Journal of Theoretical and Applied Information Technology
15th February 2023. Vol.101. No 3

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

CHILDRENS' HAPPINESS, ENJOYMENT, PERCEIVED MOTIVATION AND ACHIEVEMENT TOWARDS SCIENCE AUGMENTED REALITY PICTURE BOOK

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ABSTRACT

This study aims to explore the application of an augmented reality (AR) picture book in science subjects among children. A mixed-method research design was adopted where qualitative and quantitative data were collected and corroborated to address the research questions. There were 60 children aged-six years old with 33 boys and 27 girls that were involved in this study. Data were collected using surveys, interviews, and pre and post-test questions. The findings showed that children were happy to learn science using the AR picture book due to the vibrant colours and animation portrayed. Children's level of happiness was found to have a significant and positive relationship on their achievement. These results provide a promising perspective of AR technology for children's learning and contribute to the scarce study on AR among children. Future research on the use of AR technology for other subjects or younger children could be further explored to provide insight into children's learning through AR as an early childhood intervention.

Keywords: *Augmented Reality; Children, Happiness; Enjoyment; Perceived Motivation; Achievement; Science Augmented Reality Picture Book*

1. INTRODUCTION

There has been a keen interest in Augmented Reality (AR) applications in recent years, wherein the explosive development of this dominant technology has contributed to an expansion of science pedagogy. In the light of the Horizon reports published each year by [1], it has been noted that AR technology is outstanding in having a prompt influence on education in the future. Notwithstanding, [2] noted that AR may potentially have an influence and a seductive effect on the transformation of education. Indeed, the usage of it has received a focal view, notably from educational researchers.

Research on AR has been conducted since the early 1990s and the term AR was coined by Caudel and Mizell in 1992 where it was applied in manufacturing applications. Augmented technology is a technology that integrates virtual 3D objects with the real physical world, whereupon it enables users to interact with overlays of virtual objects. Pursuing that, several attempts have been made to define the principle of AR as an interactive system with three characteristics exemplified, involving the integration of real and virtual information, real-time interactivity with virtual objects, and subsequently three dimensional registration for users' experience [3].

In early childhood education, AR can provide children with new and exciting ways to explore and understand the world around them. By bringing digital content to life, AR can help to foster curiosity, imagination, and creativity in children, as well as develop their technical and critical thinking skills. The technology of AR also helps children to develop their social and emotional skills [4]. Through collaboration and teamwork, children can work together on AR projects, improving their communication and interpersonal skills.

Additionally, AR can also provide a safe and controlled environment [5]. With its ability to create interactive and immersive experiences, AR is poised to play a significant role in shaping the future of early childhood education. By providing children with engaging, interactive, and personalized learning

experiences, AR can help to foster the development of critical skills and provide them with the foundation they need to succeed in their future studies and careers.

Augmented Reality (AR) has transformed children's picture books by incorporating various art forms through the use of digital images, audio processing, and dynamic image technology. By incorporating AR, picture books are becoming increasingly engaging, enriching children's senses, and broadening their perspectives [6]. Picture books with AR technology elevates the multi-sensory experience of reading picture books. With a variety of features like multi-touch, voice interaction, and other AR-powered interactive elements, children become more engaged and involved in the reading process. Rather than being just a one-way dissemination of information, picture book reading with AR allows children to participate through sight, hearing, and touch.

Assessing the integration of new technologies is always valuable and can be enhanced by examining children's attitudes towards AR. However, there is a lack of research on the impact of AR on children's happiness and enjoyment. The level of enjoyment when using technology can be determined by the personal enjoyment felt while using it [7]. Positive emotions such as enjoyment is important as it is related to students' performance. It is uncertain whether the use of AR contributes to children's overall happiness and well-being. Despite [8] reported that children were happy and enjoyed using AR picture books, the use of this AR picture book was on storytelling and not science. Therefore, this study examined happiness and enjoyment as variables for science learning because both are key indicators of positive attitudes towards technology.

