

Development of AR (Augmented Reality) Learning Media Based on Ethnotechnology to Enhance Kindergarten Students' Creativity

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Abstract - This study aimed to create and evaluate the efficacy of augmented reality-based learning materials guided by an ethnotechnological lens, hoping to spur more imaginative processes in kindergarteners. A research and development approach was taken using the ADDIE design model to analyze, conceptualize, develop, implement, and assess the product. Observations, expert questionnaires for validation, and trials with students and instructors provided insights. Analysis tested validity, practicality, and effectiveness. Findings revealed the materials satisfied criteria for appropriateness, feasibility, and impact in enhancing student imagination. Expert validation affirmed suitability, while pilot testing showed amplified participation and creativity during lessons. Incorporating an ethnotechnology-infused augmented reality curriculum holds promise as an innovative early childhood education tool. Further development should enlist broader involvement over longer periods to comprehensively gauge effects.

Keywords: ADDIE Model, Augmented Reality, Early Childhood Education, Ethnotechnology, Student Creativity

Additionally, children have time to play at home or gather with their families (Nurina Hakim & Rizky Yuwana Putra, 2018).

The goal of learning in kindergarten is to enhance children's creativity and encourage them to learn about various fields of knowledge through an approach that values character, religion, social, emotional, physical, motor, cognitive, language, art, and independence (Kismianti, 2017). National education policy has not yet indicated that the management of kindergartens is aligned with the management of elementary schools (SD), where all material and personal needs are met by the government (Depdiknas, 2001). The learning that has been conducted in kindergartens still uses educational play tools (APE), whereas the independent curriculum fully grants children the right to grow, develop, and receive appropriate educational services. (Kismianti, 2017; Khalikova et al., 2024).

I. INTRODUCTION

Early childhood sets the foundation for a child's future. From birth through age six, little ones undergo remarkable growth, both physically and cognitively. During these formative years, educational programs aim to foster development through hands-on, play-based learning experiences. Whether in preschool or kindergarten classrooms, children explore their world through songs, stories, crafts and creative play under the guidance of trained teachers. This is a concrete example of the first education that parents can provide to their children (Kemdikbud, 2003). Kindergarten (TK) is an educational institution organized to develop basic skills and foster holistic development in accordance with the principle of early and lifelong education (Nugraha et al., 2022). The regular kindergarten program has several advantages, such as the absence of diverse teaching methods, which allows children to absorb lessons more easily, preventing them from getting bored or tired when they come home from school.

Based on observations conducted at TK Widya Nugraha, there are several shortcomings of the APE media; it can only be used when the children are at school, whereas if the children want to learn at home, not all parents are able to provide it. In addition, the wooden block game, when viewed from a cleanliness perspective, is very lacking because after use, it is only placed without being sterilized for the next use. It is necessary to make breakthroughs and innovations to achieve better and higher quality learning at the kindergarten level. One of the recent developments in learning media that is still new is learning media using AR (Augmented Reality). Augmented Reality is an application that combines the real world with the virtual world in the form of two-dimensional or three-dimensional projections within a real environment simultaneously. Augmented Reality is often also referred to as anchored reality (Cahyaningtyas, 2020). In the development of Augmented Reality learning, ethnotechnology-based learning is required. Ethnotechnology (ethnotech) can be defined as the entirety of

tools possessed by a particular society or social group along with their usage methods, which are used to achieve goals or solve problems when facing specific situations and environments (Syarifudin, 2017).

Developing students' creativity in learning generically can be done by using various conditioning or creating an environment that triggers the development of thinking and creation abilities. Creativity in learning involves the development of skills that enable kindergarten students to create new knowledge, skills, and models (Nasution & Srikanthi, 2021). One of the learning media that can enhance the quality of education and students' creativity in learning is Augmented Reality-based learning media using ethnotechnology (Syarifudin, 2017). The purpose of using ethnotechnology as the basis for developing learning media is (1) to develop students' potential to become individuals with good behavior and cultural values, (2) to develop students' habits and behaviors in line with the values of local religious cultural traditions, (3) to develop students' abilities to become independent and creative individuals, (4) to instill a sense of leadership and responsibility in students as the next generation of the nation, (5) to develop the school environment as a learning environment full of creativity, (6) to provide local cultural stimuli so that children can later preserve and cultivate a love for their own culture (Anggreani & Satrio, 2021).

