

Development of an EGMA-Based E-Booklet Numeracy Assessment Instrument for Phase B Students in Elementary School

Bagus Santoso¹, Gunawan^{2*}

^{1,2} Universitas Muhammadiyah Purwokerto, Indonesia

*gun.oge@gmail.com

ARTICLE INFO

Article history

Received June 29, 2026

Revised July 26, 2026

Accepted August 2026

Keywords: Deputy Minister for Numeracy, E-Booklet, EGMA, Phase B, Elementary School.

ABSTRACT

This study aimed to develop an e-booklet numeracy assessment instrument based on the Early Grade Mathematics Assessment (EGMA) that meets the criteria of validity and practicality for Phase B elementary school students. The study employed a Research and Development (R&D) approach using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. The participants included two expert validators, eight Grade III and IV teachers, and 45 Phase B students. Data were collected through expert validation sheets, teacher and student response questionnaires, and students' performance on the numeracy assessment instrument. Data were analyzed using descriptive quantitative analysis based on percentage scores to determine the validity and practicality of the product, while students' performance results were used to map numeracy achievement across the assessed domains. The results showed that the EGMA-based e-booklet numeracy assessment instrument achieved a validity percentage of 85.00% and met the valid criteria. User responses indicated that the instrument achieved a practicality percentage of 88.54% from teachers and 89.48% from students. The assessment results also indicated variations in achievement across the numeracy domains, with basic numeracy demonstrating the highest achievement and numeracy problem solving demonstrating the lowest. The developed instrument has the potential to serve as an alternative formative assessment tool for mapping Phase B students' numeracy abilities in a more structured, contextualized, and easily implementable manner through digital media.

1. INTRODUCTION

Numeracy is one of the fundamental competencies that students need to master at the elementary school level as a foundation for addressing various problems encountered in everyday life. In the Merdeka Curriculum, numeracy is not merely defined as the ability to perform arithmetic operations, but also encompasses the ability to reason, interpret quantitative information, and apply mathematical concepts to make decisions in various contextual situations (Kemdikbud, 2020). Mastery of numeracy from the early stages of education serves as an important foundation for students' success in other subject areas while also supporting critical thinking and problem-solving skills. Nevertheless, various evaluation results indicate that the numeracy abilities of Indonesian students still require attention. The results of the Programme for International Student Assessment (PISA) in 2018 ranked Indonesian students' mathematical literacy at 73rd out of 79 participating countries, with most students failing to reach the minimum competency level in solving context-based numeracy problems (Ekowati et al., 2019). This condition is consistent with the results of the 2024 Computer-Based National Assessment (Asesmen Nasional Berbasis Komputer/ANBK), which showed that the numeracy achievement of elementary school students remained in the moderate category, with a score of 68.95, despite an improvement compared with the previous year (Nadiatussalma, 2025). These findings indicate that students' ability to connect mathematical concepts with real-life situations still needs to be improved. One factor contributing to this condition is the suboptimal implementation of numeracy assessment in elementary schools. The instruments commonly used by teachers tend to emphasize procedural knowledge and basic computational skills, and therefore may not adequately measure students' reasoning abilities or their capacity to apply mathematical concepts in everyday contexts. In addition, teachers still tend

to provide procedural problems, resulting in students having limited exposure to numeracy tasks that require higher-order reasoning (Nyoman & Suarantini, 2023). Therefore, there is a need for an assessment instrument that can measure numeracy abilities comprehensively and contextually while taking into account students' developmental characteristics. In line with the implementation of the Merdeka Curriculum, assessment is expected to provide a comprehensive picture of students' competencies through authentic and contextual tasks oriented toward formative assessment. The development of numeracy assessment instruments should not only meet the criteria of validity and practicality but should also accommodate the characteristics of students at each learning phase. At the same time, advances in educational technology provide opportunities to develop assessment instruments that are more engaging, interactive, and easy to implement in learning activities (Sulistiyawati, 2024).

The Early Grade Mathematics Assessment (EGMA) is an assessment framework designed to measure students' foundational mathematical skills in the early grades of elementary education through fundamental numeracy indicators, such as number identification, quantity comparison, basic arithmetic operations, and simple problem solving (RTI International, 2014). EGMA encompasses several foundational skills, including number identification, quantity comparison, number patterns, basic arithmetic operations, and simple problem solving. This structure enables students' numeracy abilities to be mapped in greater detail across the foundational components that serve as prerequisites for more complex mathematical abilities. The selection of EGMA in this study is based on its characteristics as an assessment framework that maps fundamental mathematical skills that form the foundation for the development of more complex mathematical abilities (Platas et al., 2016). The selection of EGMA in this study is not intended to position it as generally superior to AKM or PISA, but rather as a framework that is more aligned with the purpose of the instrument development, namely identifying and mapping the foundational numeracy abilities of elementary school students. PISA is designed to assess the mathematical literacy of 15-year-old students, with an emphasis on their ability to formulate, apply, and interpret mathematics in various real-life contexts. Meanwhile, AKM Numeracy is used within the National Assessment to measure foundational competencies through the domains of numbers, geometry and measurement, algebra, and data and uncertainty, with cognitive levels involving understanding, application, and reasoning. AKM also provides learning levels for students in Grades 3–4, making it relevant to the Phase B level. Nevertheless, the characteristics of AKM and PISA, which emphasize the broader mapping of numeracy competencies, do not fully address assessment needs that specifically aim to identify students' foundational mathematical abilities in greater detail. In this context, EGMA has strategic value because it is based on fundamental mathematical skills that develop progressively and can be used to identify areas of ability that students have mastered as well as those that still require reinforcement. Therefore, EGMA is considered relevant as a foundation for developing an assessment instrument for Phase B, particularly when assessment is directed not only at determining students' final achievement but also at obtaining diagnostic information regarding the specific components of numeracy that need to be addressed in subsequent learning. Several studies have developed numeracy assessment instruments using different approaches. Mulyadi and Nursetyo developed an information technology-based literacy and numeracy instrument that was reported to be valid and feasible for use in learning. Febriyanti and Wardana (2024) developed a formative assessment instrument for fractions with a high level of validity. Utari, Susanta, and Koto (2024) developed a numeracy AKM instrument based on the PISA framework with high validity and reliability. Other studies have developed numeracy instruments through ethnomathematical approaches and everyday-life contexts to enhance the meaningfulness of assessment. These findings indicate that numeracy assessment development has been pursued through the use of technology, contextual approaches, and the AKM and PISA frameworks. However, the focus and frameworks employed vary according to the objectives of each study.

