

Future Driven: Innovative Biology Teaching Through Augmented Reality Technology for Better Quality Education: A Concept Paper

Dorongan Masa Depan: Pengajaran Inovatif Biologi Melalui Teknologi Realiti Tambahan Untuk Pendidikan Berkualiti Tinggi: Kertas Konsep

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Abstract: Biology is a field of learning about life, a branch of natural science. Students assume Biology as an abstract subject that is difficult to understand. Although the number of students taking biology subjects is decreasing due to the notion that Biology subjects are boring, learning nowadays can be explored with various technologies to help students understand the subject more deeply. The use of Augmented Reality in the process of teaching and learning has become one of the technologies that serve as a teaching aid to help teachers give understanding to students in the topics taught, in addition to this technology that meets the learning of the 21st century today. Augmented Reality or AR is a technology that combines real-time against digital content created by computers with the real world. Through Augmented Reality, students can observe 2D or 3D virtual objects emitted against the real world. The effectiveness of Augmented Reality in improving students' understanding of the titles taught in Biology can be identified based on its use in the classroom. This paper aims to propose Augmented Reality to be used by teachers in improving student achievement in Biology subjects. This, in turn, can assist teachers in better planning their teaching and learning activities to enhance students' understanding of teaching and learning Biology. Augmented Reality results can improve students' academic achievement, involvement, understanding and interest. In conclusion, teachers should be open to accepting using AR as a positive change in teaching and learning. In addition, the Ministry of Education Malaysia (MOE) could incorporate learning through activities in the school curriculum.

Keywords: Augmented Reality (AR), biology education, 3D objects, achievement

Abstrak: Biologi merupakan bidang pembelajaran tentang kehidupan, satu cabang dari ilmu alam. Pelajar beranggapan bahawa Biologi merupakan mata pelajaran abstrak yang susah untuk difahami. Meskipun bilangan pelajar yang mengambil mata pelajaran biologi berkurangan kesan daripada tanggapan bahawa mata pelajaran Biologi ini amat membosankan, namun pembelajaran pada masa kini boleh diterokai dengan pelbagai teknologi yang dapat membantu pelajar memahami sesuatu tajuk itu dengan lebih mendalam. Penggunaan Augmented Reality dalam proses pengajaran dan pembelajaran menjadi salah satu teknologi yang menjadi alat bantu mengajar dalam membantu guru-guru memberi kefahaman kepada pelajar dalam tajuk yang diajar, selain daripada menepati pembelajaran abad ke 21. Augmented Reality atau AR adalah teknologi yang menggabungkan kandungan digital yang dihasilkan komputer dengan dunia nyata secara real-time. Melalui Augmented Reality, murid dapat melihat objek maya 2D atau 3D yang dipancarkan terhadap dunia nyata. Keberkesanan penggunaan Augmented Reality dalam meningkatkan kefahaman pelajar terhadap tajuk yang diajar dalam Biologi dapat dikenal pasti berdasarkan penggunaannya di dalam kelas. Kertas kerja ini bertujuan mencadangkan Augmented Reality yang boleh digunakan guru dalam meningkatkan pencapaian murid dalam mata pelajaran Biologi. Ini seterusnya dapat membantu guru dalam

merancang aktiviti pengajaran dan pembelajaran dengan lebih baik bagi meningkatkan tahap kefahaman murid terhadap mata pelajaran Biologi. Hasil kajian menunjukkan bahawa penggunaan Augmented Reality dapat meningkatkan pencapaian akademik, penglibatan dalam pembelajaran, kefahaman dan menarik minat murid. Kesimpulannya, guru harus bersikap terbuka untuk menggunakan Augmented Reality sebagai perubahan positif dalam proses pengajaran dan pembelajaran. Selain itu, pihak Kementerian Pendidikan Malaysia (KPM) boleh menyelitkan penggunaan AR menerusi aktiviti dalam kurikulum sekolah