Developing the school life environment as a creative learning environment requires a holistic approach that involves various aspects, including physical, social, psychological, and pedagogical (Pan & Liu, 2021). Developing a creative learning environment requires commitment and cooperation between teachers, students, school staff, and parents. This approach recognizes that young minds develop at different paces. Educators must adapt lessons and activities to meet each student's evolving abilities and interests. As technology transforms the modern world, so too must teaching methods evolve. Innovative tools like augmented reality bring the classroom to life, sparking curiosity. By blending digital content with real-world objects, AR engages children in active, immersive learning. Studies show such innovative techniques boost understanding and motivate students to learn. With individualized support and cutting-edge methods, today's early education sets children up for future success in school and beyond (Wu et al., 2013).

Augmented reality learning based on local traditions offers a novel approach for integrating technology with cultural knowledge (Muhayat et al., 2017). This method utilizes 3D simulations to provide vivid renderings of indigenous concepts, making complex cultural ideas more intuitive for students to comprehend and explore with their imagination (Madanipour & Cohns, 2020). By incorporating ancestral wisdoms into interactive digital presentations, students gain a multi-sensory learning experience that deepens their connection to cultural roots in an engaging hands-on way (Retnowati, 2020).

Students' inventiveness greatly depends on their ability to relate academic theories to practical scenarios and devise innovative solutions (Runco & Jaeger, 2012). When augmented reality focuses on indigenous knowledge in educational media, it gives learners opportunities to both absorb comprehensive lessons and actively participate in self-directed cultural discovery (Billinghurst et al., 2015; Khodjaev et al., 2024). Through technology enabled experiences with their heritage, students can enhance digital proficiency while nurturing appreciation for community traditions an inspiration for generating new culturally-inspired works (Dunleavy et al., 2009). By fusing tech skills with cultural heritage preservation, this approach empowers students to learn in personally meaningful ways that foster original thinking (Retnowati, 2020).

Therefore, the progress of Enhanced Reality (AR) learning media with an ethnotechnology approach turns into extraordinarily critical within the international of schooling. This can reinforce scholars' wisdom of the instructing cloth and in addition encourage their creativity in connecting cutting-edge era with local tradition. It's hoped that programs of this media can provide a extra significant, innovative, and related learning revel in for college students in Indonesia.

II. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

a. Kindergarten Students

Kindergarten (TK) is an early childhood education (PAUD) level in the form of formal education that is available for children aged 6 years and under (Karimov et al., 2024; Anthony Sahaya Michael et al., 2018). The TK curriculum emphasizes providing educational stimulation to support the physical and spiritual growth and development of children so that they are prepared to enter further education. (Nugraha & Sudatha, 2022; Mitra & Shah, 2024). The duration of a student's study period in kindergarten usually depends on their level of intelligence, which is assessed through semester reports. Generally, to graduate from the kindergarten program level, it takes 2 (two) years, namely: TK 0 (zero) Small (small kindergarten) for 1 (one) year and TK 0 (zero) Large (large kindergarten) for 1 (one) year. (Anhusadar & Islamiyah, 2020). Based on the Decree of the Minister of Education and Culture of the Republic of Indonesia Number 0486/U/1992 Chapter I Article 2 Paragraph (1), it is stated that "Kindergarten Education is a means to assist the physical and spiritual growth and development of students in accordance with the natural characteristics of children." (Nurina S., & Rizky, 2018).

b. Ethnotechnology

Ethnotechnology is a technical instrument possessed by a certain society or ethnic community that is used as a supporting means to solve problems in a specific environment in order to meet primary and secondary needs to achieve certain goals passed down from generation to generation over a certain period (Syarifudin, 2017).

