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Augmented Reality in Read Aloud: An English Language Interactive Engagement

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ABSTRACT

Currently, Augmented Reality (AR) technology is emerging as a popular means to encourage children to enjoy reading books. AR technology, which creates a virtual element from a real physical environment, increases a sense of connectivity between the real and the virtual world. The Read-Aloud project aimed to spark interest in reading English language storybooks among primary school children by innovating the chosen storybook with embedded AR technology. The book, 'Nyatoh the Friendly Tree,' was selected in support of United Nations Sustainable Development Goal No. 15 on the Sustainability of Life on Land, particularly focusing on issues related to trees and sustainable forests. Primary research through a simple questionnaire was distributed to the students and analysed by the researchers using a statistical percentage table. Oral feedback and interactions were observed and recorded by the researchers. A total of 160 students, with 82 aged 12 and 78 aged 10, from a government primary school in the urban city experienced AR in the read-aloud session. The book was initially read to the students, followed by language activities and hands-on AR experiences using smartphones and physical books. All activities were conducted in smaller groups of five. The AR features 3D models of the main character and side characters, including animals from the rainforest. Comprehension questions in the form of a quiz were generated, and to expand vocabulary, audio explanations of words in animation were created. Feedback was gathered at the end of the session in two categories: (a) interest, engagement, and interaction with the story, and (b) comprehension of the language and story. Students reported positive experiences with AR in both categories and generally found the activity fun, interesting, and enjoyable and were motivated to read. While scores in the comprehension area were lower, they still indicated a positive impact of AR on vocabulary comprehension, contributing to the overall understanding of the story. Interaction with animation also plays a role in supporting the sense-making of non-verbal representation. This project demonstrated that AR holds tremendous appeal in generating interest in reading when it incorporates a modification of physical reality with virtual elements. Exploring the potential of AR in storybooks and read-aloud sessions is valuable, especially considering the benefits of reading on learners' development. The research was still in its early stages, with additional variables to be considered. Longitudinal studies could be conducted for clearer validity and reduction of the novelty effect. This includes identifying individual learning styles in software design, providing training for both teachers and students, and developing appropriate learning activities for AR applications.

Keywords
Augmented Reality, Read-aloud, Motivation, Engagement, Vocabulary enhancement, Comprehension

Introduction

Around the world, a general phenomenon that could be observed is that young people are more engrossed in their screen rather than in reading printed media. The attraction of screen in providing instant stimulation through entertainment and easy access to the most updated information has changed how young people spend their free time. In a study conducted on the Malaysian Reading Profile in year 2010, only eight to twelve books per year were read by Malaysians age 10 and above (National Library of Malaysia, 2010). (The most recent study on Malaysian Reading Profile, conducted by National Library of Malaysia is still on-going at the time this paper is written.) In another report on Literacy Statistics in 2016, out of 85% Malaysian who read regularly, 77% of them preferred newspapers, 3% magazines, 3% books, and 1.6% comics (Borneo Post Online, 2017). This statistic shows that Malaysians who read for pleasure are shockingly few.

Amidst all the alternatives to spend free time, young people no longer prioritize reading for pleasure. Instead, many choose to listen to and watch screen for immediate gratification. The choices available on screens offer a variety of entertainment that appeals to their senses. From watching dramas through streaming, subscribing to vlogs in YouTube and TikTok, catching the latest entertainment and information through social media, to playing online games, reading printed media seems to be the last activity they would consider.

Sociologists (Stanica et al. 2019, p. 95) classify the main reasons young people do not read is due to the lack of immediate satisfaction or entertainment they get when reading a print media. Another reason is that screens provide many alternatives to spend their time. For example, watching is considered better than reading. In addition, the literature prescribed by schools is not captivating and trendy but too classical for their preferences.

The problem of the lack of interest in reading and reading English books needs to be addressed. Musa, Lie, and Azman (2012) cite three reasons for the lack of motivation: an unenthusiastic attitude, a lack of interest in learning the language, and an environment that does not encourage reading (Mahadzir & Phung, 2013).

To address this issue, the read -aloud project aimed to reach learners and encourage them to like and read English language storybooks. This project collaborated with a primary school in the Highly Immersive Programme (HIP) where it fulfilled two of the program's targets: to increase contact time for English language use and to strengthen the command of the English language among students. Instead of the conventional way of reading aloud with just print media, Augmented Reality (AR) was embedded into the storybooks to (1) increase the motivation, interest, and engagement of the readers and (2) to enhance reading comprehension through vocabulary building and knowledge transfer.

