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Students' Interest in Learning Technology and Biodiversity Misconceptions: An Empirical Basis for the Development of AR-Based Informal Learning at Zoo Johor

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Abstract

This empirical basic study was conducted to support informal learning related to biodiversity at Zoo Johor. The main issue of this study is the existence of misconceptions among students regarding biodiversity, including animal habitats, the differences between zoo and wild animals, and the diets of certain species. At the same time, the existing interpretive materials at the zoo are still lacking in interactivity and do not help students understand the concept of biodiversity in depth. The study uses a pre-experimental design involving 20 students aged 7 to 17 years. The research instruments consist of a questionnaire on interest in Augmented Reality (AR) technology, diagnostic items on biodiversity misconceptions, and descriptive analysis to assess user needs for the development of Augmented Reality (AR) in learning is high, with mean scores ranging from 3.25 to 3.70. Students also showed a positive inclination toward the use of 3D animations, interactive maps, and quizzes as important components in the learning application. However, the level of biodiversity misconception is at a moderate level (Mean = 2.05 - 2.25)**,** indicating a significant confusion regarding the basic concepts of biodiversity. This study concludes that the development of AR applications has great potential as an informal learning medium that can enhance interest, improve understanding of scientific content more accurately, and reduce misconceptions among students.

Keywords: Augmented Reality, AR Application, Biodiversity, Informal Learning, Zoo Johor, Student Misconceptions

Introduction

Biodiversity education is a critical component of science and environmental education as it not only enables students to understand the diversity of life and organismal interactions but also fosters awareness of the impacts of human activities on ecosystems. However, previous studies have shown that students in Malaysia still exhibit significant misconceptions regarding animal habitats, species diets, and the differences between wild animals and zoo

animals (Karpudewan et al., 2020; Rosada, Susilo, & Gofur, 2022). These misconceptions often arise from inaccurate prior knowledge, misleading media exposure, and overly simplified formal learning methods. The lack of interactive and contextual learning materials, particularly during zoo visits, impedes students' deep understanding and reduces their interest in biodiversity learning. Consequently, there is a pressing need for more effective learning interventions. Previous research has highlighted the effectiveness of technology in enhancing student motivation, interest, and comprehension. Ahmad & Abu Samah (2024) found that the use of Augmented Reality (AR) applications in science education, including biology, positively impacts students' motivation, acceptance, and academic performance. Similarly, Yusof et al. (2022) emphasized that AR has the potential to create a more dynamic learning environment, particularly for students who are less motivated by traditional instructional methods. Furthermore, Hassan, Ismail, & Tan (2023) demonstrated that AR not only supports informal learning but also increases student engagement and attracts tourist interest during zoo visits. In Malaysia, particularly at Zoo Johor, there is currently no AR application specifically designed to support interactive and contextual biodiversity learning. This pedagogical gap forms the basis for developing an AR-based learning tool. Preliminary research conducted by the researcher with 20 students aged 7–17 years indicated that students exhibit a high level of interest in using AR (Mean = 3.25–3.70), while their level of misconceptions remains moderate (Mean = 2.05–2.25). Students showed a positive inclination toward the use of 3D animations, interactive maps, and quizzes; however, confusion regarding fundamental biodiversity concepts persists. These findings reinforce the justification for developing an AR intervention that not only enhances student interest but also effectively reduces misconceptions. Based on both preliminary and prior research findings, the development of an AR application is conceptualized as a strategic and practical learning medium that allows students to engage actively through visual, auditory, animated, and quiz-based interactions. This approach overcomes the limitations of conventional learning methods and provides a learning experience tailored to the profiles of local students, making it relevant and effective in the context of informal zoo-based education.

Beyond benefiting students, this study is also significant for teachers, zoo managers, and educational policymakers, as it provides empirical data that can be used to enhance science and biodiversity teaching strategies holistically. By emphasizing the utility, effectiveness, and practical impact of AR, this study establishes a strong foundation for the development of interactive and engaging learning tools that support conceptual understanding of biodiversity, increase student interest, and address existing educational gaps in local zoo settings.