Kata kunci: *Augmented Reality (AR), pendidikan biologi, objek 3D, pencapaian*

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INTRODUCTION

A common issue always highlighted is that students have difficulty studying Biology, and some even find Biology boring. Biology is a field that covers too many abstract and invisible contents, which can cause misunderstandings and low academic achievement. The characteristics found in biology subjects that are abstract and complex, together with the use of Latin terms, make these subjects difficult to learn (Tekkaya et al., 2001). So, there is a need to attract and improve learning techniques to overcome this problem. As a science subject with unique characteristics, Biology also requires a unique and technology-based learning process (Rizhal Hendi Ristanto, 2022). Augmented Reality can effectively make invisible subjects visible and give concrete examples for abstract content in biology education. According to Ümit Yapıcı (2021), students believe that the multimedia features used in AR activities increase the comprehensibility of the taught information and abstract concepts by making them more concrete. Furthermore, AR has been instrumental in innovatively transforming education by describing abstract concepts in a rich virtual 3D object replicating real-world objects. In addition, some objects are invisible to the naked eye in biology subjects. AR allows students to further the learning paradigm by exploiting virtual 3D objects that replicate the real world of objects. Ari and Sivri (2020) stated that through AR activities in Biology, students in the study thought that using AR technology in education would increase interest in lessons and help them critique abstract cases. In addition, students noted that the use of AR is very effective in terms of enhancing their biological learning (Weng, 2019).

BACKGROUND OF AUGMENTED REALITY

Information technologies can be utilised to support and enhance education as the skills of the 21st century are technology-focused. Augmented reality technology is among the cutting-edge digital innovations. The student activities have become more interesting as the augmented reality applications give abstract ideas a physical form, making them more durable. Without changing the real environment, students can interact with virtual items while also interacting with them. Augmented Reality works by taking input (or 'trigger') from an environment and using it to determine how to overlay multimedia output (or 'expression') on the worldview through an intermediary device. Augmented Reality is not only widely used in games, entertainment or medical industries but also the world of education. Augmented Reality (AR) is a technology that combines two-dimensional or three-dimensional virtual objects into a real three-dimensional environment, making them appear in the real world (James R. Valino, 1998). According to previous studies, innovative learning media, including AR, provides different, relevant and engaging learning experiences. In addition, the effectiveness of the use of AR directly as a 21st-century learning medium attaches great importance to technology (Adzandini, 2022).

Industry 4.0 has not only redefined industrial progress on a global scale but also cast its transformative spell upon education. Within this tapestry of technological evolution, the harmonious fusion of augmented Reality (AR) into a modular learning ecosystem represents a symphony composed of digital marvels and the tangible universe. AR is the key that unlocks the doorway between Reality and virtuality, enriching people's sensory perception through an artistic dance of physical and digital realms (Azuma, 1997).

Azuma's visionary lens, dating back to 1997, crafted the essence of AR by painting a triptych of characteristics: the intertwining of real and virtual, the cadence of real-time interaction and the symphony of three-dimensional alignment. In the annals of terminology, Tom Caudell and David Mizzel, in their 1990 declaration, etched the term "Augmented Reality" into history. They bestowed upon it a transparent realm, where Head-Mounted Displays served as portals to a world reimaged with ethereal computer-generated apparitions. This architectural metamorphosis is facilitated by a headset, a silent conductor conducting visual expansions of user experiences, thus baptising it as "Augmented Reality" (Tom Caudell, 1990).

Amongst these pioneers, the luminary Steve Mann stands as the maestro who orchestrated the dawn of a computing era known as the "father of AR." He envisaged a majestic ensemble of head-mounted devices, harmonising seamlessly with human's unaided vision. While the symphony of definitions resonates throughout the tech realm, Azuma's 1997 tapestry emerged as the quintessential opus in the academic lexicon, portraying AR's poetic dimensions. Furthermore, to the end-user, it is that moment of pure wonder, an arcane enchantment that anything 'magical' bestows, which is the spellbinding essence of Augmented Reality.

