Jurnal Media dan Teknologi Pendidikan
Volume 4, Number 3, Tahun 2024, pp. 379-390
E-ISSN: 2798-0006
Open Access: https://doi.org/10.23887/jmt.v4i3.74367

Upakara Bali Ethnomathematics Monopoly Media Based on Augmented Reality on Geometry Material

Ni Luh Puspa Pratiwi[1]*, I Made Suarjana[2], Basilius Redan Werang[3]

[1,2,3] Primary Education Department , Universitas Pendidikan Ganesha, Singaraja, Indonesia

ARTICLE INFO

Article history:
Received January 17, 2024
Accepted June 10, 2024
Available online July 25, 2024

Kata Kunci:
Media Monopoli, Etnomatematika, Geometri, Augmented Reality

Keywords:
Monopoly Media, Ethnomathematics, Geometry, Augmented Reality

ABSTRAK

Penelitian ini dilatarbelakangi kurangnya pengintegrasian kearifan lokal dan inovasi media pembelajaran pada materi geometri di kelas II sekolah dasar. Penelitian ini bertujuan untuk menghasilkan media monopoli etnomatematika Upakara Bali berbasis Augmented Reality pada materi geometri *di kelas II sekolah dasar yang baik digunakan dalam pembelajaran. Penelitian ini tergolong jenis penelitian pengembangan dengan menggunakan model ADDIE. Subjek uji coba penelitian ini adalah dua orang dosen ahli materi, dua orang dosen ahli media, satu orang guru kelas II sebagai praktisi, 6 orang siswa kelas II pada uji coba perorangan dan 10 orang siswa kelas II pada uji coba kelompok kecil. Metode pengumpulan data yang digunakan yaitu observasi, wawancara, studi dokumen, dan kuesioner. Data dianalisis menggunakan teknik analisis statistik deskriptif kualitatif dan analisis statistik deskriptif kuantitatif. Hasil penelitian menunjukkan bahwa media monopoli etnomatematika Upakara Bali berbasis Augmented Reality valid dan layak digunakan. Penilaian ahli materi sebesar 97,5% dan ahli media 99%, keduanya berkualifikasi sangat baik. Respon guru kelas II SD mencapai 100%, sedangkan respon siswa pada uji coba perorangan 94,06% dan kelompok kecil 93,99%, semuanya berkualifikasi sangat baik. Dapat disimpulkan bahwa, inovasi media monopoli etnomatematika Upakara Bali berbasis Augmented Reality pada materi geometri di kelas II sekolah dasar sudah valid dan layak digunakan dalam proses pembelajaran. Penelitian ini berimplikasi pada pelestarian kearifan lokal melalui media pembelajaran di sekolah.*

ABSTRACT

This research is motivated by the lack of integration of local wisdom and innovation of learning media in geometry material in grade II of Elementary School. This study aims to produce monopoly media of Balinese traditional ceremony ethnomathematics based on Augmented Reality in geometry material in grade II of Elementary School that is good for use in learning. This study adopts development research using the ADDIE model. Trial subjects included two material experts, two media experts, one grade II teacher, six grade II students for individual trials, and ten for small group trials. Data collection methods used were observation, interviews, document studies, and questionnaires. Data were analyzed using qualitative descriptive statistical analysis techniques and quantitative descriptive statistical analysis. The results of the study indicate that the monopoly media of Balinese traditional ceremony ethnomathematics based on Augmented Reality is valid and feasible to use. The assessment of material experts was 97.5% and media experts 99%, both of which were very well qualified. The response of the second grade elementary school teachers reached 100%, while the student response in the individual trial was 94.06% and the small group was 93.99%, all of which were very well qualified. It can be concluded that the innovation of Balinese ethnomathematics monopoly media based on Augmented Reality on geometry material in second grade elementary school is valid and feasible to be used in the learning process. This study has implications for the preservation of local wisdom through learning media in schools.

1. INTRODUCTION

Learning is essentially a process, namely the process of managing, and organizing the environment around students so that it can grow and encourage students to carry out the learning process. Learning is said to be effective if the learning allows students to learn easily, have fun, and achieve

*Corresponding author
E-mail addresses: puspa.pratiwi@undiksha.ac.id (Ni Luh Puspa Pratiwi)

the learning goals that have been set (Casnan et al., 2022; Anwar, 2017). Gradual mathematics learning is one of the characteristics of mathematics learning at the elementary school (SD) level. Learning mathematics at the elementary school level does not only start from something concrete, semi-concrete, and abstract but also needs to start from the simplest concepts to concepts that are more difficult in level. Mathematics at the elementary school level is a very important foundation for studying mathematics at the next level (Suardiana, 2021; Friantini et al., 2020).

Currently, mathematics learning in class II at the elementary school level is included in subject-based phase A. Geometry is a very strategic mathematical study to encourage mathematics learning towards appreciation and experience of mathematics by learning mathematics meaningfully. Objects in geometry are very abstract so understanding them requires sufficient reasoning power (Nasution & Sukmawarti, 2023; Simbolon & Sapri, 2022; Sukayasa, 2022). In the theory of intellectual development, elementary school children are in the concrete operational period (Nasution & Sukmawarti, 2023; Munir, 2017).

Elementary school-age children's thinking about mathematics, especially geometry, is still based on concrete objects and real situations. Based on this, an approach is needed in the geometry learning process that can bridge the characteristics of elementary school students who are in the concrete operational period with geometry learning which has abstract characteristics, in this case making it difficult for students to understand. One approach that can be used is the ethnomathematics approach. Ethnomathematics is mathematics practiced by cultural groups such as urban and rural communities, labor groups, children of certain age groups, and other communities (Safitri & Sulistyorini, 2023; Sari et al., 2023; Mulyani & Natalliasari, 2020).

