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QR Code Pop-up Book Based on Ethnomathematics to Improve Problem Solving Skills

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ABSTRAK

Kurang pengoptimalan penerapan media pembelajaran dan penerapan metode yang digunakan dalam pelaksanaan proses pembelajaran matematika sekolah dasar menjadi latar belakang penelitian ini. Penelitian ini memiliki empat tujuan menganalisis kevalidan media pembelajaran, menganalisis kepraktisan media pemelajaran, menganalisis keefektifan media pembelajaran QR code pop-up book *berbasis etnomatematika untuk meningkatkan kemampuan pemecahan masalah siswa pada materi operasi hitung campuran kelas III sekolah dasar. Model penelitian yang digunakan pada penelitian ini adalah model ADDIE yang terdiri dari lima tahapan, yaitu* analyze, design, development, implementation, *dan* evaluation*. Subjek dalam penelitian ini adalah 4 ahli, dan 33 siswa sekolah dasar. Ojek uji coba penelitian ini adalah kemampuan pemecahan masalah siswa pada materi operasi hitung bilangan cacah kelas III sekolah dasar. Metode pengumpulan data yang digunakan adalah kuesioer/angket dan tes. Instrumen yang diterapkan untuk mengumpulkan data yaitu angket berupa jenis angket tertutup dengan menggunakan rating scale dan tes esai. Hasil penelitian menujukan bahwa media pembelajaran yang telah dihasilkan memperoleh indeks validitas ahli yang sangat baik, tingkat pencapaian kepraktisan media pembelajaran ditinjau dari respon siswa mendapatakn kualifikasi sangat baik, pelaksanaan penelitian pada uji-t berkorelasoi memperoleh hasil yang signifikan sehingga media pembelajaran* QR code pop-up book *berbasis etnomatematika efektif untuk meningkatkan kemampuan pemecahan masalah pada materi operasi hitung campuran kelas III sekolah dasar.*

ABSTRACT

Lack of optimization of the application of learning media and the application of methods used in the implementation of the elementary school mathematics learning process is the background of this study. This study has four objectives, namely: (1) analyzing the validity of learning media, (2) analyzing the practicality of learning media, (3) analyzing the effectiveness of ethnomathematics-based QR code pop-up book learning media to improve students' problem-solving abilities in mixed calculation operation material grade III elementary schools. The research model used in this study is the ADDIE model which consists of five stages, namely analyze, design, development, implementation, and evaluation. The subjects in this study were 4 experts, and 33 elementary school students. This research trial motorcycle taxi is the problem-solving ability of students in the operation material to calculate the number of cacah class III elementary schools. The data collection methods used are questionnaires and tests. The instrument applied to collect data is a questionnaire in the form of a closed type of questionnaire using a rating scale and an essay test. The results showed that (1) the learning media that had been produced obtained a very good expert validity index, (2) the level of achievement of practicality of learning media in terms of student responses obtained very good qualifications, (3) the implementation of research on correlated t-tests obtained significant results so that ethnomathematics-based QR code pop-up book learning media was effective for improving problem solving skills in class mixed calculation operation material III elementary school.

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1. INTRODUCTION

The low ability of students in mathematics is also shown by the results of the PISA (Program for International Assessment of Students) survey in 2022, especially for the mathematics category, which showed a decline in international learning outcomes due to the pandemic, especially for the mathematics category (Mejía-Rodríguez et al., 2021; Sintawati et al., 2020).Mathematics literacy score in 2022 Indonesia's score fell 13 points, the mathematics literacy score from 2018.Research conducted by PISA stated that Indonesian children's ability in mathematics is very low and is slumped in the bottom ranking. The results of the TIMSS 2015 study showed that Indonesia's ranking dropped to 44 out of 49 countries with an average of 397.The low TIMSS results show that the problem-solving abilities of Indonesian students are still low (Mejía-Rodríguez et al., 2021; Sintawati et al., 2020).The questions tested in TIMSS are questions with a high difficulty index.

One of the skills emphasized in the curriculum and the National Council of Teachers of Mathematics (NCTM) is problem-solving skills. Problem-solving is the process of applying previously acquired knowledge to new, unfamiliar situations..In solving problems in mathematics, systematic solutions are needed. Problem-solving skills are very important for students and their future. In developing problem-solving skills, students still need tangible objects, the cognitive of elementary school students is still at the concrete operational stage. At the concrete operational development stage, students have been able to think using logic (Davidi et al., 2021; Rahmani & Widyasari, 2018). The concrete operational development of students prefers the use of real objects during learning and can think logically regarding real or concrete objects so that contextual learning involves students in important activities that help them relate academic lessons to the real life contexts they face.