Problem Statement

Primary and secondary school students often have misconceptions about biodiversity, including misunderstandings about animal habitats, the differences between zoo and wild animals, and the diets of specific species. Although numerous international studies have examined biodiversity misconceptions, research focusing on the learning context in zoos among Malaysian students remains limited. Most local studies only focus on classrooms, not informal learning environments like the Zoo Johor.

In Malaysia, most zoos still rely on static information boards, printed brochures, and passive guided tours (Hassan et al., 2023). At the Zoo Johor, interpretive materials such as

information boards and traditional tours are still not interactive enough and are unable to convey the concept of biodiversity in depth, especially to student generations who are more inclined toward visual and digital learning. The absence of technology-based learning materials also makes the visit experience less impactful and does not help to reduce existing misconceptions.

International studies (Garzón et al., 2020) state that the use of AR in education can increase student engagement and motivation thru gamification elements and immersive experiences. Although Augmented Reality (AR) technology has proven effective in enhancing motivation and understanding in informal learning contexts, there is still no specific AR application for Zoo Johor that can deliver biodiversity information visually, realistically, and interactively. The review results also show that students have a very high interest in using technological elements such as 3D animation, interactive maps, and quizzes in learning applications. This situation creates a research gap, namely the lack of AR-based interactive learning platforms that can combine immersive digital experiences with biodiversity learning in zoos. Therefore, the development of AR applications becomes relevant and critical as an innovative medium to enhance understanding of biodiversity concepts, reduce misconceptions, and meet the needs of a generation of students who are more inclined toward visual and digital learning. Therefore, there is an urgent need to develop AR applications that can help reduce biodiversity misconceptions, support informal learning, and enhance the visitor experience at Zoo Johor.


Methodology

Research Design

This study was conducted using a quantitative survey design aimed at assessing students' interest in technology and identifying their misconceptions about basic biodiversity and wildlife ecology concepts. This survey approach allows for the systematic collection of data from a relatively large number of respondents using easily manageable methods, thus providing an initial overview of students' readiness to engage in technology-based learning.

Instrument

The study instrument was developed in the form of a Google Form consisting of three main sections. The first section covers the demographic profile of the respondents, including gender, age, race, education level, location of residence, and experience visiting zoos. The second part focuses on students' interest in technology and interactive learning, measured using a Likert scale to assess students' readiness and excitement toward digital learning tools. The third section includes misconceptions related to biodiversity, designed based on fundamental ecological concepts such as animal diets, habitat adaptations, predator

behavior, and the differences between zoo and wild animals. Question types including Likert scales allow for easy quantitative measurement that is easily analyzed.

Sampling

The study sample consisted of 20 primary and secondary school students, with respondents selected using purposive sampling. This method was chosen based on specific criteria relevant to participant accessibility and suitability with the initial study objectives, which were to obtain baseline data on technology interest and misconceptions before developing the AR application.

Data Collection Procedure

Data was collected online via Google Forms and self-administered by the respondents. This approach allows students to answer questions at their own pace without pressure, while providing easily analyzable digital data records. This procedure also reduces the risk of errors during data transfer and allows for efficient information gathering, particularly in the context of primary school studies.

Data Analysis

The collected data were analyzed using descriptive statistics with SPSS software, including calculations of percentages, means, and tabular distributions to illustrate the patterns of students' responses. The questionnaire instrument used a four-point Likert scale (1 = Strongly Disagree to 4 = Strongly Agree) to assess students' levels of interest, acceptance, and readiness toward the use of technology. To measure students' misconceptions about basic biodiversity concepts, the questionnaire employed a different four-point Likert scale (1 = Very False to 4 = Very True), while the percentage of incorrect responses was also used as an additional indicator to identify the degree of students' misconceptions. The analysis of technology readiness utilized frequencies and means to determine students' tendencies toward technology-based learning. Overall, these data serve as a critical baseline needs assessment for planning the development of the AR application, which aims to correct misconceptions and effectively enhance students' understanding.

