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Augmented Reality as an Innovative Tool for Digitizing North Sumatran Folklore: Enhancing Educational Tourism Media Literacy for Children With Special Needs in Indonesia

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***Abstract*—This research develops a digital product based on North Sumatra folklore, utilizing Augmented Reality (AR) as an educational tourism literacy tool for children with special needs in Indonesia. Using the Research and Development (R&D) method, the study involved 30 students from Sekolah Luar Biasa (SLB) TPI Medan, comprising autistic, deaf, and disabled children aged 9–13. Findings show that digitizing folklore with AR is highly effective, receiving an average positive response of 87.4% in clarity, presentation, language, and appeal. Over 90% of respondents found the product beneficial to understanding North Sumatra's ethnic diversity, cultural heritage, and tourism. The interactive AR-based approach significantly enhanced students' learning experiences.**

***Index Terms*—Augmented Reality, North Sumatran folktales, children with special needs, educational tourism, digitizing**

I. Introduction

In the digital age, media literacy is important for all, including children with special needs. Media literacy includes understanding and utilizing digital information, especially those related to culture and education. Children with autism spectrum disorder (ASD), dyslexia, or other developmental challenges often struggle to access information through traditional methods. They need adaptive, interactive, and visual-based approaches to be more engaged and understand the material being taught (Darvishi et al., 2022; Zavaraki & Schneider, 2019).

Folklore in North Sumatra has great potential as educational content for media literacy, as it contains cultural values, history, and local wisdom (Farisi et al., 2024; Courtney, 2021). However, many folktales are only documented in texts or oral narratives, which are difficult for children with special needs to access. Without innovation, folklore risks losing its relevance in modern education, especially in the context of inclusivity (Zhetpisbayeva et al., 2024; Riastini et al., 2020).

In recent years, Augmented Reality (AR) has been rapidly growing as a multisensory learning technology. AR transforms static stories into interactive experiences that are more engaging and easily understood by children with special needs (Karunanayaka et al., 2021). With visual, audio, and digital interaction elements, AR helps children absorb information intuitively and enriches experiential learning (Yang & Wang, 2023). This approach is particularly beneficial to children with special needs who require varied sensory input to support learning (Heller et al., 2019).

North Sumatra has eight ethnic groups with folklore that reflects local culture and wisdom and has the potential to become a tourist attraction. If developed properly, these folktales can be an interesting tourist education tool (Nasution, 2018; Sihite et al., 2024). Unfortunately, educational tourism media that is inclusive of children with special needs (ABK) is still limited, contrary to the inclusivity policy promoted by the Indonesian government (Su et al., 2018). Children with special needs experience significant barriers to growth, including intellectual, sensory, motor, physical, social, communication, and learning aspects. Therefore, they require special education that is tailored to their needs (Qandhi & Kurniawati, 2019). In addition, parents of children with disabilities face greater challenges and fatigue than other parents and require additional support in their care (Laçin & Doğan, 2024).

The unique diversity of children with special needs should not hinder their equal access to education and tourism. Inclusive education, which integrates them into regular learning environments, is a key approach. This system requires significant adjustments in curriculum, facilities, teaching methods, and evaluation to meet diverse student needs (Ionescu & Vrăsmaș, 2023; Yada & Savolainen, 2017). Additionally, professional development in inclusive practices enhances teachers' confidence and competence, leading to better educational outcomes for these children (Holmqvist & Lelinge, 2021; Strakšienė & Musneckienė, 2024). By adapting teaching methods, facilities, and support systems, educators can create an environment that not only accommodates but also celebrates diversity, fostering a more equitable education system.

Educational tourism can benefit children with special needs by promoting inclusive digital media. One innovative approach is digitizing North Sumatra folklore with Augmented Reality (AR) to enhance accessibility and cultural preservation. AR integrates virtual objects into the real world, creating an engaging learning experience. Digital storytelling helps children with special needs better understand cultural narratives while increasing their engagement (Gretzel et al., 2015; Widhiyanti & Gunanto, 2021). This initiative also supports tourism digitization by making cultural exploration more immersive and inclusive, strengthening cultural appreciation, and enriching educational tourism (Destiana & Kismartini, 2020; El Archi et al., 2023).

