A Conceptual Framework For An Interactive AR Textbook Prototype Uses Design-Based Research (DBR) To Assess Elementary School Students' Learning Experiences And Emotions.

Noraini Ramli and Mohd Ekram Al Hafis Hashim

***Abstract* – Learning experiences that are immersive and captivating can be enhanced by augmented reality. Learning may be made more engaging and dynamic by combining traditional textbook formats with augmented reality technology, a concept known as dynamic AR textbooks. Educational innovation design and assessment are best served by design-based research (DBR). In DBR, practical educational interventions are designed, put into action, and assessed. In order to assess the learning and emotions of primary school children using DBR, this study suggests a conceptual framework for an interactive AR textbook prototype. The Design-Based Research (DBR) cycle and the uncanny valley form the basis of the conceptual framework. Using the interactive AR textbook prototype, students should have real-world learning experiences. AR materials ought to be grounded in reality and provide children with a purposeful education. With the interactive AR textbook prototype, students should take part in the learning process. Visually stunning and interesting material is what AR is all about. Evaluations of students' learning and feelings should be included in the prototype interactive AR textbook. Student performance and AR attitude data collection may be used to achieve this. The design and testing of an interactive AR textbook prototype for primary school students will be conducted using the conceptual framework. The conceptual basis of interactive AR textbook production will be reinforced by the study's conclusions.**

***Keywords* – Augmented Reality; Interactive AR Book; early school; Design-Based Research; ICT integration; IR4.0 for education; ICT in education; interactive AR textbooks, elementary school students' learning experiences, emotions**.

I. INTRODUCTION

The potential for enhancing the learning experience and affective engagement of students has been demonstrated through the integration of interactive augmented reality (AR) technology in primary school education(Net et al., 2023a). An innovative method for addressing the varied learning requirements of elementary school pupils is the development of a conceptual framework for an interactive augmented reality textbook prototype through the utilisation of design-based research (DBR) (Abdusselam & Kilis, 2021). Examining the efficacy of prototypes in gauging the emotions and learning experiences of elementary school pupils is the purpose of this research. Students' prospective benefits as well as an examination of the expanding use of interactive augmented reality (AR) technology in primary school (Drljević et al., 2022).

The significance of design-based research methodologies in developing efficacious solutions customised to the particular requirements of primary school education will be underscored, along with the necessity of employing a methodical and evidence-driven strategy when developing prototypes (Amado et al., 2021).

Furthermore, an assessment of the prototype's influence on emotional investment, student contentment, and the holistic learning experience will be documented among the study's objectives (Nasri et al., 2020). It will establish a coherent framework for assessing the efficacy of interactive augmented reality textbooks in primary school education, laying the groundwork for subsequent methodology, discussion, and conclusions (Hiererra et al., 2023). This paper will provide a contextual framework for understanding the significance of prototype development and its potential impact on the emotional investment and learning experiences of elementary school pupils via interactive augmented reality textbooks.

II. BACKGROUND

Our nation's educational system is currently executing a strategy that is more compatible with the requirements of the region (Zakaria & Janan, 2022). Because reading proficiency can improve vocabulary, words, and writing abilities, it is vital to equip primary school students with these skills (Zakari et al., 2022). Balanadam and Jamaluddin state the following: "Despite this, literacy issues continue to plague our country. 10.31% of National Primary School (SK) students and 3.40 percent of Primary School (SJK) students, according to the 2019 Primary School Assessment Report, have not achieved the minimum proficiency level in Malay handwriting (Balanadam & KhairulAzhar, 2021). The UPSR examination students' inadequate performance in Bahasa Melayu can be attributed to their inability to choose pertinent and engaging vocabulary that is appropriate for the question's context, according to a report published in 2019 by the Malaysian Examinations Board (LLM) (Karuppannan et al., 2023).

The current state of language ability is low proficiency, according to the Ministry of Education Malaysia (KPM) in 2019 (Shaari et al., 2020). This classification is based on a restricted vocabulary and incongruous communication. Literacy and writing in Malay are the objectives of the KIA2M (Basic Reading Intervention Class and Writing)

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programme, which is implemented in Year Facilitating children's mastery of reading and writing is KIA2M's principal objective (Jamiat & Othman, 2019). Students who cannot yet comprehend the fundamentals of reading and writing or who are progressing slowly constitute this group (Soon et al., 2022). These individuals include students who necessitate remediation solely in the classroom, apart from those who are special remedial students. 65.5%, or 28,700 students, of grade 1national institutions in Sabah were unable to acquire the reading, writing, and arithmetic skills of the K1A2M programme, according to the K1A2M Screening Test administered in January 2008 (Norziah et al., 2021)

Consequently, in order to ensure that these students acquire these fundamental skills expeditiously, the instructional and learning approaches implemented must conform to this demand (Net et al., 2023b). Academics and instructors are placing greater emphasis on the integration of emergent technologies into PDPC activities in recognition of the importance and advantages of technology in education (Antoniadi, 2023). Over the past few years, the domain of education has witnessed the integration of various technologies. These technologies include handheld devices, immersive technologies (e.g., augmented reality (AR) and virtual worlds), the Internet, e-learning, the social web, and simulations (Alakrash & Razak, 2021). In addition to content, instruction, and presentation, future research is strongly encouraged to investigate the issue of elementary school students' inability to comprehend literacy skills (Kiew & Shah, 2020). Recent usage has also been observed of this High School Standard Curriculum (KSSM) textbook (Jamrus & Razali, 2021). A comprehensive analysis of this textbook is warranted (Indiran et al., 2022). An effort is consequently made to integrate and utilise AR as a pedagogical and educational method (Angeles et al., 2022; Yuwono et al., 2021; Zakaria & Janan, 2022).