Ethnomathematics studies aim to understand the belief system, thinking, and mathematical behavior of a group which can then be used as a basis for providing meaningful mathematics learning for students. Learning must start from things that students can imagine, close to students, and related to students' lives. Currently, ethnomathematics studies have also reached Balinese culture, namely *Upakara Bali*. Apart from that, integrating cultural elements and local wisdom in the learning process will be able to stimulate and stimulate children to learn and preserve their culture and traditions.

Learning planning is very important for teachers, such as designing what models to use, what approaches to use, and what media to use in the learning process so that later the learning process becomes focused and learning achievements can be met (Mubarok, 2022; Lase, 2020; Widyanto & Wahyuni, 2020). Teacher skills in preparing learning media used in the teaching and learning process are very necessary. As we know, the teacher's role in the learning process is to be a mediator and facilitator. A mediator can be interpreted as an intermediary in student learning activities, for example mediating or providing a way out or solution when the discussion is not going well. Mediators can also be interpreted as providers of learning media, teachers determine which learning media are appropriate to use in learning.

As a facilitator, teachers are obliged to provide facilities or convenience in the teaching and learning process, for example by creating a conducive atmosphere for learning activities, in harmony with student development, so that teaching and learning interactions take place effectively and optimally (Mubarok, 2022; Sundari, 2017). Learning media is an intermediary tool or means of communicating and conveying the meaning of the message conveyed which aims to assist teachers in providing material or students' understanding in achieving the goals of learning (Winangsih & Harahap, 2023; Wulandari et al., 2023; Anwar, 2017). Therefore, learning media has a very important role in learning activities (Lestari & Salsabila, 2023; Rizko et al., 2023).

Media and materials are important components to develop in learning. It is very common to find teachers who rarely develop learning materials and media for various reasons. Teachers often only learn according to the material in the students' books. However, the materials contained in students' books can still be developed according to students' learning needs, one of which is by utilizing things around students as supporting learning resources. Geometry is closely related to the formation of abstract concepts. Difficulties in learning geometry are classified into two types, namely (1) students' difficulties in using concepts, and (2) students' difficulties in using principles. Several previous studies have shown the difficulties experienced when learning geometry (Rahayu, 2021; Fauzy & Arisetyawan, 2020).

The results of observations and interviews conducted at SD Cluster IV Sukasada District show that all class II teachers in this cluster are still lacking in developing materials in the learning process and learning media are also rarely developed for various reasons such as limited time, many demands that must be met in implementing the curriculum. Freedom, readiness to carry out learning. Even though students focus on studying mathematics subjects in one meeting, there is also a need to develop the materials in each meeting, especially in geometry material. This is supported by the results of a questionnaire for 5 class II teachers at Cluster IV Elementary School, Sukasada District, stating that 60% of the teachers said it was necessary to develop learning materials in mathematics subjects and the

remaining 40% stated that it was very necessary to develop materials in mathematics subjects. If teachers do not develop learning materials, students' insights will also be limited to student books.

In this era, technology also plays an important role in education so teachers and students must be able to adapt to technology. Referring to the problems above, it is necessary to develop a learning media in which there is material development from mathematics subjects that can help teachers in the learning process. The media that can be developed is monopoly media which is integrated with ethnomathematics and Augmented Reality technology. Monopoly is a game played by more than two people or in groups. This game was modified into a fun learning medium to support learning so that students can understand the material to be taught by the teacher using the *Upakara Bali* ethnomathematics approach. Augmented Reality is an application that combines the real world with the virtual world in two-dimensional or three-dimensional form which is projected in a real environment at the same time (Putra et al., 2023; Mustaqim & Kurniawan, 2017).

Based on the background of these problems, the learning media that needs to be developed is the, an *Upakara Bali* ethnomathematics monopoly media based on augmented reality on geometry material for 2nd-grade elementary school which is a media that can help teachers in the learning process that uses an ethnomathematics approach where there is the development of material on the topic of flat shapes and space shapes in the media that uses the *Upakara Bali* image model. Closely related to the scope of Balinese society, students often encounter these objects in the surrounding environment.

Apart from that, integrating cultural elements and local wisdom in the learning process will be able to encourage and stimulate children to learn and preserve their culture and traditions. The use of Augmented Reality technology in the media provides a different experience when students play Monopoly, namely showing two-dimensional animated videos related to flat shapes and space shapes. The use of learning media does not require each student to have one learning media and also a device, because monopoly is used in groups so that learning time is efficient and makes it easier to use learning media.

Several previous studies revealed that monopoly learning media in mathematics learning for elementary school students is very valid to use in the very feasible category (Putri et al., 2024; Fajriah et al., 2022). Apart from that, ethnomathematics-based mathematics learning in elementary school has a positive and significant effect on students' understanding of geometric concepts (Solihin & Habibie, 2024; Naitili & Nitte, 2023). The results of further research are that Augmented Reality-based learning media makes learning more interactive so that students understand the material more easily, can increase interest in learning, and can increase student understanding (Ningrum, Utomo, Marini, & Setiawan, 2022; Nugraha et al., 2021). These studies show that the development of monopoly media, learning using an ethnomathematics approach and Augmented Reality-based media are valid and effective when implemented in the learning process.

However, for the mathematics content of geometry learning, the Balinese traditional ethnomathematics integrated monopoly media has never been developed, so the development of this media is new. The distinctive feature of this research is that apart from implementing ethnomathematics, it uses the *Upakara Bali* image model. This study aims to produce a monopoly media of Balinese ethnomathematics ceremony based on Augmented Reality on geometry material in grade II of elementary school that is good for use in learning. The results of this study are expected to add innovation to Mathematics learning media and can preserve local wisdom through learning media in schools.

2. METHOD

This research is classified as a type of development research that was developed using the ADDIE model. The selection of this model was based on a consideration regarding this model being developed systematically and being able to stand on the theoretical basis of learning design. This model is structured programmatically with systematic sequences of activities to solve learning problems related to learning resources that suit learning needs and characteristics (Anafi et al., 2021; Pitriani et al., 2021; Putra et al., 2014). This model consists of five steps, namely: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation. The implementation and evaluation stages were not due to limited costs and time so this research only reached the validity test and drew responses from teachers and students regarding the product being developed.

