



Producing Interactive Animated E-books: Design Frameworks, Educational Efficacy, and Future Directions

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Abstract

Interactive animated e-books represent a dynamic frontier in educational technology, poised to transform digital learning landscapes. This investigation delves into the burgeoning domain of interactive animated e-books, evaluating their underlying design principles and the potential impact on educational enhancement. It navigates through the intricate architecture of e-book creation, the interactive and animated elements they incorporate, and examines how these factors contribute to elevating educational endeavors.

Employing a comprehensive review method, the study synthesizes existing literature to dissect the mechanisms by which interactive animated e-books foster heightened student engagement and accommodate individual learning needs. The methodology focuses on qualitative analysis, drawing on case studies and comparative evaluations to illuminate the efficacy of these digital tools in diverse educational settings.

The conclusions drawn highlight the profound implications of interactive animated e-books in education. The findings demonstrate their efficacy in reinforcing engagement, personalizing learning paths, and aligning with modern pedagogical practices. The study also underscores the necessity for further exploration into their role in remote learning environments and their accessibility across different regions, thereby charting a course for future research and implementation in global education.

Keywords: Interactive Animated E-books, Educational Technology, Review, Personalized Learning, Digital Education.

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Introduction

In the contemporary world of digital education, interactive animated e-books have emerged as a significant phenomenon, disrupting traditional educational patterns and providing an engaging vehicle for knowledge acquisition and consumption (Murage, 2021). This transformation of academic philosophy and practice is completely aligned with the digitalization encompassing human knowledge and engagement, changing how learning materials are accessed, consumed, and interacted with. Offering a combination of multimedia and textual format, interactive animated e-books play a novel role in participation, creating suitable learning experiences for increasingly diverse modern learners (Çırakoğlu et al., 2022; Nugraini, 2013).

Because of unique (pedagogical) dimensions, animated e-books should be designed in conformity with educational and instructional models and in a manner that enriches children's learning development (Çirakoğlu et al., 2022; Dunn et al., 2022). There are no clear criteria to assess if animated e-books have such attributes (Alshaya & Oyaid, 2017; Lim et al., 2020; Rojas-Murillo & Pennathur, 2019). This impairs professors' capacity to successfully advise pupils on how to utilize them. The possible use of animated e-books as an instructional form is an emerging area with limited academic studies.

This study reviews the usage of animated, interactive e-books, focusing on frameworks employed to enhance learning. A framework is a direction used to define effective methods in students' academic environments. It can influence the learning process through interactive relationships that improve pedagogical delivery (Nugraini, 2013) and support learning even without a teacher or parental guidance. Recent research has shown that when multimedia features in the new electronic formats are matched with verbal narration, it enhances the effects of the information on the child's brain. Motion pictures in the form of animations are more beneficial to the brain than static pictures and do not need much explanation when accompanied by verbal narration (Rvachew et al., 2017). Animated e-books could be used in different levels of education, such as in universities and schools in different levels. The cerebral cortex grows thicker as you find out how to use it. In the early years of a child's growth, animation develops new brain connections by providing an exciting and stirring environment for learning (Sharmila, 2014). Kids have an exemplary realization of cinematic montage. Animated stories, published online, sustain the kid's imagination and foster a child's emotional construct. Children who are apt for animation are more expressive than others.

The importance of e-books as digital instruments lies in the fact that they eliminate traditional barriers to knowledge acquisition and offer a wide range of interactive content that includes students in the learning process and engages multiple senses (Abdinejad et al., 2021; Giacornini et al., 2013; Farmer, 2021). In addition to the general relevance, progress in transferring to Arab students could also be imperative as it presents the new cultural learning environment and helps more adeptly apply the knowledge. Moreover, the way these products are designed is significant as it sets the mental model of the user's engagement and the educational benefits they may have. This paper will thus explore the matter of interactive animated e-book production with an emphasis on the design framework and methods used, their educational effectiveness with using the proposed example of Arabic education and how they matter, what challenges and limitations the current environment faces (Adams, 2007; Hadaya & Hanif, 2019; Koh et al., 2016; Salsberg (2019).

The primary objective of this study is to explore the prospective future effects of e-books by conducting a thorough investigation into conceptual exploration, theoretical frameworks, literature research, result interpretation, and comparative analysis of current e-book offerings. The paper is structured in the following manner: an introductory section that establishes the context for a comprehensive investigation, a literature review that delineates the fundamental principles of e-books and their creation, a section dedicated to conceptual example definition to clarify the evolution of interactive animated e-books, an analysis of principal characteristics through conceptual foundation, a deconstruction of spatial engagement to underscore educational advantages, critical evaluations of e-book production and comparison, and a concluding section that envisions future advancements based on the findings.