Literature Review

Reading is the process of simultaneously extracting and constructing meaning through interaction and involvement with written language (Literacy, Glossary, International Literacy Association, n.d., cited in Danaei, 2020). Reading is believed to be associated with success in learning, cognitive development, academic achievements, critical thinking, and problem-solving (Kao et al., 2016; Rambli et al., 2012). The earlier children start reading, the better their literacy skills, vocabulary acquisition, and cognitive development become, which in turn determine their success and effectiveness in learning.

However, reading comprehension can be hindered when words or vocabulary are too difficult to grasp, or when there is a lack of interaction between the reader and the book, often due to the book's difficulty level. Another reason is due to the absence of supervision, when no one is available to co-read or engage in shared book reading to explain the story or when encountering difficult words. All of these factors could potentially lead to a loss of engagement with the story's meaning and demotivate the reader from reading further.

Prints vs E-books

With the competition from screens, print books are losing their relevance for today's generation (Stanica et al., 2019, p. 95). However, there is an ambivalent acceptance of reading print books compared to e-books. The many benefits of reading from print media cannot be denied. Print books give readers the time to engage with the text

and pictures, and they can be flipped through repeatedly. They provide readers with a better understanding and a deeper connection with literature (Wallis, 2010, as cited in Anuar & Wan, 2021).

In contrast, e-books are known to cause blurred vision and eye fatigue after prolonged reading. Repeated distractions due to advertisement pop-ups are interruptions that disrupt the flow of reading. In Malaysia, e-books are not widely circulated among students, and while there are many free e-book versions available on the internet, they may not be the most conducive for engaging with literature due to many limitations.

Having said that, e-books have their perks as they are usually instantly available (no waiting for days or weeks to get the book) and, in the long run, offer value for the money spent. Technological innovations in e-books mean that they can now mimic the features of print books, such as dimmed eye comfort, flipped pages, highlight features, annotation, and many others. With innovation in e-books, print books seem to have their contenders and have resulted in a significant decline in independent bookstores in most countries. Despite this radical change, independent booksellers have shown resilience by shifting their marketing tactics to capitalize on community-based businesses, such as the 3Cs – community, curation, and convening (Raffaelli, 2020). This has resulted in a resurgence of readers for print books.

Despite these technological advances, school children in Malaysia still use textbooks and storybooks as their primary literacy sources. Most schools are equipped with a library that holds a variety of books, including storybooks. Print books are still the source for developing literacy skills which includes reading. It is still essential to engage readers with letters and words from a printed source rather than from an e-book. One way to attract students to books is to embed Augmented Reality (AR) into the printed source. As the world becomes progressively digitally savvy, it is even more important to revolutionize the conventional way of teaching reading skills, particularly in the area of increasing motivation to read and vocabulary acquisition. Using and reusing existing print books that are readily available in the school library but innovating them by embedding simple AR applications to the printed sources will more likely ensure the continuity of reading for pleasure for these young learners.

Augmented reality story books

AR technology modifies the elements of real environment into virtual materials without disturbing the real world (Rambli et al., 2012; Tomi & Rambli, 2013). It transforms, for example, a bird illustration from a book into a virtual 3D pop-up. It creates a powerful tool for interactive engagement for users/readers (Zarzuela et al., 2013). Embedding AR technology in a storybook creates a sense of interest in reading print media while increasing immersion and engagement with the story. Readers still use the print media (the real world) by flipping and reading, and they enjoy the illustrations or words while AR intensifies their reading experiences through multi-dimensional sensory engagement (Kerawalla et al., 2006). The reading experience is transformed into a new immersive experience that enhances the coherent representation of language beyond the sentence level (Kao et al., 2016, p.58).

The passive readers are now transformed into active and autonomous readers (Garrett et al., 2018), fully engaged in reading strategies such as recalling, retelling, and answering quizzes with questions that are implicit or explicit through the AR applications. With the 3D model pop-ups of the story characters, readers become attached to the characters, creating excitement to continue reading and further developing their creativity and imagination (Klopfer &Yoon, 2004). The entertainment factor, social interaction with the print and with peers (if shared reading), physical mobility, and gamification are key factors that increase positive attitudes held by readers towards AR applications. The enjoyment factor is another reason why AR is praised for the growth of interest in reading. The interactive components transform the learning experience, making it fun, game-like, and entertaining (Binhonram & Altalhab, 2021; Kaufman & Dünser, 2007; Liu et al., 2009; He et al., 2014; Yilmaz et al., 2017). All of these factors make embedding AR into storybooks more appealing, leading to an increase in readers' motivation, interest, and engagement with printed media.