Based on this review, three research gaps need to be addressed. First, the development of numeracy assessment instruments at the elementary school level has predominantly employed the AKM or PISA frameworks, specific subject matter, or particular contexts, while the use of EGMA as a framework for mapping foundational numeracy abilities remains relatively limited. Second, relatively few studies have adapted EGMA indicators into an instrument explicitly designed to

accommodate the characteristics of Phase B students and the context of the Merdeka Curriculum implementation in Indonesian elementary schools. Third, the use of digital technology in numeracy assessment has not yet been widely integrated with the EGMA framework and contextual instruments that can be used by teachers for formative assessment. Thus, the research problem is not merely the lack of digital assessment media, but rather the absence of an integrated instrument that combines a framework for assessing foundational mathematical abilities, the developmental characteristics of Phase B students, numeracy contexts, and ease of assessment implementation. Based on these gaps, this study offers a novel contribution through the development of a contextual numeracy assessment instrument based on EGMA, adapted to the characteristics of Phase B students and presented in a digital e-booklet format. This integration is expected to produce an instrument that not only measures numeracy abilities but also provides a more structured mapping of the foundational components underlying students' numeracy development. Accordingly, the contribution of this study lies in adapting the EGMA framework to the context of elementary school numeracy assessment in Indonesia, integrating foundational ability indicators with everyday-life contexts, and presenting them in a digital format that supports teachers in implementing formative assessment. Based on these issues, this study employed a Research and Development (R&D) approach to develop a contextual numeracy assessment instrument based on the Early Grade Mathematics Assessment (EGMA). The study aimed to produce an assessment instrument that is valid and practical for Phase B elementary school students. The developed instrument is expected to assist teachers in implementing formative assessment more effectively, increase student engagement in the assessment process, and provide more accurate information regarding students' numeracy achievement as a basis for improving the learning process.

2. METHOD

Research Design

This study employed a Research and Development (R&D) approach using the ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation, to develop a contextual numeracy assessment instrument based on the Early Grade Mathematics Assessment (EGMA) in the form of a digital e-booklet for Phase B elementary school students. The ADDIE model was selected because it provides a systematic development process, ranging from needs analysis to product evaluation, thereby facilitating the development of an assessment instrument that meets the criteria of validity and practicality. The analysis stage involved identifying the needs of teachers and students regarding numeracy assessment instruments within the Merdeka Curriculum. The design stage included developing an instrument blueprint based on EGMA indicators, constructing contextual numeracy items, and designing the digital e-booklet interface. The development stage involved preparing the initial product, followed by validation by material and media experts and revisions based on the validators' feedback. The implementation stage involved testing the product with teachers and Phase B elementary school students. Subsequently, the evaluation stage aimed to assess the quality of the product based on the results of validity and practicality assessments, resulting in a final product considered suitable for use in learning.

Research Participant

The study was conducted in public elementary schools within the Widya Sarana Cluster, Rawalo District, Banyumas Regency, involving expert validators, elementary school teachers, and students as research participants. Product validation was conducted by two expert validators, consisting of one material expert and one media expert, to assess the content, presentation, visual design, and appropriateness of the developed assessment instrument. The material expert was selected based on expertise in elementary school assessment, while the media expert was selected based on expertise in instructional media for elementary education. The material expert assessed the aspects of content, construction, language, and presentation, whereas the media expert assessed visual appearance, navigation, readability, and ease of use. Each validation sheet consisted of 21 assessment items rated on a 1–5 scale. The practicality test involved eight elementary school teachers, consisting of four Grade III teachers and four Grade IV teachers. The teachers were selected because they represented potential users of the instrument in implementing numeracy assessment for Phase B students. Teacher assessments covered ease of use, clarity of instructions, readability, visual presentation, content suitability, and the usefulness of the instrument in the

assessment process. The field trial involved 45 Phase B students, consisting of 21 Grade III students and 24 Grade IV students. The students were selected because they represented the target population for the developed product. The student characteristics considered in the study included an age range of 8–9 years. The Grade III group consisted of 11 male and 10 female students, while the Grade IV group consisted of 10 male and 14 female students. The school context and student characteristics were considered in evaluating the suitability and practicality of the EGMA-based e-booklet as a numeracy assessment instrument.

Development Procedures

The instrument development process was conducted through the five stages of the ADDIE model. The analysis stage focused on identifying numeracy assessment needs, the characteristics of Phase B students, as well as the curriculum and EGMA indicators. The design stage involved developing the instrument specifications, assessment blueprint, assessment indicators, and digital e-booklet design. At the development stage, the assessment instrument was constructed and subsequently validated by a material expert and a media expert. Feedback from the validators was used as the basis for product revisions prior to the field trial. The implementation stage involved a practicality assessment conducted by teachers and a field trial with Phase B students. The evaluation stage was carried out continuously throughout each development stage to produce an assessment instrument that met the criteria of validity and practicality. The development process is presented in the table below.