Based on the results of interviews with homeroom teachers and the implementation of initial tests for grade III students at SD Negeri 1 Antapan on May 31, 2023, which obtained the results of the learning process in the classroom, especially in mathematics learning, only using lecture and question and answer methods. In addition, the material presented in the student's book is still incomplete and not broad enough. It is also known that the lack of ability of grade III students of SD Negeri 1 Antapan in solving problems given by the teacher. Judging from the data obtained from the test results in the form of student answers, regarding the problem-solving abilities of students based on indicators. From the implementation of the student problem-solving ability test, it was found that out of 33 students, 10 students (30.30%) had problem-solving abilities with very low criteria. From the implementation of the test, it can be seen that grade III students of SD Negeri 1 Antapan are still lacking in mathematical problem-solving abilities, this is due to various aspects such as the lack of students' abilities in determining problem-solving steps. Teachers do not understand the use of technology, resulting in minimal use of technology in learning. Evaluation shows that students have achieved the KKM, but have not mastered the material well (Boentolo et al., 2024; Maritsa et al., 2021).

To improve students' problem-solving skills, they can use the problem-solving learning model. The problem-solving learning model is a model that relates to students' problems in everyday life (Adeoye & Jimoh, 2023; Sintawati et al., 2020).The problem solving learning model is a learning model that presents learning materials that confront students with problems that must be solved to achieve learning objectives. The stages of the Problem-Solving model are: 1) determining the problem, 2) collecting data, 3) determining the answer, 4) testing the truth, 5) conclusions. Students are trained to find solutions to problems given by the teacher actively, logically, and creatively by following the steps that have been determined (Novitasari & Shodikin, 2020; Saputri & Wardani, 2021).

The development of learning media that applies technology is a solution to overcome the lack of students' ability in problem solving. Learning media can be effective in achieving learning objectives with attractive and creative designs. The use of media can also increase learning efficiency. However, currently, learning media based on culture and local wisdom are rarely used, especially in mathematics learning. The ethnomathematics approach is the right choice to present mathematics learning that is more relevant to the culture of students. By linking mathematics to the nation's culture and everyday life, students can more easily understand and feel connected to the learning material (Diah Purnami Dewi & Wayan Suniasih, 2022; Mahendra, 2017).

Based on the problems above, it is known that students' difficulties in understanding mathematics learning in elementary schools still occur a lot. Such as the lack of students' ability to solve problems and the lack of media development in the learning process. Therefore, the researcher intends to develop a local culture-based learning media that will be packaged into a QR code pop-up book. Pop-up books are three-dimensional books that allow interactive movement and interesting display filling. Pop-up book media is very practical and has an interesting form because it has moving parts and has two-dimensional elements (Nihayah et al., 2019; Sholeh, 2019).

This study aims to develop a QR code pop-up book learning media based on ethnomathematics to improve students' problem-solving abilities. This media will focus on the material of arithmetic operations of whole numbers in learning theme 1 sub theme 1. The use of this learning media will make it easier for students to improve their mathematical problem-solving abilities and help teachers deliver the material more effectively. In addition, this learning media will also introduce local culture and wisdom to students in elementary schools. In line with the research on the development of pop-up book media on flat shape material from six validators, an average validation questionnaire of 94.83% was obtained (very valid/interesting) so that this research is worthy of being continued to test its effectiveness..In addition, this study is also in line with the research on the Development of ethnomathematics-based learning media. The development of ethnomathematics-based learning media is suitable for use in learning according to media experts of 92.4%, material experts of 93% (very good), based on student responses of 93.4% (very good) (Icmi et al., 2022; Wahid et al., 2020).

The novelty of this research lies in the development of QR code pop-up book learning media based on ethnomathematics to improve students' problem-solving abilities. This innovation combines interactive technology through QR codes and a local culture-based approach in the form of a pop-up book, which provides a more interesting learning experience and is relevant to the context of students' lives. Unlike conventional learning media, this research integrates ethnomathematics, which links mathematics material with local wisdom, so that students can learn mathematics through cultural aspects that they are familiar with. This approach is expected to increase learning motivation, problem-solving abilities, and student involvement in learning. The combination of digital technology and interactive visual representations in the form of pop-up books adds a new dimension to learning design, which is rarely found in previous research. This makes this research relevant to the development of the times while preserving local culture in education.

