



Development of an ethnomathematics-based pop-up book for elementary students' numeracy literacy

Ummi Tadzkiroh ^{a,1,*}, Sutama ^{a,2}, Yulia Maftuhah Hidayati ^{a,3}

^a Universitas Muhammadiyah Surakarta, Surakarta, Indonesia

¹ q200220019@student.ums.ac.id; ² sut197@ums.ac.id; ³ ymh284@ums.ac.id

* corresponding author

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ABSTRACT

Multiplication learning in elementary schools often emphasizes memorization through multiplication cards and "multiplication stars," with limited integration of local cultural contexts. The use of interactive ethnomathematics based media to connect multiplication concepts, local culture, and numeracy literacy remains insufficiently developed. This study aimed to examine teachers' use of multiplication learning media, develop an ethnomathematics based pop-up book, and evaluate its feasibility. The study employed a research and development (R&D) approach using the 4-D model (Define, Design, Develop, and Disseminate), limited to the Develop stage. Data were collected through classroom observations, teacher interviews, and expert validation questionnaires. The developed product, *PINTAR Pop-Up Book* (Interactive Multiplication for Happy Children), integrates basic multiplication concepts, Javanese cultural elements, and contextual numeracy literacy exercises through interactive pop-up illustrations. The feasibility assessment involved material, media, and language experts. The validation scores were 94 for material, 85 for media, and 89 for language, all categorized as "very feasible." These results indicate that the *PINTAR Pop-Up Book* meets the assessed feasibility criteria and can serve as an alternative resource for contextual multiplication learning. However, the findings do not establish its effectiveness in improving students' conceptual understanding or numeracy literacy because the study was limited to product development and expert validation. Further classroom trials are needed to assess its practicality and learning outcomes. This study contributes to the development of contextual mathematics learning media by integrating ethnomathematics, interactive learning, and numeracy literacy into a single educational resource. The *PINTAR Pop-Up Book* offers an alternative for connecting multiplication learning with Javanese cultural contexts in elementary education.



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1. Introduction

Numeracy literacy is an essential competency that enables individuals to interpret, analyze, and apply mathematical concepts to solve problems and make informed decisions in everyday life [1]–[3]. However, developing numeracy literacy remains a significant challenge in Indonesia. According to the Organisation for Economic Co-operation and Development (OECD, 2023), the results of the Programme for International Student Assessment (PISA) 2022, released on December 5, 2023, showed that Indonesia's mathematics score was 366, which was 106 points below the OECD average. Although Indonesia's relative position in mathematics improved by five places compared with 2018, its average score declined by 13 points.

Furthermore, approximately 82% of Indonesian students performed below Level 2 in mathematics [4]. These findings indicate that strengthening mathematical competencies requires sustained attention, particularly through meaningful mathematics learning at the elementary school level. Early mathematics education plays an important role in establishing foundational skills that students need to understand and apply mathematical concepts in increasingly complex situations. One of the fundamental mathematical concepts introduced in elementary school is multiplication. However, learning multiplication may become challenging when students are expected to memorize multiplication facts without sufficiently understanding the underlying concepts and their practical applications.

This problem was identified in a preliminary study conducted among third-grade students at SDN Sugihan 04, Indonesia, under the Independent Curriculum. The initial assessment indicated that 80% of the students had not achieved the expected level of proficiency in multiplication problems. Preliminary observations also suggested that some students relied primarily on memorization rather than understanding multiplication as repeated addition or applying it to contextual problems. In addition, students demonstrated limited enthusiasm for mathematics because they perceived it as a difficult subject involving frequent calculations [5]. These initial findings suggest a need for learning approaches that make multiplication more concrete, engaging, and relevant to students' everyday experiences. This need is consistent with the characteristics of elementary school students, who benefit from learning experiences that connect abstract mathematical concepts with concrete representations [6], [7]. Learning media that provide visual, manipulative, and contextual experiences may therefore help students develop a more meaningful understanding of multiplication while supporting the development of numeracy literacy.

One potential learning medium is the Pop-Up Book, a three-dimensional instructional resource that presents visual representations through interactive paper structures. Previous studies have demonstrated the potential of Pop-Up Books for various educational purposes. Hartanti *et.al*, reported that an ethnomathematics-based Sigeru Pop-Up Book for learning cubes and cuboids met validity and practicality criteria [8]. Similarly, Faizah *et.al*, found that Pop-Up Book media for plane geometry attracted students' attention and was suitable for use in fourth-grade mathematics learning. In addition to mathematics instruction, Kirom and Lestanti investigated the use of Smart Pop-Up Books to support reading and writing literacy among children aged five to six years [9], [10]. These studies demonstrate that Pop-Up Books can support visual engagement, concept representation, and learning experiences across different educational contexts.