Ethnotechnology (ethnotech) can be defined as the entirety of tools possessed by a certain society or social group along with their usage methods, which are used to achieve goals or solve problems when facing specific situations and environments. (Suci, 2017).

c. *Augmented Reality*

Augmented reality is the concept of integrating the digital global into the real global. Augmented reality is an era that mixes 2D or 3D objects into a real surroundings after which projections the mixed gadgets in real-time (Hincapié et al., 2011). Augmented truth includes the usage of 2D or 3D items in a actual environment, which permits interaction in real-time. It combines items into three dimensions, which requires powerful communicate (Nugraha et al., 2022). Alternatively, augmented truth has the ability to enrich students' revel in and engagement via offering relevant digital content material overlaying on precise surroundings and empowering them to be curious learners. This media has huge capacity to customize learning in keeping with scholars' personnel interests and talents.

The integration of technology into education has the potential to enrich learners' experiences, lessen work-related anxiety, and boost their social standing (Madanipour & Cohrsen, 2020; Stefanov, 2018). Augmented reality's benefits for learning include: 1) Helping students comprehend challenging concepts in a more tangible and visible manner. For example, in science classes, AR technologies can display molecular models or the entire solar system in three-dimensional formats that may be rotated and explored directly (Dunleavy & Dede, 2014). 2) Creating a more engaging and interactive educational experience, which can heighten learners' motivation to study. According to an investigation performed by Radu (2014), it was discovered that pupils who employ AR during learning are more actively involved and retain information better compared to traditional methods. 3) Offering students the opportunity to conduct virtual experiments that are impossible to carry out in reality owing to limited resources or safety risks, like chemical reaction simulations or research on human anatomy (Wu et al., 2013). In contrast to memorization, technology allows for hands-on exploration and discovery.

d. *Student Creativity*

Creativity is a blossoming skill in students that requires fertile conditions to grow. By actively nurturing imagination, creative learning cultivates this innate ability. Such an approach awakens creativity within each learner, allowing their ideas to bloom. Developing students' creativity in learning means developing competencies that meet the ever-evolving standards of learning processes or products. Creativity in learning involves the development of skills that enable students to create new knowledge, skills, and models. Teachers should encourage creativity and inspire students to be creative in their own ways. (Nasution & Srikandi, 2021).

According to Runco & Jaeger (2015), creativity involves more than just creating new things; it also relates to the value held in specific situations. In preschool children, creativity is often seen through artistic activities, imaginative play, and unique ways of solving problems (Runco & Jaeger, 2015; Wirawan & Mahendra, 2024). In a study conducted by Wyse & Ferrari (2015), it was found that environments providing a lot of sensory stimulation, such as drawing tools, craft materials, and role-playing activities, are very helpful in enhancing children's creativity. Craft (2002) argues that some effective ways to encourage creativity among kindergarten children include giving them the freedom to explore ideas without fear of making mistakes, using open-ended questions to stimulate creative thinking, and facilitating cooperation among children to promote innovation and collaborative problem-solving.

III. RESEARCH DESIGN AND METHODS

The ADDIE model, with its stages of Analysis, Design, Development, Implementation, and Evaluation, was employed in this research for creating educational materials is illustrated in Figure 1. This systematic instructional design approach was chosen due its adaptability across different contexts and ability to structure the process of developing learning media. Chiefly, each successive step can be assessed before moving forward, ensuring improvements are made along the way. ADDIE offers an organized roadmap for building educational products (Branch & Varank, 2009).

Compared to other instructional design models like Dick and Carey or Borg and Gall's, ADDIE is especially well-suited for technology-based instruction given its flexibility. Educators and designers can tailor learning tools to suit audiences and available tech. What's more, continuous refinement is built into the process through evaluation at every phase (Reiser & Dempsey, 2018). This iterative refinement before wide deployment enhances how students learn. ADDIE has also been widely applied in designing e-learning and digital instructional tools given that it provides a framework for crafting more engaging interactive experiences (Hodell, 2016). With ADDIE, learning resources aligning with different learning styles can be custom-built, strengthening student engagement in their education (Morrison et al., 2019).