Another important feature of AR is its ability to increase comprehension of story through vocabulary building. Wilkins (1972, p. 111-112) expresses that effective communication can only occur when one has a repertoire of vocabulary, saying, 'Without grammar, very little can be conveyed; without vocabulary, nothing can be conveyed.' Vocabulary development is particularly important in English learning. Results from Huckin (1995) and August et al. (2005) found that students with slow English vocabulary development are likely to perform poorly in text

comprehension. Nation and Webb (2011) further elaborate that teachers are encouraged to train learners to use vocabulary strategies, such as guessing from context, learning word parts, learning from word cards, and using a dictionary, so that they are equipped with the skills to acquire a range of vocabulary. Schmitt and McCarthy (1997) divide these skills into determination vocabulary strategies, where readers discover the meanings of new words independently, and social vocabulary strategies, which refer to readers' interaction to discover meanings of new vocabulary. Having an array of vocabulary is essential to understanding story as a whole and the implicit messages the story conveys. AR technology achieves both determination and social vocabulary through engagement in interactivity, animation, and games that can be incorporated into the content to focus on pronunciation, meaning, and vocabulary (Nation, 2001) through solo reading and reading with peers.

Another notable feature of AR is that through visualization and animation, AR makes the introduction of scientific or abstract concepts easier to grasp. Visualization of the concept in a motion graphic medium can potentially bridge the gap in understanding, making meaning seamless to the reader.

This project investigates the impacts of embedded AR in storybooks in two key areas: increasing readers' motivation and interest, and facilitating comprehension through vocabulary building and knowledge transfer.

Methodology

Nyatoh the Friendly Tree was the first of the Nyatoh trilogy chosen for AR applications. The book was selected for its content and characters, especially the endemic animals of Borneo. The Nyatoh Trilogy consisted of picture books filled with illustrations and minimal text on each page. Nyatoh the Friendly Tree introduced the scientific concept of symbiosis to promote a sustainable rainforest, alongside the endemic animals and creatures from Borneo.

AR graphical user interface designs were created using a Web-based Augmented Reality software. The AR application was user-friendly, as it did not require users to download any mobile application to function. In total, there were eight AR scenes in the storybook. The AR used was marker-based, utilizing QR codes attached to the surface of the book pages. When readers held a phone in front of a marker, they could view digital content superimposed on the marker in their hands. The content included 3D and 2D visualizations (Figure 1), interactive animations, or external links to different applications or pop-ups (Figure 2). Readers could interact with the virtual 3D models by zooming in on the AR from different angles; essentially, the AR production moved and rotated with the readers' movements. Readers could also take fun photos with the characters from the storybook through AR.

The markers were placed on relevant pages following the plot of the story to stimulate and sustain readers' interest, serving the first purpose of this study. The placement of the markers was based on the first two categories of motivation (Keller, 2008), namely bringing attention to the characters and the relevance of the plot build-up, including the introduction of side characters on subsequent pages.

To enhance reading comprehension and knowledge transfer, the second purpose of this study, three AR pop-up scenes were created. The quiz was placed on the second last page of the book, using multiple-choice questions to test understanding of the storyline. Feedback was provided based on the correctness of the answers. Another AR pop-up was a vocabulary enhancement page where readers could hear the pronunciation of words, watch motion graphics, and read sentences in which the vocabulary was used in context. The last AR pop-up was an information page introducing new knowledge about the main and side characters of the story. This provided additional information about the characteristics of the animals and the environment in the story, ultimately creating new knowledge transfer and adding another layer of interpretation to the story (Figure 2).

Figure 1: Augmented Reality of 3D models in the storybook

Figure 2: Rainforest Information Page (left) and Augmented Reality Quiz Pop-up and Vocabulary Enhancement Pop-up (right)

The read-aloud sessions took place at an urban primary school and were divided into two groups: Year 6 (age 12) with 82 students and Year 4 (age 10) with 78 students. Each session lasted for 1 hour and 30 minutes and included the following activities:

Table 1: Activities and materials used in read-aloud session

	Activities	Materials:
1	Read-aloud & interactive questions & answers	Power-point version of *Nyatoh the Friendly Tree*
2	Storyboard plotting	Booklets
3	AR experience	Books with QR codes & smartphones
4	Feedback on questionnaire	Manila cardboard and stickers

After the read-aloud session, the presenters introduced the characters and settings of the story for the students to use in their storyboard plotting. The students were divided into groups of five to work on their storyboard plots. While working on their stories, each group was invited to try out the AR applications on their smartphones. After completing the AR activity, the participants were asked to respond to four simple questions that encouraged them

to reflect on their experiences with AR. The questionnaire collected feedback in two categories. The first category inquired about the participants' interest, engagement, and interaction with the story, while the second category focused on their comprehension of the language and the story. Participants were asked to rate their experiences with the options 'Agree' and 'Not Agree.' The data collected from the questionnaire was presented and analyzed using a statistical percentage table (Table 2). In addition to the feedback, the participants' reactions to the AR experience were observed by the teachers.