2. METHOD

This research is a research and development (R&D) study using the ADDIE model which consists of five stages, namely analysis, design, development, implementation, and evaluation (Andi Rustandi & Rismayanti, 2021; Usta & Guntepe, 2017). At the analysis stage of the study, observations, interviews, and curriculum analysis were conducted, at the design stage, media design was carried out using the Canva application, at the development stage, printing and compiling the media as a whole were carried out, at the implementation stage, testing was carried out on experts and practitioners to determine the feasibility and practicality of the media that had been developed, and at the evaluation stage, seen from the results of the One Sample T-Test analysis/Correlated sample t-test, it was found that there was a significant difference in students' problem-solving abilities before and after implementing learning using QR Code Pop-up Book learning media based on ethnomathematics. In implementing this research, there are two types of data, namely qualitative data and quantitative data (Ilhami & Rimantho, 2017; Simarmata et al., 2022). Qualitative data were obtained from the analysis of competencies achieved by students and words in the form of input, responses, criticisms, and suggestions from experts. While quantitative data are score data obtained by expert validity tests and effectiveness tests. The subjects in this study were 4 experts, and 33 elementary school students. The object of this research trial was students' problem-solving abilities in the material of arithmetic operations of whole numbers in grade III elementary school.

The data collection methods used are questionnaires and tests. The instrument used in this development is a rating scale (Dwiqi et al., 2020; Ilhami & Rimantho, 2017).The instrument used to collect data is a questionnaire in the form of a closed questionnaire using a rating scale and essay test. The instrument grid used in this study can be seen in Table 1, Table 2, Table 3, Table 4, Table 5, and Table 6

Table 1. The Data Collection Instruments

Data Types	Method of collecting data	Instrument's Shape	Data source
Results of Expert Tests on Elementary School Mathematics Learning Content.	Non-Test	Questionnaire	Expert Judges
Media Expert Test Results	Non-Test	Questionnaire	Expert Judges
Student response test results	Non-Test	Questionnaire	Student
Field Trial/Effectiveness Test Results	Test	Essay	Student

Table 2. The Content Expert Instrument Grid/Learning Content

No	Aspect	Indicator
1	Curriculum	Suitability of media to learning achievement.
		Learning indicators
		Learning objectives
2	Material	Suitability of material content
		Systematics of material
		Level of ease and depth of material
3	Language	Clarity of information
		Use of language in accordance with EYD
		Legibility
4	Evaluation	Level of difficulty of questions
		Clarity of the question formula
		Suitability of questions to material

Table 3. The Learning Media Expert Test Instrument Grid

No	Aspect	Indicator
1	Design View (cover)	Cover appeal
		Media identity
		The design used is in accordance with ethnomathematics.
2	Writing Format	Compliance of writing with EYD
		The language used is easy to understand.
		The instructions for each exercise are easy to understand.
3	Contents	Clarity of the material presented
		The material is in accordance with KD and learning indicators
		Learning activities that can improve students' problem solving abilities.
4	Practical	Ease of use of QR code pop-up book learning media.
		Can help in understanding the material.
5	Attraction	The overall appeal of the QR code pop-up book learning media.

Source: modified from(Nopiani, 2021)

Table 4. The Practitioner Instrument Grid

No	Aspect	Indicator
1	Media Presentation	Clarity of instructions for using learning media.
		Ease of use of learning media.
		Readability of learning media content.
		Suitability of the layout of writing and images in learning media.
2	Media Quality	The quality of the content of the material is in accordance with basic competencies.
		The quality of the content of the material is in accordance with the indicators.
		The quality of the letters used in learning media
		The quality of the content of the learning media contains ethnomathematics values.
		Language suitability to students' cognitive development.

Table 5. The Effective Test Instruments

No	Problem Solving Ability Indicator	Question indicator	Cognitive Level	Question Form	No. Question
1	Understanding the problem (understanding problem)	Understand and write number symbols	C2	Stuffing	1
		Understanding the properties of arithmetic operations on whole numbers	C2	Stuffing	2

No	Problem Solving Ability Indicator	Question indicator	Cognitive Level	Question Form	No. Question
2	Making a plan to solve the problem (devising a plan)	Designing questions about addition arithmetic operations in the context of everyday life.	C6	Stuffing	3.7
3	Carrying out the plan	Solving problems regarding subtraction arithmetic operations in the context of everyday life.	C3	Stuffing	4.8
		Solving problems regarding division arithmetic operations in the context of everyday life.	C3	Stuffing	5.9
4	Rechecking the answers obtained (looking back)	Evaluate the solution of multiplication arithmetic operations in the context of everyday life.	C5	Stuffing	6.10

3. RESULTS AND DISCUSSION

Results

PThis development research produces a QR Code pop-up book learning media Based on Ethnomathematics to Improve Problem Solving Skills in Mixed Arithmetic Operation Material for Grade III Elementary Schools. The development of this media goes through five stages: analysis, design, development, implementation, and evaluation.