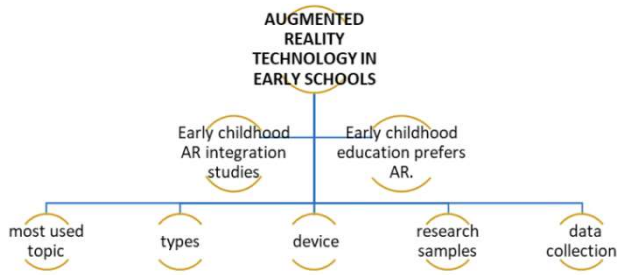

Figure 1. Augmented reality technology in early childhood AR integration topic studies (Ramli et al., 2023)

Augmented reality (AR) is a type of three-dimensional animation, as defined by Ronald Azuma (Azuma, 2017), that integrates the physical and virtual environments and enables real-time feedback. Additionally, technology facilitates this learning activity, which is geographically independent and accessible at any time (Faisal & Shaker, 2017). By creating learning experiences for students and fostering creativity in lecture-centred traditional teaching methods, this circumstance can help to motivate students. Such was the case with chiew (Chiew et al., 2019). In the twenty-first century, educators must prioritise the use of ICT to facilitate learning (Ghavifekr & Rosdy, 2015). The proliferation of electronic devices and computers has diminished the literary value of corporeal books among young people (Masoumi, 2021). Due to inadequate instructional materials, primary school pupils, especially those of Orang Asli descent, experience increased anxiety and diminished motivation to learn (Md Jaafar & Harun, 2022; Nor Aimi Harun & Fauziah Md Jaafar, 2019). The effects of stress may impede children's psychological and physiological development (Kim & Kwon, 2017). Approximately 29.5% of infants and adolescents in Malaysia are afflicted with stress-related mental health disorders, according to the National Strategic Plan for Mental Health 2020 (MeSVIPP, 2020).

Furthermore, it is agreed upon by educators that proficiency in writing can facilitate the growth of reading abilities, as students' minds indirectly observe and scrutinise the written words when they compose or reproduce sentences(Miftari, 2015). The students enhance their memorization of written words through indirect reading when they engage in regular writing(Hassan et al., 2021). The discipline is still in its infancy, despite the growing popularity of augmented reality (AR) in primary, elementary, and upper education (Takkaç Tulgar et al., 2022). Assisting parents and educators in facilitating students' effortless and enjoyable comprehension of learning modules through the integration of manual and digital distribution methods is a significant advantage(Usop et al., 2022). Since augmented reality hasn't been studied much in early childhood education (Kelpšienė, 2020)more research needs to be done on it so that design principles can be suggested that make it better at helping teach and learn (Zazali & Nasir, 2022). Concerns like how augmented reality will affect elementary schools that serve kids of all ages in both cities and rural areas need to be properly thought through, despite the many benefits that may come from using it (Cascales et al., 2013).

The acceptance of new technology tools is influenced by demographics; therefore, it is critical to identify these facets of the experience associated with utilising such tools (Greenwald et al., 2017). Therefore, the objective of this research is to assess the effectiveness of incorporating augmented reality (AR) interactive textbooks into primary school curricula, with a specific focus on their design, compatibility with user experience, and influence on cognitive style. As previously stated, the goal of this study is to look at how users of information and communication technology (ICT) perceive the student experience (LX), with an emphasis on augmented reality (AR) as a teaching tool and resource for improving literacy skills among primary school students. After that, the cognitive styles of students are looked at through the lens of AR interactive textbook design, along with their motivation to learn in relation to using AR interactive textbooks with varying levels of realism. Determining the conceptual framework and design principles of augmented reality (AR) interactive textbooks with the aim of enhancing student motivation constitutes the principal contribution of this research endeavour.

III. PROBLEM STATEMENT

Innovative, competitive, and inventive instructional materials are necessary for the fourth educational revolution (MOE, 2023; Polyzou et al., 2022). Reading proficiency can

enhance the vocabulary, language, and writing abilities of elementary school students (Balanadam & KhairulAzhar, 2021). According to the Primary School Assessment Report, 10.31% of SJK students satisfied the requirement for Malay writing proficiency (Bung et al., 2022). 20% of the Standard 1 children in Johor may lack proficiency in reading, writing, and counting(Noh, 2021). In the period from 2013 to 2025, 4.4% of primary school students failed to attain proficiency in the 3M skills as outlined in the Education Development Plan(Zakari et al., 2022).