Previous studies have found that AR impacted positively on students' motivation and achievement [9] [10]. However, AR was not effective for those who showed high academic achievement [11]. In addition, numerous studies have been conducted on AR in science education. However, [12] found that most AR studies in the science education area were predominantly focused on higher education settings as well as primary and secondary schools. Of the reviewed studies, only one study of science learning was involving children.

In addition, previous studies also recommended that there is a need for more studies on AR in early childhood education as it was scarce [13] [14] [15]. Therefore, this study also investigated children's motivation and achievement after using an AR picture book for science learning. Moreover, previous study also recommended investigating the relationship between enjoyment and performance [8]. Hence, in this study, the correlations between happiness, enjoyment, perceived motivation, and achievement were explored.

1.1 Research Objectives

1. To investigate children's level of happiness and enjoyment towards the Science AR Picture Book.
2. To investigate children's level of perceived motivation towards the Science AR Picture Book.
3. To investigate children's level of achievement after using the Science AR Picture Book.
4. To investigate the relationships between happiness, enjoyment, perceived motivation and achievement.

1.2 Research Questions:

1. What is the children's level of happiness and enjoyment towards the Science AR Picture Book?
2. What is the children's level of perceived motivation towards the Science AR Picture Book?
3. What is the children's level of achievement after using the Science AR Picture Book?
4. Are there correlations between happiness, enjoyment, perceived motivation, and achievement?

1.3 Learning Science with an Augmented Reality (AR) Book

In particular, AR technology has been discovered as an eminent platform for learning science in an educational region. A study by [16] observed that students have frequently experienced the difficulties in learning a science subject due to the abstract concept enclosed within it. Therewith, in pursuance of stimulating children's understanding about abstract concepts or phenomena, mobile technologies have been incorporated into certain physical activities, whereupon mobile augmented reality applications as well as a highly interactive physical interface design AR book are employed and developed. Augmented physical books are enriched with the virtual object of 3D models, simulation, sound and animations as visualised over a mobile device itself. Likewise, this illuminating technology

of interfaces augmentation imparts the future prospects for young children to learn virtually.

1.4 Augmented Reality in Early Childhood Education

Nowadays, pedagogy of teaching and learning in early childhood education settings has been addressed as a fundamental role for children's development. Thereafter, this pedagogy itself was categorised in accordance with the social interactions and knowledge construction, digital media production as well as teaching and learning with digital technology [17]. In achieving mastery of the object and furthering symbolic ability, play is an essential instrumental for preschoolers, upon which they are driven and motivated by their need to suppress immediate impulses and their need for instant gratification. Further to this, it is the source of development and establishes the zone of proximal development (ZPD) [18].

Nevertheless, [19] investigated the efficacy of astronomy science education activities among preschool children in the age range from 5 to 6 years old. The results revealed that the new concepts related to the learning subject of "Exploring the sky" activities positively affected their curiosity and passion concerning the subject matter discovered. The comprehended activities children had approached also assisted them to utilise their scientific practice skills as the developmental characteristics such as linguistic, social-emotional, motor and cognitive domains were examined among them, respectively. Not only that, but children also mentioned that the topics in astronomy were best portrayed in three dimensions and were highly realistic using augmented reality applications and a three-dimensional representation was intended to aid children's recall of knowledge during the preschool period.

2. METHODOLOGY

2.2 Research Design and Participants

The research design of this study was explanatory sequential design of mixed-method study [20]. In this study, quantitative data were first collected through surveys including the happiness survey, enjoyment survey, children motivation survey with emoticons, pre-test and post-test for achievement. Subsequently, one-to-one interviews with participants were conducted. A comprehensive interview protocol was developed to provide further information and insight into children's happiness and enjoyment towards the Science AR Picture Book.

