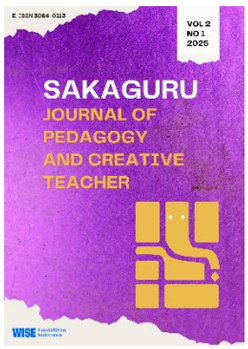

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Research Article

Integration of Kaliurang Local Culture into Augmented Reality for Spatial Geometry Learning Media Development

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Abstract

A new challenge in 21st-century learning processes is the demand for technology integration without neglecting the richness of local culture. This research aims to develop Augmented Reality (AR) learning media integrated with the local culture of Kaliurang that is feasible and practical to use. This research approach uses a quantitative and qualitative approach, also known as a mixed method, with a research and development (R&D) design model 4-D consisting of four stages: define, design, develop, and disseminate. Data collection was conducted through interviews and questionnaires. The selection of subjects was carried out through random sampling with a population of sixth-grade students. The sample used in this study consisted of 25 sixth-grade students from SD Negeri Umbulharjo 2 over 2 months. The analysis of interview data was conducted descriptively, while the questionnaire data used descriptive statistical analysis. The analysis results found the need for the development of learning media, which was subsequently assessed for feasibility with an average score of 3.93 or 98.43%, categorized as "Very Feasible" by subject matter experts, and an average score of 4 or 100%, categorized as "Very Feasible" by media experts. The practicality test received an average score of 3.6 or 90%, classified as "Very Practical" by the students. The results of the study show that Augmented Reality (AR) integrated with the local culture of Kaliurang is good for use as a learning medium for spatial geometry with the use of technology in elementary school classes that contribute to the process of student understanding.

Keywords: Augmented Reality (AR); Elementary School; Ethnomathematics; Spatial Building

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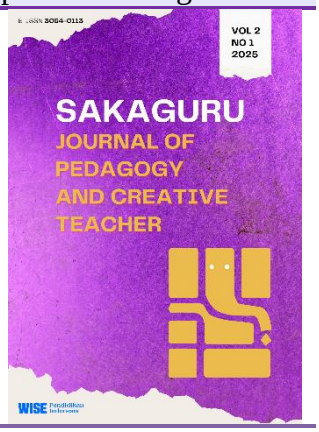

INTRODUCTION

Entering the 21st century, the world of education faces new challenges that demand changes in the teaching and learning process. All education stakeholders must be able to deliver learning by always utilizing technology. This is based on the need for 21st-century learners to master digital literacy, new media, and ICT (Information and Communication Technologies) skills to access various knowledge effectively [1]. The use of technology in educational practice has become a focal point in enhancing teaching and learning [2]. More broadly, the use of technology as a learning medium has proven to have implications for the enhancement of critical thinking skills, as students are exposed to various sources of information, learn to evaluate their credibility, develop analytical abilities, increase their interest in learning, engagement, and ease of material delivery [3], [4], [5]. However, this great potential has not yet been fully implemented effectively in the field, such as in schools, leading to various issues in the learning process involving students and teachers.

The use of technology as a learning medium is still minimal due to challenges such as limited access to technology and difficulties in integrating it into the learning curriculum because of insufficient time and teacher training services related to the application of technology [6], [7]. However, the ability to provide technology-based learning media and understand its application in education is very important. Teachers need to design technology-based learning according to the needs of students, one of which aims to explain abstract concepts to facilitate students' absorption when understanding a subject [8], [9]. Previous research findings have conducted studies that emphasize that the application of technology has great potential in bridging difficult-to-learn abstract concepts in learning material.

Understanding abstract concepts becomes one of the goals in mathematics education, especially in spatial geometry, which requires deeper comprehension by elementary school students. Research related to analyzing the difficulties faced by elementary school students in understanding mathematical problems due to their inability to visualize abstract three-dimensional shapes [10]. Monotonous teaching without considering the needs of students and minimal innovation in learning media becomes a factor underlying the difficulty in understanding abstract concepts such as spatial figures [11]. Generally, teachers still use printed books to teach spatial building materials, causing students to struggle because two-dimensional images are not sufficient to represent three-dimensional objects [12]. Meanwhile, referring to the old but still relevant theory related to cognitive development, elementary school students aged 7-11 are still in the process of transitioning from the concrete period to the abstract period, which affects their understanding of an object's shape such as spatial figures in mathematics [13]. Referring to relevant research, technology-based learning can be a solution for effective mathematics education by students' development, proving to surpass traditional learning [14]. Based on the issue of the mismatch between the cognitive development phases of elementary school students and the learning media commonly used, the utilization of technology can be an effective and efficient solution. The role of technology becomes important in helping to visualize abstract concepts such as spatial shapes more concretely.