The 2017 Annual Statistical Report of the Malaysian Education Development Plan (PPPM) determined that reading habits hold greater significance than efficacy. Reading is said to increase levels (Kutay, 2014). The study examines the performance of Malaysian students on all PISA examinations prior to their involvement and finds that the country continues to lag significantly behind the OECD average(Shaari et al., 2020). These data also show how proficient primary school students are in literacy. This enabled researchers to assess the effectiveness of promoting student reading through the use of augmented reality and Malay textbooks (Ivanova et al., 2014). In grades four and five, 161 rural primary school students in Negeri Sembilan, Pahang, and Sarawak exhibited reading comprehension deficits (Jamian, 2011). These students were incapable of comprehending the text's literal meaning (minimum = 3.24; sp =.60) and factual content (average = 3.40; sp =.71). Levels 4 and 5 primary school students would struggle in Year 1 if they were unable to comprehend the literature, the phrase, read quickly, or change tyres simply.

Considering AR interactive textbook space is prudent and identification of readers at risk early on aids in the prevention of illiteracy(AlNajdi, 2022a; Net et al., 2023b). The relationship between reading and literacy is interconnected and asserts that early education is most effective in terms of identification and prevention (Juppri Bacotang, 2014). The Findings evaluated 168 first-graders, students might have difficulty identifying and assessing their classmates who are less inclined towards academics (Mahyuddin & Elias, 2008). Despite the educational value of reading, 33.8% of first-graders lack this skill. This issue has the potential to worsen if it is not effectively managed (Balanadam & KhairulAzhar, 2021). Language and mathematical difficulties impact reading and literacy. Elementary school students use Malay textbooks as their main source of academic information and as a guide for literacy (A Ghani et al., 2021; Norziah et al., 2021).

Therefore, previous studies propose that these textbooks be scrutinised from various angles (Hasan et al., 2020; Mohamad Hanapi et al., 2022; Nurul Hasna Hassan et al., 2019; Zakaria & Janan, 2022). AR technology is employed within educational settings to assist pupils in comprehending the PDPC process (Eleftheriadi et al., 2021; Kravtsov & Pulinets, 2020). AR Interactive Textbooks have the potential to enhance the reading comprehension of grade 1pupils in conjunction with traditional textbooks (Haida et al., 2016). Characters, sound, and motion are drawing factors for the alpha generation of students to interactive materials (Polyzou et al., 2022). In elementary schools, augmented reality textbook-based formal reading, writing, and counting activities have not progressed significantly (Ivanova et al., 2014; Kiryakova, 2021; Kiryakova et al., 2018; Saforrudin et al., 2012). Keep in mind, when instructing young children, the close connection between the physical and digital worlds of books and their intellectual development. Digital cameras, iPads, laptops, desktop computers, digital touch displays, e-books, interactive whiteboards, and digital cameras have all been the subject of research (Saxena & Hew, 2016)

An investigation involving grade 1 primary school students is required in order to ascertain the extent to which AR Interactive Textbooks enhance the skills of reading, writing, and calculating. Thus, the desirability of grade 1 students will increase. With the passage of time, AR interactive textbooks will gain in value and significance. Which character design ought to be utilised to represent the information in the augmented reality interactive textbook in order to enhance student engagement and motivation? The observation of two-dimensional objects through a video display system can result in a variety of consequences (Casteleiro-Pitrez, 2022). The augmented reality (AR) interactive textbook exhibits linguistic sounds, the alphabet, and cat symbols. Malay-themed interactive AR textbooks assist children in learning to read, write, and do mathematics. Additionally, inquiry, questioning, memory, and creativity are all enhanced in youth (Ong & Mydin Kutty, 2022; Polyzou et al., 2022) propose that in order to foster innovative thinking and equip oneself for the era of education 4.0, AR interactive textbooks integrated with the PdPc method be utilised. State that the majority of instructors adopt PdPc technology integration due to the perceived advantages it provides for the institution, students, and instructors(Mohamad Hanapi et al., 2022).

Thus, the IR4.0 revolution, which includes interactive AR texts, will be accelerated (Mohd Shahneel et al., 2021). In accordance with the diversity of virtual technologies, the alpha generation requires transparency. Utilising this technology in education would help to close the gap in instructional aids and equalise children's happiness. Due to the benefits of the current technological adaptation in education, Kelpien (2020) asserts that innovative teaching aids are abundant from prekindergarten through higher education (Adili et al., 2022). English, mathematics, the Quran, and art are all taught utilising augmented reality technology (Roslinda Ramli et al., 2020; Sulaiman et al., 2022; Wang, 2009). Reading proficiency for grade 1students should be a top priority. Educators ought to pose inquiries that promote intricate reading processes and design and facilitate exercises that empower pupils to derive their own interpretations.

This research primarily contributes a conceptual framework and principles for character design in the context of augmented reality interactive novels. The results of this research may support the hypothesis that character design influences the positive learning experiences of students. It is critical that students maintain positive attitudes towards an AR interactive textbook-based learning session through the use of consistent character design.

IV. LITERATURE REVIEW

Digital Technology In Education

Advanced developments, including but not limited to virtual reality (AR), information and research apprehensions, distributed and portable computing systems, online networks, artificial intelligence (AI), and augmented reality (AR), are revolutionising the educational sphere and paving the way for the implementation of novel computer-based learning approaches and smart-class products (Braun et al., 2021; Lee & Yeo, 2022; Nurzaman et al., 2021; P. Sharma, 2019; Souththaboualy et al., 2021). The emergence of Generation Z, characterised by their advanced technological prowess and digital literacy, has introduced educators to a multitude of novel challenges. The current definition of "Gen-Z" pertains to a computer-related vernacular utilised by the younger demographic, which is occasionally misconstrued by the more senior population (Soroko, 2021).

