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The development of numeracy problems for junior high school students

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Abstract

Numeracy has become part of the Minimum Competency Assessment (MCA) used in the National Assessment (NA) since it was established in 2021. However, previous research shows that the numeracy skills of junior high school students are still in the low category. The purpose of this study was to obtain a prototype of a practice book about preparation for dealing with numeracy MCA for junior high school students that were valid, according to experts. This research was development research (R&D) using the Plomp development model, which consists of preliminary research, a prototyping phase, and an assessment phase. At the end of the development stage, there was a formative evaluation to assess the product development's validity by two experts. The instrument used was the validation sheet for the numerical problems book. The results of this study obtained a prototype of the book that contains at least 90 numeracy problems for Junior High School students, which was categorized as valid with an average score of 89 and an excellent classification. The questions used include multiple choice, multiple complex choice, matchmaking, short essay questions, and essay. The dominant portion is in the form of complex multiple-choice questions. This book is suitable for students' preparation for the numeracy MCA.

Keywords: mathematical literacy; minimum competency assessment; numeracy problems; numeration; question exercise book

Introduction

The Minimum Competency Assessment (MCA) is part of the National Assessment (NA) which will begin to be implemented in 2021. The MCA serves as a benchmark for achieving educational quality in reading and mathematical literacy further to map the quality of Indonesian education with international standards (Tju & Murniarti, 2021). Pusmenjar (2020a) states that there are three primary cognitive levels in the numeracy MCA that students must use to answer questions: knowing, applying, and reasoning. First, questions at the understanding level are used to assess students' abilities about facts, processes, concepts, and procedures. Second, questions at the applying level assess mathematical abilities in applying knowledge and understanding facts, relations, processes, concepts, procedures, and methods in real situations to solve problems. Finally, the questions at the reasoning level are used to assess students' reasoning abilities in analyzing data and information, making conclusions, and expanding understanding in new situations, including unknown situations or more complex contexts.

Based on the PISA test result conducted in 2018, Indonesia's numeracy aspect was ranked 73rd out of 79 participating countries (OECD, 2019a). In this PISA test, it is known that the mathematical ability of Indonesian students only reached 379 points from an average of 487 points. Furthermore, OECD (2019b) show that there are 28% students who are able to achieve level two proficiency. In that level, students can interpret and recognize, without direct instruction, how the situation can be represented mathematically. In addition, only one percent of Indonesian students master a high level of mathematics skills (level five and above). At that level students can model mathematically complex situations, select, compare, and evaluate the right problem-solving strategies to deal with them. This result also shows that there has been no increase in Indonesia's PISA results in the last 10-15 years. It shows one basis for implementing – NA as a substitute for the national exam in evaluating the quality of Indonesian education with international standards (Winata et al., 2021).

The newly implemented evaluation form certainly makes teachers and students have to adapt to the form of the numeration test given. Meanwhile, PISA questions are dominated by non-routine questions and are questions that can measure the ability to reason, solve problems, argue, and communicate (Hidayati et al., 2020; Maulyda et al., 2019). Therefore, it can be said that good problem-solving skills will provide convenience for students in solving various mathematical problems in learning and everyday life (Wartini et al., 2018). In the other hand, basic problems that require problem-solving skills are not only in mathematics but lead to much more complex problems. Solutions to these problems can be found if students master literacy and numeracy skills well (Anderha & Maskar, 2021; Patta et al., 2021).

Numeration is an important part of various literacy that must be mastered by everyone (Patriana et al., 2021). Numeration is the ability to think using concepts, procedures, facts, and mathematical tools to solve everyday problems in various contexts relevant to individuals as citizens of Indonesia and the world (Pusmenjar, 2020a, 2020b). Furthermore, according to Han et al. (2017), numeracy is knowledge and skill in using numbers and symbols related to basic mathematics to solve practical problems in various contexts of everyday life and analyze

information displayed in various forms (e.g., tables, graphs, and charts) then predict and make decisions based on the interpretation of the analysis results. The result of previous study conducted by Ahyan et al. (2019) show that the mathematical literacy of two junior high school students in the ninth grade at Lombok, Indonesia is relatively low. There are 68.75% of the students had difficulties in interpreting, applying, and evaluating mathematical results. The results of research conducted by Cahyanovianty and Wahidin (2021) show that the numeracy ability of 75% of students at SMPN 7 Tambun Selatan is still in the medium category. Meanwhile, research conducted by Winata et al. (2021) show that the numeracy ability of 61.90% of students at MA Darul Ma'wa Phandiredjo is still low. This fact certainly raises concerns for educators when giving non-routine questions to students.