This study advances technology, education, and cultural preservation by exploring Augmented Reality (AR) to bring North Sumatran folklore to life, enhancing educational tourism and media literacy for children with special needs. AR's role in digital tourism and education has been widely recognized for creating immersive learning experiences, especially for children with disabilities (Nuenen & Scarles, 2021). The tourism sector also embraces digital transformation to improve visitor experiences and sustainability (Kalia et al., 2022). AR makes folklore more interactive, supporting cultural preservation and inclusivity in educational tourism (Cheng et al., 2023).

This research introduces Augmented Reality (AR) to digitize North Sumatra folklore, making cultural preservation more inclusive, especially for children with special needs. AR modernizes storytelling, keeping the younger generation connected to local heritage (Borysova et al., 2022). It also enhances learning for children with disabilities through engaging in multisensory interactions, improving comprehension and retention (Shumilova et al., 2022). Beyond education, this study bridges educational tourism and media literacy, fostering cultural awareness and critical thinking. By integrating folklore studies, educational technology, and digital tourism, it highlights AR's role in accessibility, cultural preservation, and inclusive learning (Happ & Bolla, 2022).

This study advances digital tourism and educational technology by introducing an inclusive, AR-based model for cultural preservation. AR enhances engagement, accessibility, and media literacy for children with disabilities, fostering a deeper appreciation of local heritage. It integrates natural and cultural elements into folktales, making them more appealing as educational tourism media. To support accessibility, sign language video features are included. The study will evaluate AR's effectiveness in improving children's understanding of North Sumatra's cultural tourism. Given its focus on inclusivity, this research is crucial in providing tailored educational tourism media for children with special needs.

II. Literature Review

A. Augmented Reality in Educational Tourism

Augmented Reality (AR) enhances perception by overlaying digital elements onto the real world, creating interactive experiences that enrich cultural and historical understanding (Abdul-Jabbar & Alwehab, 2023). In educational tourism, AR facilitates experiential learning by enabling direct interaction with heritage sites and folklore, making cultural content more engaging and accessible (Judijanto & Salim, 2024). AR also supports inclusivity by providing multisensory experiences tailored to children with special needs, fostering engagement and critical thinking (Keckes & Tomicic, 2017). Additionally, it ensures the preservation and transmission of local traditions to future generations. By integrating digital storytelling in real-time, AR enhances educational tourism, making folklore more immersive while catering to diverse learning needs.

B. Folklore Digitization and Preservation

Digitizing folklore is essential for preserving cultural identity in a globalized world, ensuring traditional narratives remain accessible and relevant (Hidayat et al., 2019). By converting oral traditions into digital formats, communities can safeguard their values and history while expanding engagement through interactive platforms (Friatin, 2023; Nijdam, 2023). Integrating technologies like Augmented Reality (AR) enhances folktale learning, particularly for children with special needs, fostering deeper cultural connections (Zhetpisbayeva et al., 2024). Digital storytelling not only preserves heritage but also promotes intercultural understanding, making folklore globally accessible (Asamoah-Poku, 2024). Additionally, folktales contribute to education by developing critical thinking and media literacy (Friatin, 2023). Thus, folklore digitization strengthens cultural identity, enhances accessibility, and enriches learning through interactive and inclusive storytelling.

C. Media Literacy and Special Needs Education

Media literacy is essential in modern education, fostering critical thinking and helping students analyze, evaluate, and create media (Kharchenko et al., 2024). It enables students to identify credible sources, understand media influence, and engage in informed discussions. For children with special needs, media literacy supports better comprehension and independence in navigating media, promoting inclusivity and participation (Levitskaya, 2015). Augmented Reality (AR) enhances learning by providing interactive and multisensory experiences, particularly for students with special needs. It helps make abstract concepts more tangible and supports students with memory or abstract thinking challenges (Alqarni, 2021; Baragash et al., 2020). Combining AR with media literacy fosters critical thinking and ensures broader educational accessibility.

III. Methodology

This study employs the Research and Development (R&D) methodology. The research and development (R&D) methodology is employed to create specific goods and evaluate their efficacy (Sugiyono, 2015).