The design phase of the ADDIE model, taking into account the cycle of each stage, calls for thoughtful consideration of learner needs, curriculum objectives, and student characteristics (Branch, 2010):

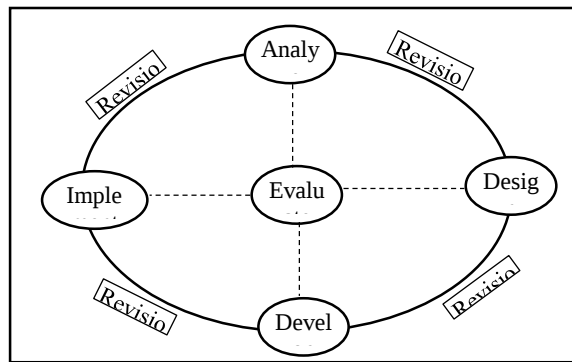


Fig 1. Desain Phase ADDIE Model

- A multifaceted analysis was conducted to thoroughly understand all relevant aspects.
- Design (Perancangan). Design begins with the identification of learning objectives, followed by the analysis of content and pedagogical knowledge, identification of potential technology use, integration of knowledge, and the design of learning experiences. Collecting references used in developing materials for learning media. Determining the draft characteristics of learning media, learning characteristics, and learning principles.
- Development (Pengembangan). The development stage is the stage of product realization. At this stage, the development of learning media is carried out according to draft 1. The product is named prototype-1.
- Implementation. The implementation was carried out three times: (1) Limited trial. This trial involved 6 students and teachers at Widya Nugraha Kindergarten. The revised result of this activity is called prototype 2. (2) Field trial 1. This trial involved 30 students and teachers at Widya Nugraha Kindergarten, and the revised result of this activity is called prototype 3. (3) Field trial 2. This trial involved 30 students and teachers at Widya Nugraha Kindergarten. The results were used to revise prototype 3, and the revised result of this activity is called the final product.
- Evaluation. Formative evaluation is conducted at every phase.

- Subject research at Widya Nugraha Kindergarten in the 2023/2024 academic year. This research was conducted at Widya Nugraha Kindergarten. The product produced in this research is an AR (Augmented Reality) learning media based on ethnotechnology. The quality of the learning media in this study is viewed from three aspects: validity, usability, and effectiveness.

The validity data analysis includes the analysis of expert validation questionnaire data, teacher responses, and student response questionnaires during limited trials. Content and construct validity of the product are obtained from experts through expert testing/validation. Analysis of student perception questionnaire data after the use of AR (Augmented Reality) based on ethnotechnology in the learning process is conducted through effectiveness analysis, including: 1) Test instrument reliability analysis technique and 2) Student creativity data analysis technique (Sugiyono, 2019).

IV. RESULTS

a. Analysis Stage (Analysis)

The needs analysis for students was conducted using a questionnaire that included the learning resources preferred by the students. As many as 71.25% of students preferred learning resources related to the ethnotechnology they chose, and 80.65% preferred learning using Augmented Reality media over textbooks. Curriculum analysis is conducted by considering the characteristics of the curriculum currently used in the school. This is done to ensure that the development carried out aligns with the requirements of the applicable curriculum. Augmented reality possesses immense potential to revolutionize education by bringing lessons to life in an interactive, immersive manner. The interface depicted a traditional Balinese cultural setting where an instructor engrossed students with an explanation enhanced by technology. Options like "Learning Objectives," "Download Marker," and "Play" hinted at an engaging experience integrating digital and cultural learning to both preserve traditions and spark creativity and comprehension in young minds. Such innovative approaches make the acquisition of knowledge a more exciting and meaningful endeavor for students.



Fig. 2 The Initial AR Interface Offers Interactive Cultural Learning

The Figure 2 presents an Augmented Reality (AR) application for educational purposes. A design inspired by local culture includes buttons like "Objectives," "Download Marker," and "Play" for engagement. This visually appealing

interface merges traditional elements with modern technology, offering an immersive learning experience that enhances students' understanding through digital interaction and visualization (Figure 3).