The first stage carried out in this study is the analysis stage (analyze). The analysis activities carried out are needs analysis through observation activities, interviews, to teachers and students of grade III of SD Negeri 1 Antapan and giving initial tests to determine the level of students' problem-solving abilities. The results of observations and interviews show that all grade VI teachers in the cluster are still lacking in developing materials and even rarely and learning media are also rarely developed for various reasons such as time constraints, many demands that must be met in implementing the 2013 Curriculum, readiness in conducting learning. In addition, from the results of the initial test of students' problem-solving abilities, there were 10 students who still had very low problem-solving abilities. If teachers do not develop learning materials, then students' insights will also be limited to student books. In this era, technology also plays an important role in education so that teachers and students must be able to adapt to technology.

The second stage in this research is the design stage. This ethnomathematics-based QR code pop-up book media is designed and designed using the Canva application. Canva is one of the graphic and publication content applications or websites that is very easy to use. The features on this website make it easy to design the learning media that has been developed. In the next development stage, print the design using cardboard, art paper, double tape, and other supporting materials. This learning media is in concrete form, the design and material presented are adjusted to the ethnomathematics of Balinese culture. The animated images and videos used in the learning media are sourced from the internet. On the cover there is the media identity and developer identity. In the introduction on the next page there are Instructions for use, KD, Indicators, and a table of contents. The contents contain videos, materials, and sample questions that have been integrated with Balinese culture. In the closing section there are practice questions according to the material that has been studied previously. The material explained is about the arithmetic operations of whole numbers for grade III SD. The design of the ethnomathematics-based QR code pop-up book learning media can be seen in Figure 1.

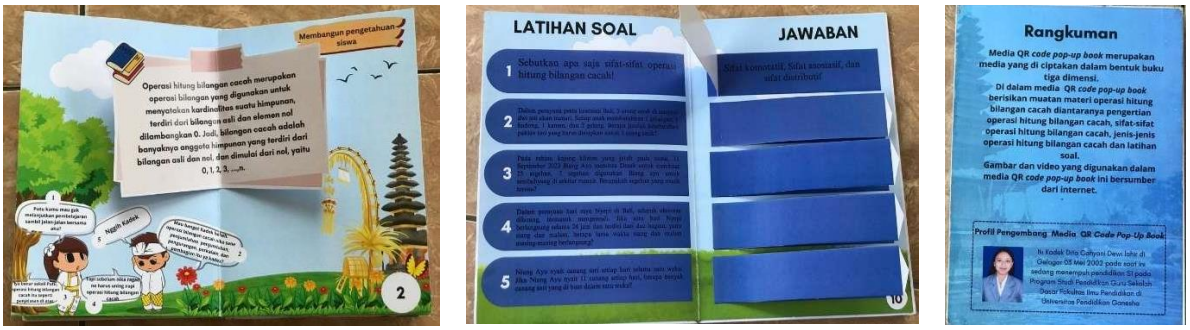


Figure 1. Learning Media Design

The third stage in this research is development. At this stage, a validity test is carried out by experts in their fields. The instruments tested are the material expert instrument, media, and practicality and effectiveness. From the results of the instrument validity test, the results of the material expert instrument, media and practicality were tested using the Gregory formula with a score of 1.00 with a very high content qualification. The validity test of the effectiveness instrument using the CVR / CVI formula got a result of 1 with a valid qualification. The developed product was then tested for validity, practicality, and effectiveness on students' problem-solving abilities. The overall validity results of the material expert were 0.91 with a very good qualification and the overall feasibility of the media expert was 0.94 with a very good qualification. The practicality test through student responses got a percentage of 99.26 with a very good qualification. After that,The results of the media effectiveness test consisting of the normality test are presented in Table 6, homogeneity in Table 7, and hypothesis testing is presented in Table 8.