The first stage is the analysis stage. The initial steps taken were analyzing needs, curriculum analysis, analysis of student books, analysis of student characteristics, and analysis of media creation requirements. The second stage is the design stage. The design stage is the stage of designing the product concept to be developed. Based on the results of the analysis, a product design was designed which included: (1) a Collection of images of Balinese rituals and images in each plot on Monopoly media, (2) a Design of the Monopoly media game board, (3) Design of cards on monopoly media, cards as a monopoly

media component containing magic cards, answer cards and flash cards designed with the Canva application, (4) Determining colors for the game board and card components (magic cards, answer cards, and flashcards), Making game guide book designs carried out in Canva application, and (5) Making evaluation questions that are adapted to the material and then coordinating with the supervisor.

The third stage is development stage. At the development stage, designs or frameworks that are still conceptual are realized into products that are ready to be implemented. The development stages in this research include: (1) Making an animated video containing an explanation of the characteristics of flat shapes or spatial structures that are by the *Upakara Bali* image model in question, (2) Integrating Augmented Reality Technology between *Upakara Bali* images and animated videos using Artivive website, (3) Installing monopoly board design stickers on wooden boards, (4) Printing card components (magic cards, answer cards, and flashcards) as well as guidebooks, (5) Preparing other equipment in the game such as pieces games, dice, markers, and pins, (6) Products that have been completed then carry out product validation or feasibility testing from material experts and media experts. Next, product revisions will be carried out based on reviews from material experts and media experts, (6) Next, trials and product practicality tests. (7) After carrying out product trials and practicality, if there are revisions, media product revisions will be carried out.

The test subjects in this research were two material expert lecturers, two media expert lecturers, one class II teacher as a practitioner, 6 class II students in individual trials, and 10 class II students in small group trials. The data collection methods used were observation, interviews, document studies, and questionnaires. The data analysis techniques used in this research are qualitative descriptive statistical analysis techniques and quantitative descriptive statistical analysis techniques. The research instrument grid can be seen in Table 1, Table 2, Table 3, and Table 4.

Table 1. Material Expert Instrument Grid

No.	Aspect	Indicator	Number of Items
1	Curriculum	Suitability of material to learning outcomes	1
		Suitability of material to learning objectives	1
		Suitability of material with indicators of achievement of learning objectives	1
2	Language	The use of language is appropriate for the development of students	1
		Use language according to applicable spelling	1
3	Material	The material increases students' understanding of concepts	1
		The material contains concepts that need to be known	1
		Suitability of material to the scope of learning material	1
		Material is easy to understand	1
		Attractiveness of presentation	1
4	Evaluate	Suitability of the questions to the material	1
		Availability of instructions for working on questions	1

Source : Suartama (2016) with modifications

Table 2. Media Expert Instrument Grid

No.	Aspect	Indicator	Number of Items
1	Appearance/Design	The attractiveness of the appearance/design of the media	1
		The use of fonts and font size is easy to read	1
		Harmony of composition and color combination	1
		Image attractiveness	1
		Suitability of image and text layout	1
2	Appropriateness	Suitability to learning objectives	1
		Suitability to student characteristics	1
		The material presented is correct	1
3	Operation	Ease of operation	1
		Smooth operation	1

Source : Suartama (2016) with modifications

Table 3. Practitioner (Teacher) Response Instrument Grid

No.	Aspect	Indicator	Number of Items
1	Material	Completeness of information	1
		Suitability of material to learning outcomes	1
		Suitability of learning objective material	1
		Suitability of material with indicators of achievement of learning objectives	1
		Suitability of the material presented with the learning material	1
2	Language	The use of language is appropriate for the development of students	1
		The material is coherent and systematic	1
		The attractiveness of presenting the material	
3	Design/Appearance	Clarity of text presentation	1
		Image attractiveness	1
		Harmony of color combinations	1
4	Operation	Ease of operation	1
		Smooth operation	1

Source : Suartama (2016) with modifications

Table 4. Student Response Instrument Grid

No.	Aspect	Indicator	Number of Items
1	Appearance	Attractive appearance	1
		The use of fonts and font size is easy to read	1
		Image attractiveness	1
		Harmony of color combinations	1
2	Material	Clarity of material	1
		Material can increase student motivation	1
		Material is easy to understand	1
		Media appeal	1
3	Operation	Ease of use	1
4	Evaluation	Suitability of questions to the material	1

Source : Suartama (2016) with modifications

Before the instrument is applied, its validity is first tested. Content validity is used to measure the level of validity of the *Upakara Bali* ethnomathematics monopoly media based on augmented reality on geometry material for 2nd-grade elementary school instrument grid. The content validity test was carried out using the Gregory formula, namely using expert assessment. The 2 x 2 cross-tabulation is used to measure content validity.

3. RESULT AND DISCUSSION

Result

This research has the following objectives: (1) to describe the design and development of *Upakara Bali* ethnomathematics monopoly media based on augmented reality on geometry material for 2nd-grade elementary school; (2) to describe the validity of the *Upakara Bali* ethnomathematics monopoly media based on augmented reality on geometry material for 2nd-grade elementary school; (3) to describe the teacher's response to *Upakara Bali* ethnomathematics monopoly media based on augmented reality on geometry material for 2nd-grade elementary school; and (4) to describe students' responses to *Upakara Bali* ethnomathematics monopoly media based on augmented reality on geometry material for 2nd-grade elementary school.

This research was carried out from 20 September 2023 to 02 October 2023 at SDN 2 Sukasada. The research subjects in this development research were two material expert lecturers, two media expert lecturers, one class II elementary school teacher as a practitioner, and 16 class II elementary school students. The object of this research is the validity and practicality of the learning media being developed. The ADDIE model is the model used in this research. This model consists of five stages, namely: (1) first, analysis; (2) second, design; (3) third, development; (4) fourth, implementation; and (5) fifth, evaluation.