Nevertheless, their findings concern different mathematical topics, grade levels, or literacy domains and do not directly establish the effectiveness of this medium for strengthening multiplication-related numeracy literacy among third-grade elementary school students. Research has also begun to examine the use of Pop-Up Books specifically for numeracy literacy and ethnomathematics-based learning. Maulidya *et.al*, reported that Pop-Up Book media could improve students' numeracy literacy in plane geometry, while Moertu *et.al*, investigated its application to arithmetic operations among second-grade students [11]. Other studies have explored ethnomathematics as a means of connecting mathematical concepts with cultural knowledge. Luthfiyyah and Haqiqi reported the feasibility and practicality of an edupreneurship-based ethnomathematics Pop-Up Book for learning flat-sided geometric shapes [12]. Hamidah and Fiantika explored ethnomathematics-based Pop-Up Book media in the context of mosque design and geometric representations [13]. Collectively, these studies suggest that integrating visual learning media with cultural contexts offers opportunities to make mathematics more meaningful and to connect school knowledge with students' environments.

Despite these contributions, the existing studies predominantly address geometry, general arithmetic operations, or literacy outcomes in contexts that differ from the specific learning needs of third-grade students studying basic multiplication. Moreover, the use of ethnomathematics in Pop-Up Book development has largely been discussed in relation to geometric concepts, whereas the potential of culturally contextualized three-dimensional media for teaching basic multiplication requires further investigation. The distinction is important because multiplication involves understanding numerical relationships, repeated addition, equal groups, and the application of multiplication facts to everyday situations [14]. For third-

grade students, merely presenting attractive visual media may not be sufficient; the representations must also help students connect concrete objects, multiplication expressions, and contextual problem-solving [15]. Incorporating familiar Javanese cultural elements into a three-dimensional Pop-Up Book may provide opportunities to establish these connections while introducing students to their cultural heritage. However, the extent to which such a medium can be developed to meet the learning needs of third-grade students and support multiplication-related numeracy literacy remains insufficiently addressed by the studies reviewed above.

To address this research gap, the present study focuses on the development of an ethnomathematics-based three-dimensional Pop-Up Book for teaching basic multiplication to third-grade elementary school students at SDN Sugihan 04. Its principal novelty lies in the integration of three elements within a single instructional medium: three-dimensional visual representations, multiplication concepts presented through concrete and contextual learning activities, and Javanese cultural elements that connect mathematical learning with students' cultural environment. Unlike previous studies that primarily focused on geometry, arithmetic operations in other grade levels, or literacy domains other than multiplication-related numeracy, this study specifically positions the Pop-Up Book as a medium for introducing and strengthening conceptual understanding of basic multiplication in the context of elementary numeracy literacy.

The study aims to develop and evaluate the quality of this learning medium in terms of its feasibility for classroom use and its potential to support students' understanding of basic multiplication and numeracy literacy. The expected contribution is a contextually relevant instructional resource that connects concrete mathematical representations with local cultural knowledge, thereby providing an alternative approach to multiplication learning in elementary schools. The findings are also expected to inform the development of culturally responsive mathematics learning media for foundational numeracy instruction.

2. Method

2.1. Type and Design

This study employed a Research and Development (R&D) design based on Sugiyono to develop a learning media product and assess its feasibility through expert validation [16]. The development process followed the 4-D model, consisting of four stages: Define, Design, Develop, and Disseminate. A mixed-methods approach was used to collect and analyze quantitative and qualitative data to obtain a comprehensive evaluation of the developed product. Quantitative data were obtained from validation questionnaires completed by media, material, and language experts and were analyzed descriptively to determine the product's feasibility. Media experts assessed the visual presentation, image and text arrangement, and usability of the media.

Material experts evaluated the presentation and suitability of the learning content, while language experts assessed the appropriateness of the language for elementary school students' cognitive levels and its compliance with Indonesian spelling conventions (PUEBI). Qualitative data were obtained from the experts' comments and suggestions and were analyzed descriptively to identify aspects requiring improvement. The qualitative findings complemented the quantitative results by providing specific recommendations for product revision. Therefore, the research design was an R&D study guided by the 4-D development model, with a mixed-methods approach to data collection and analysis and an evaluative component to determine product feasibility and guide revisions.