Research Findings

This section presents the descriptive analysis related to the respondents' demographics, their interest in technology and interactive learning, as well as the level of biodiversity misconceptions based on three diagnostic items. All findings are presented in tables accompanied by detailed interpretations. To obtain the interpretation of mean scores, this study refers to the guidelines by Harrell (2017), which provide a standardized method for determining score levels and are widely used in educational research. Since this study's instrument uses a four-point Likert scale without a neutral option, the mean score range has been adjusted as shown in Table 1. This adjustment enables the categories of low, moderate, and high levels to be determined more consistently, thereby facilitating the analysis and interpretation of data for each questionnaire item.

Table 1
Mean and interpretation of mean score (Harrell, 2017)

Mean Score	Interpretation
1.00 -2.00	Low
2.01- 3.00	Moderate
3.01- 4.00	High

Demographic Profile of Respondents

The demographic profile of the respondents provides an initial overview of the study's characteristics, including gender, age, ethnicity, education level, place of residence, experience using educational applications, and history of zoo visits. This information is important for understanding the students' sociodemographic background. Table 2 shows a demographic summary of the 20 study respondents.

Table 2
Demographic Profile

Background Demographics	Item	Frequency (N=20)	Percentage (%)
Gender	Male	8	40
	Female	12	60
Age	7–12 years	13	65
	13–17 years	7	35
Race	Malay	20	100
	Chinese	-	-
	Indian	-	-
	Other	-	-
Education Level	Primary School	13	65
	Secondary School	7	35
Location of Residence	Town	16	80
	Outside Town	4	20
Have you ever used educational applications?	Yes	20	100
	No	-	-
Number of Visits to Zoo Johor?	Never	10	50
	Rarely	9	45
	Sometimes	1	5
	Always	-	-

The respondents in this study consisted of students from a national primary school and secondary school, aged 7 to 17 years, with the residing in city or outside city areas. This demographic profile makes this initial study suitable as a baseline diagnosis for the target age group of the AR learning application at the zoo. This baseline diagnosis aims to assess students' knowledge level, interest in technology, and misconceptions about biodiversity before any intervention or use of the AR application is implemented. This baseline data will serve as a reference point for evaluating the effectiveness of the AR application in improving understanding of biodiversity concepts and correcting student misconceptions after the intervention.

Descriptive Analysis of the Interest Construct Toward Technology and Interactive Learning

Referring to Table 3, overall, respondents showed a high level of interest in using technology, digital games, and visual interaction-based learning. Analysis of items such as application usage, preference for visual media, and attitudes toward digital learning shows:

- Students are more interested in interactive learning compared to static textbook materials.
- Almost all respondents have basic skills in using digital devices.
- The digital learning environment is considered more engaging and easier to understand compared to traditional learning.

These findings confirm a high level of digital readiness among primary school students, making them a suitable target group for the use of AR applications. This result supports recent literature stating that digital generation students tend to show higher motivation when using interactive media.

Table 3
Descriptive Analysis of Interest in Technology and Interactive Learning Constructs

Num.	Item	Frequency				Mean	SD	Level
		Strongly Disagree (SD)	Disagree (D)	Agree (A)	Strongly Agree (SA)			
1	I like learning about animals and zoos using apps on my phone	-	-	13 65%	7 35%	3.35	0.49	High
2	Interactive applications like AR can help me understand science better	-	-	10 50%	10 50%	3.50	0.51	High
3	I prefer learning using images, animations, or games rather than just reading books	-	1 5%	8 40%	11 55%	3.50	0.61	High
4	I am able to use new technologies such as AR when visiting Zoo Johor	-	-	15 75%	5 25%	3.25	0.44	High
5	AR applications can make me more interested in learning science and the environment	-	-	9 45%	11 55%	3.55	0.51	High
6	3D animal animations can help me learn more clearly	-	-	11 55%	9 45%	3.45	0.51	High
7	Interactive maps and animal information labels	-	-	9 45%	11 55%	3.55	0.51	High

	are essential in AR applications							
8	I want this application to have quizzes or games to test understanding	-	-	8 40%	12 60%	3.60	0.50	High
9	The application needs to be easy for primary and secondary school students to use	-	-	6 30%	14 70%	3.70	0.47	High
10	The content in the application needs to be suitable for school learning	-	-	7 35%	13 65%	3.65	0.49	High

The study findings indicate that students' interest in using technology, including AR-based applications, is high for all evaluated items. Item 1 recorded a mean score of 3.35 (SD = 0.49), indicating that students are very interested in learning about animals and zoos using the phone application. Items 2 and 3 each received a mean score of 3.50, indicating that students believe interactive applications like AR can aid in science understanding and prefer visual learning such as images, animations, and games over traditional methods like books alone.

