity to provide criticisms and suggestions for textbooks so that they could help the achievement of research objectives, namely textbook products that could be used maximally in lectures.

Data analysis which conducted is quantitative data analysis conducted on the results of the validation of the textbooks and the results of student questionnaires. While the results of the interviews were analyzed descriptively qualitative.

The resulting product feasibility data is performed by tabulating data, calculating the average score, changing the score into a five scale criterion (See table 1).

In this research, a minimum B product eligibility value with a good criterion was established. If the criteria have not been reached, a revision will be carried out. Furthermore, to analyze the effectiveness of the developed textbooks is done by

analyzing the results of a questionnaire filled out by students at the time of limited trials and final trials.

RESULTS

This numerical logic textbook was developed with the results of elementary school students thinking plot analysis with character.In accordance with the stages of development conducted as subsequent.

Define

The analysis study results related to the numerical logic of elementary school students show that low-grade elementary school students (1) students use visuals more to solve mathematical problems, they tend to explain things through pictures, in addition they also still involve a lot of imagination in synthesizing existing problems, (2) students describe the problem very simply by minimizing the use of numbers or algorithms, (3) the lowest level students need a lot of assistance and explanation from the teacher, (4) the higher the grade level, students tend to use algorithms.

Based on this analytical study of the research found that the plot of thinking of low-grade students still prioritizes visualization. Students tend to use any help around them to be able to become modelling, such as using pictures, using hands, or even imagining in various forms of their favourite characters.But in third-grade elementary school students tend to use more abstract functions that have developed.In learning, first-grade students still need intensive guidance from the teacher. Gradually the intensive mentoring decreases at each level. even in grade 3 students tend to be released to be able to solve problems even though the answers obtained are not all appropriate(Wijayanti & Lestari, 2019).

After an analysis study of the student's thinking plot and literature study, the textbook has been defined and is ready to be processed at the next development stage.

Design

At this design stage, the textbook templates are arranged and adjusted to the objectives to be achieved from the development of the textbooks. By paying attention to the subject and object of the prospective reader.Textbooks are also arranged with a very pleasant concept and good visualization by prioritizing many colours and also images to facilitate the reader in understanding the contents of the book closer to the conditions of elementary school students. The preparation of this book contains some theoretical and applicable content that is adjusted to the flow of thought elementary students by multiplying examples and exercises of learning development with visual-based. Also in each discussion given a special space to integrate material with character. In addition, the book is also adjusted to the publisher's provisions where this book will be registered with the ISBN, namely the binaguru publisher.

Develop

At this develop stage, draft textbooks that have been developed are then validated by material and language experts. Following are the validation data (See Table 1).

The average validation results from the developed textbooks were 3.88 in the Good category. These results indicate that the textbook is declared valid and can be used in lectures with several revisions.

After that, the validated book draft is revised prior to being tested. Next is a limited trial phase conducted on 5 students of the fourth semester of PGSD STKIP Al Hikmah.The observations seen from the questionnaire obtained a mean score of 4.3, which means textbooks in the category of very practical to be used in lectures. Whereas in the final trial phase the final score is 4.2 which means that the textbook is very practical to use.

This product was revised 4 times. The first revision was made after a review by a colleague. The second revision was made after receiving an assessment and input from the validator. The third revision was carried out after a limited trial, and the final revision was carried out after the final trial which became the final product in the form of a numerical logic textbook in accordance with the analysis of the thinking plot of elementary students charged with the character which is the result of this study.

Disseminate

After a series of developments, the final product from the development of this textbook is packaging which can then be distributed to the wider community. This final draft is then registered to the national book listing through ISBN and then duplicated to be distributed to students and also the Al Hikmah STKIP library as a textbook or learning resource in numerical logic courses in education of elementary school teacher Departement STKIP Al Hikmah study program.In addition, information related to this research is disseminated through scientific publications both in journals and proceedings.

Table 1. Conversion of Quantitative Data to Qualitative Data

Score Interval	Score	Category
0 - 1	E	Very Bad
1,1 - 2	D	Poor
2,1 - 3	C	Fair
3,1 - 4	B	Good
4,1 - 5	A	Excellet

Table 2. Expert Validation Score Data Results

Assessment Aspects	Score	Category
Content Eligibility	3,92	Good
Linguistic	3,50	Good
Presentment	3,79	Good
Finesse	4,3	Excellent

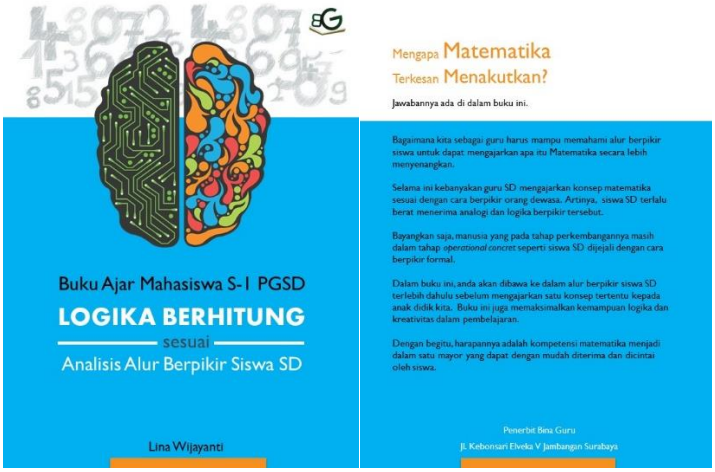

Figure 1. Textbook Cover developed

DISCUSSION

This Numerical Logic Textbook is the development of a new finding textbook, where no numeracy logistical courses have been found before in any campus in Indonesia, so no one has ever developed a numeracy textbook. Some of the previous studies that developed textbooks for mathematical logic in several secondary schools, not numeracy logic were developed for the preservice elementary teacher.