A. Population and Sample

The study population consisted of children with special needs in the categories of autism, deafness, and disability aged between 9 and 13 years. The research sample was selected from students at Sekolah Luar Biasa (SLB) TPI Medan with a total of 30 children, consisting of 14 autistic children, 12 deaf children, and 4 children with disabilities. The sample selection was based on intensive communication with teachers and supervisors of children with special needs at the school. The selection criteria included mild to moderate levels of special needs and the ability to interact with AR-based media. The selection of these three categories of children with special needs is based on the characteristics of research products that combine visual, audio, and animation elements, so children with special needs can still access them.

B. Data Collection

The research team identified and documented folklore resources for educational tourism across eight ethnic groups in North Sumatra, Indonesia. Field studies were conducted in key regions, including Langkat (Malay), Samosir (Toba), Simalungun (Simalungun), Mandailing Natal (Mandailing), South Tapanuli (Angkola), Pakpak Bharat (Pakpak), Karo (Karo), and South Nias (Nias). Each site was selected based on its cultural significance and local folklore. Research on the Malay ethnicity took place in Bukit Kubu Village, Langkat Regency, focusing on Datok Besitang: Subuh Maut di Bukit Kubu. In Tomok Village, Samosir Regency, the team documented the Toba folktale Sigale-gale. The Simalungun story Asal Mula Simalungun was explored in Pematang Tanah Jawa Village, Simalungun Regency. Research on Mandailing folklore, Sampuraga, was conducted in Sirambas Village, Mandailing Natal Regency, while the Angkola tale Danau Si Losung and Sipinggan was studied in Pargaulan Village, Humbahas Regency. Further, the Pakpak legend Legenda Terjadinya Air Terjun Sampuren Mbilulu was recorded in Prongil Village, West Pakpak District. In Kutagugung Village, Karo Regency, the team examined the Karo folklore Danau Lawu Kawar. Lastly, research on Nias folklore took place in Bawumataluo Village, South Nias Regency, focusing on Hombu Batu. This documentation effort aimed to integrate local folklore into educational tourism through digital storytelling and Augmented Reality (AR) technology.

C. AR-Based Folklore Digitization Product Development

This study developed an Augmented Reality (AR)-assisted digitalization of North Sumatran folklore as an educational tourism tool for children with special needs. The research followed seven stages: needs analysis, resource identification, product specification, development, validation, testing, and finalization. The needs analysis assessed the educational and tourism needs of children with special needs while gathering folklore from eight North Sumatran ethnic groups. Resource identification involved field visits to Langkat, Samosir, Simalungun, Mandailing Natal, South Tapanuli, West Pakpak, Karo, and South Nias to document folklore and identify key human resources, including sign language experts and student participants. Novi Syafitri, an assistant educator at SLB TPI Medan, contributed to sign language video recordings. The next phase focused on defining product specifications tailored to special needs students before developing AR-based storytelling media. Validation was conducted with experts, including Mrs. Suri Handayani Damanik, S.Psi, M.Psi (material expert) and Drs. Mesra, M.Sn (media design expert), ensuring content accuracy and usability. Product testing at SLB TPI Medan assessed its effectiveness and suitability for special needs education. The final stage involved usability testing in Medan City, where children interacted with the product through interviews and questionnaires to measure its impact. The finalized AR-assisted folklore digitalization is now ready for implementation, offering an interactive learning tool that enhances cultural and tourism literacy among special needs students.