Table 6. Normality Test

Group	Shapiro Wilk		
	Statistics	df	Sig.
Pretest	0.951	33	0.141
Post-test	0.948	33	0.114

Table 7. Homogeneity Test

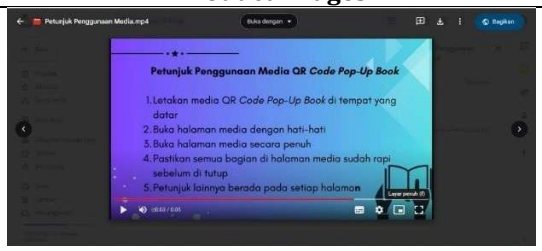
Parameters		Levene Statistics	df1	df2	Sig.
Dependent Variable	Based on Mean	2,636	1	64	0.109

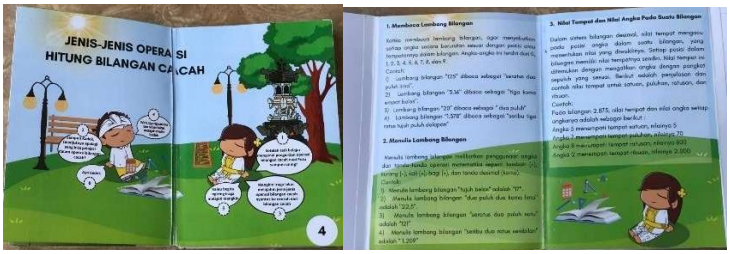
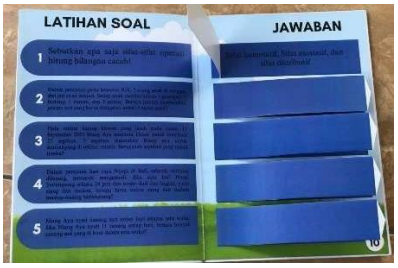
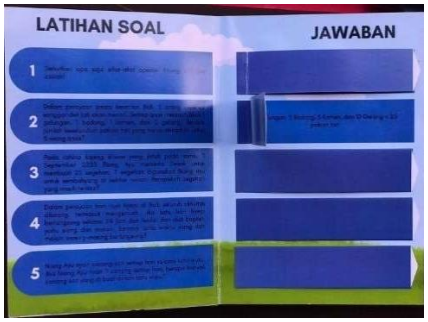
Table 8. Paired Samples Test

Paired Group		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest - Posttest	-17,27273	5.97402	1.03994	-19,39102	-15,15443	-16,609	32	0,000

The product also received revisions from the tests that had been conducted. Product revisions were made based on suggestions and comments that had been given by experts, and student responses. The suggestions and comments given were used as consideration materials to improve and perfect the QR code pop-up book learning media based on ethnomathematics that had been developed. The following are suggestions and comments given regarding the QR code pop-up book learning media based on ethnomathematics presented in Table 9.

Table 9. Product Revision

No	Feedback and Suggestions	Product Images
1	In the section on how to use the QR code pop-up book learning media, it is more detailed.	 Before Revision  After Revision
2	In the text font section used in the table of contents so as not to be too formal.	 Before Revision  After Revision
3	Conversations should use one language.	 Before Revision  After Revision

No	Feedback and Suggestions	Product Images
4	The material on the types of arithmetic operations for whole numbers is further emphasized in its relation to Balinese cultural ethnomathematics.	 Before Revision  After Revision
5	In the practice questions section, use a font that is not too formal and the writing size should be the same.	 Before Revision  After Revision

Discussion

This development research produces a QR code pop-up book learning media based on ethnomathematics. This QR code pop-up book based on ethnomathematics has its own characteristics compared to other QR code pop-up book media, namely because the QR code pop-up book media is based on ethnomathematics to improve students' problem-solving abilities so that students get a mathematics learning experience that is associated with Balinese culture so that it can be applied in everyday life to solve problems around. The topic of the material on the QR code pop-up book learning media based on ethnomathematics is also only focused on the material on arithmetic operations of whole numbers, the contents of which in the QR code pop-up book media are adjusted to ethnomathematics, contain instructions for use, QR codes that contain learning videos related to arithmetic operations of whole numbers, and contain examples of questions related to Balinese cultural ethnomathematics. This research went through several stages, namely the analysis stage*(*analyze)The analysis activities carried out were needs analysis through observation activities, interviews, to teachers and students of class III of SD Negeri 1 Antapan and the provision of initial tests to determine the level of students' problem-solving abilities. The next stage was carried outdesign, this stage carries out the design using the Canva application (Yahya & Bakri, 2019; Yanti & Ana, 2023).