Results

A total of 82 students from Year 6 and 72 from Year 4 participated in this read-aloud project. However, not all students provided feedback through the questionnaire. From Year 6, a total of 133 responses were recorded, while Year 4 yielded 211 responses. The lower feedback response rate from Year 6, despite being a larger cohort, may be attributed to students rushing back to their groups to complete their storyboard plotting after engaging with AR application. In contrast, Year 4 students enjoyed the AR experience more and spent more time answering the questions, resulting in a higher participation rate.

Table 2: Learners' experience of AR across two categories

	Category	Year 4		Year 6	
		Agree	Disagree	Agree	Disagree
A	Interest, engagement & interaction with story	97%	3%	100%	0%
B	Comprehension of language & story	72%	28%	70%	30%

Table 2 displays the comparison of Year 4 and Year 6 learners' experiences with AR across two categories in a percentage table. As indicated in Table 2, there was a consistent trend in the acceptance of AR by both groups. Year 4 and Year 6 students expressed overwhelmingly positive feedback, with agreement rates of 97% and 100%, respectively, regarding the enhancement of their interest, engagement, and interaction with the story. However, when it came to the category of comprehension of language and story, there was a decrease of approximately 30%, with both Year 4 and Year 6 students indicated approximately 70% agreement.

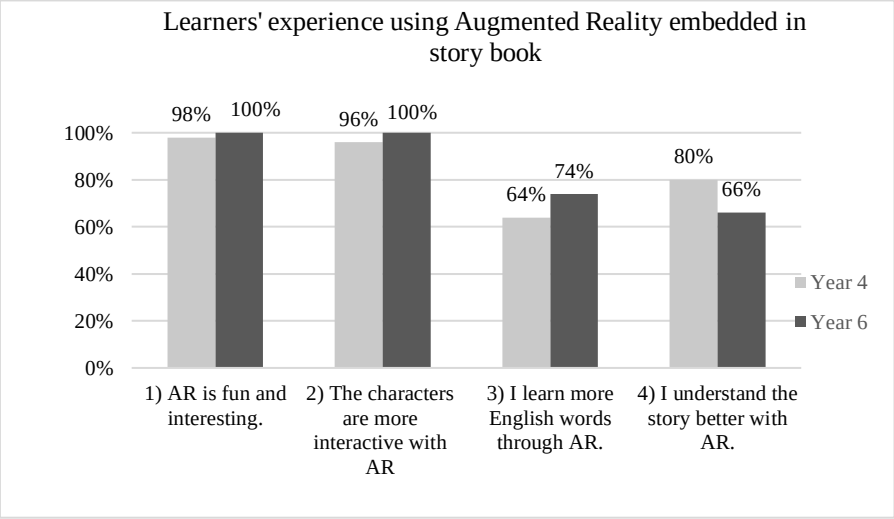

Figure 3: Learners' agreement on experiences with AR

Figure 3 displays descriptive bar charts illustrating participants' agreement with the questionnaire items listed in Table 2. Items 1 and 2 fall under the first category (Interest, Engagement & Interaction with the Story), while items 3 and 4 belong to the second category (Comprehension of Language & Story).

Both Year 4 and Year 6 recorded nearly 100% agreement with item 1 'AR is fun and interesting' and item 2 'The characters are more interactive with AR'. However, there was a 10% difference between Year 4 and Year 6 for

item 3 (I learn more English words through AR), with Year 6 recording a higher percentage. Regarding item 4, (I understand the story better with AR), Year 4 recorded an 80% agreement rate, while Year 6 recorded 14% lower.

During the observation of participants' behavior and interactions while using AR, the researchers noted some of their body language and verbal expressions while interacting with their peers. Participants from both groups generally displayed excitement, eagerness, and curiosity about the applications. They eagerly held the smartphones and experimented with the AR features. Their expressions included phrases like 'Cool!', 'Wow!', 'Woo Hoo!', 'Ohhh!', and 'Nice!'. They moved around and took turns using AR.

Discussions

The scientific benefits of reading from a printed book cannot be denied, as numerous studies have shown that readers who engage with print media develop cognitive skills and achieve better academic success. With AR technology embedded in print media, it can create a novel reading experience that is both physical and virtual.