However, in carrying out this research the implementation stage and evaluation stage were not carried out. This is because the implementation phase and evaluation phase require a long time, apart from that, this phase requires careful preparation and there is limited time, resources, and finances. This development research resulted an *Upakara Bali* ethnomathematics monopoly media based on augmented reality on geometry material for 2nd-grade elementary school which has been tested for validity and practicality.

The first stage, analysis, included needs, curriculum, student book, student characteristics, and media requirements analyses. a) Needs analysis involved observations, interviews, and questionnaires with grade II teachers and students at Cluster IV Elementary Schools, Sukasada District. Observations (17–18 July 2023) revealed that teachers struggled to develop materials and media due to time constraints, curriculum demands, and readiness challenges. Even though students focus on studying mathematics subjects in one meeting, there is also a need to develop the materials in each meeting, especially in geometry material. Apart from that, based on the distribution of questionnaires in Cluster IV, Sukasada District, it showed that out of 25 class II students, 68% of students stated that geometry material in mathematics subjects needed to be developed in monopoly media, while 32% stated that it was very necessary.

Out of the 5 class II teachers at Cluster IV Elementary School, Sukasada District, 40% of the teachers stated that they agreed that the geometry material in mathematics subjects in student books was developed in the form of an *Upakara Bali* ethnomathematics monopoly media based on augmented reality, while the other 60% of teachers stated that they strongly agreed. b) Curriculum analysis is intended to determine learning outcomes and achievement of learning objectives for mathematics subjects in class II elementary school. Regarding mathematics subjects, geometry material at the elementary school level is found in class II semester 2 of the Independent Curriculum. The Learning Outcomes and Learning Goal Achievements can be seen in Table 5.

Table 5. Learning Outcomes and Achievement of Learning Objectives for Geometry Material

Learning Outcomes	Achievement of Learning Goals
At the end of phase A, students can recognize various flat shapes (triangles, quadrilaterals, and circles) and spatial shapes (blocks, cubes, cones, and balls). They can arrange (composition) and decompose (decomposition) flat shapes (triangles, quadrilaterals and circles). Students can also determine the position of objects relative to other objects (right, left, front, back, top, and bottom).	1. Through the Monopoly game, students can find the characteristics of flat shapes (triangles, quadrilaterals, and circles) correctly. (C4-TPACK, Critical Thinking, Collaboration, Communication, Creativity) 2. Through the Monopoly game, students can find the characteristics of geometric shapes (blocks, cubes, cones, and balls) correctly. (C4-TPACK, Critical Thinking, Collaboration, Communication, Creativity) 3. Through the Monopoly game, students can arrange (composition) and decompose (decomposition) flat shapes (triangles, quadrilaterals, and circles) correctly. (C5-Critical Thinking) 4. Through the Monopoly game, students can determine the position of objects relative to other objects (right, left, front, and back) correctly. (C5-Critical Thinking)

c) Analysis of students' books is carried out to determine the coverage of geometry material in mathematics subjects contained in the books so that they can know the material that needs to be developed. Regarding mathematics subjects, geometry material at the elementary school level is found in class II semester 2 of the Independent Curriculum. The scope of the material is as follows; 1) Students can recognize various flat shapes (triangles, quadrilaterals, and circles) and spatial shapes (cubes, cubes, cones, and balls), 2) students can arrange (composition) and decompose (decomposition) flat shapes (triangles, quadrilaterals) and circles) and 3) students can also determine the position of objects relative to other objects (right, left, front, back, top, and bottom).

Analysis of student characteristics was carried out by observing learning activities in class II elementary school students in Cluster IV Sukasada District and obtained the results that class II elementary school students in Cluster IV Sukasada District had an interest in interesting media with more striking colors and variations in it. Students also provide curious responses to the media. Traced from the developmental attitude, second-grade elementary school students are at the concrete operational cognitive level, so that children at this age can understand mathematical symbols (Agustyaningrum et al., 2022; Marinda, 2020). Based on this, it would be very good to develop concrete media that students can touch and operate directly.

d) The analysis of the requirements for making media is carried out to serve as a guide in making good learning media. The learning media developed should fulfill the VISUALS principle. VISUALS is an abbreviation of the words Visible, Interesting, Simple, Useful, Accurate, Legitimate, and Structure. It can be interpreted that media creation must pay attention to things like the media being easy to understand, the media being attractive, not complicated, being useful, being compatible with the real world and what it is, can be explained logically, and the arrangement or structure of the media is good. So the media developed for this research refers to the VISUALS principle.

Second, the design stage is the stage of designing the product concept to be developed. Based on the results of the analysis, product design is carried out so that a monopoly media design is produced which includes: a)Collection of images of *Upakara Bali* and images in each plot on monopoly media. b) Designing a monopoly media game board. The game board is the main component in the Monopoly game designed using the Canva application. c) Designing cards on monopoly media, cards as components of monopoly media containing magic cards, answer cards, and flashcards designed with the Canva application. d) Determining the color for the game board and card components (magic cards, answer cards, and flashcards), choosing the color composition must be bright and have a contrast between the image or text and the background. e) Making game guidebook designs using the Canva application. f) Making evaluation questions that are adapted to the material and then coordinating with the supervisor.