Table 1. Research Steps

ADDIE Stage	Activities	Output
Analysis	Needs analysis, student characteristics, curriculum, and EGMA indicators	Instrument requirements specification
Design	Development of assessment indicators, test blueprint, test items, scoring guidelines, and e-booklet design	Initial prototype
Development	Product development, material and media expert validation, and revision	Validated product
Implementation	Practicality testing with teachers and field testing with Phase B students	User response and numeracy achievement data
Evaluation	Analysis of validation, practicality, and field trial results, followed by final revision	Final product

Research Instrument

The research instruments consisted of an expert validation sheet, a teacher practicality questionnaire, and the developed numeracy assessment instrument. The validation sheet was used to obtain assessments from the material and media experts regarding the quality of the content, construction, language, and media presentation. The practicality questionnaire was used to obtain teachers' responses regarding the ease of using the instrument in the assessment process. Meanwhile, the numeracy assessment instrument was administered during the field trial to obtain data on the quality of the items in the developed instrument.

Data Analysis

The research data were analyzed using descriptive quantitative analysis. Expert validation data were analyzed to determine the level of appropriateness of the instrument based on the material and media aspects. The validators' assessment scores were calculated as percentages using the following formula:

$$P = \frac{\sum x}{\sum x_{\max}} \times 100\%$$

P = percentage of the assessment result

$\sum x$ = total score obtained

$\sum x_{\max}$ = maximum possible score

100% = multiplication constant used to convert the score into a percentage

Practicality data were obtained through response questionnaires administered to teachers and students. The analysis was conducted by calculating the percentage of the obtained score relative to

the maximum possible score. The resulting percentage was then used to determine the level of product practicality based on the predetermined criteria. Data from the student field trial were analyzed descriptively to describe numeracy achievement across each assessed domain. The analysis included the percentage of achievement in basic numeracy, patterns and place value, numeracy problem solving, and data interpretation and estimation. The results of the analysis were used as supporting information to evaluate the implementation and suitability of the instrument and as a basis for refining the final product. This study did not conduct comparative effectiveness testing or statistical reliability testing because the focus of the development at this stage was to produce an assessment instrument that met the criteria of validity and practicality based on expert assessments and user responses.

3. RESULT AND DISCUSSION

RESULT

This section presents the research findings on the development of a contextual numeracy assessment instrument based on the Early Grade Mathematics Assessment (EGMA) in the form of a digital e-booklet for Phase B elementary school students. The findings are organized according to the development stages of the ADDIE model, including needs analysis, product development, expert validation, practicality testing, and the resulting final product. The data presented were derived from the data collection and analysis processes and are displayed in tables and figures to facilitate understanding of the research findings. The presentation of the findings is organized in accordance with the research objectives, while the interpretation of the findings, their relationship to relevant theories, comparisons with previous studies, and implications of the results are discussed separately in the Discussion section.

Needs Analysis

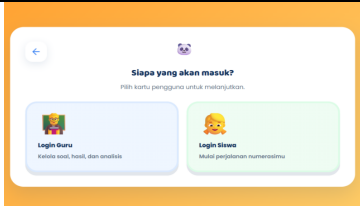
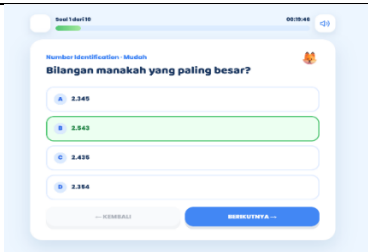
The initial stage of the study involved a needs analysis to identify the current conditions of numeracy assessment implementation among Phase B elementary school students. The analysis was conducted through classroom observations, interviews with teachers, and a document review of the assessment materials used in mathematics learning. The results of the analysis showed that the assessment instruments used by teachers were still predominantly composed of procedural tasks focusing on computational skills and therefore had not adequately measured students' reasoning, problem-solving, and ability to apply mathematical concepts in everyday-life contexts. In addition, the instruments were still presented in conventional formats, making them less engaging and indicating that digital media had not yet been optimally utilized as an assessment tool. Teachers also indicated that the implementation of the Merdeka Curriculum requires assessment instruments that are more contextual, easy to use, and capable of providing a more comprehensive picture of students' numeracy abilities. Based on these findings, a contextual numeracy assessment instrument based on the Early Grade Mathematics Assessment (EGMA) was developed in the form of a digital e-booklet adapted to the characteristics of Phase B elementary school students. The use of EGMA in the context of Indonesian elementary education has previously been reported for evaluating students' mathematical abilities, as demonstrated by Angu Bima et al. (2023) in East Sumba. However, their study focused on evaluating students' abilities, whereas the present study focuses on developing a contextual EGMA-based assessment instrument adapted to the characteristics of Phase B students and presented in a digital e-booklet format.

Product Development

Based on the results of the needs analysis, the numeracy assessment instrument was developed using the ADDIE model. The developed product was a digital e-booklet containing a numeracy assessment instrument based on the indicators of the Early Grade Mathematics Assessment (EGMA). The development of the instrument began with the preparation of an assessment blueprint based on the Phase B mathematics learning outcomes, followed by the development of indicators, construction of contextual numeracy items, preparation of scoring guidelines, and design of the digital e-booklet interface. The final product consisted of several components, including a cover page, teacher and student login menus, assessed competencies, contextual numeracy items based on EGMA, answer keys, student identity information, and a final scoring display. All components were systematically designed to facilitate teachers' use of the

instrument in implementing formative assessment. The e-booklet interface was designed using a combination of illustrations, colors, and a simple layout to suit the characteristics of Phase B elementary school students. An example of the developed product interface is presented in Table 1.

Table 1. Preliminary Design of the EGMA-Based E-Booklet Assessment Instrument

No	Media	Description
1		Home Page
2		Teacher Login and Student Login Menus
3		Student Information Entry Menu
4		Sample Assessment Questions with Correct Answers
5		Final Results of the Assessment Work

Based on Table 1, the design of the EGMA-based e-booklet numeracy assessment instrument begins with the opening page. The next menu features options for teacher login and student login, which can be used to access the instrument as a teacher or a student. Teachers can access a summary of scores, while students must fill out their personal information before taking the assessment. Students who complete the assessment will receive a score displayed in the final results.