The way they express themselves and understand the world sets them apart. In more sophisticated environments, innovative, creative, and expressive elements of digital security are developed using the powerful resources offered by the Internet and advancements in computer technology (M. Sharma et al., 2021). Individuals belonging to the Wi-Fi generation who are technological captives have an inclination to engage in intelligent learning through the use of artificial intelligence (AI), complex image manipulation, symbols, audio, films, entertainment, and information transmission.

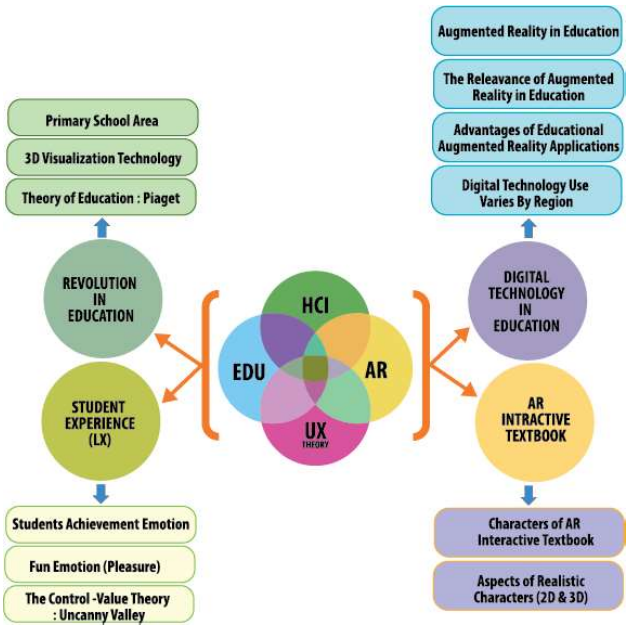

Figure 2. Theoretical Framework Interactive AR Textbook

The Theoretical Framework Interactive AR Textbook illustrates in Figure 2 the significance of augmented reality (AR) in the field of education. It emphasises the benefits of augmented reality (AR) applications in education, including customisable avatars, interactive textbooks, and 3D visualisation technology. The relationship between augmented reality (AR) and the use of digital technology in education, as well as the impact of human-computer interaction (HCI) on the learner experience, are also illustrated in the diagram. AR can provide students with a more immersive learning experience and make learning more engaging and interactive, in addition to the benefits outlined in the diagram. AR can be utilised to facilitate real-time feedback on student performance, enable students to interact with 3D representations of historical objects, and create virtual field excursions. Despite being a relatively new technology, augmented reality has the capacity to transform education. Prior to the complete implementation of augmented reality (AR) in education, the following obstacles must be surmounted: A financial concern is the expense of AR software and hardware. Another obstacle is the requirement to create educational AR content of superior quality. Notwithstanding the obstacles, augmented reality (AR) possesses the capacity to yield a substantial enhancement in the field of education. Ensuring ongoing investment in research and development and creating a more affordable and accessible augmented reality environment for schools and students are both critical objectives in this domain.

In contemporary academic competition, blended learning, an instructional approach that integrates conventional classroom teaching with online resources such as massive open online courses (MOOCs), has assumed greater significance (Saxena et al., 2016). Augmented reality systems significantly improve collaborative efforts among students in the classroom. Every variety of instructional game requires interest, motivation, and enjoyment. Augmented reality technologies and tactile interfaces are currently accessible to primary school students and their instructors. The interaction between the instructor and students made possible by AR technology will increase motivation and collaboration (Bistaman et al., 2018; Jdaitawi et al., 2023). Therefore, the development of AR Interactive Textbooks is an obvious progression towards realising the complete potential of educational technology.

Augmented reality in education

Augmented Reality (AR) references to the practise of superimposing computer-generated sensory data onto live images or video. Augmented reality (AR) truly possesses the capacity to revolutionise the educational domain by augmenting student engagement and relevance (Bower et al., n.d.; Kesim & Ozarslan, 2012; Marín et al., 2022; Nair Vargavan & Yunus, 2021; Nincarean et al., 2013). One of the ways in which augmented reality can be utilised in the classroom is to concretize complex concepts. Augmented reality can generate visual representations of complex concepts that are difficult to comprehend when instructed using conventional methods. Students may conduct research in the fields of biology and chemistry, including molecular structure and physiology, using augmented reality (AR)(Avila-Garzon et al., 2021; Basumatary & Maity, 2023; Lampropoulos et al., 2022).

Augmented reality (AR) technology enables the creation of life like simulations, which affords students invaluable training in a secure and controlled setting(Nur Amierah Mohd So et al., 2022). Students may utilise augmented reality to simulate a variety of real-world activities.

Figure.3. The AR module interface when scanning Source markers from (Nur Amierah Mohd So et al., 2022)

Augmented reality (AR) technology has the potential to transform traditional textbooks into interactive educational resources (Naw & Hkyeng, 2021). A 3D representation of the subject matter that students are examining can be accessed by scanning a page in a textbook, for instance(Chen et al., 2021). Augmented reality enables students to experience virtual field excursions to locations that are typically inaccessible to them. Students may utilise augmented reality to visit distant worlds or historic locations (Suwandi et al., 2023). Utilising augmented reality applications that are gamified in the classroom can increase student motivation and engagement. Students can acquire knowledge on a multitude of topics through the utilisation of augmented reality (AR) activities. Augmented reality (AR), through its capacity to enhance student engagement and interest in classes, possesses the capacity to fundamentally revolutionise the educational system (Saxena et al., 2016).