AUGMENTED REALITY IN BIOLOGY EDUCATION

The use of AR helps students easily obtain, process and remember information, as well as making learning itself more interesting and fun. In addition, given that the current students come from the Z and Alpha generations, the best approach to teaching them would be through technology. It is important for Z and Alpha children to look at issues from multiple views to make the best decision. AR technology has now been widely used in today's education, with the potential to positively impact learning. For instance, AR helps students explore the real world in an authentic way (Dunleavy, 2009). In addition, AR also helps in understanding concepts and events that cannot be observed with the naked eye by displaying virtual objects on top of real objects (Wu et al., 2013). Akc ayır and Akc ayır (2017) reported that AR promotes learning outcomes, such as achievement, motivation, attitude, interest, engagement, and satisfaction. Therefore, it is clear that AR can potentially support learning and teaching (Akc ayır and Akc ayır, 2017). According to D Roopa (2021), using AR can provide students new opportunities to imagine subjects for understanding concepts and abstracts and using practical skills. A learning process that uses technology will be more effective, engaging, motivated and meaningful. A person's learning style can influence the extent to which one is less attached to the concept of learning. Therefore, integrating AR content can increase student productivity to the next level (D Roopa, 2021). The results of Ivan Stojšić's study (2022) showed that the majority of students considered augmented reality applications very useful and easy to use, besides demonstrating a positive attitude and a desire to use this educational technology if given the opportunity, which indicates a good acceptance by students of the use of AR whether secondary or primary school.

POTENTIAL OF AUGMENTED REALITY IN THE MALAYSIAN CURRICULUM

The rapid development of the education system will contribute to improving the quality of education, especially in the teaching and learning process. The advancement of information technology in Malaysia is also experiencing no less rapid development. There has always been

an evolution of student-centred learning. Teachers have used various teaching aids to assist students in teaching and learning. Technology has also become necessary to give students a clear understanding of a subject. In line with the recommendations of the Ministry of Education under the Malaysia Education Blueprint 2013-2025, the use of information technology in education has been emphasised as a necessity in the school system to enhance high-level thinking skills, which is in the leap 7 utilising ICT to improve the quality of learning in Malaysia. Technology integration in biology education has also been given in-depth attention at all academic ranks. The integration of Augmented Reality (AR) in the Malaysian curriculum holds substantial promise. AR can transform education by providing dynamic, interactive and context-rich learning experiences. Moreover, it can potentially bridge the gap between theoretical knowledge and practical application, fostering higher-order thinking skills and problem-solving abilities. By enabling students to visualise complex concepts and interact with virtual models, AR can enhance conceptual understanding and retention. Furthermore, AR can promote personalised learning, catering to diverse learning styles and abilities. It can accommodate different learning paces, offering remediation or enrichment as needed. Collaborative AR activities can encourage peer-to-peer learning and teamwork, mirroring real-world situations. However, effective implementation requires addressing challenges like technological infrastructure, content quality and teacher professional development. Properly designed AR content aligned with the curriculum, combined with educator training, can unlock AR's potential to revolutionise Malaysian education by making it more engaging, interactive and effective.

Augmented Reality (AR) presents a multitude of potentials within the Malaysian educational landscape, spanning from primary schools to university levels. In primary education, AR can captivate young minds by transforming traditional lessons into interactive adventures. For example, in science, concepts could be visualised through virtual experiments. AR's engaging nature can nurture curiosity and foundational learning. At the secondary level, as students' progress to secondary education, AR can offer deeper insights. Complex scientific concepts could be visualised in 3D, aiding understanding. Meanwhile, biology lessons could allow virtual experiments, providing exposure beyond textbooks. At the high school level, AR can be used as a tool for interdisciplinary exploration. History could be taught through immersive historical recreations, literature could be analysed by stepping into the setting of a novel, whereas art classes could include virtual galleries showcasing masterpieces from around the world. In higher education, AR can facilitate experiential learning. Medical students could simulate surgeries, architecture students could construct virtual models, and engineering students could interact with complex machinery simulations. Besides, AR can facilitate remote collaboration, allowing students to work on projects together regardless of physical location. Throughout the education journey, AR can help students develop critical skills. Problem-solving, creativity and adaptability can be fostered through interactive challenges. AR's appeal to different learning styles can create inclusive environments, accommodating various strengths and needs. However, successful integration requires robust technological infrastructure, teacher training and high-quality AR content aligned with curricular goals. The potential is immense, but realising it demands a comprehensive approach, incorporating innovation, collaboration and pedagogical expertise.