Expert Validation

The developed product was subsequently validated by two expert validators, consisting of one material expert and one media expert. The validation was conducted to assess the appropriateness of the instrument based on the aspects of content, presentation, language, construction, and media design. The validation results indicated that the instrument met the very valid category based on the assessments of both validators. The material expert indicated that the

indicators, content alignment, and item construction were appropriate for the numeracy competencies of Phase B students. Meanwhile, the media expert provided highly favorable assessments of the visual appearance, readability, systematic presentation, and ease of use of the digital e-booklet.

Table 2. Expert Validation Results

No	Aspect	Score	Item	Category
<i>Subject Matter Expert</i>				
1	Content Appropriateness	85.00	4	Valid
2	Language	86.67	3	Valid
3	Presentation	86.67	2	Valid
4	Product Benefits	80.00	2	Valid
<i>Media Expert</i>				
1	Application	85.71		Valid
2	Appearance	85.00	7	Valid
3	Practicality	86.67	8	Valid
4	Product Benefits	80.00	3	Valid

Based on Table 2, the validity test results were obtained from two experts. The material expert's assessment of each component indicated that all aspects were categorized as valid, with an average score of 85.00%, which met the validity criteria. Similarly, the media expert's assessment showed that all components met the validity criteria, with an average score of 85.00%. Validity is not only concerned with the magnitude of the validation score but also with the alignment between validity evidence and the intended purpose and interpretation of assessment results (Perry, 2018). In this study, expert validation was conducted to ensure the alignment of the EGMA indicators, content, language, presentation, and media with the intended purpose of mapping the numeracy abilities of Phase B students. Therefore, based on the evaluations provided by both experts, the developed EGMA-based e-booklet numeracy assessment instrument can be considered valid.

Practicality Test Results

After the validation and revision processes, the product was tested with eight elementary school teachers, consisting of four Grade III teachers and four Grade IV teachers, to determine the practicality of the instrument. The teachers' assessments covered the aspects of ease of use, clarity of instructions, readability, media presentation, content suitability, and the usefulness of the instrument in implementing formative assessment.

Table 3. Results of the Practicality Test Conducted by Teachers

No	Validator	Percentage	Category
<i>Teacher</i>			
1	Application	88.75	Highly Valid
2	Presentation (Media)	88.13	Highly Valid
3	Content	87.50	Highly Valid
4	Language	85.94	Highly Valid
5	Application Usage (Practical)	88.54	Highly Practical
6	Product Benefits	89.58	Very Good
<i>Students</i>			
1	Media Suitability	87.80	Highly Valid
2	Aspect Suitability	85.49	Highly Good
3	Application Use (Practical)	89.48	Highly Practical
4	Product Benefits	84.38	Very Good

Based on Table 2, the responses from teachers and students indicated high ratings for the practicality and usefulness of the EGMA-based e-booklet. In terms of practicality, teachers provided a rating of 88.54%, categorized as very practical, while students provided a rating of 89.48%, also categorized as very practical. Regarding the usefulness of the product, teachers provided a rating of 89.58%, while students provided a rating of 84.38%, indicating very positive responses toward the benefits of the product in supporting the implementation of numeracy assessment. These findings indicate that the e-booklet was well received by users in terms of ease of use and usefulness. However, these user responses were not interpreted as evidence of the product's effectiveness in improving students' numeracy abilities.

Table 4. Recapitulation of Teacher and Student Responses to the Practicality and Usefulness of the EGMA-Based E-Booklet

Response	Aspect	Mean	
Teachers' Responses to the EGMA-Based E-Booklet	Application Usability (Practical)	88.54	
	Product Benefits		89.58
Students' Responses to the EGMA-Based E-Booklet	Application Usability (Practical)	89.48	
	Product Benefits		84.38
Mean		89.01	86.98
Category		Highly Practical	Very Good

Based on the responses from teachers and students, the e-booklet received high ratings in terms of practicality and usefulness. The average scores indicate that the product was perceived as easy to use and provided positive support for the implementation of Phase B numeracy assessment in elementary schools. These findings reflect user acceptance of the product.

Final Product

The final product developed in this study is a contextual numeracy assessment instrument based on the Early Grade Mathematics Assessment (EGMA), presented in the form of a digital e-booklet. The product underwent a series of development stages, including needs analysis, design, development, expert validation, revision, and practicality testing, resulting in an assessment instrument that meets the criteria for use with Phase B elementary school students. The developed e-booklet contains contextual numeracy items based on EGMA indicators, presented in a systematic, communicative, and engaging format. The product is also equipped with user instructions, scoring guidelines, and visual features designed to support student engagement throughout the assessment process. Based on the overall development process, the product resulted in a valid and practical EGMA-based contextual numeracy assessment instrument for Phase B elementary school students. Therefore, it can serve as an alternative numeracy assessment instrument to support the implementation of the Merdeka Curriculum.

Table 5. Summary of Student Competency Aspects

Competency Aspect (Task)	Perenatge	Category
Basic Numeracy (1,2,3,4)	87.78	Very Good
Patterns and Place Value (5,6)	75.56	Good
Numeracy Problem Solving	66.67	Fair
Data Interpretation and Estimation (9,10)	76.39	Good

Based on the recapitulation of students' numeracy abilities following the use of the EGMA-based numeracy e-booklet, different levels of achievement were observed across the assessed domains. The basic numeracy domain achieved the highest percentage at 87.78%, categorized as very good, indicating that students were able to recognize number symbols, compare numbers, and perform simple arithmetic operations successfully. The patterns and place value domain achieved 75.56%, categorized as good, while the data interpretation and estimation domain achieved 76.39%, also categorized as good. These findings indicate that most students were able to understand number patterns, place value, interpret simple data, and perform estimation, although some difficulties remained with certain concepts. The differences in achievement across domains indicate that students tended to have greater mastery of direct and procedural numeracy skills than of abilities requiring the integration of information and the selection of appropriate problem-solving strategies. The difference between basic numeracy (87.78%) and numeracy problem solving (66.67%), amounting to 21.11 percentage points, suggests that mastery of basic operations was not fully accompanied by the ability to apply this knowledge in contextual situations. The reporting of achievement by domain in this study is consistent with the principle that assessment scores should be aligned with the intended purpose of score interpretation. Reporting achievement by domain enables students' abilities to be interpreted more specifically than relying solely on an overall score (Ketterlin-Geller et al., 2018). This finding is important because it demonstrates that students' numeracy achievement is not homogeneous across all domains; therefore, assessment

should provide more specific information regarding the components of ability that have been mastered and those that still require further reinforcement. Differences in achievement across numeracy domains are also consistent with the concept of numeracy, which extends beyond computational skills to include the ability to use mathematical knowledge to interpret information, reason logically, and solve contextual problems.