In addition to the results of previous studies, the needs analysis carried out by researchers on teachers and students from several junior high schools in Mataram City, West Nusa Tenggara, also supports the product development carried out by researchers. Based on the survey results, as many as 78% of teachers stated that it was challenging to teach numeracy to students. According to the teachers, sequentially, the topics of numeracy that are the least mastered by students are geometry and measurement, data and uncertainty, and algebra. In contrast, students dominantly control the topic of numbers. This statement is in line with the results of a survey of students, which stated that only 17.6% of students did not master the topic of numbers.

Furthermore, 55% of teachers stated that this was due to insufficient learning resources to teach numeracy. In addition, 55% of teachers also stated that students needed help to solve numeracy problems. Finally, this survey also revealed that both teachers and dominant students stated a great need for a numeracy practice book that provides step-by-step practice questions according to cognitive level and is equipped with discussions.

Based on the explanation above, the previous research focused on the level of mathematical literacy ability of junior high school students. So, this research focuses on the sustainability of the study's results by developing numeracy question exercises to assist students in preparing themselves to face MCA. Purwantoro and Saryantono (2020) show that teaching practice questions, especially contextual ones, can improve mathematics learning outcomes. Therefore, this study aims to obtain a prototype of a practice questions book about preparation for dealing with numeracy MCA for junior high school students that are valid according to experts.

Methods

This research was a type of development research (R&D) using a research design developed by Plomp (2010). It is because this research was oriented toward product development, where the development process was described as accurately as possible, and the final product was evaluated. There were three phases that researchers needed to use in this model: the preliminary, the development (prototyping), and the assessment phase. The preliminary research phase consists of problem identification. It needs analysis, a literature review, and a conceptual or theoretical framework (initial framework) for product development in the form of a numeric

Minimum Competency Assessment (MCA) preparation exercise book for junior high school students.

Furthermore, at the development phase, namely developing a product prototype to be tested using iterations, each consisting of a small cycle with formative evaluation as the basis for revising/improving the developed product. One of these evaluations is intended to test the product's validity. This evaluation process will be stopped when the data is saturated and ready to be tested with a broader range of subjects. Finally, the assessment phase (summative evaluation) is used to evaluate and conclude whether the developed product has met the specifications determined based on user assessments with a broader scope.

At the formative evaluation phase (the end of the development stage), a validity test must be carried out to determine whether the practice book developed is valid and feasible. In other words, this valid criterion means that the developed exercise book can measure what should be measured according to the development objectives. This validity test was carried out by experts, namely two mathematics education lecturers with a minimum level of masters. Furthermore, the instrument used to assess is the experts' validation sheet for the numeracy MCA practice book. Experts will assess aspects of eligibility contents, conformity with MCA numeration, language, and graphics. The assessment results are used as a reference for improvements so that the books developed could reach higher quality. The scale used on the validation sheet is a Likert scale of 5, namely (1) Very poor, (2) Poor, (3) Fair, (4) Good, and (5) Excellent. The number of assessment items on the validation sheet of the practice book on numeracy is 21. Thus, the maximum score obtained in this validation process is 105, and the minimum score is 21. The classification of the quality of the validity of this exercise book on numeracy can be seen in Table 1 (Widoyoko, 2016). This numeracy practice book can be valid and feasible if the score reaches a good minimum qualification.

Table 1. Classification of the validity of the numeration questions practice books

Indicators	Classification
$X > 88.2$	Excellent
$71.14 < X \leq 88.2$	Good
$54.6 < X \leq 71.4$	Fair
$37.8 < X \leq 54.6$	Poor
$X \leq 37.8$	Vey poor

Results

The preliminary research phase consists of problem identification and needs analysis, reviewing the literature, and developing a conceptual or theoretical framework (initial framework) for product development in the form of an exercise book on the preparation of the numeracy MCA for junior high school students. At this phase, activities to identify problems and analyze needs were carried out by researchers by reviewing various sources related to MCA and conducting surveys to teachers and students in several junior high schools/equivalents in Mataram City, Lombok, Indonesia. The needs analysis results show that as many as 78% of teachers stated that it was challenging to teach numeracy to students. According to the teachers, sequentially, the topics of numeracy that are the least mastered by students are geometry and measurement,

data and uncertainty, and algebra. In contrast, students dominantly control the topic of numbers. This statement is in line with the results of a survey of students, which stated that only 17.6% of students did not master the topic of numbers.

Furthermore, 55% of teachers stated that this was due to insufficient learning resources to teach numeracy. In addition, 55% of teachers also stated that students needed help to solve numeracy problems. Finally, this survey also revealed that both teachers and dominant students stated a great need for a numeracy practice book that provides step-by-step practice questions according to cognitive level and is equipped with discussions.