ADVANTAGES OF USING AUGMENTED REALITY (AR)

The integration of Augmented Reality (AR) in pedagogy (teaching and learning processes) brings together several important aspects that can enhance the learning experience. AR allows students to be directly involved in the learning process. They are able to interact with 3D objects, undergo simulations, and actively engage in learning activities, making the learning experience more dynamic and meaningful. This provides an opportunity for the visualization

of complex concepts, such as the structure of molecules or organs of the body, which are difficult to understand through pictures or texts in traditional textbooks (A Pregowska, 2022). By providing 3D visualization, realistic simulations, and additional contexts, AR can improve conceptual understanding and information retention. Students can understand complex concepts through practical experience.



Figure 1. Student use AR in the classroom during teaching and learning activities

AR allows for the contextual addition of additional information in the student's physical environment. AR enables the personalization of learning by adapting the experience of each student based on their needs. This can include customized difficulty levels, learning styles, or focusing on specific areas that require more attention. AR also leverages a variety of senses, including visual and auditory, to create a more effective learning experience. This helps to improve the understanding and retention of information, especially for students who learn through various means. By offering 3D visualization and realistic simulations, AR helps students better understand abstract concepts. This provides a deeper visual perception and helps to overcome the challenges of understanding that may arise in traditional methods

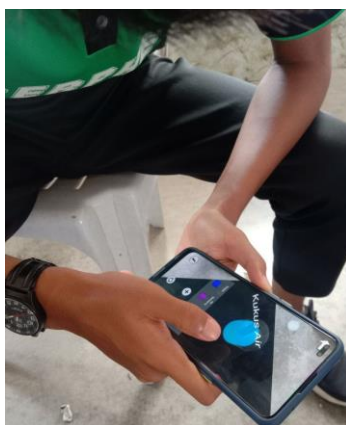


Figure 2. Student Collaborative Experience using AR

The AR app can allow students to collaborate in a virtual environment, share information, and collaborate in completing tasks or projects. This creates a more dynamic and social learning experience. Interactive factors and surprises brought by AR can increase student motivation. They can feel more involved in learning, especially when teaching is made more fun and engaging. Using AR helps students develop digital skills and adapt to modern technology, providing them with relevant experiences for life.

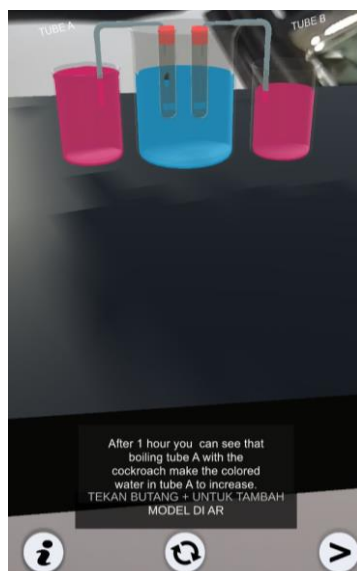


Figure 3. AR visualization in education for example in conducting virtual experimentation

AR applications can provide realistic simulations in a variety of fields, including science, medicine, and engineering. Students can live a practical experience without real risk, allowing them to test theories and skills in a safe and controlled environment. The potential use of AR is also not limited as a teaching aid for teachers to explain something in class, but it can also be used by students in conducting virtual experiments. This activity will be more interesting because often when a pupil conducts a real experiment in the classroom, it takes a considerable amount of time and the teaching and learning time is very limited, if using AR in a virtual experiment the results to obtain the results of the extraction can be shortened.