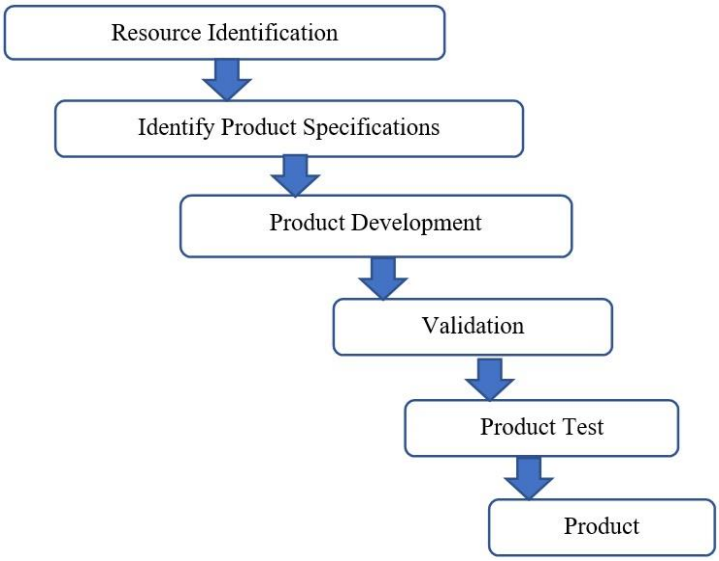


Figure 1. Stages of Research Procedure

IV. Result

A. Product Development

The product development process initiates with a validation stage, wherein experts assess the feasibility of the material, presentation, and language employed. The validation process for folklore materials assesses several aspects, including content feasibility, language appropriateness, and presentation quality. The purpose of this validation is to confirm that the created folklore materials are suitable as a literacy resource in educational materials or as media for children with special needs. The validation process occurred in two stages, with results displayed in the table below.

Table 1
Validation by Material Experts

Variable	Percentage	Category
Content feasibility	86 %	Valid
Language feasibility	87 %	Valid
Feasibility of presentation	88 %	Valid
Average	87 %	Valid

According to the data in Table 1, the mean validation score from material experts is 87%, categorizing it as valid. The "valid" category signifies that the generated item complies with eligibility criteria and is suitable for use as a literacy resource in instructional materials or media for children with special needs. The validation findings demonstrate that experts have deemed the content, language, and presentation characteristics to be suitable. The content feasibility scored 86%, language feasibility 87%, and presentation feasibility 88%, all classified inside the legitimate category. This verifies that the created materials have satisfied the established requirements and are prepared for implementation in the learning process.

Upon completion of the material validation procedure, the subsequent phase entails validation by media specialists. This validation seeks to assess the visual and technical elements of the created educational materials. The variables evaluated in media validation encompass size, design, illustration choices, and content design. The outcomes of the media expert validation are displayed in the subsequent table.

Table 2
Validation by Media Experts

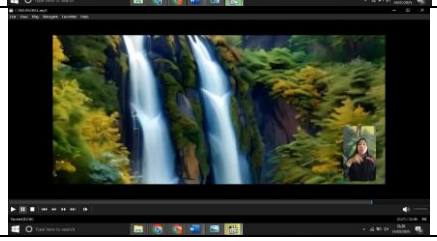
Variable	Percentage	Category
Size	86 %	Valid
Design	87 %	Valid
Illustration	86 %	Valid
Content design	87 %	Valid
Average	86,5 %	Valid

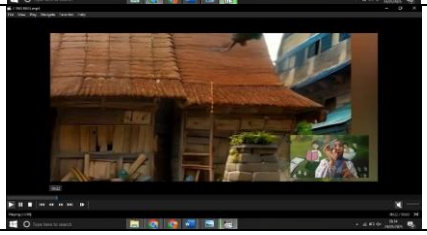
Based on the product validation test data in Table 2, the average validation value of each category is 86.5%, which is included in the valid category. The "valid" category indicates that the visual and technical aspects of the teaching materials developed have met the established eligibility standards. The results of this validation indicate that the size, design, selection of illustrations, and design of the material content have been assessed as feasible by media experts and

can be used in the learning process. Specifically, the size aspect scored 86%, the design of teaching materials 87%, the selection of illustrations 86%, and the design of the material content 87%, all of which were in the valid category. Thus, the teaching materials developed are considered to meet visual and technical criteria that are suitable for the needs of children with special needs.

The following is a table of product images that represent the diversity of folklore from 8 ethnicities found in North Sumatra. These images aim to show the cultural diversity, traditional clothing, and characteristics of each ethnicity that is part of the teaching materials. Based on the results of validation by experts, it shows that the teaching materials in Table 3 below have met the criteria of "valid" and are suitable for use as learning media for children with special needs.

TABLE 3
AUGMENTED REALITY PRODUCT IMAGES REPRESENTING EIGHT ETHNIC GROUPS OF NORTH SUMATRA

No	Ethnicity	Description	AR images
1.	Melayu	The folktale is titled “Datok Besitang: Subuh Maut di Bukit Kubu”	
2.	Batak Toba	A folktale entitled “Sigale-gale”	
3.	Simalungun	A folktale entitled “Asal Mula Simalungun”	
4.	Mandailing	A folktale entitled “Sampuraga”	
5.	Angkola	A folktale entitled “Danau Si Losung dan Sipinggan”	
6.	Phakpak	A folktale entitled“Legenda Terjadinya Air Terjun Sampuren Mbilulu”	

7.	Karo	A folktale entitled “Danau Lawu Kawar”	
8.	Nias	A folktale entitled “Hombu Batu”.	

B. Product Usefulness Test

The concluding phase of development research involves product testing. This phase involves disseminating the product to schoolchildren, specifically youngsters with special needs. The evaluation of learners' responses to the digitization of folklore is assessed by measures of conceptual clarity, exemplification, presentation quality, language usage, and aesthetic appeal. The analysis of student responses to the digitization of folklore indicates that each criterion is satisfied. Table 4 displays the mean learner response for each evaluation criterion.