Various previous studies have shown efforts to develop learning media by utilizing technology in teaching spatial building materials, which have proven to be effective for use at the elementary school level. For example, research and development of educational media such as the Wordwall Educational Game [15]. The GeoGebra application in spatial building

materials [16]. Spatial building learning media based on Adobe Flash, and Augmented Reality (AR) assisted by Unity 3D have been conducted [17], [18]. The use of technology in these learning media can visualize abstract concepts in spatial geometry material into more concrete forms through virtual displays. However, unlike previous technologies, Augmented Reality (AR) can integrate virtual objects, such as three-dimensional objects on a computer, into the real world in real time [19]. Although the development of Augmented Reality (AR) learning media has been carried out, the context of the material and the target students are still limited, so further development is needed, such as for sixth-grade elementary school students. Therefore, the development of Augmented Reality (AR) learning media to meet the needs of students can be a superior choice, providing an impressive, interactive, and easy-to-use experience in the classroom.

Expert research has proven that learning using Augmented Reality (AR) media affects the improvement of spatial abilities, which is the ability to imagine or visualize the shape of an object that has changed [20], [21]. Furthermore, studies have shown that high spatial ability can enhance mathematics learning outcomes in geometry [22]. Based on that study, the use of Augmented Reality (AR) in learning is deemed appropriate, as it enhances visualization and impacts optimal learning outcomes, particularly for abstract spatial materials, by developing students' spatial abilities through their cognitive development.

In addition to the potential of technology in facilitating the understanding of abstract concepts, the development of learning media also needs to consider the local cultural context so that the material presented is more meaningful and relevant to the student's lives. In line with the other reseacrh, learning using technology within the context of ethnomathematics not only has a significant potential to enhance conceptual understanding but also fosters students' awareness of cultural richness [23]. Not only that, the effective integration of ethnomathematics strengthens students' learning motivation, and critical thinking skills, and encourages them to master mathematical concepts within the context of local culture [24], [25]. Referring to the results of the related systematic literature review, the integration of ethnomathematics in developing learning media overall can positively impact the improvement of learning quality [26]. These findings affirm that local cultural elements in technology-based learning media can enhance the effectiveness of education.

Although various studies have examined the benefits and potential of integrating technology with local culture in learning media, the reality on the ground still shows a gap. Schools like SD Negeri Umbulharjo 2 have not yet opened opportunities for the application and development of learning media by maximizing the use of technology. The urgency of the research is centered on students' difficulties in solving the abstract concepts of spatial shapes, while the current learning media used are not yet capable of effectively addressing these issues. Highlighting the urgency of solving the existing problems, this research offers novelty by developing Augmented Reality (AR)-based learning media that integrates the local culture of Kaliurang into the spatial building material in elementary schools, which has never been done before.

Formulating objectives to address the focus of this research problem, namely the development of Augmented Reality (AR)-based learning media integrated with the local culture of Kaliurang to be tested until it is feasible and practical for use in teaching spatial building materials in a concrete and engaging manner. The contribution of this research is

capable of enriching learning theory, providing innovative solutions in education, applying development-based research methods to create learning media, and offering a new approach related to the implementation of technology in mathematics education. Furthermore, this research contributes to the achievement of the Sustainable Development Goals (SDGs), particularly point 4 related to Quality Education, as it can provide inclusive education, highlight the context of local potential, and promote the enhancement of 21st-century skills through technology utilization and cultural preservation. To achieve the research objectives, the next step is to develop an appropriate methodology to ensure that the development process is systematic and relevant to the expected learning context

METHODS

Research Design

This research uses a qualitative and quantitative approach, also known as the mixed method. The research design used is Research and Development (R&D) aimed at producing a product that has the potential to be studied and evaluated to achieve validity [27]. The Research and Development (R&D) design used in this study is the 4-D model, which consists of four stages: define, design, develop, and disseminate. This model was chosen because it is capable of effectively identifying the real needs of students in the field, developing products based on theory, and testing the feasibility and practicality of the media before it is disseminated for application. Therefore, this design is relevant in developing Augmented Reality (AR)-based learning media integrated with the local culture of Kaliurang, which is contextual and innovative for effective application in elementary schools.