Augmented Reality Applicability To Education

Augmented reality (AR) has the potential to profoundly transform the pedagogical approach of educators (Aydoğdu & Kelpšiene, 2021). Students may engage in the learning process more effectively when augmented reality generates a more immersive and dynamic environment. Students can enhance their understanding of complex concepts by engaging in more active investigations using augmented reality (AR) (Hossain & Ahmed, 2021; Nincarean et al., 2013). AR has the capability of generating simulations of real-world occurrences, thereby affording students the opportunity to gain hands-on experience within a controlled and secure environment (Flores-Bascuñana et al., 2020). By simulating engineering projects or surgical procedures with augmented reality, students can perform them. Augmented reality can be utilised to tailor learning experiences in accordance with the specific needs and learning inclinations of every learner.

Students have the ability to independently study subjects at their preferred tempo and in their preferred way by utilising augmented reality (AR) (Jamrus & Razali, 2021). By creating more memorable learning experiences through the use of augmented reality (AR), information recall and retention can be improved. By utilising augmented reality (AR), students have the opportunity to interact with and memorise information through the use of three-dimensional replicas of the subjects they are studying (Cubukcu & Üniversitesi, 2021). AR grants students access to remote resources by enabling them to embark on virtual field excursions to locations that may otherwise be inaccessible to them. Students may, for instance, explore outer space or ancient ruins by utilising augmented reality (Cheng & Tsai, 2016). Augmented reality has the capacity to fundamentally transform the way in which we teach and learn by imbuing education with greater interactivity, immersion, and captivation. By integrating augmented reality (AR) technology into the educational setting, instructors have the potential to offer students more personalised and fruitful learning experiences (Nordin & Daud, 2020; Ozcakir & Cakiroglu, 2021).

Use of augmented reality in the classroom and its benefits

An increasing number of academic fields are observing the growth of augmented reality's educational applications. Anatomy 4D is an application that provides students with an immersive and cutting-edge method of studying the human anatomy. Utilising their mobile devices, pupils are able to view and interact with three-dimensional representations of the human body, including its organs, musculature, and bones. Additional animations depicting the interaction of different body systems are available via the application. Interactive functionalities encompass the ability to rotate and concentrate on various anatomical regions. By employing unorthodox methods, this application provides students with a novel and engaging approach to studying anatomy (W. Huang et al., 2019; Tang et al., 2016).

As a result, a multitude of prior inquiries have been conducted, leading to the development of multimedia resources and materials intended for educational objectives. For example, researchers have investigated video-multimedia interactive packages and implemented digital storytelling as a means of instructing vocabulary. Ali has conducted an investigation into YouTube channels, while Saxena has written the e-books Al Hijaei and PH2-PSYCO. Notwithstanding its potential advantages, this methodology continues to be underutilised due to the fact that it demands pedagogical proficiency and knowledge of the essential abilities required to facilitate the incorporation of augmented reality technology into the daily lives of children (Mohamed1 & Hoque, 2019).

Figure 4. Augmented Reality using hand-held device application examples of the experimental group (Aydoğdu, 2022)

The current accessibility of augmented reality (AR) tools in the educational process is not adequately reflected in their implementation. Acquiring knowledge is unattainable without interest and concentration (Zulhaida Masmuzidin & Abdul Aziz, 2018). In order for teaching and learning (P&L) activities to effectively foster the growth of learning potential, it is crucial to not only generate initial interest and

focus but maintain them throughout the entire process. The Malaysian Education Development Plan (PPPM) 2013–2025 positions the seventh of eleven substantial reforms to the education system as its central theme. In an effort to enhance the educational milieu in Malaysia, this seventh transition places significant emphasis on the integration of multimedia and ICT. Technological advances have a significant influence on the field of education by enabling the implementation of novel learning activities (Kesim & Ozarslan, 2012).

Key responsibilities of educators include fostering student interest and engagement in learning and facilitation (PDPC) activities through the implementation of a diverse range of PDPC strategies. Traditional teaching methods, such as "chalk and talk," fail to pique the interest of students, who prefer innovative and dynamic approaches that integrate pertinent subject matter. An approach to fundamental education that is rudimentary in nature and customised to suit the unique preferences of each pupil should be implemented. At this time, augmented reality is being utilised as a practical mode of communication, surpassing its speculative capacity. On the other hand, authentic and realistic augmented reality (AR) demonstrations enable user engagement via various means, such as real-time manipulation and reflective sound accompanied by two-dimensional object displays (Aydoğdu, 2022). Beyond the realms of education, advertising, and entertainment, this augmented reality platform has the potential to be employed for an extensive array of objectives.

