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Enhancing Children's Learning of Malay Traditional Musical Instruments using Multimedia Elements in Augmented Reality Book

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ABSTRACT

The decline in awareness and appreciation of Malay traditional musical instruments among younger generations in Malaysia presents a pressing cultural concern. Due to limited exposure and a lack of engaging educational resources, many children are unfamiliar with instruments like the gambus, rebana, and marwas. This study aims to investigate how multimedia elements in Augmented Reality (AR) books can enhance children's learning and appreciation of Malay traditional musical instruments. Using a qualitative content analysis approach, six selected AR books were examined to identify the use and effectiveness of multimedia elements such as text, image, video, audio, and animation. These elements were analysed based on their contribution to enhancing engagement, motivation, and knowledge retention. The findings revealed that while video was not utilized in any of the selected AR books, all incorporated text, images, and sound effects, with varying degrees of narration and music. A strong emphasis was placed on interactive 3D and animated features, which significantly enriched user experience and learning outcomes. The results support the application of Mayer's Multimedia Learning Theory, demonstrating that the combination of visual, auditory, and interactive elements in AR books effectively facilitates children's understanding and enjoyment of traditional content. This study suggests that AR technology offers a promising tool for cultural preservation and recommends further exploration into its integration within formal education systems.

Keywords: *Traditional Musical Instruments, Multimedia Elements, Augmented Reality Book*

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1 INTRODUCTION

Malaysia is a multi-ethnic country recognized for its diverse range of ethnicities, each contributing significantly to the country's rich cultural tapestry (Nurizah et al., 2024). This cultural richness has facilitated the development and preservation of numerous traditional musical instruments, many of which have historical significance and date back several centuries (Shauqi, 2023). The instruments like *rebana*, *marwas*, *gambus*, and many more have been used in various ceremonies, festivities, and performances, such as dances, weddings, and religious events, for centuries (Facts and Details, 2015). Every traditional Malay musical instrument carries its own story, fulfils a specific role, and produces a unique sound that showcases the richness of Malay culture (Roots, 2019).

The integration of Augmented Reality (AR) can greatly enhance children's understanding of Malay traditional musical instruments by providing an interactive and immersive learning experience that engages visual, auditory, and kinesthetics senses (Masmuzidin et al., 2020). With AR technology, children can view 3D models of the instruments, hear their authentic sounds, and learn about their historical and cultural contexts, making the learning process more engaging and

meaningful (Tan & Lim, 2019). This technology supports experiential learning by enabling students to interact with virtual instruments anytime and anywhere, which increases their motivation and retention of knowledge (Borhan & Rahim, 2025). Moreover, AR bridges the gap between traditional and modern educational methods, fostering a deeper appreciation of Malay musical heritage among younger generations through seamless transitions between real and virtual environments (Tan & Lim, 2019). Thus, AR motion design presents a dynamic and effective approach to preserving and promoting Malay traditional music in contemporary education (Masmuzidin et al., 2020).

According to Mayer's Multimedia Principle, multimedia elements are designed to help children's learning in interactive illustration books by combining words and pictures, which leads to better understanding and retention than words alone (Botne, 2023). Studies regarding multimedia in education indicate that learners who engage with both texts and images achieve superior outcomes compared to those who rely solely on text (Chen, 2012). By integrating these multimedia principles, interactive illustration books can promote greater engagement, motivation, and effective learning results for children (Khalidi, 2021).

Augmented Reality (AR) books offer an innovative and immersive approach to enhancing children's learning experiences by merging traditional printed content with digital information (Rachael, 2023). This technology has the potential to transform how individuals engage with literature, making reading more accessible, enjoyable, and informative (Rachael, 2023). Overall, AR books provide a dynamic platform that not only preserves traditional knowledge but also inspires a new generation to connect with and appreciate Malay culture through interactive learning. This study explores how multimedia elements are incorporated into AR books, focusing on using text, image, video, audio, and animation to enhance the learning and appreciation of Malay traditional musical instruments.

1.1 Research Objectives

The research of this study was to examine the use of multimedia elements in an augmented reality book to preserve Malay traditional musical instruments.

1.2 Problem Statement

In Malaysia, traditional music is being overshadowed by modern genres. Research by Zhang and Li (2021) shows that this trend may lead to a decline in the younger generation's knowledge about traditional musical instruments. Many young Malaysians today have limited familiarity with traditional Malay musical instruments, and while some may be aware of their existence, they often do not recognize these instruments, such as *gambus*, *seruling*, and *marwas*, or understand their cultural significance (Hidayatullah et al., 2024; Nur & Rahayu, 2024). This indicates that the understanding of Malay traditional musical instruments is slowly being forgotten.