Population and Sample

The population in this study consists of sixth-grade elementary school students, based on the relevance to the learning outcomes of spatial building materials and the suitability of the cognitive development stage, namely from concrete operational to formal. The sampling was conducted using the random sampling technique, which can represent the entire population, thereby ensure representativeness and reduce selection bias. In this study, the sample used consisted of 25 sixth-grade students from SD Negeri Umbulharjo 2. The inclusion criteria in this study include students in the 4th grade during the academic year of the research, participating in mathematics learning specifically on spatial building materials, and obtaining permission from responsible parties such as parents and the school to participate. Meanwhile, exclusion criteria are set for students who do not fully participate in the learning process during the research period and for students who refuse to consent to participate in the research process.

Location and Timing

The chosen research location is SD Negeri Umbulharjo 2, located in Kaliurang, Special Region of Yogyakarta. The school has implemented a free curriculum that is relevant to the material tested on learning media and has access to digital devices. The research was conducted between March and April of the even semester of the 2024/2025 academic year, aligning with the schedule for teaching spatial geometry at the school. The time and location of this research have been strategically considered to ensure the continuity of implementing Augmented Reality (AR) learning media in a real context, supporting the validity of the research results.

Research Procedure and Instruments

The research procedure refers to the 4-D model, which consists of four stages: define, design, develop, and disseminate. The definition stage plays a role in determining and defining the needs related to learning media by utilizing technology and aligning with the cognitive development of the learners. Additionally, it is conducted to gather information that will be used in the development of Augmented Reality (AR) media. The design stage involves media selection, process selection, and initial design. The development stage refers to the creation of the product using the Assembler Edu application and adding image elements from the Pinterest application. The result of the development of the Augmented Reality (AR) media product then goes through several assessment stages by subject matter and media experts before being tested on students as users. At the dissemination stage, the product is distributed and presented to elementary schools. The development steps are explained in Figure 1.

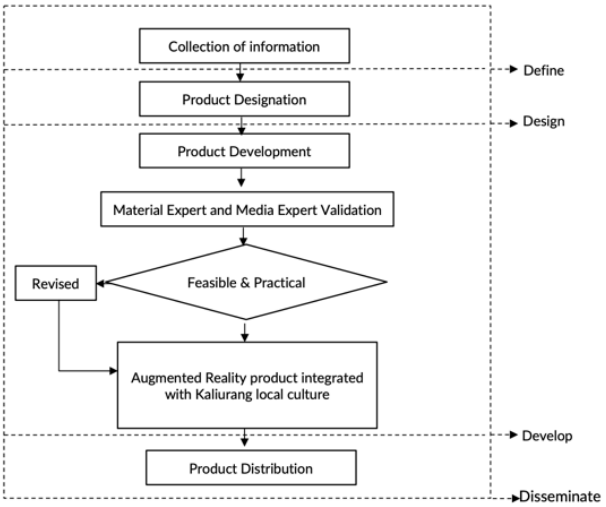

Figure 1. Stages of Research and Development
(Source: 2025 Compilation Team)

The research instrument is adopted based on previous studies that have been assessed for their validity and reliability. The interview guideline instrument is used as a data collection tool to analyze the main learning needs. Interviews were conducted with sixth-grade elementary school teachers and the principal. In addition, there are questionnaire instruments to assess the feasibility of the learning media. This feasibility assessment is conducted by lecturers from the PGSD program with a concentration in mathematics and media learning at Universitas Negeri Yogyakarta. The aim is to identify aspects that may not yet meet the criteria, such as the alignment of the material with learning outcomes and learning objectives. The assessment is conducted in two stages to achieve satisfactory results. Furthermore, a questionnaire was also given to the students to measure the practicality of the media, including the students' responses regarding the clarity of the usage instructions and the ease of operating the media. Details of the instruments used are in Table 1.