A total of 60 children aged-six years old with 33 boys and 27 girls were involved in this study. Noticing that the participants had not yet been able to read proficiently, the questions were read to them. In addition, all the emoticons used for the scale were printed in large sizes to facilitate the data collection process, with which the participants could simply show their chosen emoticons that represent their preferences. Figure 1 depicts the data collection process for this study.

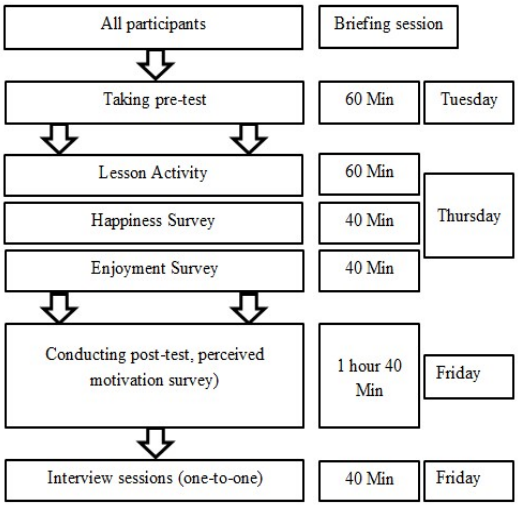

Figure 1: Research procedure of this study.

Quantitative data were analysed using the Statistical Package of Social Sciences (SPSS) by applying descriptive, inferential and correlational analysis. On the other hand, for qualitative data, NVivo12 was used to analyse the eight childrens' responses on their happiness and enjoyment of the Science AR Picture Book. A thematic analysis [21] was used to analyse the interview transcripts.

3. RESULTS

The results of this study were reported based on the research questions.

RQ1: What is the children's level of happiness and enjoyment towards the Science AR Picture Book?

Table 1 presents the children's level of happiness towards the Science AR picture book. The level of children's happiness when using the Science AR Picture Book were determined by a five-point Likert scale (5 = very happy, 1 = very unhappy) of the happiness survey. Majority of them reported feeling very happy (M = 4.80, SD = .44).

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Table 1. Mean and Standard Deviation of Happiness level towards the Science AR Picture Book

Dependent Variable	*f*	Percentage (%)	Mean ($\underline{x}$)	SD
Level of Happiness	60	100	4.80	.44

Meanwhile, in Figure 2, 82% of the children were very happy with their AR learning experience. Figure 3 and Figure 4 show the results for boys and girls, respectively. About 82% of boys in Figure 3 were very happy, 15% happy and the remaining 3% were neutral and the percentage of girls illustrated were 81% very happy and 19% happy after learning with the Science AR Picture Book.

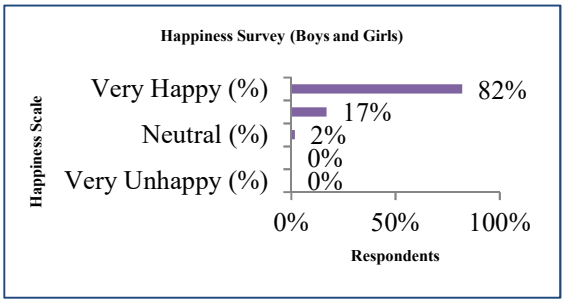

Fig. 2. Children's (Boys and Girls) happiness level after conducting the Science AR Picture Book lesson activity

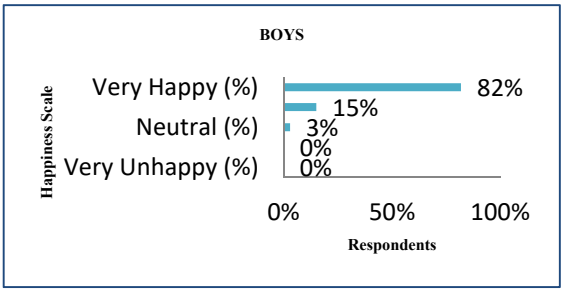

Fig.3. Happiness level of boys after conducting the Science AR Picture Book lesson activity