Regarding the aspect of readiness to use new technology, Item 4 shows a mean score of 3.25 (SD = 0.44), also at a high level, reflecting the students' willingness to use AR during their visit to Zoo Johor. Additionally, Items 5 and 6, which each recorded a minimum score of 3.55 and 3.45 respectively, further support the idea that AR and 3D animation can increase interest and aid students' understanding of science and the environment.

Next, Items 7 and 8 were also at a high level with mean scores of 3.55 and 3.60, indicating that students view interactive maps, animal information labels, and quiz or game elements as important components in AR applications to support their learning. Item 9, with a mean score of 3.70, indicates a high level of agreement regarding the need for an application that is easy for primary and secondary school students to use. Finally, Item 10 (mean = 3.65) confirms that students want application content that aligns with formal learning in schools.

Overall, all items showed high mean scores, proving that students have a very positive interest in using AR as an informal learning medium, in addition to demonstrating a willingness to use AR applications in educational contexts and visits to the Zoo Johor.

Descriptive Analysis of the Biodiversity Misconception Construct

Referring to Table 4, three instrument items were used to assess students' level of misconceptions about ecology and wildlife. Table 4 summarizes the results.

Table 4
Descriptive Analysis of the Biodiversity Misconception Construct

Num.	Item	Frequency				Mean	SD	Level
		Very False (VF)	False (F)	True (T)	Very True (VT)			
11	Eagles can live naturally in cities	-	16 80%	3 15%	1 5%	2.25	0.55	Moderate
12	Zoo animals are just like wild animals	-	3 15%	15 75%	2 10%	2.95	0.51	Moderate
13	All birds are herbivores	6 30%	8 40%	5 25%	1 5%	2.05	0.89	Moderate

Overall, the descriptive analysis for the biodiversity misconception construct shows that students' understanding level is moderate for all three items tested. For Item 11, "Eagles can live naturally in cities," the mean score of 2.25 (SD = 0.55) is at a moderate level, indicating there is still confusion about the ability of certain species to adapt in urban areas even tho the majority of students answered incorrectly. Item 12, "Zoo animals are the same as wild animals," scored a mean of 2.95 (SD = 0.51), also at a moderate level, indicating that many students still have the misconception that animals in zoos do not undergo changes in behavior, diet, or care compared to wild animals in their natural habitats. Next, Item 13, "All birds are herbivores," scored a mean of 2.05 (SD = 0.89), also at a moderate level, but with a higher standard deviation, indicating significant variation in responses and greater confusion among students regarding the different diets of birds across species.

Overall, these three items indicate that students still have moderate misconceptions about biodiversity, specifically regarding animal habitats, the differences between zoo and wild animals, and bird diets. This highlights the need for more interactive and visual learning approaches, such as AR, to help reduce these misconceptions.

General Summary of Findings

Overall, the study findings indicate that students have a high level of interest in using technology and interactive learning, particularly thru Augmented Reality (AR) applications. The mean analysis shows that all items assessing students' interest, readiness, and acceptance of technology are at a high level, indicating their positive inclination toward using 3D animation, interactive maps, quizzes, and visual content to enhance their understanding of science and biodiversity. However, the analysis of biodiversity misconceptions showed moderate levels for all three diagnostic items, indicating that confusion still exists regarding animal habitats, the difference between zoo and wild animals, and bird diets. This decision confirms that students still need more engaging, accurate, and visually-based learning approaches to strengthen their understanding of biodiversity concepts. Overall, these findings support the need for developing AR applications as an informal learning tool capable of increasing student interest, reducing misconceptions, and delivering scientific information more effectively.