Besides, there is a lack of learning experiences related to traditional instruments in Malaysian music education. According to Kian and Chen (2019), this gap creates challenges in teaching and learning about traditional music. There are not many resources that are fun and educational at the same time. Without interactive media like AR books, it is hard to attract children's interest and make them appreciate traditional music in modern days.

Despite the longstanding use of traditional educational methods like printed media, people increasingly see these approaches as limited because their content remains static, they lack interactivity, also they inflexibly update information, which can reduce student engagement and obstruct the presentation of dynamic or complex concepts (Teachers Institute, 2023). Unlike conventional ones, modern educational methods that incorporate interactive technologies, like augmented reality (AR) books, create engaging, multi-sensory, and exciting learning experiences, improving comprehension, retention, and motivation among students (ClassVR, 2022; Lin & Yu, 2023). However, a notable research gap exists in understanding how these interactive technologies can be systematically integrated

into educational practice, as challenges remain regarding high development costs, lack of standardized pedagogical frameworks, and the need for teacher training and infrastructure support (DigitalDefynd, 2025), creating an important gap in research on integrating interactive technologies into educational practice systematically.

Although AR improved print media may close the divide for physical and digital learning spaces, empirical research comparing printed media to interactive AR books, plus their implications within actual classrooms, remains restricted (Commercial Copier Leasing South Florida, 2024; Altera Institute, 2024). Educators and policymakers must be informed on the best practices for addressing this gap. Interactive technology can then be used to improve the outcomes of learning beyond customary print media's capabilities.

2 LITERATURE REVIEW

The literature review offers an in-depth understanding of the topic. It analyses the multimedia elements found in augmented reality books, such as text, images, video, audio, and animation. Additionally, it explores the role of augmented reality books as educational tools and discusses their benefits in the education sector.

2.1 Malay Traditional Musical Instruments

Malay traditional instruments are the musical tools that form an integral part of Malaysia's rich cultural heritage. These instruments serve as an entertainment and communication channel that accompany the performing arts in the local community through the production of a wide range of sound strains (Masmuzidin et al., 2020). Malay traditional musical instruments can be categorized into four different classifications, which are Aerophones for wind instruments, Chordophones for stringed instruments, Idiophones for percussive instruments that are struck or shaken, and Membranophones for drums, which are derived from the membrane stretched over the instrument that produces sound when struck (Augustin, 2023).

2.2 What is Multimedia?

Mayer's Multimedia Principle describes multimedia elements as the integration of text and images used together in educational materials to improve learning (Mayer, 2009). It specifically indicates that individuals learn more effectively from a combination of words and visuals rather than from words alone, highlighting that the simultaneous presentation of information through both verbal and visual means enhances comprehension and memory retention. These multimedia elements consist of text, pictures, animations, videos, and other visual resources that reinforce spoken or written content, thus engaging multiple cognitive pathways for more efficient information processing (Mayer, 2009).

Mayer's principles as a whole provide a practical guideline for creating multimedia learning experiences that correspond with human cognitive structures. Research has repeatedly upheld these principles, showing that multimedia learning developed according to these recommendations results in better knowledge acquisition and transfer when compared to less organized methods (Ayres, 2015).

2.3 Elements of Multimedia

2.3.1 Text

One fundamental element of multimedia is text, which consists of character sequences entered through a keyboard to form words, phrases, paragraphs, and entire articles (Banerjee, 2019). Text acts as an essential medium for providing explanations and descriptions, which learners interpret through the auditory or visual verbal channel, depending on whether the text is read aloud or in silence (Mayer,

2009). Richard Mayer (2001) states that text represents the verbal aspect and pertains to the delivery of information in printed form, such as written language.

2.3.2 Image

Images play a vital role as multimedia elements in augmented reality (AR) books by offering visual representations that enhance the verbal information provided, thereby enriching traditional print content. This combination creates an immersive and engaging experience for readers (Rachael, 2023). According to Richard Mayer (2001), learners are more likely to understand and retain material when words are paired with images, as pictures activate the visual channel and facilitate dual-channel processing. Additionally, images can convey ideas or evoke emotions, whether through photographs, illustrations, or graphics.