Table 6. Summary of Students' Numeracy Skill Categories

Summary of Students' Numeracy Skill Levels		Total	Percentage
A	Proficient	11	24.44
B	Competent	17	37.78
C	Basic	12	26.67
D	Needs support	5	11.11

Based on the evaluation of students' performance on the EGMA-based numeracy e-booklet, four levels of competency mastery were identified: proficient, competent, basic, and requiring support. The competent category had the highest number of students, with 17 students (37.78%), indicating that most students were able to complete the majority of numeracy tasks successfully, although they still required further practice with more complex problems. Meanwhile, 12 students (26.67%) were classified in the basic category, while 11 students (24.44%) were classified as proficient. These findings indicate that most students had mastered basic numeracy skills, with some students demonstrating the ability to complete numeracy tasks independently, accurately, and consistently. Meanwhile, five students (11.11%) were classified as requiring support, indicating that some students still needed guidance in understanding numeracy concepts and completing the assigned tasks. Overall, the competency mastery results showed that the majority of students were classified as competent or proficient. These findings indicate that the instrument can be used to map variations in students' numeracy competency mastery across the proficient, competent, basic, and requiring-support categories.

DISCUSSION

This section interprets the research findings obtained during the development of a contextual numeracy assessment instrument based on the Early Grade Mathematics Assessment (EGMA) in the form of a digital e-booklet. The discussion relates each research finding to relevant foundational concepts, particularly theories of numeracy assessment, instrument development, and the implementation of formative assessment within the Merdeka Curriculum. In addition, the findings are compared with previous research to identify similarities and differences as a basis for demonstrating the scientific contribution of this study. The final part of the discussion outlines the implications of the findings, both theoretically for the development of numeracy assessment instruments and practically as an alternative instrument that teachers can use to conduct numeracy assessments for Phase B elementary school students.

Needs Analysis

The needs analysis results showed that most elementary school teachers had implemented numeracy assessment as part of the learning process; however, its implementation was not yet supported by systematically developed instruments based on specific numeracy competency indicators. In addition, teachers' understanding of the Early Grade Mathematics Assessment (EGMA) approach remained relatively limited, although all respondents demonstrated strong interest in the development of digital-based numeracy assessment instruments. These findings indicate a gap between the need to implement numeracy assessment in accordance with the demands of the Merdeka Curriculum and the availability of instruments capable of comprehensively measuring students' numeracy abilities. This condition is consistent with the concept of formative assessment in the Merdeka Curriculum, which positions assessment as an integral part of the learning process. Assessment does not merely function to measure learning outcomes but also provides information about students' competency achievement that can serve as a basis for teachers to design appropriate instructional follow-up. Therefore, numeracy assessment instruments need to be designed contextually and should be capable of measuring mathematical reasoning, problem-solving, and the application of mathematical concepts in various real-life situations. The use of Early Grade Mathematics Assessment (EGMA) indicators in this study

represents an effort to develop a more systematic instrument for identifying students' numeracy abilities at the elementary school level. The findings of this study are consistent with the research conducted by Mulyadi and Nursetyo, which reported that the development of information technology-based literacy and numeracy instruments could produce instruments that were valid and feasible for use in learning. However, their study primarily focused on the use of technology as an assessment medium without integrating EGMA indicators as the foundation for instrument development. In contrast, the present study developed a contextual numeracy assessment instrument that not only utilizes digital media in the form of an e-booklet but also incorporates EGMA indicators, thereby providing a more structured framework for identifying the numeracy abilities of Phase B elementary school students. The implications of these findings indicate that the development of an EGMA-based numeracy assessment instrument in the form of a digital e-booklet is relevant to supporting the implementation of the Merdeka Curriculum. Theoretically, this study reinforces the potential use of EGMA indicators as a framework for developing numeracy assessment instruments at the elementary school level. Practically, the developed instrument can serve as an alternative for teachers in implementing formative assessment in a more systematic, contextual, and accessible manner, thereby providing more comprehensive information about students' numeracy abilities.