Discussion and Recommendations

The findings of this empirical baseline study indicate that students' interest in using Augmented Reality (AR) technology in learning is high (Mean = 3.25–3.70). This indicates students' willingness to embrace a more digital, visual, and interactive informal learning

approach. Elements such as 3D animation, interactive maps, and quizzes are the most engaging components for students, aligning with the needs of 21st-century learning, which emphasises immersive experiences and visual stimulation. However, analysis of biodiversity misconceptions among students showed only a moderate level of understanding (Mean = 2.05–2.25), particularly regarding animal habitats, the difference between wild and zoo animals, and the diets of specific species. These findings confirm that students still experience confusion about basic biodiversity concepts, requiring a clearer, more contextual, and interactive delivery approach.

The environment at Zoo Johor currently still relies heavily on conventional interpretive materials such as static information boards and traditional guided tours. This approach was found to be less helpful in supporting deep understanding or correcting existing misconceptions. These findings are consistent with the report by Hassan et al. (2023), which states that most zoos in Malaysia still use passive display materials such as printed brochures and signs. Khan et al. (2023), also reported that over 70% of zoo visitors found their visits less interactive, while Tan and Ng (2020), found that 65% of visitors aged 13–25 were not actively engaged with static display information. Additionally, Tay et al. (2023), stated that the overly dense scientific content on the signboards caused some visitors, including school children, to make their own assumptions to fill in the information gaps, which ultimately led to misconceptions.

Conversely, international and local literature indicates that AR technology can enrich learning in zoos by delivering information visually, realistically, and interactively. The studies by Garzón et al. (2020), and Fernández-Villarán et al. (2024), confirm that AR enhances student motivation and understanding, as well as providing 3D visualisation, animated simulations, and gamification elements that are difficult to obtain through traditional information boards. AR technology also allows students to observe animal behaviour, anatomical structures, and habitat ecology more clearly. However, the use of AR in Malaysia is still limited and many applications do not emphasise local biodiversity content (Shamsudin et al., 2022). Researchers such as Shafie et al. (2021), Ahmad & Abu Samah (2024), and Yusof et al. (2022) also emphasised the need to develop AR applications that are more relevant to the local users' culture and context. However, to date, there is no dedicated AR application for Zoo Johor that is contextually designed for biodiversity learning.

In this regard, this study proposes the development of a dedicated AR application for Johor Zoo that focusses on local biodiversity content and integrates interactive components such as 3D animations, interactive maps, and visual quizzes to enhance the learning process. This application needs to be built with a user-friendly interface, concise yet accurate information delivery, and AR functionality that can help directly reduce misconceptions through realistic visualisation. Further studies are recommended using a pre- and post-intervention design to evaluate the effectiveness of this application in improving students' understanding of biodiversity. Strategic collaboration with Zoo Johor is also important to ensure the accuracy of the content, contextual suitability, and the potential integration of the application into the actual visitor experience. Overall, the need for AR application development at Johor Zoo is significant and critical for supporting informal biodiversity learning more effectively, engagingly, and impactfully.

Conclusion

This study provides empirical evidence that the use of Augmented Reality (AR) technology has great potential in supporting informal biodiversity learning at the Johor Zoo. Although students showed a very high interest in using AR technology in learning, the moderate level of biodiversity misconceptions proves that science learning still requires a more visual, interactive, and contextual approach. AR can meet these needs by delivering information that is clear, realistic, and engaging, thus helping to reduce confusion and improve students' understanding of biodiversity concepts.

Overall, this study reinforces the justification for developing an AR application for Johor Zoo as a relevant, innovative, and appropriate educational intervention for current learning needs. Integrating elements such as 3D animation, interactive maps, and digital quizzes can enrich the visitor experience, increase student motivation, and provide added value as an informal learning medium. Therefore, the development of this AR application is considered important in improving the quality of tourism education, strengthening biodiversity understanding, and supporting Zoo Johor's efforts to provide a more impactful and effective learning experience.

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