2.3.3 Video

Another element of multimedia is video. It is defined as an electronic technology that captures, records, stores, processes, transmits, and reconstructs still images that capture scenes in motion (Banerjee, 2019). Videos as multimedia elements in augmented reality (AR) books serve as dynamic tools that integrate moving images and sound to enrich the learning experience. According to a review of multimedia elements in science learning, video, alongside text, audio, graphics, and animation, provides a practical and multi-sensory learning experience that can enhance learner engagement and understanding (Muhilarasaan Arumugam, 2021). Videos can demonstrate processes, narrate stories, or animate characters, making complex information more accessible and engaging, consistent with Mayer's emphasis on using complementary channels to enhance learning (Mayer, 2009).

However, studies comparing AR and video for listening comprehension suggest that the effectiveness of video alone may be limited if not properly integrated with interactive or contextual elements typical of AR environments (Lai et al., 2020). Research on AR picture books highlights that virtual content, including video, must be carefully designed to harmonize with the narrative of the physical book to avoid disjointed experiences that distract readers from the story (Liu & Park, 2019).

2.3.4 Audio

The next multimedia aspect is audio, which encompasses auditory elements like narration, music, sound effects, and voice-over. This element is vital for establishing tone, creating ambiance, and reinforcing the message. Incorporating audio enhances the emotional resonance of the content, making the audience's experience more engaging. Richard Mayer's Cognitive Multimedia Learning Theory (2001) suggests that sound can aid comprehension when utilized properly, such as in oral storytelling, as it complements visual information and lessens cognitive load. However, unnecessary or distracting sounds, such as irrelevant background music, can negatively impact the learning experience (Mayer, 2001).

2.3.5 Animation

Animation serves as a crucial multimedia element in augmented reality (AR) books, significantly improving the reading experience by introducing dynamic, interactive, and audio-visual elements to otherwise static content. In AR storybooks, animations often feature character movements, scene enhancements, and synchronized audio, effectively bringing stories to life and boosting reader engagement (Liu & Park, 2019). These animations can operate automatically, where virtual characters or scenes animate as soon as the AR device is turned on, aiding readers in comprehending narratives through vivid and detailed visualizations (Liu & Park, 2019).

Besides, interactive animations in AR books enable readers to manipulate virtual content using gestures such as tapping, dragging, and zooming, or by utilizing interface buttons. This encourages

active participation and tailored story exploration (Liu & Park, 2019). Such interactivity amplifies the immersive and enjoyable aspects of reading, making the experience more captivating and motivating for learners (Liu & Park, 2019). From a cognitive standpoint, animations align with Mayer's Multimedia Principle by offering dynamic visual information that enhances verbal explanations, thereby promoting dual-channel processing and facilitating deeper learning (Roskos et al., 2017; Zeller et al., 2020).

2.4 Children's Learning Experience

The learning experiences of children are influenced by a diverse combination of cognitive, social, environmental, and emotional factors that begin at birth. Studies indicate that even when they are very young, children are inquisitive and thoughtful learners. They instinctively explore, ask questions, and enhance their understanding as they engage with their surroundings and the people in their lives (National Academies of Sciences, Engineering, and Medicine, 2015). As they develop, their thinking progresses through distinct stages. They initially learn through physical interaction and movement, then gradually start to use language, think more abstractly, and solve problems with greater logic (Counselling in Melbourne, 2023). Active and open-ended learning is most effective in early childhood education. Children flourish when they are motivated to play, experiment, and make discoveries on their own. These practical experiences ignite their creativity, foster their independence, and contribute to a lifelong passion for learning (Launchpad Early Education, 2024).

2.5 Augmented Reality Book

Augmented reality (AR) books represent an innovative combination of traditional print media and digital technology, enhancing the reading experience by overlaying virtual elements such as animations, audio, and interactive features onto physical books (Rachael, 2023). This hybrid format allows for more immersive and engaging reading practices, enabling learners to both explore and interact with paper and digital content at the same time (Panchenko et al., 2024). AR books go beyond typical enhancements like pop-ups or tactile features by integrating dynamic digital elements that can boost reading motivation, focus, comprehension, and knowledge retention (Vanderschantz et al., 2019; Yilmaz et al., 2017; Danaei et al., 2020).

Moreover, research indicates that AR books positively affect children's reading engagement in behavioral, cognitive, emotional, and social aspects. Children express a greater desire to read, demonstrate improved reading strategies, enjoy enhanced imagination, and experience more enjoyment compared to conventional print books (Panchenko et al., 2024). The technology also facilitates social interaction surrounding reading, encouraging discussions and collaborative meaning-making (Panchenko et al., 2024). These findings are consistent with broader research suggesting that AR books can promote emotional and motivational benefits such as increased interest, motivation, and enjoyment, along with cognitive advantages like enhanced reading comprehension and narrative skills (Villar Arellano-Yanguas, 2023).