This numerical logic content is also new. Although this logic is not entirely stand alone. Some points, researchers study elementary mathematics in other countries, including learning through principles and standards for school mathematics by the National Council of Teachers of Mathematics which also describe how the teachers organized mathematics for each grade, because as we know that mathematics has a very special content for every grade(National Council of Teachers of Mathematics, 2000).In addition, some content was also taken from the everyday mathematics book project from the University of Chicago in the school mathematics project which developed presented mathematics using many figures and contextual content(Bell et al., 2007).

As already mentioned that the development of textbooks themselves has been carried out by several researchers with a variety of models. Most of the researchers in developing textbooks are using the development model(Borg & Gall, 1983)which using ten stages i.e research and information collecting, planning,

develop preliminary form of product, preliminary field testing, main product revision, main field testing, operational product revision, operational field testing, final product revision, and dissemination and implementation. And another one is the development model in this study, the For-D model by Thiagarajan.

The research which was started from the analysis of elementary school students' thinking plot makes this research not only the research of textbook development. This research requires the direct participation of students and teachers in schools to get data related to low-grade elementary school students' thinking plot. This is done to see the development and characteristics of students in the learning process.

Primary school age is the final childhood that lasts from the age of six to twelve. The main characteristics of elementary school students are those who display differences in intelligence, ability in thinking and language, personality development, and physical development of children. Generally, their behaviour is very active, has great curiosity, but the concentration and reasoning are still not good at receiving subject matter. In addition, elementary school-age children who have the characteristics of playing, moving, working in groups, and like doing things directly. This is consistent with the results of observations made by Ningrum & Leonard(Ningrum & Leonard, 2015)who found that generally, low-grade students were active, always moving with a sense of curiosity that was quite large because of their limited thinking ability so that whatever he had just seen and heard was always asked. But in terms of emotional control is not well controlled so that he is still easily influenced by the surrounding environment.

In a study comparation conducted by(Chairin, Hatim, & Wijayanti, 2019)that prospective elementary teachers in predicting the results of student answers by observing the thinkingplot of elementary school students obtained the results of (1) 90% of students using images as prediction answers with completed completion formula mathematically on the concept of numbers, (2) 60% of students use pictures while the rest use mathematical logic formulas on the concept of number patterns, and (3) 60% of students count by being redrawn and counted per part, while others go directly to the final result on spatial concepts.

The data above shows that the average prospective teacher candidates in understanding the flow of elementary school students thinking in the context of mathematics are only 70%. The rest of them still use their own perspective in teaching mathematics. This figure is quite alarming if the prospective elementary school teacher candidates do not have the appropriate reading or learning resources in their process of becoming elementary school teachers.

This research is in accordance with several previous studies related to how to teach mathematics for elementary school-age children. Based on the results of the literature review in previous studies found that (1) learning mathematics in elementary school low class could use concrete objects to be able to improve student understanding(Frengky, 2015), (2) contextual approaches could be applied to improve mathematical ability and mathematical reasoning of students(Fuadi, Johar, & Munzir, 2016), (3) mathematics learning for elementary school-age children is more appropriate to use learning with concrete objects media(Sumarjilah, 2015), (4) (4) edugame (educational games) in mathematics learning could improve numeracy skills of elementary school students in low grade(Jundu, Kurnila, & Jelatu, 2018),(5) students' numeracy skills could be improved by modified game methods using game tools and objects that are already known to students(Sulaimah, 2013).

From the results of the literature study, it can be seen that elementary students need concrete objects, contextual, and through fun ways in the learning process.

Research from(Amir, 2015)states that students' visual, auditory, and kinesthetic thinking processes are still the same in the stages of identifying problems, but they have significant differences that could be seen from their answers and answers are chosen based on facts and logical reasons. The accuracy of students is also one of the differences. Visual students tend to see the focus of the problem and analyze answers based on the picture. Auditory students often read questions and answers back in order to mention the focus of the problem, what is known, what is asked, and analyze the problem. While kinesthetic students do it by moving their limbs and pencils to determine focus and analyze problems.

As for things that have not been accommodated in this textbook is how elementary teacher candidates can develop mathematics in accordance with the intelligence of each elementary student. This textbook only looks at the cognitive and character side, while how students with kinesthetic or audio intelligence have not been touched in the development of this textbook.

CONCLUSION

The textbook developed in this research could be used in lectures at education of elementary school teacher Department STKIP Al Hikmah because the textbook is valid. The textbooks that were developed were seen from all aspects is good categorized assessment. Aspects of the feasibility of the contentare good categorized. The language aspect is good categorized. The presentation aspects are good categorized and the categorized graphic aspects are very good.

This textbook has practical value from several aspects, namely (1) able to add insight, (2) information is very clear, (3) very

motivating, (4) using language that is effective and clear, (5) has enough guidance, (6) font usage is very suitable, (7) layout is very appropriate, (8) has very clear illustrations and images, and (9) excellent display design. So this textbook fulfils very effective criteria.

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