AR Interactive Textbook

In accordance with the needs of the current generation of students (Casteleiro-Pitrez, 2021), education must be pertinent. I appreciate digital learning environments; they were created with technology. Roumli et al. (2023) argue that in order to stimulate students' curiosity, existing textbooks should be adapted with appropriate modifications. University of Ruse mechanical engineering students will soon have access to a more engaging blended curriculum through the development of an augmented reality interactive textbook on cutting instruments. An innovative learning experience is created through the application of augmented reality technology to lecture notes. Utilising their mobile devices, pupils are able to locate and identify indicators in lecture notes while also investigating in three dimensions (Kravtsov, 2020). The school textbook serves as the principal educational resource within the augmented reality systems. An image from the textbook is used as a stimulus to visualise an extant object model that the user observes on their smartphone screen as a result of the application. "Electronic books" refer to digital versions of books containing text, images, or both that are readable on flat-screen computers or other electronic devices (Alhumaidan, 2017).

The integration of augmented reality (AR) technology into educational curricula facilitates the creation and integration of effective supplementary learning materials, as indicated by a study. This increases children's motivation to learn as well as their capacity for innovative thought. Implementing e-learning tools that utilise augmented reality (AR) technology is viable, attractive, and efficacious, according to a survey of secondary school educators. Students have access to these digital resources for self-directed study at home and in the classroom(Casteleiro-pitrez, 2022).

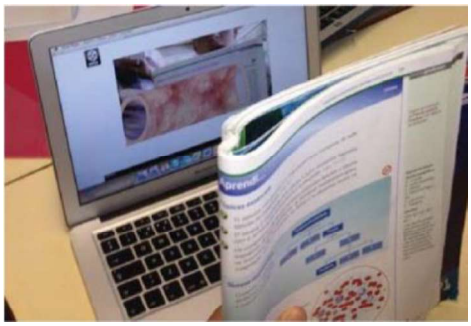

Figure 5. CSI-Sciences under Research, Augmented textbook (Casteleiro-Pitrez, 2021)

Afterwards, the mother language education process is modernised through the use of augmented reality books. The purpose of this study is to determine the educational value of Lithuanian-language books with augmented reality functionality for preschool-aged children, as well as how pedagogues incorporate this technology into the educational process (Kelpšienė, 2020). The bulk of augmented reality books, according to study data feature natural-cognitive content. Educators can use it to enhance environmental awareness and research abilities. The content of the book allows for the organisation of group and outdoor activities, combining information with experiential education and fostering children's learning through self-discovery.

However, certain research offers fresh perspectives on how kindergarten-aged kids use interactive AR and traditional books. Early on in school, students struggle with interactive paper books,this is also true of AR books. Early school fine motor skills aren't ready for touch screen movements on augmented reality items. AR books are not as interesting as traditional interactive books (Gu et al., 2022). They hardly stand out. Although these characteristics are related to the make-believe world that children inhabit as "play readers," 5 and 6-year-olds nonetheless stress the importance of using actual playbooks. Interactive children's books with multiple media It is an excellent method for comprehending many semiotic modes, such as spoken words, written words, pictures, moving components, sounds, pointers, and others. By analysing results from a survey of 198 Malay language teachers, this article concludes that Malay textbooks are only moderately effective and have room for development. Since Malay textbooks can be revised and utilised as supplementary and essential instructional tools, they are an excellent choice for educators (Mahamod et al., 2011).

Even though the study found that only 3.4% of Malay teachers were aware of AR's educational uses, the endeavour to merge textbooks with AR technology is the best space for meeting the need for improvement through AR technology. Yet they spoke highly of the potential of AR to improve their schooling, particularly in Malay-language classes. They see augmented reality as a cutting-

edge, engaging, and highly productive form of educational media in the years to come(AlNajdi, 2022b).

V. METHOD

The study is built upon its technique. All research studies use different methodologies in order to obtain their conclusions. As Cotton and Reeves have both explained (Abdusselam & Kilis, 2021; Svihla, 2014a), the researcher employs the Design-Based Research (DBR) approach. S. T. For further clarification, the terms "formative evaluation," "development research," and "engineering research" are all subcategories of "design research" that fall under this umbrella. Researchers in the learning sciences occasionally use the design-based research (DBR) method, which is a subfield of education. According to Sharp et al. (1979), the first step of the DBR process consists of problem-solving responses, sometimes known as "interventions".

Following their integration into the system, the treatments' efficacy is evaluated (Casteleiro-Pitrez, 2021). Utilising a quasi-experimental design and a quantitative methodology, the current work explores the development of interactive augmented reality (AR) textbook character prototypes intended for use as instructional tools in cooperative learning environments (Cera et al., 2020). This research attempt aims to examine how two realistic tiers of interactive augmented reality (AR) textbooks affect students' emotions and the emotive dimension of their learning experience (Angeles et al., 2022; Casteleiro-Pitrez, 2021). The nature of augmented reality (AR) interactive textbooks was also examined in this study project to ascertain how the experiences of both urban and rural students impacted the development of these materials (F. L. Schmidt, 2020).

To improve research relevance to educational policy and practice, design research—which is why this study selected design-based research, or DBR—was employed. Frequently blamed for failing to advance practice is educational research. By defining the principles of the numerous intervention impacts, researchers and practitioners may create an accurate and successful intervention model (Abdusselam & Kilis, 2021; Svihla, 2014a).