3 METHODOLOGY

3.1 Research Design

This research utilized a qualitative content analysis study to evaluate the presence and quality of multimedia elements in selected augmented reality books, such as text, image, video, audio, and animations (Tay Vaughan, 1993). Content analysis is a research technique that aims to draw dependable conclusions about texts or other significant content and the contexts surrounding them (Krippendorff, 2013). A total of six augmented reality books were examined, specifically ARPeddia Musical Instruments, 3D Traditional Musical Instrument-Based Augmented Reality: Exploring Indonesian Traditional Instruments in Augmented Reality, Music-Augmented Reality Book, EMMAR: Exploration

of Malaysian Traditional Musical Instruments with Augmented Reality, Devar: Wow Wonder of the World, and The Giant and The Longhouse Folk, as outlined in Figure 1.

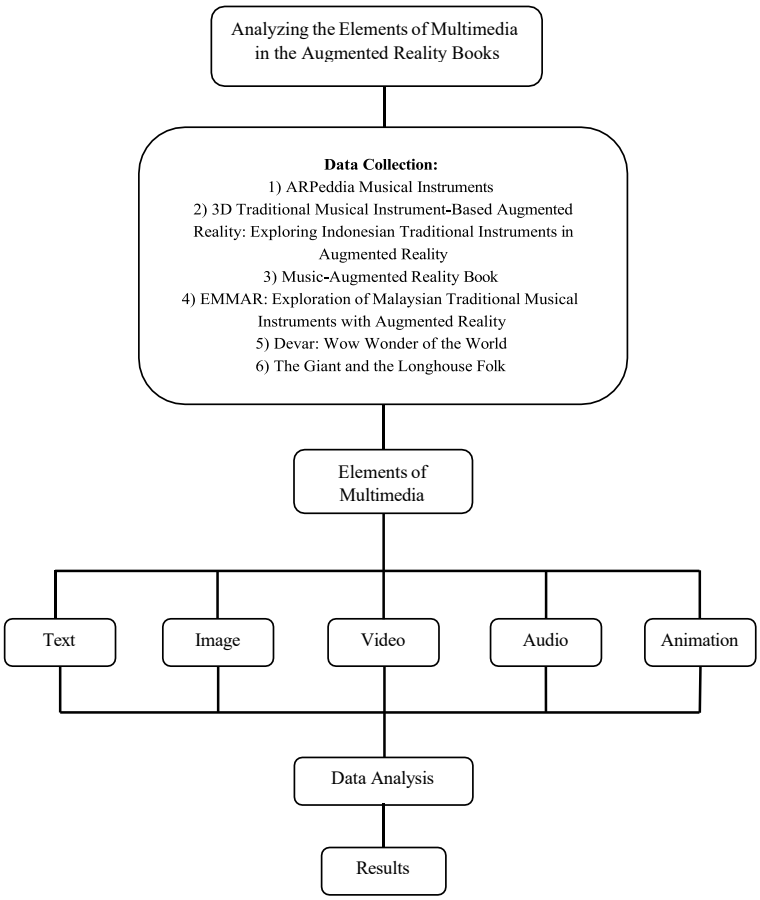
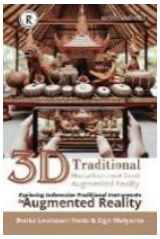


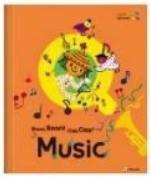
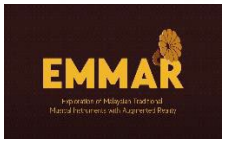
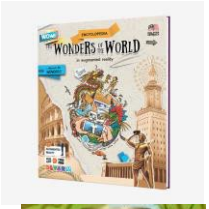
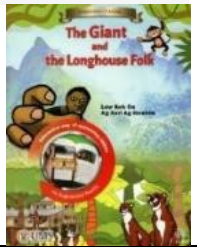
Figure 1 Framework of study

3.2 Selection Samples

The selection criteria for augmented reality (AR) books were based on the increasing interest and integration of advanced technology like AR in education between 2017 and May 2025. The selection of the sample for this study is based on the criteria outlined in Table 1.