Table 1. Research Instruments

Research Objectives	Instruments Used
Development of Augmented Reality (AR) Media According to Needs	Interview Guidelines
Feasibility Assessment of Augmented Reality (AR) Media	Expert Material Assessment Questionnaire Expert Media Assessment Questionnaire
Assessment of the Practicality of Augmented Reality (AR)Media	Student Assessment Questionnaire

Data Analysis Techniques

The data analysis technique for qualitative data from interviews using descriptive analysis is conducted by interpreting the transcripts based on the meanings conveyed by the informants, namely the teachers and the principal of SD Negeri Umbulharjo 2, Kaliurang, Special Region of Yogyakarta. The analysis process includes data reduction, data presentation, and conclusion drawing, resulting in explanations related to how challenges occur, and the characteristics possessed by students during the mathematics learning process of spatial shapes in the classroom. Next, the quantitative data analysis technique from the feasibility and practicality questionnaire results was conducted using statistical calculations with Microsoft Excel. The acquisition of questionnaire scores to assess feasibility using the following formula according to [28].

$$\text{Feasibility} = \frac{\text{Total eligibility score}}{\text{Total maximum score}} \times 100\%$$

After conducting the feasibility assessment process, the results are described based on the feasibility categories [29], in Table 2.

Table 2. Eligibility Criteria

Score	Category
0% – 20%	Not Feasible
21% – 40%	Less Feasible
41% – 60%	Decent Enough
61% – 80%	Feasible
81% – 100%	Very Decent

Based on the feasibility criteria in the table above, the development of Augmented Reality (AR) learning media can meet the criteria for being feasible to use if it falls within the score range of (61% - 80%). Furthermore, to calculate the practicality response data from students, the following formula is used.

$$\text{Practicability} = \frac{\text{Total score obtained}}{\text{Total maximum score}} \times 100\%$$

After conducting a practicality calculation, Augmented Reality (AR) learning media is categorised based on the criteria in Table 3.

Table 3. Practicality Criteria

Score	Category
0% – 20%	Not Practical
21% – 40%	Less Practical
41% – 60%	Practical Enough
61% – 80%	Practical
81% – 100%	Very Practical

Impact Evaluation

The success determined in this research is through the scores from expert evaluations and student evaluations. The product is considered successful if the expert assessment score reaches the category of minimally feasible to very feasible. In addition, the assessment by the students must also reach the practical to very practical category to be considered successful. Evaluation data were collected after implementation, to what extent the Augmented Reality (AR) learning media based on local culture is considered feasible and practical through post-intervention questionnaires and Focus Group Discussions (FGD) focused on the experience of using the media. The impact evaluation of this research has limitations, including the specific location context, the short duration of media implementation, and the potential subjectivity in interviews with teachers and school principals, so the research results need to be interpreted with caution.

RESULT AND DISCUSSIONS

Development of Augmented Reality (AR) Integrated with Kaliurang Culture

The development carried out has resulted in a product in the form of Augmented Reality (AR) learning media integrated with the culture of Kaliurang. The material taken includes three-dimensional shapes such as cubes and rectangular prisms for mathematics learning. The development process of this Android-based application follows the 4-D development model stages as proposed by Thiagarajan. This model consists of four sequential stages, namely definition, design, development, and dissemination.

In the define stage, an analysis is conducted related to various aspects such as curriculum analysis, student needs, concept exploration, and learning evaluation. This stage was conducted through observations and interviews carried out at SD Negeri Umbulharjo 2. The analysis produced information related to fundamental issues in learning and student characteristics, particularly the low student activity which leads to a lack of interest in learning mathematics. The sixth-grade teacher stated that students still have difficulty understanding spatial mathematics and that the available teaching media do not adequately facilitate the teacher's delivery of the material. Next, the identification of local content in the form of cubes and rectangular prisms found in Kaliurang was conducted according to the spatial geometry material, namely Besek Kenduri, and Stonehenge, to be integrated into Augmented Reality (AR). Besek Kenduri is a square-shaped container made of woven bamboo that is usually used by the people of the Kaliurang area to place food after village celebrations. In addition, Stonehenge Merapi is made from rocks that originated from the eruption of Mount Merapi, located in the Special Region of Yogyakarta. The rocks are block-shaped and stacked on top of each other. Stonehenge Merapi has become one of the tourist attractions in the Kaliurang area, thus it is part of the local culture that can be used as a learning context by highlighting its three-dimensional shape. Here are the local contents of Besek Kenduri and Stonehenge as seen in Figure 2.