The Evolution of E-books in Education

Innovation has transformed student methods, as shown by the emergence of e-books from their early forms to the foundations of modern education. This transition goes beyond digital technology development to educational viewpoints and academic needs. The 1970s saw the first attempts to synthesize text into e-books. This time saw Project Gutenberg's pioneering work. Michael Hart created the first e-book, a Declaration of Independence adaption, in 1971. Project Gutenberg initially focused on textual output to spread culture. Due to its focus on employing digital technology to transform information access, Hart's program was astonishingly foresighted. Several technical advances in the ensuing decades turned textual digitalization into current e-books. They were helped by the fast development and adoption of the World Wide Web in the 1990s, which created a

complete environment for storing, transferring, and retrieving digital text (Allanwood & Beare, 2014). E-books advanced significantly with the commercial development and launch of the SoftBook Reader and Amazon Kindle in the late 1990s and early 2000s. Interactive animated texts replaced boring textual content in these publications (Aliagas & Margallo, 2017). Smartphones and digital platforms with improved software allowed e-books to integrate multimedia material, interactive features, and animated films (Alsalhi et al., 2020). This level involves recognizing the potential of educational efforts to engage students in eBooks while customizing material to student learning styles and preferences (Al-Balushi & Al-Aamri, 2014).

E-book evolution is more than a story of how technology has shaped education advancements. This theme story shows how individuals have used digital productivity to design or improve technologies that democratize information, promote active learning, and prepare for the ongoing transformation of education (Ambarita et al., 2021). Forecasting their ubiquity and revolutionary relevance is hard without considering their historical growth and how the tools may change and extend to match future generations' new elbow pads on learning. E-books revolutionized education by replacing printed books with electronic content. This media flip signified a significant shift in how students consume, understand, and engage with learning information. Rapid structural change and a focus on active learning have led to the rise of sophisticated, animated websites. Since the Gutenberg Project digitized and recorded text to preserve and make it available in the 1970s, e-books have evolved. E-books were the first digitized reproductions of traditional literature, focusing on the content and underutilizing electronic databases' dynamic capabilities.

Educational technology has entered a new age with interactive animated electronic books. Animations, videos, audio narrations, and interactive activities have made e-books engaging learning platforms. Chen et al. and Tosun say electronic books have become "an e-environment in which the word and multimedia interact," improving learning (Anuradha & Usha, 2006). Multimedia learning, which proposes that words and images help people learn, has propelled this change. Animated e-books use animation, visual cues, and other multimedia to display text and pictures simultaneously, following cognitive learning principles (Aristov et al., 2021). Multimedia may assist students in understanding complex subjects by graphically illustrating ideas and processes. Technological advances were crucial to this evolution. Improved software and apps allow schools and publishers to build and distribute interactive animated e-books, removing numerous hurdles (Bodemer et al., 2004). These innovations have made educational content more accessible, engaging, and suitable for learning design, according to Rojas-Murillo and Pennathur. Interactive e-books have also made it easier to tailor learning to individual students' learning styles and preferences. Finally, tablets and smartphones may now use animated e-books thanks to multimedia software.

To conclude, the short history and primary features of conventional and interactive animated e-books demonstrate the progress in creating new educational tools. Animation e-books have transformed learning with their captivating multimedia and interactive features. Students have gained fresh views on learning complex subjects in fascinating and helpful ways. Technology is predicted to make interactive animated e-books the core of education.

Technology has dramatically influenced e-book development (Bengtsson, 2016). E-books have rapidly progressed from digital textbooks to interactive, animated instructional aids (Arslan-Ari, 2018; Billingsley et al., 2019). E-books have evolved due to technical advances, including the internet, quick digital publishing, and mobile devices. The Gutenberg Project, which digitized and offered free online books, enabled digital libraries. E-books became a milestone when digital technology demonstrated it could preserve, transmit, and enable egalitarian access to information (Boynton, 2022). E-books became important in education once multimedia and interactivity were added to digital texts and documents. Rapid technology advances enabled the creation of complicated e-book software and mobile apps with diverse features. The breakthrough allowed for animated e-books with aural, visual, and kinetic aspects that learners can see, hear, and touch. Integrating software and programs that include animations, movies, audio narrations, and quizzes creates animated e-books (Boynton, 2022; Bevan, 1998). Multimedia and interaction help students grasp and recall topics via visual, aural, and kinesthetic learning (Bozkurt &

Bozkaya, 2013b). Mobile phones, tablets, and e-readers have also affected e-book use in education. Mobile devices make reading e-books and papers from many languages and publishers possible anytime, anywhere. E-books are popular in official and informal education due to mobile phone and tablet convenience.