2.2. Data and Data Sources

The subjects of this study were third-grade students at SDN Sugihan 04. The number of students was 28, with 15 female students and 13 male students. This study was planned by the researcher for 6 months starting from July to December. Product validation involved two experts who were lecturers in Elementary School Teacher Education and certified Elementary School Teachers. Both validators were selected based on their abilities and expertise in assessing the developed media.

2.3. Data Collection Technique

The development research model used is the 4-D model which is divided into 4 stages, namely: (1) Define: The definition stage is the stage used to determine and define needs in the

process of collecting various information related to the product to be developed; (2) Design: At this stage, researchers design the media product to be created. In this stage, product design activities on the Pop-Up Book learning media include creating assessment instruments, designing product designs, and creating products; (3) Development: This development stage aims to determine the assessment of the results of the development of the revised Pop-Up Book learning media based on validation input (material experts, media experts, language experts) by academics (lecturers) and practitioners (teachers); (4) Dissemination: At the dissemination stage, it is the final stage in the 4D research model which contains activities to disseminate ethnomathematics-based Pop-Up Book learning media products that have been tested valid, feasible and effective for use in learning, especially in elementary schools.

This research is limited to the development stage. Data collection techniques in this study include questionnaires, interviews, and observations. A questionnaire was used to obtain assessment data from expert validators and teachers regarding the suitability of the developed learning media. Interviews were conducted to gather information regarding the use of multiplication learning media and the challenges teachers faced during the learning process. Meanwhile, observations were used to directly observe school conditions and classroom learning processes to obtain data that reflected actual conditions in the field.

2.4. Data Collection Instruments

Data collection instruments through media expert validation play a crucial role in ensuring the quality, feasibility, and effectiveness of the developed learning media before implementation in the learning process. Validation is conducted to assess the media's appearance, efficiency, technical quality, and usability to ensure it aligns with the characteristics of elementary school students. In this study, the media expert validators consisted of lecturers from the Elementary School Teacher Education Study Program (PGSD) and certified elementary school teachers. The involvement of these validators provided a more objective and comprehensive assessment because it was based on academic competence, pedagogical experience, and an understanding of learning needs in elementary schools. The media expert validation instrument is presented in Table 1.

Table 1. Media Expert Validation Instrument

Assessment Aspects	Assessment Indicators	Likert Scale
Efficiency	Ease of understanding the media workflow, ease of use and simplicity of program operation	1-5
Appearance	Clarity of instructions for use, consistency of features, readability of language and text, attractiveness of design, suitability of images and effects, color composition, and accuracy of menu placement.	1-5
Technical Quality and Program Effectiveness	The media is not boring, the material is appropriate to the learning objectives, the evaluation is accurate, and the program is presented systematically.	1-5
Uses of Media	Maintainability, usability, and reusability of learning media	1-5

Likert scale description: 1 = very inappropriate, 2 = inappropriate, 3 = quite appropriate, 4 = appropriate, and 5 = very appropriate. The data collection instrument, validated by subject matter experts, aims to ensure the suitability of the material content with the learning objectives, student characteristics, and learning outcomes at the elementary school level. This validation is important to ensure that the material presented in the learning media is not only conceptually correct, but also relevant, systematic, and easily understood by students.

In this study, the subject matter expert validators consisted of lecturers from the Elementary School Teacher Education Study Program (PGSD) and elementary school teachers who already hold teaching certificates. The involvement of these validators provided a comprehensive assessment based on academic competency and practical experience in elementary school learning. The results of the subject matter expert validation were used as a basis for refining the content and presentation of the material so that the developed learning media was more effective and suitable for use. The material expert validation instrument is presented in Table 2.