Furthermore, at this phase, the researchers also review the literature that follows the development topic - for example, in junior high school, mathematics books/equivalent, design books for developing MCA questions, and other references related to numeracy at the junior high school / equivalent level. In addition, we continued by compiling the initial framework of the exercise book on MCA numeracy for junior high school students/equivalents. Completed at the preliminary research phase, then continued at the development phase (prototyping phase). At this phase, a prototype of the product developed by the researcher is obtained.

The product produced in this study is a numeracy MCA practice book for junior high school students. This book was compiled by adjusting the topics in the summary section of the material and overall questions based on the topics in the numeracy MCA, namely numbers, geometry and measurement, algebra, data, and uncertainty. In general, the structure of this book consists of a cover page, a preface, a table of contents, a summary of the material accompanied by examples of questions from each topic, and practice questions called *AKSI* (a.k.a MCA numeracy). In addition to the development results in a numeracy MCA question book, this study was also accompanied by the preparation of other research instruments, namely validation sheets, pre-test and post-test sheets for numeracy skills, and questionnaires. Figure 1 below is an example of the cover page of this book.
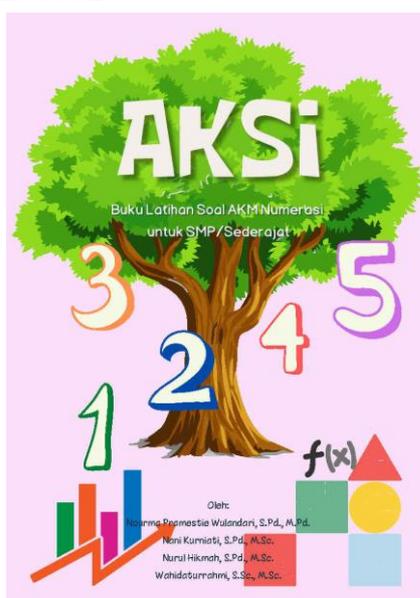

Figure 1. Sample book cover

The questions in each *AKSI* chapter in this book are arranged based on the cognitive level of understanding, applying, and reasoning, with the dominance of questions at the application

level. Moreover, this corresponds to the scope of level 4 (grades 7-8) in developing numeracy AKM questions tested at the junior high school/equivalent level (Pusmenjar, 2020b). The questions used include multiple choice, multiple complex choice, matchmaking, short essay questions, and essay. The dominant portion is in the form of complex multiple-choice questions. Figure 2 below is a piece from the *AKSI* chapter of this book.

Translation:
For question number 3, read the data below carefully.
Favorite Breakfast Menu
Risa surveyed 12 of her friends to find out their favorite breakfast menu, namely uduk rice, fried rice, and yellow rice. To assess your favorite breakfast menu using the following scale.
(picture of scale)
The survey results are as follows.
(The results table)
3. Put a check mark (√) in the True or False column for each of the following statements.
The statements on the table are:
- Risa's average friend gives a "casual" rating for the fried rice menu
- The average score of the student's favorability scale for the yellow rice breakfast menu is 3.5
- The most preferred breakfast menu by Risa's friends is uduk rice
4. If it shows a positive number 2 (+2) and it shows a negative number 2 (-2), pair the following arrangement of symbols with the correct values.

Figure 2. Snapshot of the *AKSI* chapter on the cognitive level of understanding

Whether or not this book is suitable for preparing students to face MCA can be determined by testing the book's validity. An assessment determines the results of the validity of this book carried out by two mathematics education experts with the following criteria: (1) being a mathematics education lecturer at a university and (2) a minimum educational qualification of a master's degree. In addition, this validity test is also carried out to obtain input and feedback from experts to produce a quality numeration practice book that can be used in research on a broader scale.

Validation data is in the form of quantitative and qualitative data. Quantitative data in the form of the average value was obtained from the scoring of the validation sheet of the numeration practice book by the validator. Meanwhile, qualitative data is in the form of

suggestions and comments from the validator. Suggestions and comments from the validators are used as the material for product revision. Quantitative data from the test results of the validity of the practice book on numeracy are presented in Table 2 below.

Table 2. Quantitative data from the validation of the numeration problem practice book

Validation Description	Results
Number of assessment questionnaire items	21
Maximum score	105
Minimum score	35
Total Score of Validator 1	87
Total Score of Validator 2	91
Average Score	89
Classification	Very Good

On the other hand, after using the same formulas to get Table 1, the quantitative data on the validity agreement of experts based on their rating from aspects assessed are presented in Table 3 below.

Table 3. Details of quantitative data from the validation of the numeration question exercise book

Aspects Assessed	Total Validator Score 1	Total Validator Score 2	Average ($\bar{X}$)	Classification Validity
Eligibility Contents	28	30	29	Good
Conformity with AKM Numeration	18	16	17	Very Good
Language	24	26	25	Good
Graphics	17	19	18	Very Good

Meanwhile, the qualitative data on the validity of the practice book questions are presented in Table 4 below.