TABLE 4
RESULTS OF LEARNER RESPONSE ASSESSMENT

No	Aspect	Percentage	Criteria
1.	Clarity of Concept	86	Very good
2.	Example Usage	87	Very good
3.	Presentation	86	Very good
4.	Language Usage	88	Very good
5.	Attractiveness	90	Very good
Average Percentage		87,4	Very good

According to the data presented in Table 4, it can be concluded that the results of the test regarding students' responses to teaching material products indicate an average value of 87.4%, which falls within the "very good" category. The "very good" category signifies that the digitization of folklore has achieved high-quality standards in clarity of concepts, use of examples, presentation, language proficiency, and overall appeal. The clarity of concept received a score of 86%, the use of examples was rated at 87%, the presentation achieved 86%, language use scored 88%, and attractiveness was rated at 90%. All these scores are categorized as "very good." The results suggest that the teaching material products are likely to be positively received by students, making them appropriate for use as effective learning media for children with special needs.

A survey involving 30 students with special needs was conducted to evaluate the effectiveness of digitizing North Sumatran folklore using Augmented Reality (AR) technology. The findings indicate that 60% of students found this digital approach helpful in understanding the story content, while 30% considered it highly beneficial. Additionally, 9.5% found it somewhat helpful, and only 0.5% reported no perceived benefit. In terms of recognizing North Sumatra’s ethnic diversity, 35% of respondents found it highly beneficial, 55% found it helpful, 9% somewhat helpful, and only 1% reported no benefit, with over 90% demonstrating improved recognition of the region’s eight main ethnic groups. The study confirms that AR-based digitization of North Sumatra folklore is an effective educational tool for children with special needs. Students gave an average rating of 87.4% ("very good") across clarity, presentation, language, and engagement. Over 90% found it helpful in understanding ethnic diversity, tourism, and cultural heritage, benefiting visual and kinesthetic learners. These findings highlight AR’s role in preserving culture while enhancing inclusive education through interactive learning.

Furthermore, the integration of AR technology facilitated students' understanding of tourism-related folklore, with 45% finding it highly useful, 34% moderately useful, 18% slightly useful, and only 2% reporting no benefit. The impact on cultural awareness was also significant, with 35% of students reporting substantial improvement, 45% finding it helpful, 18% somewhat helpful, and only 2% perceiving no impact, leading to an overall positive response from 80% of participants. Regarding its suitability as a learning tool, 44% of students deemed the product highly appropriate, 40% found it appropriate, 15% considered it moderately appropriate, and only 1% found it unsuitable. These results suggest that the digitization of folklore through AR technology is an effective, engaging, and inclusive educational tool that enhances cultural literacy and tourism awareness among students with special needs.

V. DISCUSSION

The results of this study indicate that 1) the results of material expert validation obtained a score of 87% which included the valid category; 2) The results of the design expert validation obtained a score of 86.5% which included valid; 3) The results of the usefulness test of the product digitization of North Sumatra folklore received an average score of 87.4% which was categorized as very good; and 4) The usefulness test of the product digitization of North Sumatra folklore received an average score of 87.4% which was categorized as very good. The product of digitizing North Sumatra folklore can help and facilitate children with special needs in understanding the content of folklore, recognizing various ethnicities in North Sumatra, recognizing tourist attractions in North Sumatra, knowing the culture of 8 ethnicities of North Sumatra and is suitable for use as teaching material and educational media for children with special needs.