Table 2. Material Expert Validation Instrument

Assessment Aspects	Assessment Indicators	Likert Scale
Learning	Relevance of material to competencies and indicators, clarity of material, adequacy of exercises, and use of language	1–5
Contents	Ease of use of media, clarity and accuracy of material, readability of language, attractiveness of material, and suitability of supporting images	1–5

Likert scale description: 1 = very inappropriate, 2 = inappropriate, 3 = quite appropriate, 4 = appropriate, and 5 = very appropriate. The data collection instrument, validated by linguists, aims to assess the appropriateness of language use in learning media to suit the cognitive development level and characteristics of elementary school students. Language validation includes aspects of readability, accuracy of diction, clarity of sentences, conformity to Indonesian language rules, and effectiveness of communication in delivering material. In this study, the linguists consisted of lecturers from the Elementary School Teacher Education Study Program (PGSD) and elementary school teachers who already hold teaching certificates. The involvement of these validators provided academic and practical assessments based on professional competence and experience in teaching in elementary schools. The validation results were used as a basis for revising and refining the language in the learning media so that the information conveyed was more communicative, systematic, and easily understood by students. The language expert validation instrument is presented in [Table 3](#).

Table 3. Language Expert Validation Instrument

Language Aspects	Likert Scale
Suitability of language to the intellectual level of elementary school students	1–5
Consistency in the use of terms, symbols and emblems	1–5
Conformity of sentences with Indonesian grammar	1–5
Clarity and ease of understanding of language	1–5
Language compatibility with PUEBI	1–5
Language is interactive	1–5
Language is communicative	1–5

Likert scale description: 1 = very inappropriate, 2 = inappropriate, 3 = quite appropriate, 4 = appropriate, and 5 = very appropriate.

2.5. Data Analysis

Qualitative data were analyzed using an interactive analysis model according to Miles and Huberman which includes the stages of data collection, data reduction, data presentation, and drawing conclusions or verification [17]. This analysis was used to examine in depth the level of understanding of the principal and teachers as participants regarding deep learning lesson planning through the use of Ethnomathematics-Based Multiplication Pop-Up Book Media. Quantitative analysis used descriptive statistics (categorized as high, medium, and low). The purpose of descriptive statistical analysis was to obtain a more detailed picture of user evaluations of this prototype through categorizations of high, medium, and low. These categories serve to assess the product. The categories are very good (SB), good (B), sufficient (C), and poor (K). Assessment guidelines presented in [Table 4](#).

Table 4. Assessment Guidelines

Category	Score Value
Very Good	4
Good	3
Enough	2
Less	1

The following is a classification of calculation results using interval classes for categorization. As can be seen in [Table 5](#).

Table 5. Categorization Guidelines

Average Score	Presentation	Category
3.26–4.00	81.26%–100%	Very Good (Very Decent)
2.51–3.25	62.51%–81.25%	Good (Decent)
1.76–2.50	43.76%–62.50%	Enough (Decent Enough)
1.00–1.75	25.00%–43.75%	Less (Less Worthy)

3. Results and Discussion

The result of this development research is an Ethnomathematics-Based Pop-Up Book media on multiplication material made of photo paper, manila paper, and sticker paper, equipped with elements of traditional Javanese food and traditional Javanese games in three-dimensional form, which is able to become an attraction in the Pop-Up Book being developed. The process of developing this Pop-Up Book media involves several stages in accordance with the 4-D development model, namely Define, Design, Develop, and Disseminate. However, this research is limited to the Develop stage. The following is a series of stages used in development research using the 4-D model.

3.1. Exploration of the use of learning media on basic multiplication concepts used by teachers at SDN Sugihan 04

The analysis activities included a needs analysis through interviews with third-grade elementary school teachers. At this stage, the main activity was analyzing the basic problems faced in the learning process at school related to learning media. Essentially, the analysis stage is used to analyze the basic problems that exist in schools. This aims to identify and classify the problems faced by schools, especially those related to the learning media used by the school so far. The learning process in the classroom only uses the available learning media prepared by the school. From the results of observations of the learning activities of third-grade students, multiplication star cards were found that can monitor students' memorization of multiplication, called multiplication stars, as shown in Fig. 1.

**Fig. 1.** Multiplication Star

The multiplication stars are used to record students' memorization of multiplication. They will get a star if they successfully memorize the multiplication. However, many students still have the wrong way of calculating. The analysis was conducted by interviewing the third-grade teacher of SDN Sugihan 04. Based on the results of the interview with the third-grade teacher, when students work on multiplication problems, some students calculate backwards. For example, in the problem $2 \times 3 = 2 + 2 + 2 = 6$, this is the wrong way. The correct way should be $2 \times 3 = 3 + 3 = 6$. In addition, students, when participating in class learning, pay attention to the teacher during the learning process because the media used during the learning process is less interesting. Therefore, it is necessary to develop more innovative learning media to make it easier for students to understand the learning, especially in the mathematics subject of multiplication material for third-grade SDN Sugihan 04. The results of the analysis show the need to develop interesting learning media for students, namely Pop-Up Book learning media. Learning using Pop-Up Book learning media can make students more interactive and learning more meaningful.