Table 1 Selection Sample of Augmented Reality Books

No.	Augmented Reality (AR) Books		Publisher	Publication Date	AR Platform	Code
1.	ARPeddia Musical Instruments		Createspace Independent	28th December, 2017	Android	AR1
2.	3D Traditional Musical Instrument-Based Augmented Reality: Exploring Indonesian Traditional Instruments in Augmented Reality		Asadel Publisher	25th November, 2023	Android and iOS	AR2

3.	Music-Augmented Reality Book		ARpedia	2nd November, 2020	Android and iOS	AR3
4.	EMMAR: Exploration of Malaysian Traditional Musical Instruments with Augmented Reality		Institute of Electrical and Electronics Engineers	6th February, 2024	Android and iOS	AR4
5.	Devar: Wow Wonder of the World		Devar	2020	Android and iOS	AR5
6.	The Giant and the Longhouse Folk		Perbadanan Kota Buku	2019	Android and iOS	AR6

3.3 Copyright Notice

All AR book names, cover pages, logos, and trademarks referenced in this table, including © ARPeddia Musical Instruments by Createspace Independent, © 3D Traditional Musical Instrument-Based Augmented Reality: Exploring Indonesian Traditional Instruments in Augmented Reality by Asadel Publisher, © Music-Augmented Reality Book by ARpedia, © EMMAR: Exploration of Malaysian Traditional Musical Instruments with Augmented Reality by Institute of Electrical and Electronic Engineers, © Devar: Wow Wonder of the World by Devar, © The Giant and the Longhouse Folk by Perbadanan Kota Buku, are the property of their respective owners and are used here for academic purposes only.

4 DATA ANALYSIS

The data were analysed thematically to identify multimedia elements, such as text, image, video, audio, and animation across all 6 selected AR books.

Table 2 Analysis of Text Elements in AR Books

AR BOOKS		TEXT									
		Typography				Alignment				Colour	
		Serif	Sans Serif	Script	Decorative	Left	Right	Center	Justified	Warm colour	Cold colour
1	AR1	-	/	-	-	/	-	/	-	/	/
2	AR2	/	/	-	-	/	-	/	/	/	-
3	AR3	-	/	-	/	/	-	/	/	/	-
4	AR4	-	/	-	-	-	-	/	/	/	-
5	AR5	/	-	/	/	/	-	/	/	/	/
6	AR6	-	/	-	-	-	-	/	/	/	-

Table 3 Analysis of Image Elements in AR Books

AR BOOKS		IMAGE		
		Graphics	Illustrations	Photographs
1	AR1	/	/	/
2	AR2	-	/	/
3	AR3	/	/	-
4	AR4	/	/	/
5	AR5	/	/	/
6	AR6	/	/	-

Table 4 Analysis of Video Elements in AR Books

AR BOOKS		VIDEO
1	AR1	-
2	AR2	-
3	AR3	-
4	AR4	-
5	AR5	-
6	AR6	-

Table 5 Analysis of Audio Elements in AR Books

AR BOOKS		AUDIO		
		Sound Effects	Music	Narration
1	AR1	/	-	-
2	AR2	/	-	-
3	AR3	/	/	/
4	AR4	/	/	-
5	AR5	/	/	-
6	AR6	/	/	/

Table 6 Analysis of Animation Elements in AR Books

AR BOOKS		ANIMATION		
		2D	3D	Interactive Animation
1	AR1	-	/	-
2	AR2	-	/	/
3	AR3	/	/	/
4	AR4	-	/	/
5	AR5	-	/	/
6	AR6	/	-	/