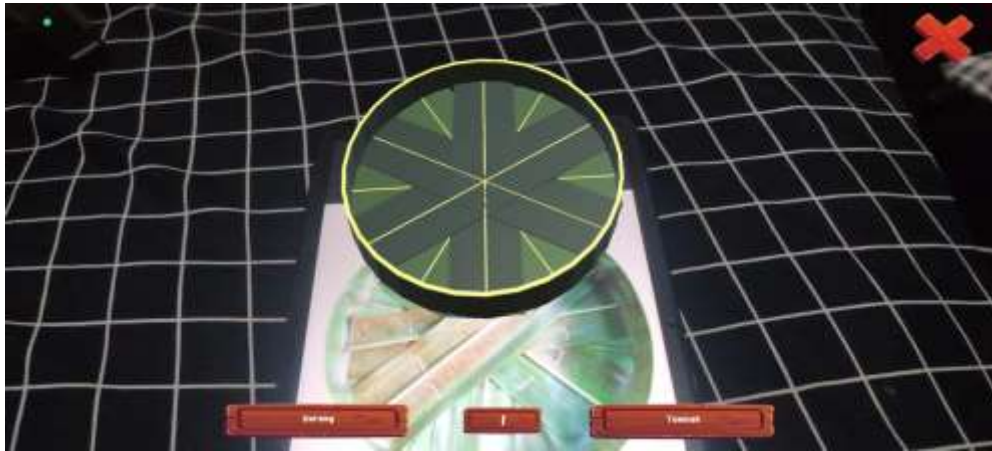


Fig. 3 Shows a Tamiang-Shaped Circle Count

Then the researcher examines the KD to apply the indicators of learning achievement. This analysis is conducted to observe students' attitudes towards learning. Based on the observations conducted, it was found that students with higher abilities are indifferent towards students with lower abilities, and vice versa, students with lower abilities are reluctant to discuss with students who have higher abilities. Only a portion of the students are willing to be active during the learning process, and even then, they are dominated by students with high intelligence. Based on the facts observed in the field, it is concluded that the creativity learning of kindergarten students only consists of a collection of general student creativity, minimal activities in learning, and a lack of focus on the teaching materials needed to support the students' skill competencies.

Based on the analysis results, an average score of 0.85 was obtained, indicating that the assessment of Augmented Reality learning media by subject matter experts falls within the score range of > 0.7 . According to the established guidelines, the developed Augmented Reality learning media is considered valid by subject matter experts. The average validation result from learning media experts is 0.82, indicating that the assessment of Augmented Reality learning media by media experts falls within the score range of > 0.7 according to the Guilford guidelines, thus the developed Augmented Reality learning media is considered valid by media experts.

b. Design Stage

The characteristics of the Augmented Reality-based ethnotechnology learning media developed are (1) Images, example questions, and discussion materials appropriate to the abilities of kindergarten students; (2) Sound can be turned off if it is disturbing; (3) Evaluations and skill checks can be done online or offline; (4) Requiring students to discuss both

online and offline before doing literacy exercises; (5) Answers and literacy exercises in the form of videos.

The characteristics of learning using Augmented Reality media based on ethnotechnology are (1) Guiding students to start learning from ethnotechnology-based problems related to kindergarten students' abilities at the beginning of the lesson; (2) Guiding students to develop vertical instruments (Charts, Models, Schemes) that are discussed in groups; (3) Guiding students to use their own work and construct it; (4) The presence of activities that can create interactivity both online and offline. Meanwhile, the principles of AR (augmented reality) learning media based on ethnotechnology are (1) containing creativity that guides students to rediscover with progressive guidance (guided reinvention and progressive mathematizing) done in groups; (2) containing didactical phenomena (Didactical Phenomenology); (3) involving activities that stimulate students to develop their own models. (Self-Developed Models).

c. Development Stage

Evaluation of prototype-1 using LORI (Learning Object Review Instrument). The results of the analysis of the subject matter expert assessment instrument based on LORI obtained an average score of 4.35, which falls within the range of $4.20 \leq \bar{X} \leq 5.00$, indicating that the developed AR learning media is very suitable for use in education. The results of the media expert assessment instrument based on LORI obtained an average score of 4.05, which falls within the range of $3.40 \leq \bar{X} \leq 4.20$, indicating that the developed Augmented Reality learning media based on ethnotechnology to enhance creativity is suitable for use in kindergarten student education.

d. Implementation Stage

The fourth stage is implementation, where there are limited trials and wide field trials.

1) Limited Trial

This trial involved 6 Widya Nugraha kindergarten (TK) students. The results of the evaluation of etnoteknologi-based

Augmented Reality learning media on a limited trial based on *User Experience* Questionnaire (UEQ) obtained an average of 81.25 in the range of $75\% < X \leq 90\%$ with good criteria. The results of the *System Usability Scale* evaluation obtained an average of 88.05 were accepted and were in the very good range.