The digitization of North Sumatran folklore is highly valid and beneficial to children with special needs. However, challenges remain, particularly in accessibility and device availability. Limited internet access in some areas of North Sumatra hinders its use (Glencross et al., 2021; Heponiemi et al., 2023). A viable solution is providing offline versions, ensuring access without internet dependency (Sutini et al., 2022). Studies show offline digital education improves accessibility and learning outcomes in low-connectivity regions (Looman et al., 2018). Collaboration with schools and inclusive education institutions is also crucial for resource sharing (Abayeva, 2024). Additionally, developing multiplatform applications enhances flexibility, catering to diverse needs (Kumaş & Yildirim, 2024; Shumilova et al., 2022).

The implementation of digital products in educational settings and among families also faces major challenges, mainly due to the different levels of technological understanding among teachers and parents. Many teachers as well as parents do not have sufficient skills to optimally utilize digital media as learning tools, hindering the transition from traditional to digital teaching methods (Bodsworth & Goodyear, 2017; Falloon, 2020). In addition, many are still reluctant to adapt to the current changes because they feel more comfortable using conventional teaching methods, which in turn can hinder the integration of technology in the education process (Alenezi et al., 2023; Greve et al., 2022).

To make the adoption of these digital products more effective, organizing training and workshops for teachers and parents is an important step. This can help improve their understanding and skills in utilizing digital devices optimally (Thoms et al., 2022). In addition, the provision of clear and accessible guidance, whether in the form of written instructions, learning videos, or interactive tutorials, will greatly support them in adjusting to the new technology (Khramtsova et al., 2021). Building a community or discussion forum for educators and parents can also create a space for collaboration, where they can share experiences, face challenges, and find solutions together regarding the implementation of these digital products (Podbolotova et al., 2021). This cooperation-based approach not only strengthens the sense of community but also encourages the exchange of best practices, so that the utilization of digital media in education is maximized (Dong et al., 2020).

Another challenge is the ongoing maintenance and development of these digital products to keep them relevant and attractive to users. Regular content updates are a key requirement to keep these products up-to-date and in line with curriculum developments and user needs (Slijepcevic & Sevic, 2019). In addition, technical support also needs to be provided to help users if they experience problems using the product (Sarier & Uysal, 2022). A strategic approach to overcome this challenge is to establish a dedicated development team that monitors and updates content regularly. With this team, digital products can continue to evolve in accordance with applicable educational standards and user needs (García-Carrión et al., 2019). In addition, providing various technical support services, such as a chatbot, email assistance, or a dedicated hotline, can improve the user experience by ensuring they get a quick solution when facing obstacles in using these digital products (Albudoor & Peña, 2021).

Collaborating with government agencies, community organizations, and technology companies can also play an important role in maintaining the long-term sustainability of the digital products that have been developed in this research. This collaboration enables the availability of resources and expertise needed for ongoing product development and maintenance, so that these educational aids remain effective and accessible to users, especially children with special needs (Stavholm et al., 2023). By implementing these strategies, educational institutions can build a supportive ecosystem, not only to ensure digital products remain relevant but also to increase their effectiveness in supporting the learning process (Kavitha & Sikandar, 2021).

The validation scores in this study align with previous research emphasizing expert evaluation in educational media development. Nurbekova and Baigusheva (2020) highlight the need for didactic principles in AR-based education, stressing expert validation to ensure learning objectives are met. The high validation results confirm the importance of expert input, particularly for special needs education. Additionally, the 87.4% usability score supports the effectiveness of folklore digitization, consistent with Choo et al. (2020), who found digital storytelling enhances comprehension and caters to diverse intelligences. This study further demonstrates AR's potential to improve learning for children with disabilities.

The focus on North Sumatran folklore as a medium for educational tourism aligns with previous research exploring the role of folklore in cultural education. Hajisoteriou et al. (2022) argue that storytelling can empower children to engage with issues of social justice, highlighting the transformative potential of narrative in education. The current research extends this idea by showing how digitized folktales can facilitate cultural understanding and appreciation among children with special needs, thus promoting inclusive educational practices. The application of AR in this study

is in line with research by Nigam (2022), which highlighted the effectiveness of AR in improving engagement and learning outcomes. The findings of this study support the results of Nigam's research by showing that AR can make cultural narratives more accessible and engaging for children with special needs. This relationship underscores the growing recognition of AR as a valuable tool in educational settings, especially for enhancing the learning experiences of diverse students.