Students from the study found that using AR in stories made the stories more interesting and engaging. They continued reading because AR kept them connected with the characters in the story. Following the plot and seeing characters popped up in 3D made the experience surreal. It was a great way for readers to interact and engage with the main and side characters of the story. This result is supported by other studies (Lee et al., 2019; Kaufmann & Dünser, 2007; Liu et al., 2009; He et al., 2014; Yilmaz et al., 2017) where student motivation and autonomy in reading increased with the usage of AR. Due to the interactive and hands-on experience, the learning experience was fun and did not feel like conventional learning. Another factor is the mobility feature, where students could moved about while interacting with the story, AR experiences, and peers. Similar results from He et al., 2014; Mawer and Stanley, 2011; Reinhardt and Sykes, 2014, were noted, where education was merged with games and entertainment, raising students' motivation.

Even though the score for comprehension of language and story was lower than the first category, they still indicated a positive impact of AR on vocabulary comprehension, aiding in the overall understanding of the story. Words that were too difficult could be checked through the AR vocabulary enhancement portal for synonyms. The pop-up page worked its magic through graphic motion animation, depicting the meaning of the word. A sentence with the vocabulary in context was given to consolidate the meaning of the word. Comprehension quizzes and feedback on the answers prompted readers to recall, retell, and test their understanding of the story's message. Due to these multimedia representations, students excelled in comprehension and vocabulary. One possible explanation is that reading through AR representations requires less decoding effort in the learning process because the multimedia features may have facilitated the exchange of information between the reader and the text, helping in better comprehension (Doty et al., 2001; Danaei et al., 2020).

Another reason students comprehend the story better with AR books is due to animations. Visualization and animation of the story details support the sense-making of non-verbal representation and enhance visual comprehension, particularly in abstract or scientific concepts like symbiosis (Kao et al., 2016; Danaei et al., 2020). The researchers explained that cognitive load is reduced when a large amount of printed text is represented with multimedia content. The AR characters that exhibit different facial expressions can demonstrate feelings and moods, attracting students' attention and immersing them in the story. They concluded that motion attracts visual attention and changes the way students process illustrations, seeming to scaffold learning by guiding children's visual attention.

Despite the overwhelmingly positive responses, around 30% of the participants did not find the experience useful in aiding the comprehension of words or the story. This could be due to several factors like the lack of technical knowledge, distraction by tablets, and chaos, which may have hindered them from learning new words. These weaknesses resonate with previous studies by Lee et al., 2019 (which scored 56-60% for games in helping to learn vocabulary) and Kaufman and Dünser, 2007, who reported issues of usability and not accounting for individual differences when designing software.

AR embedded storybook seems to capture the motivation and interest of students to read more. If more storybooks are embedded with AR technology, it could encourage more students to initiate self-reading on a regular basis. Although there are free AR software and converting AR software is not too challenging, the issue with copyright and patent remains. A certain amount of costing is required to purchase AR technology. Not only that, teachers

must have an interest in AR application and be trained to embed books with AR. Compare to other ways of encouraging reading, AR not only used digital technology, something young learners are familiar with, AR encourages self-initiative and independent reading because it is able to bridge the comprehension gap with difficult vocabulary. With the added vocabulary enhancement page, difficult words can be explored without needing to have a teacher or adult reading supervisor constantly beside them. Thus, students can learn autonomously with the assistance of AR.

Other considerations for future studies could include training students to use technology appropriately and taking individual learning differences into account when designing software applications. Another aspect to consider is the role of social support while using technology in language learning, particularly the increase in interaction between teachers and peers, leading to a successful vocabulary gain (Bannard & Tomasello, 2012; Walter-Laager et al., 2017) which calls for teacher training and guidance before implementation.

Conclusion

Preliminary evaluation shows optimism that AR heightens the reading experience through its interactive features. AR potentially fulfills the changing needs of today's readers who are immersed in electronic gadgets, simultaneously ensuring the continuity of reading print media that is ubiquitous. AR-embedded storybooks have wide and far-reaching consequences in encouraging emergent readers to love reading print media. When there is an increase in motivation and interest in the story, and when comprehension of language and the story is enhanced, there is an active and immersive learning experience. This would ensure the continuity of reading for pleasure among young readers and increase the chances of self-initiated reading. The potential for AR in encouraging reading in an interactive environment is promising.

Limitations and Future Studies

The results of this read-aloud project could be extended to include more participants in different schools over an extended period of time for validity and to reduce the novelty effect, which may affect the results. This study, like many previous studies, has proven that AR technology plays a pivotal role in enhancing learning; however, the research is still in its infancy stage. Further research could include identifying individual learning styles in software design, training teachers and students on how to use AR, and recognizing the most suitable learning activities that would benefit from AR technology.

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