Figure 2. Local Muatal Besek Kenduri and Stonehenge Kaliurang
Source: Instagram zamzamhomedecor.id and @jogjakita

Next, the design phase is carried out to develop a product in the form of Augmented Reality (AR) learning media integrated with Kaliurang culture. The development began with designing important parts such as the image elements needed to construct the shapes of Besek Kenduri and Stonehenge Kaliurang, which were designed using the Canva application. Furthermore, these elements were combined in the Assmblr Edu application, which is an Augmented Reality (AR) design application, resulting in the creation of a barcode for student access. The Assmblr Edu application was chosen because it is easy to operate and can be

developed at no cost. The design of the Besek Kenduri and Stonehenge Kaliurang can be seen in Figure 3.

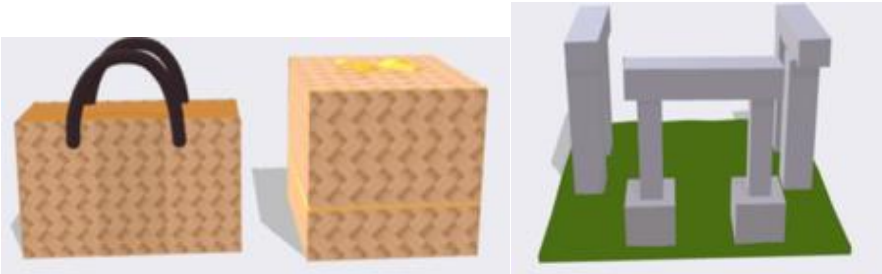

Figure 3. Design of Besek Kenduri and Stonehange Kaliurang
Source: Compiling Team, 2025

At the development stage, which is the evaluation stage of the developed Android-based application. The Android-based application undergoes a feasibility assessment conducted by subject matter experts and media experts. Then improvements were made based on the provided revisions. The revisions included the accuracy of the dimensions of the cuboid and cube images. Then, a limited trial was conducted at SD Negeri Umbulharjo 2 with 25 students to observe the response to the practicality of the product. The trial was conducted during the mathematics lesson on spatial shapes according to the schedule for teaching that material.

Students in groups used Augmented Reality (AR) media integrated with the local potential of Kaliurang. Augmented Reality (AR) can be accessed through the prepared barcodes, which have been placed in various corners of the school, allowing students to engage in learning outside the classroom. There are three barcodes that students must access. The first barcode will display a three-dimensional visual representation of the local culture of Kaliurang, namely Besek Kenduri. Next, the second barcode will display a three-dimensional visual representation of the local culture of Kaliurang, namely Stonehenge Merapi. Finally, the third barcode will display instructions for students to create a model of another local content found in Kaliurang according to their creativity. All the barcodes will display visual forms through the Augmented Reality (AR) application, namely Assmblr Edu, in accordance with the material on cube and cuboid spatial structures learned by students with Phase C learning outcomes, which include the ability to construct and deconstruct spatial structures (cubes, cuboids, and their combinations), recognize spatial visualizations (front, top, and side), and compare the characteristics of flat and spatial structures.

The product in the form of Augmented Reality (AR) learning media integrated with Kaliurang culture can be accessed for distribution through the link:
https://drive.google.com/file/d/1xrzsOm_a6xvxLTD8Gvtk5-tu82o6LIPF/view?usp=drivesdk
The following is the appearance of the product in the form of Augmented Reality (AR) learning media integrated with the culture of Kaliurang, which can be seen in Figure 4.