3.2. Making pop-up book learning media based on ethnomathematics on the basic concept of multiplication to strengthen numeracy literacy

The product design stage involves designing or initially compiling the material, questions, discussions, and prototypes for pop-ups and ethnomathematics. The design uses Corel Draw and Corel Photo Paint. The next step after the design stage is the development stage.

1) Cover

The Pop-Up Book learning media was created using the Photoshop application on A4 Art paper and equipped with colors and mathematical images according to the multiplication material taken from Google or the Pinterest application so that the cover looks more attractive. The title of the cover is *PINTAR* (Interactive Multiplication for Happy Children), which is decorated with ornamental images of traditional Javanese houses and Javanese dancers to beautify the appearance of the cover. As can be seen in Fig. 2.

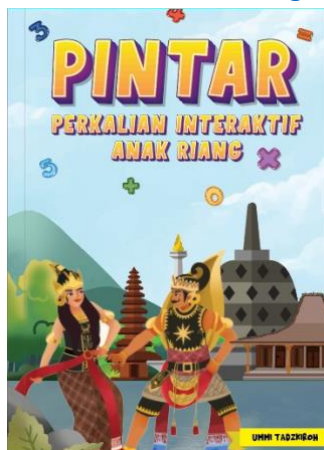


Fig. 2. Pop Up Book Multiplication Cover

2) There are elements, learning outcomes, learning objectives and how to use pop-up book learning media as well as a foreword

Design view can be seen in Fig. 3.

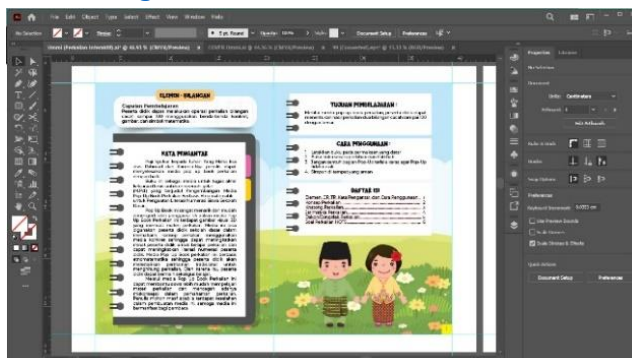


Fig. 3. Slide 1 Design View

3) Material Content

The Pop-Up Book learning media on this slide covers the concept of multiplication. It features traditional Javanese foods (*Gethuk* and *Onde-Onde*) and traditional Javanese games (*engklek* and *dhakon*) to help students understand multiplication using concrete objects. Furthermore, the traditional Javanese games, *engklek* and *dhakon*, can be used to implement multiplication calculations, allowing students to play and learn at the same time. As can be seen in Fig. 4.



Fig. 4. Slide design view 2, 3, and 4

4) Media Display

The font used in the Pop-Up Book learning media is Take a Coffee for the writing to make it more attractive, and the font used for the multiplication material is Cambria to make it easier for students to read and understand the text. The font size is also adjusted to match the background of the Pop -Up Book media so that the text can be read clearly. The images used are images downloaded from Google and the Pinterest application; the image formats used are eps, JPG, PNG. All images are designed and adjusted to the existing material. The images are then printed using Art Paper and Glossy paper so that the images are not easily damaged. Then the images are cut according to the size determined by the researcher. In addition, the images used for the material are examples of images found in everyday life, such as images of traditional Javanese food (*gethuk* and *onde-onde*) and traditional Javanese games (*engklek* and *dhakon*). Researchers also use interesting images such as images of children wearing traditional Javanese clothing and wayang to beautify each page of the Pop-Up Book. The images on each slide are made manually using manila paper. As can be seen in Fig. 5.



Fig. 5. Slide 5 and 6 design view

The color chosen for the cover is blue, a color that evokes a sense of calm. The color of the content on each page is also varied, with some being the same, to capture students' attention. The Pop-Up Book technique was chosen to determine the technique to be used in developing the Pop-Up Book media. The Pop-Up Book technique used was the V-Folding type, which involves adding folding panels to each side of the image to be attached.