TABLE I RESULTS OF STUDENT RESPONSE QUESTIONNAIRE AND TEACHER RESPONSE

Aspects	Average Student Response	Average Teacher Response
View	0,74	0,76
Presentation of Material	0,75	0,79
Benefits	0,76	0,73
Total Average	0,75	0,76

The average evaluation results of ethnotechnology-based *Augmented Reality* learning media based on student response questionnaires are 0.75 and teacher response questionnaires are 0.76. The score is converted according to the guidelines set so that the average student response questionnaire is in the range of $0,60 < \bar{X} \leq 0,80$. This shows that *Augmented Reality* learning media applied in limited trials is classified as good and useful in learning.

This trial involved 30 kindergarten students and teachers at TK. Widya Nugraha. The focus of this trial was to improve product quality. Field trial 1 based on the *User Experience Questionnaire* (UEQ) obtained an average of 80.25 in the range of $75\% < X \leq 90\%$ with good criteria. The *System Usability Scale* evaluation results obtained an average of 88.05 were accepted and were in the very good range. The ethnotechnology-based AR (augmented reality) learning media developed is useful in learning.

2) Field Trial 1.

TABLE II RESULTS OF STUDENT RESPONSE QUESTIONNAIRE AND TEACHER RESPONSE

Aspects	Average Student Response	Average Teacher Response
View	0,85	0,86
Presentation of Material	0,86	0,87
Benefits	0,84	0,85
Total Average	0,85	0,86

The average evaluation results of ethnotechnology-based *Augmented Reality* learning media based on student response questionnaire is 0.85 teacher response is 0.86. The score is converted in accordance with the assessment aspects set so that the average student response questionnaire is in the range

of $\bar{X} > 0,80$. This shows that the ethnotechnology-based *Augmented Reality* learning media applied in field trial 1 is classified as very good and useful in learning.

TABLE III RECAPITULATION OF STUDENT CREATIVITY IMPROVEMENT TEST IN FIELD TEST 1 AND 2

Acquisition	Results on Test 1	Results on Test 2
Number of students who completed	27	26
Number of students who did not complete	3	2
Percentage of classical completeness	90%	92,9%

Field trial 2 involved 28 students, only 2 of whom did not meet the criteria. The reason they did not complete the test was that they were not physically fit. The percentage of classical completeness of 92.9% is in the range of $p > 80$ with a classification of Very Good. Based on the conversion table according to the guidelines set, the *Augmented Reality* learning media applied in field trial 2 is effectively used in learning, so that student scores become complete.

e. Field Trial 2

Field trial 2 based on the *User Experience Questionnaire* (UEQ) obtained an average of 88.5% in the range of $75\% < X \leq 90\%$ with good criteria.

TABLE IV RESULTS OF STUDENT RESPONSE QUESTIONNAIRE AND TEACHER RESPONSE

Aspects	Average Student Response	Average Teacher Response
View	0,92	0,91
Presentation of Material	0,88	0,90
Benefits	0,91	0,94
Total Average	0,90	0,92

The average evaluation results of etnoteklogi-based *Augmented Reality* learning media based on student response questionnaire is 0.90 and teacher response questionnaire is 0.92. The score is converted in accordance with the assessment aspects set so that the average student response questionnaire is in the range of $\bar{X} > 0,80$. This shows that the ethnotechnology-based *Augmented Reality* learning media applied in field trial 2 is classified as very good.

f. Evaluation Stage

Six students involved in the limited trial only 2 did not meet the criteria. The percentage of classical completeness of 66.67% is in the range of $60 \leq p < 80$ with a good classification. Based on the conversion table that has been determined, the *Augmented Reality* learning media applied in the limited trial is effectively used in learning, so that student scores become complete. Observation assessment of the character of cooperation during learning reached 66.67%, of the 10 indicators met 8 indicators, while 2 indicators have not been met yaitu: Able to do problem mapping and Able to perceive a problem. The cause of 2 unmet indicators is the lack of student readiness in using ethnotechnology-based *Augmented Reality* learning media.