Figure 4. Augmented Reality (AR) Media and Its Use
Source: Compiling Team, 2025

Feasibility of Augmented Reality (AR) Learning Media Integrated with Kaliurang Culture

The feasibility of the product in the form of Augmented Reality (AR) learning media integrated with Kaliurang culture received evaluations from subject matter experts and media experts. The subject matter experts and media experts are lecturers from the PGSD program at Universitas Negeri Yogyakarta. The assessment results in Table 4.

Table 4. Material Feasibility Results

Aspect	Average Score	Percentage	Category
Relevance of the Material	4	100%	Very Feasible
Organising Material	4	100%	Very Feasible
Language	3,75	93,75%	Very Feasible
Strategy for Learning	4	100%	Very Feasible
Totally	**3,93**	**98,43%**	Very Feasible

Source: Researcher's data collection results, 2024

The average final score from the subject matter experts is 3.93 or 98.43%, which falls into the "Very Feasible" category. The comments and improvement suggestions previously given by the content expert were only minor refinements according to the advice related to language so that students could more easily understand the context conveyed in the learning media. The expert concluded that the material in the media is "suitable for trial with revisions according to the suggestions". Then, an evaluation was conducted by media experts. The feasibility results of the product in the form of Augmented Reality (AR) learning media integrated with Kaliurang culture are explained in Table 5.

Table 5. Results of Media Expert Feasibility Assessment

Aspect	Average Score	Percentage	Category
Appearance and Design	4	100%	Very Feasible
Letters	4	100%	Very Feasible
Language	4	100%	Very Feasible
Totally	**4**	**100%**	**Very Feasible**

Source: Researcher's data collection results, 2024

The average final score in the overall assessment by media experts is 4 or 100%, thus classified as "Very Feasible". The media experts concluded that the media can be used without revisions. The conclusion from the test results shows that the Augmented Reality (AR) media

integrated with the local culture of Kaliurang is suitable for use during the classroom learning process.

Discussions

The product in the form of Augmented Reality (AR) media integrated with Kaliurang culture was developed to help students visualize abstract concepts that impact conceptual understanding, especially in spatial building materials. This is based on the needs of the students, namely the availability of learning media that aligns with cognitive development at the elementary school level. The theory of cognitive development explains that elementary school students are still in the process of transitioning from the concrete period to the abstract period in understanding the shape of objects such as spatial figures in mathematics [13]. Therefore, learning with Augmented Reality (AR) media can enhance spatial abilities in visualizing abstract objects into more concrete forms, resulting in improved geometry learning outcomes such as three-dimensional shapes [20], [21], [22]. Moreover, the integration of ethnomathematics can support students' learning motivation, and critical thinking skills, and encourage students to master mathematical concepts within the context of local culture [24], [25]. In this development, integrating the interesting and relevant local culture of Kaliurang is used as a learning medium. The Integrated Augmented Reality (AR) Product of Kaliurang Culture consists of three barcode sections to display visual forms, namely Besek Kenduri, Stonehenge Kaliurang, and instructions to assemble other forms of Kaliurang culture.

An assessment was conducted on the product in the form of Augmented Reality (AR) Integrated with Kaliurang Culture, including evaluations related to the feasibility of the material and the feasibility of the media. The aspects of material feasibility include the relevance of the material, organization of the material, language, and strategies for learning. Supported by related research, the development of a learning media is deemed feasible if it refers to the aspects of material relevance and material organization [30]. Moreover, good learning devices need to pay attention to the use of language appropriate to the developmental stage of the learners and the presence of learning strategies that can foster the effectiveness of learning [31], [32]. Furthermore, the feasibility aspects of the media include design appearance, font, and language. Referring to relevant studies, the feasibility of an educational product is assessed based on these aspects, as they can effectively contribute to learning. In terms of practicality, it includes ease of use, efficient learning time, and the ability for learning to be meaningful [33]. This is in line with other research, which reveals the practicality of learning products based on aspects of use, time efficiency, and meaningfulness or related benefits [34].