5 RESULTS

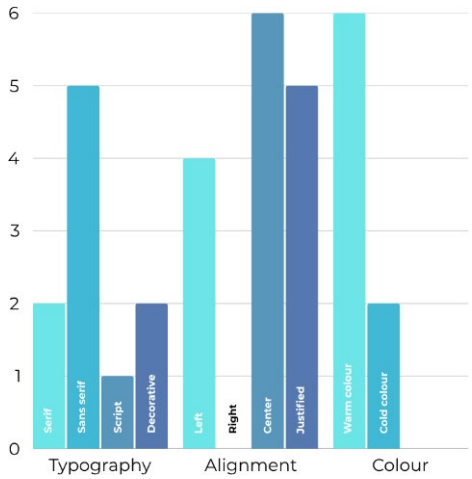


Figure 2 Results of Text Analysis in AR Books

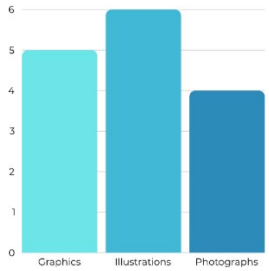


Figure 3 Results of Image Analysis in AR Books

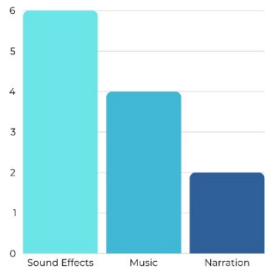


Figure 4 Results of Audio Analysis in AR Books

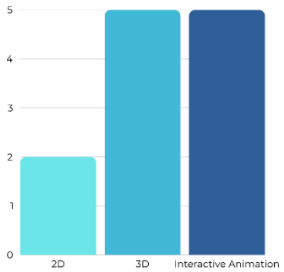


Figure 5 Results of Animation Analysis in AR Books

6 FINDINGS AND DISCUSSION

The findings indicate that video elements were not utilized since the chosen AR books primarily emphasized text, audio, images, and interactive 3D modelling for children's education. While video elements can be engaging, their omission may be due to technical limitations or a strategic decision to prioritize interactivity through dynamic augmented features instead of linear video playback. This

implies an emphasis on user engagement and control over passive observation.

Text emerged as a foundational element across all AR books. The analysis of text elements in all six selected AR books revealed that sans serif typography was the most commonly used style, which was often associated with clarity and readability for younger readers. Script and decorative fonts were rarely used, with only AR5 featuring both, and AR3 showing a decorative typeface. In terms of text alignment, centered text was the most preferred choice, found in all six books, while left and justified alignments were also present in several examples. Interestingly, none of the AR books used right-aligned text, suggesting it may not be suitable for this context. Colour usage leaned heavily towards warm tones, with five out of six books incorporating warm colours to enhance visual appeal and to reflect mood and cultural themes. Cold colours appeared less frequently, found in only one AR book, indicating a preference for a warmer, more inviting design in children's AR content.

The image analysis shows that illustrations were the most frequently used, appearing in all six AR books, which suggests a strong preference for hand-drawn or digital artwork to engage young readers. It was also highly effective in capturing children's attention and supporting storytelling. Graphics were also commonly included in five of the books, likely serving to enhance the visual appeal and clarify information in a fun and engaging way. Photographs were used slightly less, found in four books, possibly because they offer a more realistic but less imaginative style compared to illustrations. The strong presence of illustrations indicates that creators prioritize artistic and playful visuals to connect with young audiences. Graphics complement this by adding visual variety and supporting interactive features. Although photographs are still relevant, their lower frequency shows a preference for more stylized and imaginative imagery in AR book experiences.

The audio analysis across all AR books indicates that sound effects were the most commonly used element, appearing in all six titles, which shows their importance in enhancing user interaction and immersion. Music was present in four of the AR books, contributing to the overall mood and atmosphere of the experience. Narration, on the other hand, was the least utilized, found in only two books, suggesting it may not be a primary focus in current AR book designs. The strong presence of sound effects highlights their role in making the AR experience more engaging, especially for younger audiences. Music supports storytelling and can influence emotional responses, although its usage was not as universal. The limited use of narration may reflect challenges in voice integration or a design preference for more visual and interactive content.

The animation analysis reveals that 3D and interactive animations were the most frequently used, appearing in five of the AR books, showing a clear preference for immersive and engaging visual content. These types of animation likely enhance user interaction and bring the stories or information to life more dynamically. In contrast, 2D animation was only used in two books, suggesting it may be seen as less effective or appealing in modern AR environments. The popularity of 3D and interactive elements reflects current trends in digital storytelling, where users expect more lifelike and responsive experiences. This also indicates that developers are investing more in advanced animation techniques to capture children's attention. Overall, the emphasis on 3D and interactive animation shows a shift toward more sophisticated and playful approaches in AR book design.

7 CONCLUSIONS

In conclusion, the analysis of text, image, audio, and animation elements across the six AR books shows a clear focus on creating engaging and interactive experiences for children. Sans serif fonts with centered alignment and warm colour schemes are most commonly used, likely for their clarity and inviting feel. Illustrations dominate the visual style, emphasizing creativity and imagination in storytelling. Sound effects are consistently present in all books, highlighting their role in making the AR experience more immersive, while music and narration are used more selectively. The preference for 3D and interactive animations reflects a move toward more dynamic and user-responsive content. Finally, these elements work together to form a playful, educational, and visually rich environment that

captures and maintains the interest of young readers.

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AUTHOR CONTRIBUTIONS

All authors played equal contributions towards the production of this paper.

CONFLICT OF INTEREST

There is no conflict of interest.

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