At the development stage,The implementation of the validity test results of the QR code pop-up book learning media based on ethnomathematics obtained very good qualifications as reviewed from the

results of the learning material expert and learning media expert tests. This shows that the learning media is worthy of being implemented in the learning process. This condition is supported by the development of media that has been adjusted to the curriculum and learning materials applicable in schools. In the QR code pop-up book media based on ethnomathematics, there are learning videos and sample questions that are related to Balinese culture (Anam et al., 2021; Mahendra, 2017).Based on the results of the practicality of using QR code pop-up book learning media based on ethnomathematics to improve students' problem-solving abilities, the results were very good and worthy of being implemented in the learning process. Ausubel's theory states that the way to guide students to understand new knowledge from a material requires an initial concept that students already have related to the concept to be learned so that it greatly determines the success of the learning process. QR codes facilitate instant access to digital content that supports learning, such as videos, interactive images, or additional explanations (Kountul & Wibowo, 2021; Yanti & Ana, 2023).Pop-up books provide a visual and tactile dimension that invites active student engagement. In the context of ethnomathematics, the use of Balinese culture as a basis for the material not only provides local relevance, but also builds students' understanding of mathematical concepts through real cultural experiences. This creates practical, engaging learning and stimulates students' curiosity about the relationship between mathematics and their cultural heritage (Mundanti, SA et al., 2023; Wanabuliandari & Purwaningrum, 2018).

At the implementation stage, field tests are carried out.Thus, it is known that the QR Code pop-up book learning media based on ethnomathematics is effective in improving students' problem-solving abilities. The use of this media can help students understand the material on arithmetic operations of whole numbers which is combined with the Balinese cultural ethnomathematics approach which aims to solve problems in everyday life, so that students can think critically and hone their knowledge. The results of this study are in line with the results of previous research entitled the development of pop-up book media on flat building material, stating that the QR code pop-up book learning media that was developed is suitable for use in the learning process based on research that has been conducted showing that the validity of the material expert gets a value of 96.2% (very valid), followed by the validation of the media expert getting a value of 92.2% (very valid)..Other studies also show that the development of learning media for android applications based on ethnomathematics is feasible to be used in learning according to media experts at 92.4%, material experts at 93% (very good), based on student responses at 93.4% (very good). In addition, the Development of Comic Media with Problem Solving Models to Improve Mathematical Problem Solving Skills is feasible to be developed (Gumilang et al., 2019; Wahid et al., 2020).

The advantages of this ethnomathematics-based QR code pop-up book media compared to similar products that have been developed previously, namely this ethnomathematics-based QR code pop-up book learning media has three-dimensional elements and has a barcode in which there is a learning video, as well as the material presented is based on Balinese ethnomathematics. So that in addition to learning mathematics, students can also learn about Balinese culture. In addition, through this ethnomathematics-based QR code pop-up book media, it can increase students' interest and enthusiasm for learning (Winahyu et al., 2020; Yahya & Bakri, 2019).

The limitations in this study are in the scope of the material, level and learning content developed in the QR code pop-up book media based on ethnomathematics, and the subjects used in implementing the product. The material developed in the QR code pop-up book based on ethnomathematics is only limited to the learning content of Mathematics for grade III semester change on theme 1 Growth and development of living things, sub theme 1. The number of subjects used was 34 students using the One sample t-test research design (SA Febriani et al., 2023; Nihayah et al., 2019).

The implementation of this research can provide implications for improving the quality of learning which also refers to the results of improving students' problem-solving abilities. The development of QR code pop-up book media based on ethnomathematics can add variety to supporting learning media in schools, so that later it can create better learning. QR code pop-up book learning media based on ethnomathematics for grade III students is designed in the form of a three-dimensional book which contains learning materials related to Balinese culture and this media can be touched directly by students so that it can be used as a learning media that can be used repeatedly, practically, and can attract students' interest in learning which is able to improve students' problem-solving abilities in the material of whole number arithmetic operations.

4. CONCLUSION

The product developed is a QR code pop-up book learning media based on ethnomathematics with the ADDIE development model. From the results of the tests that have been carried out, it was obtained that the media developed is valid and practical to use and effective in improving problem-solving skills in the

material of arithmetic operations of whole numbers for grade III elementary schools. It is hoped that other researchers can use the results of this study as a reference for developing future research results. For future media development, it is hoped that similar learning media will be developed on different learning materials with more creative and innovative media concepts.

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