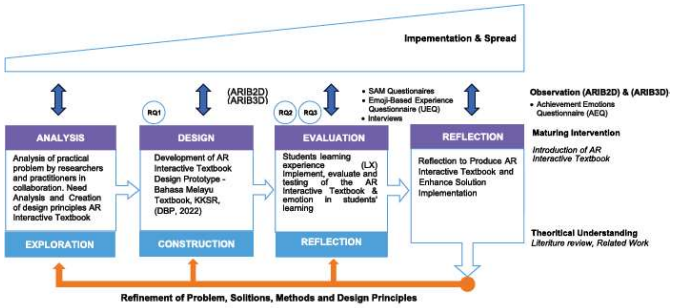

Figure 5. The Design-Based Research (DBR) cycle (based on Cotton et al., 2009,Reeves, 2006)

A scientific goal also exists for design research in educational science. According to Cotton et al. (2009), Frågåt et al. (2022), Jong et al. (2022), Svihla (2014b), Yan et al. (2021), and other authors, design research integrates studies on the learning process with support variables to provide ideas that are empirically supported. A qualitative study that produces grounded theory is called design research.

VI. CONCEPTUAL FRAMEWORK

In the first section of the study, concepts are generated and examined through the use of design-based research, or BDR. The study was put together utilising data from both phases, based on figure 1.3 of the joint work network AR interaction textbook, which illustrates how the two stages of maintenance are related. For Phase 1, researchers can additionally examine the attitudes of students (LX) about adopting AR-enabled live textbooks. In two different schools—one in an urban area and the other in a rural one the researcher will examine how various text, images, video, audio, and interactive elements from a multimedia system with an augmented reality (AR) interaction textbook application can help students improve their reading skills in the classroom.

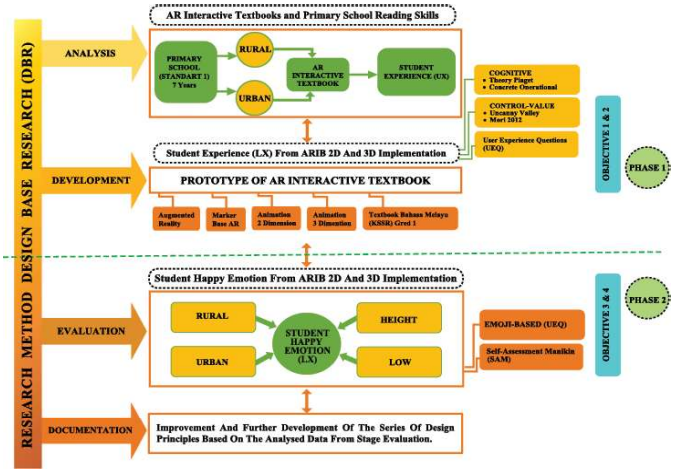

Figure 6. Conceptual Framework of AR Interactive Textbook

The study's instruments will be employed to assess the quality of the findings. ARIB2D and ARIB3D, the components of the Uncany Valley concept, will be examined through the use of user experience questions (UEQ) (Mori et al., 2012). Phase 2 has two stages of the real impact of the erased nature of emotions that occur between textbooks. According to Pekrun (2005), emotions are the result of intermediate stimuli that may be produced within the established framework of perception. BDR, or "researcher by design," is a technique used by researchers.

The ideal method for using the textbook as a teaching instrument to develop abilities indirectly through the feelings that are generated while learning may be determined by the researcher. The evaluation process will be examined using Manikan self-assessment (SAM) and emoji-based user experience questionnaires (UEQ). Enhancing and expanding on the set of design principles with the help of stage evaluation data analysis is the final phase in the BDR documentation process. Since the study's goal is to understand how students' emotions change as they learn due to the design of characters with varying degrees of realism, the control-value theory and the uncanny valley phenomenon served as the foundation for the conceptual framework (Chia & Lin, 2017).

To serve as a theoretical backup, a number of closely related theoretical frameworks, notions, models, and phenomena have been examined. Two models that seem to be closely connected to the study are the Uncanny Valley phenomenon and the Control-Value Theory for Emotions in Learning (Mori et al., 2012; Pekrun, 2005). To concentrate on the emotions of achievement, the control-value theory of achievement emotions was used. Its goal is to look at the reasons for emotional shifts and the effects of feelings that arise throughout educational experiences (Miningrum et al., 2021). Pekrun and Linnenbrink-Garcia and Pekrun, Frenzel, Goetz, and Perry have defined accomplishment emotions as the affective experiences that students have both during and after learning activities (Miningrum et al., n.d., 2021; Pekrun, 2005; Rojas-Contreras et al., 2020).

Interactive books and emotions in the education of students. This control-value theory divides the emotion of achievement into two distinct values or dimensions: the focal object (activity or learning outcome) and the emotional response (positive or negative), as well as the degree of emotional activation (activating or deactivating). Based on the two values, Table 1.1 presents a two-dimensional taxonomy of achievement feelings (Pekrun et al., 2007).

TABLE 1.1 ON THE BASIS OF CONTROL-VALUE THEORY, A TWO -DIMENSIONAL TAXONOMY OF ACHIEVEMENT FEELINGS.

	Positive		Negative	
Object focus	Activating	Deactivating	Activating	Deactivating
Outcome/ Prospective	Hope Joy	Relief	Anxiety	Hopelessness
Outcome/ Retrospective	Joy Pride Gratitude	Contentment Relief	Shame Anger	Sadness Disappointment

Adapted From *Pekrun (2007)*

The following two - dimensional taxonomy of achievement emotions illustrate that positive feelings experienced by students during learning activities can be categorised into two emotional activation levels: activating (fun) and deactivating (boring) (relaxing) (Motejlek et al., 2021). Similarly, negative emotions experienced by students during learning activities can be categorised into two emotional activation levels: activating (angry, dissatisfied) and deactivating (calm, relaxed) (boredom) (Bolter et al., 2021).