The current research emphasis on helping children with special needs is an important focus area in educational research. Previous studies, such as the one conducted by Assem et al. (2022), emphasize the importance of adapting educational resources to meet the needs of diverse learners. The findings from the current study contribute to the knowledge found by Assem et al. (2022) by showing how digitized folktales can be adapted to support the learning experiences of children with disabilities, thus promoting inclusivity in education.

This study enhances the theoretical understanding of educational media, especially in special and cultural education. High validation scores from content and design experts (87% and 86.5%) highlight the importance of expert evaluation in ensuring pedagogical effectiveness. This aligns with Knowles' (1996) andragogy and Vygotsky's Social Constructivism (1978), which stresses tailored learning for students with special needs (Wahid & Ain, 2023). The successful digitization of North Sumatran folklore demonstrates how integrating cultural narratives into education enhances engagement and understanding, reinforcing the value of culturally relevant content (Olufemi et al., 2015).

In addition, the usability score of 87.4% indicates that the product is not only valid but also user-friendly, which is crucial for maintaining engagement among children with special needs. This finding is in line with the literature emphasizing the importance of usability in educational technology, which suggests that well-designed educational tools can improve learning outcomes and foster independence among learners (Rahayu et al., 2023). These theoretical implications suggest that future educational media should prioritize content validity and usability to effectively support diverse learning needs.

A key limitation of this study is its focus on North Sumatra's cultural context, making its findings—87% validity and 87.4% usability—less applicable to other regions (Hasibuan et al., 2024). Cultural and educational differences across provinces or countries may affect the effectiveness of the Augmented Reality (AR) tool. Additionally, the study does not account for disparities in technology access and digital literacy. While AR can enhance learning, its success depends on user familiarity, especially for children with special needs who may require additional support (Morato-Espino et al., 2019). These unexamined factors could lead to educational inequalities.

Future research should explore the adaptation of Augmented Reality tools for use in diverse cultures and education. This can be done by conducting comparative studies in different regions in Indonesia, as well as in other countries with different cultural backgrounds. Such research could assess how folklore and local educational practices can be integrated into Augmented Reality applications to increase the relevance and engagement of children with special needs (Botes et al., 2023). In addition, it would be beneficial to investigate the long-term impact of using Augmented Reality in educational environments for children with special needs. Longitudinal studies can provide insights into how continued exposure to Augmented Reality devices affects learning outcomes, social skills, and cultural awareness over time (Vázquez-Sánchez et al., 2023).

To adapt Augmented Reality (AR) for various cultural and educational settings, future research should involve local teachers, cultural experts, and children with special needs in a participatory design process. This ensures culturally relevant and accessible content. AR can integrate regional folklore, enhancing cultural exploration and media literacy (Lambert et al., 2019). Adding multilingual support can further improve accessibility and inclusivity (Morato-Espino et al., 2019). Educator training programs should also be developed to enhance AR implementation for children with special needs (Bilotserkovets et al., 2020). While this study highlights AR's potential in North Sumatra, addressing its limitations and exploring broader applications will contribute to a more inclusive education system.

This research has significant implications for educators, curriculum developers, and policymakers. The findings confirm that digitized North Sumatran folktales effectively support children with special needs in understanding folklore, ethnic diversity, and cultural heritage, aligning with studies on culturally relevant education (Kusmana & Jaja, 2019). Teachers can use these digital tools to create inclusive classrooms, integrating local cultural narratives to strengthen heritage awareness and social cohesion (Martika & Salim, 2017). Additionally, teacher training programs should incorporate digital media strategies for special needs education, as effective training is essential for inclusivity (Olufemi et al., 2015). This research can also serve as a model for digitizing other cultural narratives and expanding educational tourism and cultural education in Indonesia. Policymakers should support similar initiatives to enhance learning experiences for children with special needs and promote cultural appreciation.

VI. Conclusion

The study confirms that digitizing North Sumatran folktales with Augmented Reality (AR) is highly effective for special needs education. Students responded positively, with an average rating of 87.4%, categorized as "Very Good" in clarity, examples, presentation, language, and attractiveness. The digital approach significantly improved students' understanding of North Sumatra's cultural heritage, helping over 90% recognize its ethnic diversity, landmarks, and traditions through immersive AR experiences. This method aligns with the visual and kinesthetic learning styles of

special needs students, making it an engaging and effective tool. Overall, folklore digitization preserves cultural heritage while enhancing learning, proving its value in special education.

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