Third, is the development stage. At the development stage of the ADDIE model, there are activities to realize the design or product design into reality. At the development stage, designs or frameworks that are still conceptual are realized into products that are ready to be implemented. The development stages in this research include: a)Making an animated video containing an explanation of the characteristics of flat shapes or spatial structures that follow the *Upakara Bali* image model in question. Video creation is done in the Capcut application.

b) Integrating Augmented Reality Technology between *Upakara Bali*images and animated videos using the Artivive website. c) Installation of monopoly board design stickers on wooden boards. d) Print the card components (magic cards, answer cards, and flashcards) and the guidebook. e) Prepare other equipment in the game such as game pieces, dice, markers, and pins. f) The product that has been completed then carries out product validation or feasibility testing involving two material experts and two media experts. Next, product revisions will be carried out based on reviews from two material experts and two media experts.

g) After revising the product, then carry out trials and product practicality tests. Product trials include individual trials involving 6 students as well as small group trials involving 10 students with high, medium, and low abilities. Media practicality testing was carried out by 1 class II elementary school teacher. The teachers and students involved in this stage were taken from one of the school in cluster IV Sukasada District, namely SDN 2 Sukasada. h) The final stage after carrying out product trials and practicality. The following is a visualization of the core components an *Upakara Bali* ethnomathematics monopoly media based on augmented reality, can be seen in Figure 1, Figure 2, Figure 3, and Figure 4.

Figure 1. Monopoly Media Board Visualization Figure

Figure 2. Magic Card Visualization

Figure 3. Answer Card Visualization

Figure 4. Flash Card Visualization

The results of the assessment by learning material experts, an *Upakara Bali* ethnomathematics monopoly media based on augmented reality on geometry material for 2nd-grade elementary school

material obtained a percentage of 97.5% with very good qualifications. Assessment by learning media experts obtained a percentage of 99% with very good qualifications. Meanwhile, the teacher's response results received a percentage of 100% with very good qualifications. In the individual trial, they got a percentage of 94.06%, very good qualifications. In the small group trial, the percentage was 93.99% with very good qualifications. A summary of the assessment of *Upakara Bali* ethnomathematics monopoly media based on augmented reality can be seen in Table 6.

Table 6. Percentage of Validity of Monopoly Media Development

No	Test Subjects	Validity Results	Percentage Qualification
1	Test Learning Material Experts	97.5%	Very good
2	Learning Media Expert Test	99%	Very good
3	Practitioner Test	100%	Very good
4	Individual Trial	94.06%	Very good
5	Small Group Trials	93.33%	Very good

Following comments and suggestions provided by learning material experts on monopoly media, improvements were made to the product. Comments and revision suggestions from learning material experts can be seen in Table 7.

Table 7. Material Expert Comments and Suggestions

No	Comments and Suggestions
1	The color of the answer cards and questions would be better if they were different in color.
2	No media revisions are suitable for use.

Following the comments and suggestions provided by learning media experts at Monopoly Media, improvements were made to the product. Comments and revision suggestions from learning media experts can be seen in Table 8.

Table 8. Media Expert Comments and Suggestions

No	Comments and Suggestions
1.	The manual's table of contents has been tidied up.
2.	Learning outcomes (CP) are completed in determining the position of objects relative to other objects (top and bottom).
3.	Flashcards give the sequence number of each shape.

In the assessment carried out by teachers and students of class II elementary school through drawing responses from teachers and students, there were no suggestions or comments that were used as revision material. Based on this, *Upakara Bali* ethnomathematics monopoly media based on augmented reality on geometry material for 2nd-grade elementary school is feasible and valid to be implemented in the learning process.

Discussions

Based on the study that has been carried out in detail, it can be stated that this development research study has four main objectives which include: (1) to describe the design of *Upakara Bali* ethnomathematics monopoly media based on augmented reality on geometry material for 2nd-grade elementary school, (2) to describe Validity of *Upakara Bali* ethnomathematics monopoly media based on augmented reality on geometry material for 2nd-grade elementary school, (3) To describe the teacher's response to *Upakara Bali* ethnomathematics monopoly media based on augmented reality on geometry material for 2nd-grade elementary school and (4) to describe the response students towards *Upakara Bali* ethnomathematics monopoly media based on augmented reality on geometry material for 2nd-grade elementary school. The novelty of this research is the application of *Upakara Bali* ethnomathematics which is integrated with Augmented Reality technology in this research.

In this development research, the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model was used. The ADDIE development model was chosen because it has a clear and systematic flow, so it is appropriate to use in product development. However, in practice, monopoly media development research is limited to the development stage. The implementation and

evaluation stages were not due to limited costs and time so this research only reached the validity test and drew responses from teachers and students regarding the product being developed.

The first stage is the analysis stage. The initial steps taken were analyzing needs, curriculum analysis, analysis of student books, analysis of student characteristics, and analysis of media creation requirements. The first analysis is needs analysis. The needs analysis was carried out with three activities, namely observation, interviews, and distributing questionnaires to teachers and class II students at Cluster V Elementary School, Sukasada District. The observation and interview activities were conducted in five elementary schools as a comparison. On July 17-18, 2023, at SD Cluster IV, Sukasada District, it was found that all grade II teachers faced challenges in developing teaching materials and rarely created learning media due to constraints such as limited time, curriculum demands, and readiness for teaching. A questionnaire distributed in Cluster IV revealed that 68% of 25 grade II students felt that geometry material in mathematics should be developed using monopoly media, while 32% considered it very necessary. Among the five grade II teachers in the cluster, 40% agreed, and 60% strongly agreed, that geometry materials in student books should be enhanced using augmented reality-based *Upakara Bali* ethnomathematics monopoly media.

The second analysis is curriculum analysis. Curriculum analysis is intended to determine learning outcomes and achievement of learning objectives for mathematics subjects in class II elementary school. Regarding mathematics subjects, geometry material at the elementary school level is found in class II semester 2 of the Independent Curriculum. The learning outcomes in the independent curriculum refer to phase A. At the end of phase A, students can recognize various flat shapes (triangles, quadrilaterals, and circles) and spatial shapes (blocks, cubes, cones, and balls). They can arrange (composition) and decompose (decomposition) flat shapes (triangles, quadrilaterals and circles). Students can also determine the position of objects relative to other objects (right, left, front, back, top, and bottom).