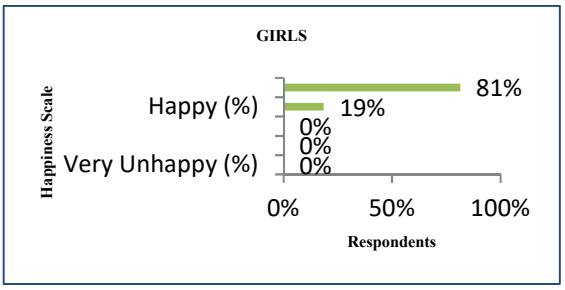

Fig. 4. Happiness level of girls after conducting the Science AR Picture Book lesson activity

Table 2 presents the children's level of enjoyment towards the AR picture book. In this study, children's enjoyment of the Science AR Picture Book was determined by an ordinal scale ("I agree," "Neutral," "Disagree"). The results showed that all children enjoyed the activity (M = 11.85, SD =.61). They found the SARPB interesting (M = 2.93, SD =.312) and fun (M = 2.97, SD =.181) and stated that "I like using it" (M = 2.97, SD =.181) and "Studying with Science AR Picture Book is enjoyable" (M = 2.98, SD =.13).

Table 2. Mean and Standard Deviation of Enjoyment level towards the Science AR Picture Book

Level of Enjoyment	*f*	Percentage (%)	Mean ($\underline{x}$)	SD
Studying is more interesting using Science AR Picture Book	60	100	2.93	.31
Using the Science AR Picture Book is fun	60	100	2.97	.18
I like using the Science AR Picture Book	60	100	2.97	.18
Studying with Science AR Picture Book is enjoyable	60	100	2.98	.13

3.2 Qualitative Findings of Happiness and Enjoyment Level

One-to-one interviews observed that children had both positive and negative responses during their activity for Science AR Picture Book learning. Table 3 above provides some examples of participants' statements and children felt very happy and excited as well as interested when using this AR application with great animations and moves. The objects were moved and perceived to be colourful. In addition, the colours of the Science AR Picture Book were described as numerous and diverse in colour, such as blue, green, white, yellow, red and brown. Furthermore, children were always eager to learn the topics embedded in the book and were obsessed with doing exercises, respectively.

In addition, for the enjoyment category, they found the book attractive and entertaining because of its image that was moving around with a large object. One of the entertainment factors was the appearance of a book like real pictures or images, wherein they found a picture of torchlight and moving shadows. They also perceived and expressed their interest in

learning and reusing this application in the future. In brief, the happiness levels of the children were determined and explored to be high for a happiness category as compared to the other categories.In comparison, some of the children also described an adverse performance of an unfavourable feelings or opinions of happiness and enjoyment category towards the Science AR Picture Book as a very small image as well as they noticed that the applications were both vague and tiny. From the open-ended questions, one of the children stated that *"I don't like this app because it has no sounds…"* They also shared their thoughts and implied that "*I saw a very small motion picture…" "The images in this app are vague and small…"* With regard to the restraints of the aforementioned AR applications, some visual sound and small screen issues were raised. In this context, it is important to analyse and decide further how the sound and animation impact AR applications, as elements were crucial to stimulate their emotion and entertainment during the Science AR Picture Book learning.

Table 3. Summary of the themes and examples of children's statement

Themes	Categories	Codes	Examples of children's statement
Positive performance	Happiness (*Emotions*)	Fun	*I really enjoyed learning this book…*
		Very Helpful	*This Science AR Picture Book is very helpful to me.*
		Love study all the topics	*I love to study all the topics in this book…*
		So much fun	*I had so much fun learning this AR app…*
		Very helpful and fun because it has pictures.	*This Science AR Picture Book is very helpful and fun because it has pictures.*
		Like doing exercises	*I like doing exercises in this book of Science AR Picture Book…*
	Enjoyment (*Entertainment*)	See pictures of objects	*I can see pictures of watermelons, ice cream, leaves, cups and bell rings in this app..*
		Very happy and excited	*I'm really happy and excited seeing this AR app...*
		Very interesting and colourful	*The colors in this Science AR Picture Book book are very interesting and colorful.*
		Really enjoy learning this title	*I really enjoy learning the title of Light and Shadow...*
		Contain colours	*There are blue, green, white, yellow, red and brown colors in this Science AR Picture Book.*
		The lights for creating shadows	*The lights in the app are for creating shadows.*
		Very good animations and moves	*There are very good animations and moves.*
		Interesting	*I love using this book because it is so interesting …*
		Learn again	*I want to learn again using this AR application …*