The product in the form of Augmented Reality (AR) Integrated with Kaliurang Culture has met the feasibility aspects based on the final assessment that has been conducted. The results of this study are in line with other research, who also developed Android-based Augmented Reality (AR) for modeling three-dimensional spatial structures, concluding that it is suitable for application in the learning of elementary school students [35]. After conducting a practicality test, the Augmented Reality (AR) Integrated with Kaliurang Culture was deemed practical for use during the learning process by students. The findings of this research support the results of similar studies, which developed Augmented Reality (AR) learning media for the introduction of spatial shapes at the elementary school level, concluding that it can be used in

the very good category during mathematics lessons [36]. Furthermore, the integration of local Kaliurang culture into Augmented Reality (AR) has also been successfully developed as an effective learning medium by the development of students. This supports related research that has integrated culture with other contexts, such as the Piring Dance with technology as a medium for mathematics learning, and it has been proven to be effectively used [37].

The product generated in this research, namely Augmented Reality (AR) integrated with the local culture of Kaliurang, faces several challenges, including the complexity of conceptualizing cultural values into digital form, as well as the need for teachers to have digital literacy skills. However, this product has pedagogical implications related to the ease of understanding abstract concepts such as spatial structures, socio-culturally capability as an effort to preserve local regional potential, and curricula aligned with the principles of contextual learning in the Merdeka Curriculum. There are limitations to this study, which lie in the relatively small sample size, the relatively short duration of implementation, and the potential bias of students when evaluating the learning media. In efforts to address these limitations, further studies are recommended to apply them to a larger sample, over a longer duration, and use more diverse assessment instruments to find the validity of the data. The potential of developing Augmented Reality (AR) integrated with the local culture of Kaliurang highlights the importance of conducting further testing to prove its impact on improving students' understanding or expanding subjects to cross-disciplinary collaboration.

The findings in this study have practical implications for implementing innovative mathematics learning using Augmented Reality (AR) media based on the local culture of Kaliurang. This media can encourage the understanding of abstract concepts to become more concrete and contextual with the use of technology that can aid visualization. Furthermore, the theoretical implications of this research contribute to the literature on the integration of technology and local wisdom of Kaliurang by cognitive development theory. Methodologically, this research contributes implications related to the application of the 4-D Research and Development (R&D) design as a valid design for developing innovative learning products with the integration of technology and the local culture of Kaliurang. This design demonstrates flexibility to meet needs and accurately test feasibility and practicality with structured and systematic procedural stages, making it replicable for similar research studies. From a policy perspective, these findings bridge the gap for education policymakers to develop contextual learning media based on technology that aligns with the Merdeka Curriculum. Its relevance to the SDGs (Sustainable Development Goals) is centered on the fourth goal, which discusses quality education. Therefore, the development of Augmented Reality (AR) learning media integrated with the local culture of Kaliurang is an effort to improve the quality and inclusivity of learning, especially in spatial mathematics, to meet the needs of 21st-century learners.

CONCLUSION

The feasibility assessment results in an average score of 3.93 or 98.43%, categorized as "Very Feasible" by subject matter experts, and an average score of 4 or 100%, categorized as "Very Feasible" by media experts. The practicality test received an average score of 3.6 or 90%, classified as "Very Practical" by the students. It was concluded that Augmented Reality (AR) integrated with the local culture of Kaliurang is well-suited as a learning medium for spatial

structures, utilizing technology in the classroom to bridge understanding by visualizing abstract concepts through the mastery of spatial abilities through the development of elementary school students. Theoretically, the development of this media can expand the discussion of technology-based contextual learning, practically provide learning media for students, and socially elevate local culture as a learning tool, thereby contributing to preservation efforts.

Recommendations that can be given to the school include providing adequate facilities to implement technology-based learning innovations, particularly the development of Augmented Reality (AR) media integrated with the local culture of Kailurang so that a contextual curriculum and digitalized learning can be applied. For teachers, there is a need to strengthen competencies in applying and using Augmented Reality (AR)-based media that align with the characteristics of students and the local cultural potential, so that learning becomes more interactive, tangible, and meaningful. Meanwhile, students are expected to take an active role while exploring Augmented Reality (AR) media integrated with the local culture of Kaliurang, which can serve to strengthen the understanding of concepts in spatial geometry mathematics, critical thinking skills, and 21st-century skills overall. As a recommendation for future research, it is necessary to test the effectiveness of Augmented Reality (AR) media using experimental or quasi-experimental methods on a large scale.

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CONFLICT OF INTEREST

"The authors declare no conflict of interest."

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