Third, analyze student books. Analysis of students' books was carried out to determine the coverage of geometry material in mathematics subjects contained in the books so that they could find out what material needed to be developed. Regarding mathematics subjects, geometry material at the elementary school level is found in class II semester 2 of the Independent Curriculum. The scope of the material is as follows; a) students can recognize various flat shapes (triangles, quadrilaterals, and circles) and spatial shapes (cubes, cubes, cones, and balls), b) students can arrange (composition) and decompose (decomposition) a flat shape (triangle, quadrilaterals and circles) and c) students can also determine the position of objects relative to other objects (right, left, front, back, top and bottom).

Fourth, analyze student characteristics. An analysis of student characteristics was conducted by observing grade II learning activities in Cluster IV, Sukasada District. The results showed that students were drawn to engaging media with vibrant colors and variations, often responding with curiosity. At the concrete operational stage, these students can understand mathematical symbols, making it ideal to develop tangible media they can manipulate directly. Additionally, an analysis of media creation requirements highlighted the importance of meeting certain criteria to ensure effective learning tools. Media should adhere to the VISUALS principle, emphasizing visibility, interest, simplicity, usefulness, accuracy, legitimacy, and structure.

The second stage is the design stage. The design stage is the stage of designing the product concept to be developed. Based on the results of the analysis, a product design was designed which included: (1) a Collection of images of Balinese rituals and images in each plot on Monopoly media, (2) a Design of the Monopoly media game board, (3) Design of cards on monopoly media, cards as a monopoly media component containing magic cards, answer cards and flash cards designed with the Canva application, (4) Determining colors for the game board and card components (magic cards, answer cards, and flashcards), Making game guide book designs carried out in Canva application, and (5) Making evaluation questions that are adapted to the material and then coordinating with the supervisor.

After the design stage is implemented, it continues with the development stage. At the development stage, designs or frameworks that are still conceptual are realized into products that are ready to be implemented. The development stages in this research include: making an animated video containing an explanation of the characteristics of flat shapes or spatial structures that follow the *Upakara Bali* image model in question, integrating Augmented Reality Technology between *Upakara Bali* images and animated videos using Artivive website. Next installing monopoly board design stickers on wooden boards, printing card components (magic cards, answer cards, and flashcards) as well as guidebooks, and preparing other equipment in the game such as pieces games, dice, markers, and pins.

Products that have been completed then carry out product validation or feasibility testing involving two material experts and two media experts. Next, product revisions will be carried out based on reviews from two material experts and two media experts. Next, trials and product practicality tests. Product trials include individual trials involving 6 students as well as small group trials involving 10 students with high, medium, and low abilities. Media practicality testing is carried out by 1 class II

elementary school teacher. After carrying out product trials and practicality, if there are revisions then media product revisions will be carried out.

The material expert test involved two experts evaluating curriculum, linguistic, material, and evaluation aspects. Key indicators included: alignment of material with learning outcomes (CP), objectives (TP), and indicators (IKTP); appropriateness of language for students and correct spelling; enhancement of concept understanding; inclusion of essential concepts; alignment with 2nd-grade geometry scope; ease of understanding; engaging presentation; alignment of questions with material; and availability of question instructions.

Validity tests on material experts obtained a percentage of 97.5% in the range of 90-100% with very good qualifications. This finding is in line with research namely that monopoly learning media in mathematics learning for elementary school students is very valid to use with a very feasible category (Putri et al., 2024; Fajriah et al., 2022). Apart from that, findings namely that ethnomathematics-based mathematics learning in elementary school has a positive and significant effect on students' understanding of geometric concepts (Solihin & Habibie, 2024; Naitili & Nitte, 2023).

Several revisions from experts include monopoly media components, namely the color of answer cards, differentiated from the colors of magic cards and flash cards. These studies show that the development of monopoly media, learning using ethnomathematical approaches and Augmented Reality-based media is valid and effective if implemented in the learning process. However, in the mathematics content of geometry learning, no integrated monopoly media has ever been developed *Upakara Bali* ethnomathematics integrated so that the development of this media is new. The distinctive feature of this research is in addition to implementing ethnomathematics using the *Upakara Bali* image model.

The media expert validity test also involves two experts who cover several aspects, namely appearance/design aspects, feasibility aspects, and operational aspects. These aspects include several indicators, namely: (1) The attractiveness of the appearance or design of monopoly media, (2) The suitability of the size and type of letters or fonts, (3) The harmony of composition and color combinations, (4) The attractiveness of the images presented, (5) Suitability of image and text layout, (6) Suitability of monopoly media to learning objectives, (7) Suitability to learner characteristics, (8) Accuracy of the material presented, (9) Ease of operation, and (10) Smoothness of operation.

The validity test on media experts obtained a percentage of 99% in the range of 90-100% with very good qualifications. This finding is in line with the first research, namely regarding Augmented Reality-based learning media in elementary school (Ningrum et al., 2022; Nugraha et al., 2021). Second, regarding ethnomathematics-based mathematics learning through games (Casnan et al., 2022; Maulida, 2020). These two studies show that learning media in the form of games and integrating ethnomathematics and Augmented Reality technology are suitable for use and application in the learning process. There are several revisions from experts including the bibliography in the guidebook needs to be tidied up again, learning outcomes need to be completed at the point of determining the position of other objects (top and bottom) and giving sequential numbers to each shape on the flash cards.

Practitioner trials for the product were conducted with 2nd-grade teachers at SDN 2 Sukasada, evaluating aspects such as material, language, presentation, design, and operation. Key indicators included: completeness of information, alignment with learning outcomes (CP), objectives (TP), and indicators (IKTP), suitability to geometry material, appropriate language for students, correct spelling, coherence, engaging presentation, text clarity, image attractiveness, color harmony, operational ease, and smooth operation. The trials achieved a 100% score (90-100%) with very good qualifications and no revision suggestions. Thus, the Bali ethnomathematics AR-based monopoly media for geometry is deemed suitable for classroom use.