Product Validity

The validation results showed that the contextual numeracy assessment instrument based on the Early Grade Mathematics Assessment (EGMA), presented in the form of a digital e-booklet, met the criteria for use after undergoing validation by material and media experts. The validators' assessments covered the aspects of content appropriateness, language, presentation, and media design. Several suggestions provided by the validators were used as the basis for revising the product, resulting in an instrument that was better aligned with the characteristics of Phase B elementary school students. In this study, expert validation served not only to assess the visual presentation and content appropriateness of the instrument but also to ensure that the adaptation of EGMA indicators to the Phase B context did not compromise the foundational abilities intended to be mapped. The level of validity obtained indicates that the instrument development process fulfilled the fundamental principles of assessment instrument development, particularly the alignment among the competencies being measured, the content presented, student characteristics, and learning objectives. The use of Early Grade Mathematics Assessment (EGMA) indicators enabled each item to be systematically developed based on the foundational numeracy skills that Phase B students are expected to master. Furthermore, presenting the instrument in a digital e-booklet format provided a more structured, communicative, and comprehensible presentation, thereby supporting readability and ease of use during the assessment process. These findings are consistent with the study by Febriyanti and Wardana (2024), which reported that the formative assessment instrument developed achieved a high level of validity because it was constructed based on clearly defined learning indicators and underwent expert validation. Similarly, Utari, Susanta, and Koto (2024) found that a numeracy AKM instrument based on the PISA model met the validity criteria as a measure of students' numeracy abilities. Nevertheless, the present study differs in its use of Early Grade Mathematics Assessment (EGMA) indicators as the foundation for instrument development and its presentation in a digital e-booklet format adapted to the characteristics of Phase B elementary school students. Thus, this study not only produces an instrument that meets the criteria for use but also offers an alternative approach to developing numeracy assessment that is more contextual and aligned with the implementation of the Merdeka Curriculum. The implications of the validation results indicate that the developed instrument meets the criteria of content appropriateness, language, presentation, and media design and can therefore be used as a numeracy assessment instrument for Phase B elementary school students. Theoretically, these findings reinforce the potential of EGMA indicators to be adapted as a basis for developing numeracy assessment instruments that are appropriate to the cognitive development of elementary school students. Practically, the validated instrument provides teachers with an alternative means of conducting numeracy assessment in a more systematic and contextual manner while remaining aligned with the demands of the Merdeka Curriculum.

Product Practicality

The practicality test results showed that the contextual numeracy assessment instrument based on the Early Grade Mathematics Assessment (EGMA), presented in the form of a digital e-booklet, received highly positive responses from teachers. The average teacher rating of the product reached 88.07%, with practicality rated at 88.54% and usefulness rated at 89.58%, all of which were categorized as very good. These findings indicate that the developed instrument was easy to use and could support the implementation of numeracy assessment for Phase B elementary school students. In this study, practicality was not limited to ease of navigation but also concerned teachers' ability to understand the objectives and indicators of each assessment task. This aspect is important because formative assessment instruments should generate actionable information for teachers rather than merely provide final scores. The instrument was designed with simple navigation, an engaging visual presentation, communicative language, and a systematic structure, making it easier for teachers to operate during the assessment process. In addition, the e-booklet could be accessed through Android-based devices, providing teachers with flexibility in conducting assessments without requiring specialized equipment. These characteristics are consistent with principles of digital learning media development that emphasize usability, readability, accessibility, and efficiency as important factors in supporting the implementation of technology-based learning and assessment. The positive user responses regarding the ease of use and usefulness of the e-booklet are consistent with Sulistiyawati (2024), who emphasized the potential of digital technology to support assessment implementation. These findings also support the study by Mulyadi and Nursetyo, which showed that information technology-based literacy and numeracy instruments had a high level of feasibility for use in learning.

In addition, Fauzi et al. (2024) explained that contextually presented instruments can provide students with more meaningful learning experiences. Nevertheless, the present study offers a distinctive contribution by integrating Early Grade Mathematics Assessment (EGMA) indicators into a digital e-booklet. Thus, the product not only provides an easy-to-use digital medium but also offers an assessment instrument designed to identify students' numeracy abilities in a more systematic manner according to the characteristics of Phase B elementary school students. The use of digital technology in assessment also has the potential to support feedback provision and differentiated instruction. Faber et al. (2017) demonstrated that the use of digital formative assessment tools can positively affect students' mathematics achievement and motivation while supporting teachers in implementing differentiated instruction. The implications of the findings indicate that the EGMA-based e-booklet can serve as an alternative formative assessment instrument within the implementation of the Merdeka Curriculum. The findings suggest that adapting EGMA into an instrument for Phase B students can support more detailed mapping of numeracy abilities, particularly in distinguishing mastery of basic numeracy skills from the ability to apply those skills in problem solving. The pattern in which basic numeracy achievement was higher than numeracy problem-solving achievement further highlights the importance of conceptualizing numeracy as a gradual and multidimensional construct rather than merely the ability to perform arithmetic operations. Pedagogically, the assessment results suggest that teachers should provide differentiated follow-up based on students' specific competency domains. Relatively high achievement in basic numeracy can serve as a foundation for developing more complex abilities, whereas lower achievement in problem solving indicates the need for further reinforcement through contextual problems, problem representation, strategy selection, and explanation of solution reasoning. Thus, assessment results can be used not only to determine students' scores but also as a basis for planning appropriate instructional follow-up.

Students' Numeracy Skills

The implementation of the Early Grade Mathematics Assessment (EGMA)-based numeracy assessment instrument revealed variations in students' numeracy achievement across the assessed domains. Basic numeracy achieved the highest percentage at 87.78%, followed by data interpretation and estimation at 76.39%, and patterns and place value at 75.56%. In contrast, numeracy problem solving achieved the lowest percentage, at 66.67%. These findings indicate that students had relatively strong mastery of foundational numeracy skills; however, such mastery had not yet been fully transferred to contextual problem-solving abilities. The lower achievement in the problem-solving domain should be understood as an indication that students encountered more complex cognitive demands when numerical knowledge had to be applied to contextual situations.

Unlike basic numeracy tasks, which primarily require number recognition and the application of computational procedures, problem-solving tasks require students to understand information, identify relationships between quantities, determine appropriate operations or strategies, and interpret the resulting answers. Thus, the differences in achievement suggest that mastery of numerical procedures does not necessarily guarantee the ability to apply mathematical knowledge in problem situations. This pattern is broadly consistent with trends reported in large-scale international mathematics assessments, in which applying mathematical knowledge to contextual problems can present different challenges from mastering mathematical procedures. However, these findings cannot be directly compared with PISA results because of differences in age groups, constructs, and assessment contexts. Nevertheless, the findings imply that presenting problems in real-life contexts should be accompanied by support for mathematical modeling and strategy selection rather than merely transforming computational exercises into word problems. Therefore, the use of context in assessment instruments should be understood as a means of eliciting students' ability to connect contextual information with mathematical representations. This finding extends the work of Najwa and Najwa (2023), who emphasized the meaningfulness of context in numeracy learning, by demonstrating the importance of combining contextualization with the mapping of underlying foundational skills through the EGMA framework.