Table 4. Qualitative data validation results of numeration questions exercise book

Validator 1	Validator 2
• There is still a writing error. • Give details to the picture of each shape	• Consistent numbering on the material summary • Fix writing errors

Discussion

Based on the validation results described above, improvements are still being made even though the validity of the practice book on numeracy is categorized as very good. Improvements were made based on the notes (qualitative data) provided by the validator, as shown in Table 4. In addition, one of the lower classification validity from aspects assessed in this validation process lies in content feasibility, which is only Good. Of course, these two reasons become a solid basis for researchers to continue making revisions so that the quality of the developed numeracy practice book can improve. Furthermore, the product developed also needs to be systematically arranged to facilitate students to learn well (Wulandari et al., 2020).

The feasibility aspect of the content has seven indicators that are checked for validity. Of the seven indicators, two indicators have the highest score, namely on points: the content of the book can encourage the emergence of independence and innovation, and the point: the book material is presented attractively so that the integrity of the meaning to be conveyed can be appropriately maintained. Learning independence is one of the things that students are expected to do using this book. The independent learning process carried out by students can make students accustomed to practicing numeracy questions with various cognitive levels and various contexts of questions that are given continuously (Wahyuni, 2017). Furthermore, this learning independence also makes students experience the learning process directly so that what is learned will be more meaningful and can last longer in memory (As'ari, 2015). So that when implementing MCA, students are familiar with the types of questions and are proficient in solving the various problems presented. As a result, students can get maximum numeracy MCA results.

Students can also relate mathematical concepts to other subject matter through this book. Cross-materials widen the scope of student understanding (Purwantoro & Saryantono, 2020). In addition, a summary of the material that satisfies the element of the integrity of the material presented is undoubtedly an essential thing of this book. Complete material can make it easier for students to recall the material taught in class and can help students as a guide in completing practice questions before checking the results of completion in the discussion chapter. The discussion included in this book serves as a means for students to examine their learning progress, namely in terms of successes and failures in practicing the numeracy questions given. Failures and successes obtained by students will have an impact on the level of student satisfaction in the learning process (Puryati, 2017).

In the aspect of conformity with numeracy MCA, four indicators are presented in the validity test sheet. The highest average score was obtained on two indicators, namely (1) the questions given following the cognitive level of MCA numeracy, which was 4.5. It is essential because the cognitive level must adjust to the level determined in the numeracy MCA guidance document for the junior high school / equivalent level, which is at level 4 (grades 7-8). Practice questions are not only used for understanding concepts but more than that. The questions given should provide benefits for students for the benefit of studying at a higher level and success in daily life (As'ari, 2015).

Furthermore, indicator (2) in the form of questions following the provisions of the numeracy MCA also obtained an average score of 4.5. The question form presented in this book has met the requirements of the question form in the form of multiple choice, multiple complex choice, matchmaking, short fill, and essay. The largest portion of the questions is in the form of complex multiple-choice questions.

In the language aspect, there are six indicators presented. The highest average score, 5, is obtained on the indicators of book titles and the titles of parts of the material/book content harmonious, interesting, able to attract interest in reading, and not provocative. The alignment of the title and its parts becomes substantial in a book. Readers will be interested in the book's title, which can attract interest because it will cause curiosity about the book's content (Sartika

& Makmur, 2020). Moreover, the harmonious title of the parts in the book can also make readers efficiently use the book's content.

Table 3 also shows that the visual aspect gets very good classification validity. The visual aspect has an essential role in the development of a book. An attractive book's physical appearance factor (interface) can make students curious to find out how detailed the book's contents are (Wulandari et al., 2021). More than that, students feel energized by a varied display. The existence of proportional colors and images in books can arouse students' interest in reading and then raise students' motivation to learn (Sumaji, 2015).

Conclusion

The product developed is in the form of a book containing numeracy problems for preparing numerical MCA for junior high school/equivalent students who have met the valid criteria based on an expert assessment. The average validation score obtained is 89, with an excellent category. Further research is needed to test the product developed on a broader scale and to determine the level of practicality and effectiveness of the products that have been developed.

Conflicts of Interest

The authors state that there are no conflict of interest regarding the publication of this article. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies, have been completed by the authors.

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Author Contributions

Nourma Pramestie Wulandari: Conceptualization, writing - original draft & editing, visualization, processing data, validation, and developing questions about numbers; **Nani Kurniati:** Writing - review & editing, methodology, and developing questions on algebra; **Nurul Hikmah:** Writing – review & editing, methodology, and developing questions on geometry and measurement; **Wahidaturrahmi:** Observation, writing – review & editing, research administration, and developing questions on data and uncertainty.

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