3.3. Evaluation of the development of ethnomathematics-based pop-up book learning media on the basic concept of multiplication to strengthen numeracy literacy.

Corel Draw X7 worksheet with dimensions of 21.2 cm wide, 2 cm thick, and 30 cm high. The cover sheet uses 260 gsm art paper. The finished cover sheet was then attached to cardboard to create a thick and rigid book cover. The appearance of the book cover can be seen in Fig. 2. The contents of the *PINTAR* book media are composed of pop-up contents created in CorelDRAW X7 and Corel Photo-Paint applications. The paper used in the *PINTAR* book media is 310 gsm art paper with a total of six sheets. The first page of the *SMART* book media shows the elements, learning outcomes, and learning objectives of multiplication material, a foreword, along with how to use it, decorated with a pop-up of a child wearing traditional Javanese clothing, which can be seen in Fig 6.



Fig. 6. Pop-up view of book slide 1

Pop-up props for the multiplication concept with pop-up *gethuk* and *onde-onde*. With these concrete media images, students will differentiate how to calculate 2×3 differently from 3×2 even though the result is the same as 6, as can be seen in Fig. 7.



Fig. 7. Pop-up view of book slide 2

Pop-up prop using multiplication pockets. It features a pop-up book depicting puppets and a mountain of puppets that will be used to calculate multiplication using the numbers drawn from the envelopes. It also features a philosophical explanation of the origins of puppetry, along with practice questions and discussions, as shown in Fig. 8.



Fig. 8. Pop-up view of book slide 3

The fourth page of the SMART book media uses a pop-up hopscotch game. Students will take a picture of a child playing the game. Students must first solve the problem by scanning the barcode. Then, they calculate the solution to the problem, as shown in Fig. 9.



Fig. 9. Pop-up view of book slide 4

The fifth page contains multiplication problems. Students must complete the problems by first scanning the barcode. Then, they calculate the solution using the stars in the envelope, as shown in Fig. 10.



Fig. 10. Pop-up view of book slide 5

The sixth page contains numeracy literacy questions that will train students to evaluate their understanding using numeracy literacy questions. When answering the questions, students are required to be analytical and thorough. There is a pop-up book featuring traditional Javanese houses and Javanese clothing, as seen in Fig. 11.



Fig. 11. Pop-up view of book slide 6

At this development stage, the media is realized according to the design that has been made. The development of Pop-Up Book- based learning media was created to improve numeracy literacy skills. After the media was completed, a validation test was conducted by media experts, material experts, and language experts. The validity test used was the instrument validity test. Instrument validity was conducted to obtain information regarding the feasibility of the material and the feasibility of media development to produce valid Pop-Up Book -based learning media according to standards and ready for use in classroom learning practices. Percentage of eligibility from subject matter experts presented in Table 6.

Table 6. Percentage of Eligibility from Subject Matter Experts

Aspect	Academic Score	Practitioner Score	Average
Contents	29	30	29.5
Presentation of Material	17	18	17.5
Material	25	24	24.5
Language	7	10	8.5
Amount	78	82	80

Calculation of average percentage of eligibility.

$$\text{Percentage} = \frac{\text{average score}}{\text{maximum score}} \times 100\% \quad (1)$$

$$\text{Eligibility percentage} = \frac{80}{85} \times 100\% = 94\% \quad (2)$$

The validation results of the material expert on the development of *PINTAR* media to facilitate students' understanding of multiplication concepts were categorized as very feasible. The validation results by the material expert obtained a score of 80 with a percentage of 94% from 4 aspects. The validated aspects were content, presentation of material, and material. As can be seen in Table 7.

Table 7. Percentage of Eligibility from Media Experts

Aspect	Academic Score	Practitioner Score	Average
Media View	18	19	18.5
Illustration	9	10	9.5
Technical Quality and Program			
Effectiveness	28	29	28.5
Attractiveness	12	14	13
Device Aspects	10	14	12
Amount	77	85	81

$$\text{Percentage} = \frac{\text{average score}}{\text{maximum score}} \times 100\% \quad (3)$$

$$\text{Eligibility percentage} = \frac{81}{95} \times 100\% = 85\% \quad (4)$$

The media expert validation results for the development of *PINTAR* media in learning the concept of multiplication are categorized as very feasible. The validation results by media experts obtained a score of 81 with a percentage of 85% from 5 aspects. The validated aspects include media display, illustrations, technical quality, effectiveness of the attraction program, and device aspects. The percentage of eligibility from linguists can be seen in Table 8.