		Pictures are moving around	*Pictures in this app can move around.*
		Pictures are moving and larger	*Pictures in this app can move and are large.*
		Picture of torchlight and moving shadows	*I saw a picture of torchlight and moving shadows…*
		Appears like the real pictures	*The pictures appear like the real pictures*
Adverse performance	Unfavourable feelings or opinions of happiness and enjoyment	Has no sounds	*I don't like this app because it has no sounds…*
		Very small motion picture	*I saw a very small motion picture…*
		Images are vague and small	*The images in this app are vague and small.*

RQ2: What is the children's level of perceived motivation towards the Science AR Picture Book in science subjects?

Table 4 presents the mean and standard deviation of perceived motivation level towards the Science AR Picture Book. Perceived motivational level of the Science AR Picture Book was determined by a five-point Likert scales involving the following options: ("Strongly Agree," "Agree," "Neutral," "Disagree", "Strongly Disagree"). As shown from Table 4, the results displayed children were motivated towards the lesson activity using the Science AR Picture Book (M = 57.15, SD = 3.11).

Table 4. *Mean and Standard Deviation of Perceived Motivation level items towards theScience AR Picture Book*

No.	No. Items	Mean ($\underline{x}$)	SD
1	I learned something new in this Science AR Picture Book.	4.78	.45
2	I think the animation in this Science AR Picture Book is attractive.	4.80	.40
3	I think this Science AR Picture Book is interesting	4.82	.43
4	I think it's worth learning using this Science AR Picture Book.	4.78	.45
5	I think the content of this Science AR Picture Book is useful to me.	4.78	.45
6	I think it's important to complete this Science AR Picture Book.	4.68	.47
7	I am confident in discussing light and shadow after using this Science AR Picture Book.	4.75	.47
8	During lesson activity, I am confident that I understand the Science AR Picture Book.	4.68	.47
9	I think this Science AR Picture Book is easier than I expected.	4.65	.52
10	I enjoy the content of this Science AR Picture Book.	4.83	.42
11	I am gratified with the 3D animation in this Science AR Picture Book.	4.80	.40
12	I am pleased to complete this Science AR Picture Book.	4.78	.42

RQ3: What is the children's level of achievement towards the Science AR Picture Book in science subjects?

Table 5 presents descriptive statistics of achievement level towards the Science AR Picture Book. The mean post-test score for 60 respondents was 5.00 as compared to the mean of pre-test score of 4.77.

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Table 5. *Descriptive statistics for Achievement level towards the Science AR Picture Book*

Achievement Test	N	Mean ($\underline{x}$)	SD
Pre-test	60	4.77	.65
Post-test	60	5.00	.00

Table 6 presents the t-test results with mean achievement score (M= 4.88, SD= 0.32) and showed a statistically significant difference (t = -2.79, p < 0.05).

Table 6. *The t-test results for achievement level towards the Science AR Picture Book*

Test	N	M	SD	t	df	p
(Achievement Score)	60	4.88	0.32	-2.79	59	.01

* p < .05

RQ4: Are there correlations between the variables of happiness, enjoyment, perceived motivation, and achievement towards the Science AR Picture Book in science subjects?

Table 7 presents the Spearman's rho correlation coefficient among variables of happiness, enjoyment, perceived motivation as well as achievement. From the table, the correlation coefficient (r_s) between the variables of happiness and achievement was 0.32. There was a weak and positive correlation between those variables towards the Science AR Picture Book and there was a significant difference at the 0.05 level, $r_s = .32$, $p = .01$.