The implications of these findings indicate that the EGMA-based numeracy assessment instrument functions not only as an evaluation tool but also as a means of identifying students' strengths and weaknesses across different numeracy domains. Theoretically, this study reinforces the potential of EGMA indicators to provide a more structured representation of the development of elementary school students' numeracy abilities. Practically, the relatively low achievement in the problem-solving domain can serve as a basis for teachers to design learning and assessment activities that place greater emphasis on mathematical reasoning, contextual problem solving, and the application of mathematical concepts to everyday situations, in accordance with the characteristics of learning within the Merdeka Curriculum.

Research Implications

Theoretical Implications

This study contributes to the development of numeracy assessment research at the elementary school level, particularly through the application of the Early Grade Mathematics Assessment (EGMA) as a basis for developing a contextual numeracy assessment instrument. The findings demonstrate that EGMA indicators can be adapted and integrated into a digital e-booklet assessment instrument that is appropriate for the characteristics of Phase B elementary school students. These findings reinforce the concept that numeracy assessment should not be limited to measuring computational skills but should also provide information about students' mathematical reasoning, problem-solving abilities, and capacity to apply mathematical concepts in various contextual situations. Thus, this study offers an alternative framework for developing numeracy assessment instruments that is relevant to the implementation of the Merdeka Curriculum and may serve as a reference for future research on competency-based assessment instrument development.

Practical Implications

From a practical perspective, this study produced an EGMA-based contextual numeracy assessment instrument in the form of a digital e-booklet that met the criteria of validity and practicality and was therefore suitable for use in formative assessment at the elementary school level. The developed instrument features a systematic presentation, is easy to operate through digital devices, and provides more detailed information regarding students' numeracy achievement across the assessed domains. The resulting numeracy mapping can be utilized by teachers as a basis for designing instructional strategies, providing follow-up activities that address students' needs, and evaluating the attainment of numeracy competencies more comprehensively. Therefore, the instrument has the potential to serve as an alternative assessment tool supporting the implementation of the Merdeka Curriculum, particularly in improving the quality of numeracy assessment in elementary schools.

Research Limitations

This study has several limitations that should be considered when interpreting the findings. First, the product trial involved eight teachers and 45 Phase B students within the Widya Sarana Cluster; therefore, the findings remain context-specific, and generalization to schools with different

student characteristics, teacher profiles, and infrastructure should be approached with caution. Second, the study focused on examining validity and practicality and mapping students' numeracy achievement; therefore, product effectiveness was not tested using an experimental design such as a pretest-posttest design, N-Gain analysis, or a comparison group. Consequently, the findings cannot be used to conclude that the use of the e-booklet resulted in an improvement in students' numeracy abilities. Third, statistical reliability testing was not conducted; therefore, the internal consistency of the instrument cannot yet be empirically established. In addition, the Early Grade Mathematics Assessment (EGMA) indicators used in this study were adapted to the characteristics of Phase B students, the context of elementary school numeracy, and the implementation of the Merdeka Curriculum. Accordingly, the developed instrument is not intended to be a direct reproduction of the original EGMA instrument but rather an adaptation of the EGMA framework to meet the needs of numeracy assessment in Indonesian elementary schools. The use of an e-booklet format also presents limitations because its implementation depends on the availability of digital devices and technological infrastructure in schools. These limitations provide a basis for future research to test the instrument with broader samples and in more diverse school contexts, conduct more comprehensive analyses of reliability and item characteristics, and examine product effectiveness through experimental research designs.

4. CONCLUSION

This study successfully developed a contextual numeracy assessment instrument based on the Early Grade Mathematics Assessment (EGMA) in the form of a digital e-booklet for Phase B elementary school students using the ADDIE development model. The findings indicate that the developed instrument met the validity criteria based on expert assessments and the practicality criteria based on teacher responses. Therefore, the resulting instrument is suitable for use as an alternative formative assessment tool for Phase B students within the context of the trial. In addition to producing a valid and practical instrument, this study demonstrated that the EGMA-based instrument can map students' numeracy abilities across several key domains, namely basic numeracy, patterns and place value, numeracy problem solving, and data interpretation and estimation. The mapping results showed that students' basic numeracy abilities were relatively high, whereas problem-solving abilities still require further reinforcement through learning activities that emphasize mathematical reasoning and contextual problem solving. The developed assessment instrument is expected to provide teachers with an alternative for implementing numeracy assessment in a more systematic and contextual manner and in accordance with the implementation of the Merdeka Curriculum. Future research is recommended to examine the use of the instrument across a broader range of schools and to investigate its effectiveness in improving students' numeracy abilities through appropriate experimental research designs.

6. DAFTAR PUSTAKA

- Angu Bima, S., Ndakularak, I. L., Nggaba, M. E., Randjawali, E., & Pakereng, Y. M. (2023). Evaluating mathematical literacy among pupils using Early Grade Mathematics Assessment in East Sumba. *Jurnal Paedagogy*, 10(2), 379–388. <https://doi.org/10.33394/jp.v10i2.7418>
- Badan Standar, Kurikulum, D. A. P., Menengah, K. P. D. D., & Indonesia, R. (2025). Panduan Pembelajaran dan Asesmen Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah Edisi Revisi Tahun 2025. https://kurikulum.kemendikdasmen.go.id/file/1755668120_manage_file.pdf
- Ekowati, D. W., Astuti, Y. P., Utami, I. W. P., Mukhlishina, I., & Suwandayani, B. I. (2019). Literasi Numerasi di SD Muhammadiyah. *ELSE (Elementary School Education Journal) : Jurnal Pendidikan Dan Pembelajaran Sekolah Dasar*, 3(1), 93. <https://doi.org/10.30651/else.v3i1.2541>
- Dyah Worowirastri Ekowati, Astuti, Y. P., Utami, I. W. P., Mukhlishina, Innany, Suwandayani, & Istanti, B. (2019). Literasi Numerasi Di Sd Muhammadiyah. *Else (Elementary School Education Journal)*, 3(4), 93–103. <https://doi.org/10.30651/else.v3i1.2541>
- Faber, J., Luyten, J. W., & Visscher, A. J. (2017). The effects of a digital formative assessment tool on mathematics achievement and student motivation: Results of a randomized experiment. *Computers & Education*, 106, 83–96. <https://doi.org/10.1016/j.compedu.2016.12.001>