Table 8. Percentage of Eligibility from Linguists

Language Aspects	Academic Score	Practitioner Score	Average
Suitability of language to the intellectual level of students	5	4	4.5
Consistency in the use of terms, symbols and emblems	4	5	4.5
Conformity of Indonesian grammar	5	4	4.5
Clarity and ease of understanding of language	4	5	4.5
Language compatibility with PUEBI	5	4	4.5
Language is interactive	4	5	4.5
Language is communicative	3	5	4.0
Amount	30	32	31

$$\text{Percentage} = \frac{\text{average score}}{\text{maximum score}} \times 100\% \quad (5)$$

$$\text{Eligibility percentage} = \frac{31}{35} \times 100\% = 89\% \quad (6)$$

The validation results of the linguist on the development of *PINTAR* media in learning multiplication concepts were categorized as very feasible. The validation results by the media expert obtained a score of 31 with a percentage of 89%. The validated aspects included compliance with PUEBI (General Guidelines for Indonesian Spelling), unambiguity, and the language used was interactive and communicative.

3.4. DISCUSSIONS

1) *Exploration of the use of learning media on basic multiplication concepts used by teachers at SDN Sugihan 04*

At the analysis stage, there are basic problems faced in the learning process at school related to learning media. The learning process in the classroom only uses simple and basic learning media, such as printed picture sheets or makeshift media prepared by the school. As a result, students become less active in participating in learning and have a poor understanding of the material presented. Sapriyah states that at the orientation stage, the use of learning media will greatly assist the effectiveness of the learning process and the delivery of messages and lesson content [18]. In addition, it can also stimulate student motivation and interest. Learning media can also help students improve their understanding, present interesting and reliable data, facilitate data interpretation, and obtain information. Students' need for more innovative

learning media can improve the quality of learning and student learning outcomes. The benefits of learning media include fostering learning motivation, facilitating understanding, and encouraging students to participate more actively in the learning process. Furthermore, learning media is a crucial factor during the learning process, with teachers using media to deliver material to students for easy understanding. Based on the explanation and analysis, it is certainly necessary to use learning media in the teaching and learning process, especially in mathematics subjects, multiplication material. The media that is suitable to be used based on the analysis is the Pop-Up Book learning media for mathematics multiplication material. With the help of this media, students can more easily understand the material presented. In addition to being able to help students understand the material, this Pop-Up Book media can also provide a new and meaningful atmosphere in the teaching and learning process, and students also become more active.

2) *Making pop-up book learning media based on ethnomathematics on the basic concept of multiplication to strengthen numeracy literacy*

The design stage is the design of the Pop-Up Book mathematics learning media for multiplication material to make it look very attractive. This Pop-Up Book learning media is considered very interesting learning media because it has surprises on each page, and there are three-dimensional images that can move when each page is opened. This is also similar to the opinion of Putranto, who explains that the definition of a Pop-Up Book is a book that, when opened will display images with three-dimensional elements that provide an interesting visualization of the story and can move when the pages are opened [19]. At the design stage or planning of this Pop-Up Book learning media, it was designed using the Photoshop application. The material contained in this Pop-Up Book learning media is multiplication material in everyday life, where the material presented in the media contains images of Javanese culture, including traditional food, traditional games, traditional clothing, and Javanese arts. The material and images are taken from Pinterest and Google applications, journals, and books as references. The multiplication material is equipped with attractive images in the form of Pop-Up Book learning media in accordance with the benefits of the media for learning activities.

3) *Evaluation of the development of ethnomathematics-based pop-up book learning media on the basic concept of multiplication to strengthen numeracy literacy.*

This development stage aims to develop Pop-Up Book learning media for mathematics on multiplication. The steps in creating a Pop-Up Book media specification include determining the size of the media, determining the materials needed to make the media, and determining the form/appearance of the media. The development stage is the stage where all materials or components collected from the analysis and design stages are gathered together and transformed into a ready-to-use media form [20]. The use of pop-up books as a learning medium in mathematics, particularly for multiplication, can improve conceptual understanding by providing three-dimensional visualizations that help students grasp abstract concepts such as multiplication more easily. With the interactive elements offered, students can see and feel the relationship between numbers and their multiplication results, thus facilitating their understanding of this mathematical operation. The attractive design and surprise elements in pop-up books can increase students' interest in reading. When students are actively engaged with this medium, they are more likely to participate in learning, which can increase their motivation. Interaction with pop-up books, such as opening and closing pages or sliding existing elements, helps develop students' fine motor skills. These skills are important in the learning process because they support the physical abilities needed to write and solve mathematical problems [21]. Overall, pop-up books are an innovative and effective tool for teaching multiplication concepts to students. By utilizing this medium, teachers can create a more interesting and interactive learning environment, helping students not only understand but also enjoy the process of learning mathematics.