Table 7. *The Spearman's rho correlation coefficient between variables*

	Happiness	Enjoyment	Perceived Motivation	Achievement
Happiness	1			
Enjoyment	.03	1		
Perceived Motivation	.09	.25	1	
Achievement	.32*	-.12	.02	1

* $p < .05$

4. DISCUSSION

In this study, the Science AR Picture Book was integrated to explore children' level of happiness, enjoyment, and perceived motivation. This study also investigated children's' achievement after using the Science AR picture book. Positive attitudes such as excitement, enthusiasm, and engagement were found to enhance children's learning experience and improve their motivation, attention, and memory retention.

This study showed that using a Science AR Picture Book in learning activities improved children's happiness and enjoyment. As shown in Figure 2, the findings suggest that most of the children were very happy. There have been several studies that have explored the impact of AR picture books on children's happiness, enjoyment, perceived motivation, and learning achievement [22] [23]. Overall, the results have been positive, with many children having increased happiness and enjoyment when using AR picture books.

In terms of perceived motivation, AR's interactive and immersive nature has increased children's motivation to learn science and new information. AR technology has also enhanced children's motivation to explore and discover new content in picture books. By combining the real and virtual elements, AR technology can create a dynamic and immersive learning environment that can increase children's attention and information retention. The technology of AR can also provide personalized and adaptive learning experiences, allowing children to learn at their own pace and level. This current study discovered that integrating AR technology in science learning activities improved children's emotional states and enhanced their perceived motivation. The results align with [24], where children had increased motivation in literacy by applying AR technology.

The results also showed that children's achievement was increased after using the Science AR Picture Book. Previous studies have found that AR picture books can improve children's learning outcomes [25] [26]. This is due to children's willingness to participate in the learning activities, ask questions, and engage in hands-on learning experiences prompted by AR technologies [27]. The technology of AR technology also enabled children to visualize and comprehend complex scientific concepts more meaningfully and interactively. Augmented Reality (AR) technology can enhance the educational experience by providing interactive and engaging multimedia materials that foster children's motivation and improve their learning performance.

Moreover, as shown in Table 7, the results revealed a significant positive relationship between children's level of happiness and achievement towards the Science AR Picture Book. This finding supports the study by [28] that using AR applications in education had a positive relationship between attitude and children's achievement.

In conclusion, the findings suggest that AR picture books have the potential to positively impact children's happiness, enjoyment, perceived motivation, and achievement. However, it is essential to note that more research is needed to understand AR's effects on children's development fully. The study highlights the importance of considering attitudes as a crucial feature in children's learning and AR technology's potential to impact learning outcomes positively.

5. CONCLUSION

The results of this study showed that children felt happy and enjoyed learning science through an AR picture book. It was also found that there is a positive but weak correlation between happiness and achievement in this study. Future research can explore the relationship between AR and children's enjoyment in learning, and to determine the factors that contribute to their happiness and achievement when using AR technology.

Children's perceived motivation was also increased and their achievement was enhanced after using the AR picture book for science learning. Further studies are needed to understand how AR technology can motivate children and enhance their academic achievement. It is important to assess if the impact of AR on children's learning outcomes are different with different levels of academic achievement.

Moreover, research on early childhood education is limited, making this study valuable in filling a gap in the literature. In light of this, there is still a need to explore how AR technology can be effectively integrated into early childhood education curriculums to enhance learning outcomes and increase students' enjoyment and motivation. In addition, future research is needed to determine the impact of AR technology on children with different learning styles and abilities, such as visual or auditory learners, to ensure that AR is accessible and beneficial to all children.

Overall, these future research directions highlight the need for further investigation into the role of AR in early childhood education. Exploring the long-term impact of AR technology on children's learning and development can help guide the development of AR technology that supports children's learning and well-being.

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