- Fauzi et.al. (2024). Pengembangan Instrumen Literasi Matematis Berbasis Etnomatematika untuk Peserta Didik Sekolah Dasar. *JUPIKA* : Vol.7 No.2, Hal. 153-167. <https://e-journal.uniflor.ac.id/index.php/jupika/article/download/4997/2717>
- Febriyanti dan Wardana (2024). Pengembangan Instrumen Asesmen Formatif pada Materi Pecahan. UMSIDA Preprints Server. <https://doi.org/10.21070/ups.2226>
- Ketterlin-Geller, L. R., Perry, L., Platas, L. M., & Sitabkhan, Y. (2018). Aligning test scoring procedures with test uses: A balancing act. *Global Education Review*, 5(3), 143–161. <https://ger.mercy.edu/index.php/ger/issue/view/34>
- Kemdikbud. (2020). Desain Pengembangan Soal Asesmen Kompetensi Minimum 2020 1 (Kemendikbud (ed.)). Pusat Asesmen Pendidikan, Balitbang dan Perbukuan.
- Kemdikbud. (2019). Kajian Akademik & Rekomendasi Reformasi Sistem Asesmen Nasional. (Kemendikbud (ed.)). Pusat Asesmen Pendidikan, Balitbang dan Perbukuan. https://pusmendik.kemdikbud.go.id/an/page/download_file/447246_4
- Kemdikbudristek. (2021). Capaian Pembelajaran Sekolah Dasar (Fase A–C). Jakarta: Direktorat Jenderal Guru dan Tenaga Kependidikan.
- Kemdikbudristek. (2022). Laporan hasil Asesmen Nasional tahun 2021–2022. Jakarta: Pusat Asesmen Pendidikan, Balitbang dan Perbukuan.
- Kemdikbudristek. (2022). PANDUAN PENGELOLAAN KOMUNITAS BELAJAR OLEH UNIT PELAKSANA TEKNIS. Direktorat Jenderal Guru dan Tenaga Kependidikan, Kemdikbudristek.
- Mulyadi, & Nursetyo, K. I. (2022). Pengembangan Instrumen Literasi dan Numerasi Berbasis TIK Untuk Siswa Sekolah Dasar. *Jurnal Pembelajaran Inovatif*, 5(2), 75–86. <https://doi.org/10.21009/JPI.052.11>
- Nadiatussalma, A. S. (2025). Kemampuan Numerasi di Sekolah Dasar: Systematic Literature review. 8(3), 1303–1312. <https://jurnal.uns.ac.id/SHES/article/download/107388/51120>
- Najwa dan Najwa. (2023). Pengembangan Instrumen Numerasi Pada Konteks Pertanian Dan Pariwisata Untuk Siswa Kelas 4 Sekolah Dasar. *Primary : Jurnal Keilmuan dan Pendidikan Dasar*. Vol. 15 No.2. <https://doi.org/10.32678/primary.v15i2.8248>
- Nuryadi, F. H., Setiawan, F., & Faradita, M. N. (2026). Peran Guru dalam Menerapkan Deep Learning di Sekolah Dasar. *Education Journal : Journal Education Research and Development*, 2, 53–67. <https://jurnal.unipar.ac.id/index.php/ej/article/view/2966/2356>
- OECD. (2019). PISA 2018 Results (Volume I): What Students Know and Can Do. Paris: OECD Publishing. <https://doi.org/10.1787/5f07c754-en>
- Platas, L. M., Ketterlin-Geller, L. R., & Sitabkhan, Y. (2016). Using an assessment of early mathematical knowledge and skills to inform policy and practice: Examples from the Early Grade Mathematics Assessment. *International Journal of Education in Mathematics, Science and Technology*, 4(3), 163–173. <https://doi.org/10.18404/ijemst.20881>
- Perry, L. (2018). Different analyses, different conclusions? Validity evidence from the EGMA spatial reasoning subtask. *Global Education Review*, 5(3), 125–142. https://eric.ed.gov/?id=EJ1193969&utm_source
- RTI International. (2018). Early Grade Mathematics Assessment (EGMA) Toolkit. Research Triangle Park, NC: RTI Press. <https://doi.org/10.3768/rtipress.2018.op.0051.1805>
- Sulistiyawati, D. Y. R. (2024). Peran Teknologi Informasi Dalam Perkembangan Literasi Numerasi Peserta Didik Jenjang Sekolah Dasar Di Era Digital. *Social, Humanities, and Educational Studies SHEs: Conference Series* 7 (3) (2024) 451 - 459, 7(3), 451–459. <https://jurnal.uns.ac.id/SHES/article/view/91608>
- Utari, Susanta & Koto. (2024). Pengembangan Instrumen Asesmen Kompetensi Minimum (AKM) Numerasi Model Pisa Dengan Konteks Musi Rawas Kelas V Sekolah Dasar. (2024). *Jurnal Kajian Pendidikan Dasar*, 3(1), 87–96. <https://doi.org/10.33369/kapedas.v3i1.29016>
- Yuliana, E. (2017). Analisis Pengetahuan Siswa Tentang Makanan yang Sehat dan Bergizi Terhadap Pemilihan Jajanan di Sekolah. <https://repository.ump.ac.id/4114/>