The development of ethnomathematics-based pop-up books for learning multiplication in elementary schools, especially in the context of Javanese culture, integrates local cultural values into mathematics education. Pop-up books are designed to help students understand the concept of multiplication through interesting and interactive visualizations. Utilizing Javanese cultural elements, such as traditional food, traditional games, traditional clothing, and traditional arts, to make learning more relevant and meaningful for students. In this *PINTAR* pop-up book, there are images of traditional Javanese foods, namely *gethuk* and *onde-onde*.

These traditional foods will help explain the concept of multiplication so that students can easily understand the multiplication material. This *PINTAR* pop-up book also depicts traditional games such as *congklak/dhakon* and *engklek*, which can implement multiplication materials such as counting by repeated addition. Through the traditional *engklek* game, students can learn mathematics, counting from 1 to 10 [22]. Javanese culture contains mathematical ways of thinking, and various Javanese cultural elements that contain mathematical ways of thinking can be utilized in learning Mathematics [23]. The media will be formed and developed according to the predetermined design and will be made into a more tangible product, after which the media that has been created will then be validated by material experts and media experts. According to Sugiyono, expert testing is carried out to measure whether the assessment instrument developed is appropriate or minimizes the level of weakness and to find out inconsistencies in the results made both from the appearance and content [24]. In addition, Suhendrianto explains that product trials before implementation aim to collect data that can be used as a basis for making improvements in order to achieve the level of feasibility of Pop-Up Book media [25]. This data validation is carried out by media experts and material experts as well as language experts from academics and practitioners.

With the presence of interesting learning media and in accordance with the material, conditions, and developments, students in understanding abstract concepts, students need concrete objects as intermediaries so that they can leave an impression, stick, and last a long time to become meaningful learning [26]. This can make it easier for students to understand the concept of multiplication. With the existence of this SMART pop-up book, students will follow more lessons while learning and playing with a sense of joy, so they do not experience difficulties in learning mathematics [27]. Therefore, the use of pop-up learning books in the implementation of the teaching and learning process takes place in an interesting way and is able to involve the active participation of students [27]. The pop-up book not only contains images but also numbers to improve students' numeracy skills. There are written numbers and questions that are easy to match with the image design on each page to improve students' reading literacy [28]. In addition, each page also presents images with Javanese customs and culture. The presence of visuals that are appropriate to the cognitive and visualization levels of students will attract attention and motivate students in learning [29]. Skills in making literacy and numeracy teaching aids are certainly abilities that teachers must have to develop effective, efficient, interesting, and enjoyable learning innovations for students [30], [31].

4. Conclusion

The development of the ethnomathematics-based *PINTAR* Pop-Up Book (Interactive Multiplication for Happy Children) addresses the limitations of multiplication learning media at SDN Sugihan 04, where existing media primarily emphasize memorization rather than conceptual understanding. The novelty of this study lies in integrating basic multiplication concepts, interactive pop-up components, numeracy-oriented questions, and Javanese cultural elements into a single learning medium. The validation results indicate that the developed media is highly feasible, with scores of 94 from the material expert, 85 from the media expert, and 89 from the language expert. These findings support the suitability of the *PINTAR* Pop-Up Book for further implementation in elementary mathematics learning. Its interactive features and culturally contextualized content offer an alternative approach to presenting multiplication concepts in a more concrete and meaningful manner. However, since this study did not include implementation trials or effectiveness testing, its contribution to improving students' numeracy literacy has not yet been empirically established. Therefore, further research should conduct limited-scale trials to examine the practicality of the media in classroom settings, followed by effectiveness testing to investigate its potential contribution to students' conceptual understanding of multiplication and numeracy literacy. Further studies may also explore the integration of local cultural contexts into mathematics learning materials across different topics and educational settings.

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