Overall, AR brings an extra dimension to learning, goes beyond traditional learning experiences, and provides students with richer opportunities and focuses on interactivity and practical experience. AR visual and interactive effects can improve student motivation (Rishka A Liono, 2021)

IMPLICATIONS OF AUGMENTED REALITY TO TEACHER TEACHING AND STUDENT LEARNING

Providing a fun learning environment is important in giving a deep understanding of the teaching process. According to Eva Schmidthaler (2023), the surveyed teachers perceived the implementation of Augmented Reality apps in biology education as innovative and increases enjoyment, collaboration, interest and learning success. Nevertheless, the teachers need guidelines on finding suitable Augmented Reality and using the apps in their biology education. AR also provides new ways to interact with the real world and can create impossible experiences in both the real and virtual worlds. AR attracts and maintains students' attention throughout learning as students can feel the relevance between learning and their lives to increase their willingness to learn biology subjects (Badrud Tamam, 2023). Based on the study by Esra Omurtak (2022), students stated that they liked the biology lessons in which augmented

reality applications were carried out since AR applications made abstract concepts concrete and made them more permanent, besides stating that the lessons conducted this way were fun. According to Dilara Sahin (2020), students were pleased and wanted to continue using AR applications in the future, showing no signs of anxiety when using AR applications. The findings suggested positive academic achievements and attitudes of the students. On another note, AR also has a positive effect on motivation for a biology subject. Visualisation and strengthening of abstract concepts assisted AR in increasing interest and motivation towards subjects. The study also showed that students can better understand abstract concepts through AR activities (Cagdas Erbas, 2019). According to Weng et al. (2019) study of biological learning, in general, the use of AR can improve understanding to describe abstract and invisible content in biology. Rishka (2021) said that Augmented Reality is an effective tool for students to use as a learning tool. According to Asmahan Md Yusoff Aizudin (2022), the level of ICT competency of teachers in the search for information, as well as the provision of various sources of information to students, was high in his study. Students were more highly motivated and showed great improvement after using AR to help them learn. Furthermore, AR allowed students to experience things they may not or may not be able to experience since any 3D object was easily transformed into a stimulating academic scenario. Based on Tahsin Ciloglu (2023), using AR showed increased motivation and attitude of students towards biological learning. In addition, as a result of student interviews, the mobile AR application was considered innovative, unobtrusive, successful in acquiring knowledge, interesting and entertaining, besides having the ability to improve information retention, strengthen the subject and facilitate learning.

CONCLUSION

In conclusion, Augmented Reality places a high emphasis on Biology education to produce a generation that aligns with global needs. The use of AR technology can improve students' achievement, interest and motivation for students to learn. Based on the concept of 21st Century Learning, AR should be implemented comprehensively in education in Malaysia in line with the transformation of the Malaysian Education Development Plan. It is hoped that the use of AR in education can be well appreciated by educators.

FUTURE SUGGESTIONS

Furthermore, future research that includes in-depth analysis of AR in all subjects should be done, not just covering biology subjects. To facilitate teachers' teaching and learning sessions, the use of AR should be included in the syllabus of the subjects. Students can see and learn something elusive that is invisible to the real world through the digital world. This situation makes the students look like they are in the real world. The learning session experienced by these students can help them in examinations later. Not only that, the experience of using AR will make for a more meaningful experience, as what students go through, feel and experience will leave a profound impression on themselves. The experience will make students more creative in the future. In the future, each classroom can be included with AR tools to attract students to study. Apart from that, there are various possible developments and future applications in AR since it can be altered in triggering smell, sound, temperature and even other expressions, including vibration and speech. Maybe one day, Augmented Reality can be combined with the emergence of "The Internet of Things (IOT)" and Artificial intelligence (AI). For example, in the world of education, the IOT can be applied to record books in the library. Through the IOT, technology can analyse children's reading interest from borrowed book statistics, which can be combined with Augmented Reality.

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