This study examined the dimension of positive emotional reaction (fun) as well as the impact of AR Interactive Textbook characters that can improve students' positive emotions during learning sessions in the classroom(Chia & Lin, 2017). This is because positive emotions, such as enjoyment and excitement, have been shown to promote student motivation, whilst negative emotions, such as boredom in their learning activities, have the opposite effect and lower student (H. Huang et al., 2018). Therefore, it has been determined that AR Interactive Textbook characters with a variety of designs are beneficial in altering students' emotional responses. Based on the Control Value theory, AR Interactive Textbook characters have been identified that are able to best boost the positive emotions of students, i.e., activating (fun) and deactivating (anger). The Uncanny Valley phenomenon serves as the foundation for the study's second hypothesis. The link between a character's emotive and realistic presentation from the perspective of human comfort is explained by the Uncanny Valley phenomenon (Mori et al., 2012).

During the character development process, it is necessary to select animated characters with the right level of realism, because overly realistic animated characters can have a negative impact on the emotional element and comfort of the user who views the character(Tay et al., 2018). Users will experience the Uncanny Valley phenomena if they make the mistake of selecting animated characters and realistic levels that match (A. Schmidt et al., n.d.).

Students may have negative emotional consequences as a result of the Uncanny Valley phenomenon; hence it is essential to choose the right characters for augmented reality AR Interactive Textbook. This phenomenon of the Uncanny Valley includes two categories of character performances: static characters and dynamic characters.

This Uncanny Valley Mori graph from 2012 clearly illustrates the rise of positive human emotions and more human-like characters. The graphs for both dynamic and static characters, however, clearly indicate a decline to a negative level when the characters are awful. In this graph, the decreasing level of comfort is known as the Uncanny Valley phenomenon. This phenomenon arises when the character design increasingly resembles reality individuals, causing the user to feel fear and horror (Rosenthal-von der Pütten & Weiss, 2015). Nonetheless, the graph demonstrates an increase to a positive level for the human emotional aspect when real human characters are included (Mori et al., 2012).

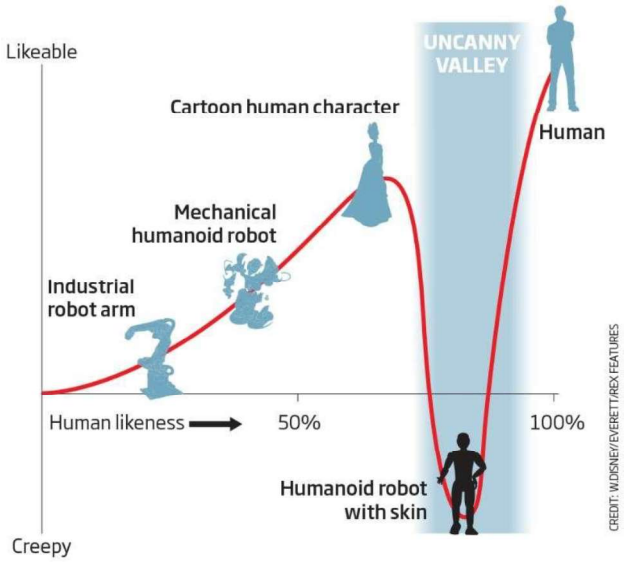

Figure 7. Original graph of the uncanny valley (reproduced from Mori et al.2012)

The graph also indicates that the Uncanny Valley phenomenon has a greater impact on dynamic characters than static ones. Consequently, the employment of AR Interactive Textbook characters may potentially have the same impact, despite the fact that this Uncanny Valley phenomena was initially developed to discover the

consequences of a realistic level for robotics research (Kravtsov & Pulinets, 2020).

VII. DISCUSSION & CONCLUSION

Augmented reality (AR) enables users to engage with virtual objects in a physical environment through the superimposition of computer-generated imagery onto the real world. AR has the capability of revolutionizing education by furnishing students with immersive and interactive learning experiences. Among the innovative and auspicious technologies in education are interactive augmented reality textbooks. AR textbooks that integrate AR technology with traditional textbook formats improve the educational experience for students.

A research methodology that is optimal for the development and evaluation of educational technology is design-based research (DBR). DBR implements practical environments in order to design, implement, and evaluate educational interventions. This study introduces a conceptual framework for a prototype of an interactive augmented reality textbook that assesses the affective and learning experiences of elementary school students via DBR.

This research investigates the development of an interactive augmented reality textbook that aims to provide a realistic level of realism for first-grade Bahasa Melayu students while they learn grammar, reading, and counting. The impact of emotive elements on these learning sessions is the subject of analysis in this study. The objective of the study is to demonstrate how the design and development of an interactive augmented reality textbook have the potential to revolutionise education by providing students with an immersive and interactive learning experience. This investigation establishes a conceptual framework for the development of interactive AR textbooks that are genuine, captivating, and evaluable. Additional research could potentially aid in the enhancement of augmented reality (AR) textbooks, their assessment, and the examination of their impacts on student engagement and learning.

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