Field trial 1 involved 30 students, only 3 of whom did not meet the criteria. The percentage of classical completeness of 90% is in the range of $p > 80$ with a very good classification. Based on the conversion table that has been determined, the ethnotechnology-based *Augmented Reality* learning media applied in field trial 1 is effectively used in learning, so that student scores become complete.

Field trial 2 involved 28 students, only 2 of whom did not meet the criteria. The percentage of classical completeness of 92.8% is in the range of $p > 80$ with a very good classification. Based on the conversion table that has been determined, the ethnotechnology-based *Augmented Reality* learning media applied in field trial 2 is effectively used in learning, so that student scores become complete.

V. DISCUSSION

Learning can run well and successfully because it is supported by the availability of the required learning components. One of these learning components is the *Augmented Reality* learning media used by teachers. Media is a tool in the form of a physical form that is usually used when delivering material content. Leslie J. Briggs also said that the tools in question, such as tape recorders, video recorders, pictures, cameras, television, graphics, and computers. With the media, everyone will be easier in carrying out daily activities. The development of *Augmented Reality* learning media is a series of processes or activities carried out to produce an *Augmented Reality* learning media following the existing development theory.

Based on the above explanation, it is clear that this research has successfully developed ethnotechnology-based *Augmented Reality* learning media for kindergarten students.

The characteristics of ethnotechnology-based *Augmented Reality* learning media developed are: (1) Images, creativity and discussion materials in accordance with the ethnotechnology of kindergarten students; (2) The sound can be turned off if it feels disturbed; (3) Evaluation and ability checks can be done online or offline; (4) Requiring students to discuss both online and offline before doing literacy exercises; (5) answers and literacy exercises in the form of learning videos.

The ethnotechnology-based *Augmented Reality* learning media developed has the characteristics of (1) Directing students to start learning from ethnotechnology problems related to creativity in kindergarten students at the beginning of learning; (2) Directing students to develop vertical instruments (Charts, Models, Schemes) which are discussed in groups; (3) Directing students to use the results of student work and construct them; (4) The existence of creativity material in students who need discussions that can cause interactivity in the network and outside the network. While the principles of ethnotechnology-based *Augmented Reality* learning media are (1) Containing creativity that directs students to *reinvent* with guidance and *progressive motivation (guided reinvention and progressive mathematizing)* which is done in groups; (2) Containing *didactical phenomena (Didactical Phenomenology)*; (3) There are questions that stimulate students to be able to develop their own models (*Self Developed Models*).

This finding is supported by previous research, including: 1) The importance of early childhood education teacher candidates being provided with technological knowledge so they can integrate it into the classroom learning process (Alelaimat et al., 2020; Mahendra, Parmithi, & Jayantika, 2022). Learning center activities can serve as an approach for kindergarten teachers to incorporate other emerging educational technologies in the future; 3) The learning processes and outcomes of students show significant differences where the use of learning media is highly recommended to enhance the quality of learning (Pan et al., 2021); 4) The development of *Augmented Reality*-based flashcard media for introducing animals that live in wetlands has met the criteria of validity and practicality for use in early childhood education (Anggreani & Satrio, 2021).

In addition to the aspect of knowledge, the *Augmented Reality* learning media based on ethnotechnology developed in this research directs students to engage in discussions, thereby fostering a spirit of cooperation during the learning process. During the discussion, students showed attitudes and behaviors that valued cooperation in solving problems together, by establishing communication and friendship, providing help and assistance to other friends in need, and making decisions together through consensus. Field trial 2 yielded additional findings, including: (1) Students do not feel awkward asking the teacher questions when there are unresolved issues; (2) Students are brave enough to express their opinions according to their abilities; (3) More intelligent students voluntarily and sincerely guide their less capable

peers; and (4) The learning atmosphere appears enjoyable for kindergarten students.

AR (augmented reality) learning media based on ethnotechnology in this study is said to meet the usability aspect due to the positive responses from students and teachers during the trial. Based on the observation results, it appears that students and teachers did not encounter significant obstacles during the learning process. Students feel satisfied studying the material on student creativity due to several reasons, namely: (1) Literacy material is closely related to the creativity chosen by students; (2) AR (augmented reality) learning media based on ethnotechnology can be used both online and offline without having to carry textbooks everywhere; (3) Discussion materials are available that allow students to explore the knowledge they possess in groups, thereby enhancing their character in terms of cooperation; (4) There are answers and literacy exercises in the form of learning videos, which allows students to learn independently anywhere and anytime; (5) creativity available both online and offline, allowing students to freely choose according to their learning comfort and to work on it repeatedly until they find the right method.