Student responses to the Bali ethnomathematics augmented reality monopoly media for 2nd-grade geometry were assessed through individual and small group trials. Evaluated aspects included appearance, material, operation, and evaluation. Key indicators were: media attractiveness, font size and type suitability, image appeal, color harmony, material clarity, ease of understanding, media engagement, ease of use, and alignment of questions with the material. The trials yielded a response score of 94.06% (very good, 90-100%). Thus, the media is deemed suitable for learning implementation. This finding is in line with research namely regarding the application of monopoly games to mathematics learning so that it can increase students' learning motivation (Rahaju & Hartono, 2017)(Sari et al., 2022; Rahaju & Hartono, 2017).

The innovation of Balinese ethnomathematics monopoly media based on Augmented Reality on geometry material in second grade elementary school is valid and feasible to be used in the learning process. This study has implications for the preservation of local wisdom through learning media in schools. The limitation of this research is that it was only conducted in one school. The next research can involve more schools to get more maximum research results.

4. CONCLUSION

The innovation of *Upakara Bali* ethnomathematics monopoly media based on augmented reality on geometry material for 2nd-grade elementary school which was developed has a very good category for implementation in the learning process. This can be seen from the validity and practicality tests involving experts/lecturers, teachers/practitioners, and students who gave good responses as well as several suggestions for improving the quality of this monopoly media.

5. REFERENCES

Agustyaningrum, N., Pradanti, P., & Yuliana. (2022). Piaget and Vygotsky's theory of development: how are its implications in mathematics learning primary school? *Journal of Mathematics and Mathematics Education*, *5*(1), 568–582. https://doi.org/10.30606/absis.v5i1.1440.

Anafi, K., Wiryokusumo, L., & Leksono, I. P. (2021). Development of Addie Model Learning Media Using Unity 3D Software. *Journal of Education and Development*, *9*(4), 433–438. https://doi.org/10.37329/cetta.v4i3.1417.

Anwar, M. (2017). Creating effective learning through hypnoteaching. *Journal of Expose*, *16*(2), 469–480. https://doi.org/10.30863/ekspose.v16i2.106.

Casnan, Purnawan, Firmansyah, I., & Triwahyuni, H. (2022). Evaluate the learning process with a Systems Thinking approach. *Scholaria: Journal of Education and Culture*, *13*(3), 31–38. https://doi.org/10.24246/j.js.2022.v12.i1.p31-38.

Fajriah, H., Putra, M. J. A., & Syahrilfuddin. (2022). Development of Muta Learning Media (Monopoly of Snakes and Ladders) in Learning Mathematics Integer Calculation Operation Material. *Journal of Basic Education and Character Research*, *4*(1). Retrieved from https://ejurnal.stkipadzkia.ac.id/index.

Fauzy, I., & Arisetyawan, A. (2020). Analysis of Student Learning Difficulties on Geometry Material in Elementary School. *Kreano: Journal of Creative-Innovative Mathematics*, *11*(1), 27–35. https://doi.org/10.15294/kreano.v11i1.20726.

Friantini, R. N., Winata, R., Annurwanda, P., Suprihatiningsih, S., Annur, M. F., Ritawati, B., & Iren. (2020). Strengthening Basic Mathematical Concepts in Elementary School-Age Children. *Journal of Abdimas Bina Bangsa*, *1*(2), 276–285. https://doi.org/10.46306/jabb.v1i2..

Lase, F. (2020). The role of lesson planning in improving teacher professionalism. *Educativo: Journal of Education*, *1*(1), 149–157. https://doi.org/10.56248/educativo.v1i1.22.

Lestari, W. M., & Salsabila, A. (2023). Development of Interactive Learning Media Digital Puzzle Class VI Circle Material SD Negeri Bluru Kidul 2 Sidoarjo. *Nusantara Educational Review*, *1*(1), 7–14. https://doi.org/10.55732/ner.v1i1.995.

Marinda, L. (2020). Jean Piaget's theory of cognitive development and its problems in elementary school-aged children. Journal *of An-Nisa*, *13*(1), 116–152. https://doi.org/10.35719/annisa.v13i1.26.

Maulida, S. H. (2020). Ethnomathematics-based mathematics learning through traditional hopscotch games. *LEMMA: Letters of Mathematics Education*, *7*(1). https://doi.org/10.22202/jl.2020.v7i1.3374.

Mubarok, R. (2022). Learning planning for face-to-face learning is limited to Madrasah Ibtidaiyah. *Auladuna : Journal of Madrasah Ibtidaiyah Teacher Education Study Program*, *4*(1), 15–31. https://doi.org/10.36835/au.v4i01.1096.

Mulyani, E., & Natalliasari, I. (2020). Ethnomathematical Exploration of Sukapura Batik. *Mosharafa: Journal of Mathematics Education*, *9*(1). https://doi.org/10.31980/mosharafa.v9i1.609.

Munir, M. (2017). Jean Piaget's Concrete Operational Stages in the Internalization of Religious Morals of Children of Primary School Age 7-12 Years. *Journal of Islamic Education*, *6*(1), 46–57. https://doi.org/10.32478/talimuna.v7i1.214.

Mustaqim, I., & Kurniawan, N. (2017). Development of Augmented Reality-Based Learning Media. *Journal of Electrical* Education, *1*(1), 36–48. https://doi.org/10.21831/jee.v1i1.13267.

Naitili, C. A., & Nitte, Y. M. (2023). The effectiveness of ethnomathematics learning using sikidoka games on understanding geometry concepts for elementary school students. *HINEF: Journal of the Educational Science Group*, *2*(1), 42. https://doi.org/10.37792/hinef.v2i1.857.

Nasution, N. M., & Sukmawarti. (2023). Reasoning Analysis of Flat Field Geometry Problems in Elementary School Mathematics Textbooks. *Journal of Research Innovation*, *4*(4), 895–902. https://doi.org/10.47492/jip.v4i4.2793.

Ningrum, K. D., Utomo, E., Marini, A., & Setiawan, B. (2022). Electronic Comic Media Integrated with Augmented Reality in Learning System Human Blood Circulation in Elementary School. *Basicedu Journal*, *6*(1). https://doi.org/10.31004/basicedu.v6i1.2289.

Nugraha, A. C., Bachmid, K. H., Rahmawati, K., Putri, N., Hasanah, A. R. N., & Rahmat, F. A. (2021). Design

augmented reality-based learning media for thematic learning in grade 5 elementary school. *Journal of Electrical* Education, *5*(2), 138–147. https://doi.org/10.21831/jee.v5i2.45497.

Pitriani, N. R. V., Wahyuni, I. G. A. D., & Gunawan, I. K. P. (2021). Application of the Addie model in the development of interactive learning media using Lectora Inspire in the Hindu Religious Education Study Program. *Journal of Educational Sciences*, *4*(3), 515–532. https://doi.org/10.37329/cetta.v4i3.1417.

Putra, A. D., Ridho, M., Susanto, D., & Fernando, Y. (2023). The application of MDLC in Lampung script learning uses augmented reality technology. *CHAIN:* Journal *of Computer Technology, Computer Engineering*, *1*(2), 32–34. https://doi.org/10.58602/chain.v1i2.19.

Putra, I. G. L. A. K., Tastra, I. D. K., & Suwatra, I. I. W. (2014). Development of learning video media with the Addie model in English language learning at SDN 1 Selat. *Undiksha Edutech Journal*, *2*(1). https://doi.org/10.23887/jeu.v2i1.3939.

Putri, R. P. A., Wahyudi, W., & Basori, M. (2024). Development of Monopoly Learning Media for Grade VI Elementary School Mathematics Spatial Building Material. *Pendekar: Jurnal Pendidikan Berkarakter*, *7*(3). https://doi.org/10.31764/pendekar.v7i3.25518.

Rahaju, R., & Hartono, S. R. (2017). Indonesian Monopoly Game Based Mathematics Learning. *JIPMat*, *2*(2). https://doi.org/10.26877/jipmat.v2i2.1977.

Rahayu, E. (2021). Problems of Elementary School Students' Difficulties in Learning Geometry. *At-Ta'lim: Journal of Education*, *7*(1). https://doi.org/10.36835/attalim.v7i1.524.

Rizko, U., Islam, M. H., & Badruttamam, C. A. (2023). Implementation of Caseme P3 in Mathematics Lessons by Using Used Goods as Learning Media. *Attadrib: Journal of Madrasah Ibtidaiyah Teacher Education*, *6*(1), 21–30. https://doi.org/10.54069/attadrib.v6i1.346.

Safitri, R. R., & Sulistyorini, Y. (2023). Ethnomathematical Study of Geometry on Historical Heritage Artifacts in Malang City. *MATHEMA JOURNAL*, *5*(2), 258–268. https://doi.org/10.33365/jm.v5i2.2876.

Sari, R. K., D, N. P., Santika, Y., Rani, N. M. S., & Cahyono, D. A. D. (2023). Pelatihan Penerapan Soal Berbasis Etnomatematika di SMA Negeri 1 Batanghari. *Journal of Social Sciences and Technology for Community Service (JSSTCS)*, *4*(1), 41–46. https://doi.org/10.33365/jsstcs.v4i1.2590.

Sari, S. P., Ibrahim, M., Amin, S. M., & Hartatik, S. (2022). The level of student learning motivation through the application of monopoly game media in mathematics learning in elementary school. *School Journal*, *7*(1), 105–111. https://doi.org/10.24114/js.v7i1.36901.

Simbolon, S., & Sapri. (2022). Analysis of Student Needs for Android-Based Learning as an Interactive Learning Media for Building Space Materials. *Basicedu Journal*, *6*(3), 4322–4330. https://doi.org/10.31004/basicedu.v6i3.2821.

Solihin, A., & Habibie, R. K. (2024). The Influence of Ethnomathematics-Based Bull Racing Cultural Integration on Elementary School Students' Geometry Learning Outcomes. *Journal of Elementary School Teacher Education Research*, *12*(8). Retrieved from https://ejournal.unesa.ac.id/index.php/jurnal-penelitian-pgsd/article/view/61971.

Suardiana, I. M. (2021). Drill Method to Improve Mathematics Learning Outcomes in Grade IV Elementary School Students. *Journal of Education Action Research*, *5*(4), 542–547. https://doi.org/10.23887/jear.v5i4.39476.

Suartama, I. K. (2016). *Evaluasi dan Kriteria Multimedia Pembelajaran*. Singaraja: Universitas Pendidikan Ganesha.

Sukayasa. (2022). The characteristics of student reasoning in solving geometry problems in terms of gender differences. *Journal of Mathematics and Mathematics Education*, *11*(2). https://doi.org/10.33387/dpi.v11i2.5104.

Sundari, F. (2017). The Role Of Teachers As Learners In Motivating Elementary Age Students. *Journal LPPM Unindra*, *1*(1), 60–76. Retrieved from https://journal.lppmunindra.ac.id/index.php/repository/article/view/1665.

Widyanto, I. P., & Wahyuni, E. T. (2020). Implementation of Learning Planning. *Satya Sastraharing: Journal of Management*, *4*(2). https://doi.org/10.33363/satya-sastraharing.v4i2.607.

Winangsih, E., & Harahap, R. D. (2023). Analysis of the Use of Learning Media in Science Content in Elementary School. *Basicedu Journal*, *7*(1), 452–461. https://doi.org/10.31004/basicedu.v7i1.4433.

Wulandari, A. P., Salsabila, A. A., Cahyani, K., Nurazizah, T. S., & Ulfiah, Z. (2023). The Importance of Learning Media in the Teaching and Learning Process. *Journal on Education*, *5*(2), 3928–3936. https://doi.org/10.31004/joe.v5i2.1074.