Some kindergarten students stated that the AR (augmented reality) learning media based on ethnotechnology that was developed greatly helped them learn independently and in groups. This is evident from the questionnaire results given to students at the end of each trial, where the average response from students indicated that the developed Augmented Reality learning media is good for use in learning. In addition, from the comments given by students on the questionnaire distributed at the end of the trial, most were suggestions for improving the Augmented Reality-based ethnotechnology learning media to make it better. This is evident from the survey results given to teachers at the end of each trial, where on average, the teachers stated that the developed Augmented Reality-based ethnotechnology learning media was very good and easy to use in teaching. The third criterion of the Augmented Reality learning media based on ethnotechnology developed in this study is effectiveness. Effective has four indicators, namely: learning quality, learning relevance, incentives, and time. The quality of learning is the result of the Augmented Reality learning media itself. The level of learning suitability involves the teacher's ability to ensure the students' readiness to learn new material. Incentives are indicators to see how much effort the teacher puts in, so they feel confident that their students are motivated to complete learning tasks.

Through research results, it has been proven that the use of Augmented Reality (AR) learning media based on ethnotechnology is effective in enhancing the creativity of children in kindergarten. This research presents an advantage by integrating local wisdom into the learning process. Syarifudin (2017) emphasizes that ethnotechnology can help children understand academic concepts with an approach that is closer to their culture, which in turn can enhance students'

motivation and participation in the learning process. Therefore, the learning media produced from this research not only introduces modern technology but also preserves local cultural values, which are rarely found in other studies. In addition, this study adds a new dimension to the effectiveness of AR by highlighting social elements through group discussions both online and offline. This supports the findings of Pan et al. (2021), which state that collaboration in AR-based learning can enhance children's social skills.

Further development is still required, as not all can readily access AR. Mustaqim (2017) noted integration in early education faces barriers like uneven technology availability. The next step involves creating adaptable media accessible through varied devices to optimize learning impact.

Overall, this research contributes more comprehensively than prior work merging AR and cultural knowledge for early education. Its main strength lies in the culturally-focused approach allowing students to learn in personally meaningful ways connected to their lives, while creative thinking is also stimulated during the learning process.

VI. CONCLUSION

The innovative application of Augmented Reality learning tools founded upon local ethnic customs has proven remarkably adept at cultivating ingenuity in our youngest pupils. The media conceived amplifies student participation in scholarly undertakings while furnishing a richer interactive environment relative to conventional pedagogies. By weaving Augmented Reality into the fabric of indigenous sociocultural motifs, young minds can grasp intrinsic folk wisdoms in a profoundly poignant fashion, thereby reaping dual benefits - a more nuanced comprehension and nurturing an affection for their own heritage. This investigation attests that employing Augmented Reality technologies in early edification can heighten the quality of erudition by generating a more energetic ambience and encouraging inquiry. Challenges in actualizing Augmented Reality encompass restricted access to advanced devices and requisite preparation for educators to maximize the application of Augmented Reality in instruction.

This research contributes to two important areas, namely innovation in the field of technology-based learning media and cultural preservation through the use of ethnotechnology. For the future, further development is needed so that this Augmented Reality (AR) learning media can be more widely accessible and optimally used in various educational environments. The practical implications of this research are:

- a) Application in Schools: This learning media can be utilized by teachers to encourage student creativity in an innovative manner and based on local culture.
- b) Curriculum Development: The findings from this research can serve as a foundation for developing early childhood education curricula that focus on technology while still incorporating local cultural values.

- c) Improvement of Teacher Competence: Training for educators is needed so that they can maximize the use of AR during the learning process.
- d) Development of AR-Based Technology: This research opens up opportunities to develop more flexible and accessible learning media through various devices.
- e) Policy Support: The government and relevant stakeholders in education can consider the results of this research to formulate policies that encourage the integration of technology related to culture in early childhood education.

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