This development is also due to cloud computing and internet advances. The two have made storing, sharing, and accessing huge interactive e-books easier without actual storage media. This has improved collaborative learning and provided additional resources for students and tutors. Technology has driven this system's macro-level shift to more interactive, adaptable, and individualized learning. Advanced e-books with immersive learning experiences in augmented or virtual reality will also emerge (Bhabha, 1994). Thus, these innovations will transform education into more engaging, accessible, and personalized. To conclude, technical advances have made e-books dynamic learning aids rather than simply digital texts. The 20th-century student needs technology to improve learning. Therefore, this transition represents a macro-level change in education.

Table 1 provides a thorough summary of the development of e-books in education, charting their progression from the first efforts in the 1970s to the current interactive and animated editions. The text emphasizes significant achievements, such as the groundbreaking efforts of Project Gutenberg, the introduction of e-reading devices like the SoftBook Reader and Amazon Kindle, and the profound influence of smartphones and digital platforms on the interactivity of e-books. The presented table underscores the importance of technological advancements in enhancing the educational efficacy of electronic books. These advancements include the integration of multimedia elements and the use of cloud computing to facilitate collaborative learning. These advancements have transformed e-books from essential digital texts into interactive educational resources that promote active learning and meet the varied requirements of learners in the 21st century.

Table 1: The Evolution of E-books in Education: A Chronological Overview of Key Developments and Technological Breakthroughs (Source: Author).

| Stage | Description | Key Developments | Citations |
|--------------------------------|--|---|--|
| Early Beginnings | It originated in the 1970s with Project Gutenberg. Focus on textual production and making culture available to the masses. | First e-book adaptation of the Declaration of Independence. | Ainsworth (2008), Wang et al. (2022), Bizzocchi & Tanenbaum (2011) |
| Technological Breakthroughs | The 1990s saw the rapid development of the World Wide Web and the creation of e-reading devices. | Introduction of SoftBook Reader and Amazon Kindle. | Allanwood & Beare (2014), Almekhlafi (2020) |
| Interactive and Animated Texts | Introducing smartphones and digital platforms led to e-books with multimedia content and interactive features. | Enhanced software solutions for engaging multimedia content. | Aliagas & Margallo (2017), Alsalhi et al. (2020), Al-Balushi & Al-Aamri (2014) |
| Democratizing Knowledge | E-books foster active learning and prepare for the continuous evolution of educational frontiers. | Emphasis on active learning settings and involved learning environments. | Ambarita et al. (2021), Al Matalaka et al. (2022), Christ et al. (2019), Winograd (1997) |
| Interactive Animated E-books | Transition to e-books with animations, videos, audio narrations, and interactive exercises. | Principles of multimedia learning are applied to enhance the quality of learning. | Aristov et al. (2021), Bodemer et al. (2004), Rojas-Murillo & Pennathur |

| | | | |
|----------------------------|--|---|--|
| Technological Advancements | Rapid technological developments led to the creation of complex e-book software and mobile applications. | Development of digital libraries and integration of multimedia and interactivity. | Arslan-Ari (2018), Billingsley et al. (2019), Boynton (2022), Bevan (1998) |
| Mobile and Cloud Computing | Mobile phones, tablets, and advancements in cloud computing and broadband are rising. | Easier access to e-books and collaborative learning enhanced by cloud computing. | Bozkurt & Bozkaya (2013b), Bhabha (1994) |

Conceptual and Theoretical Frameworks

The evolution of e-books in education is more than just a technological saga; it is also a conceptual and theoretical maturation story. The story's protagonist is the three interrelated concepts of interactivity, animation, and educational engagement, which have been instrumental in transforming e-books from static texts to interactive learning devices. Interactivity in the context of e-books refers to the possibilities of two-way communication the platform provides to the e-book consumers (Campbell & Martin, 2010). From an educational standpoint, it includes ways for learners to 'do things' to the content: follow the links, use the integrated test devices, or complete the interactive quizzes. In terms of theory, the cognitive theory of multimedia learning suggests that interactivity allows for catering to more learning styles and increasing processing even further. Animation gives movement to e-books and, by extension, temporality to the information – it shows learning material as moving visual images that can depict processes, explain concepts, and tell stories (Casselden & Pears, 2020).

From the standpoint of educational science, it guides attention, explains complicated things in simple terms, and improves retention by providing learners with extra visual information along the textual cues (Carroll et al., 2004; Crowe, 2019; El-Assaad, 2014; Edwards et al., 2002). In the context of theory, it is consistent with the dual coding theory and the variability-hiking theory (Chen et al., 2013). Finally, education engagement encompasses the cognitive, emotional, and behavioral investment students put into action. In their interactionist e-books, the interactivity- and the animation-rich content has been argued to make the materials more attractive to students and more comfortable for many learners. Educational engagement is a foundational construct of educational psychology tied to academic achievement, deep learning, and student satisfaction (Carruth, 2017; Cherry, 2014).

The above theoretical framework is the backbone of the development of e-books in education. In this case, the evolution of education has seen the increased use of these innovations due to the increased levels of interactivity and animation (Cavanaugh, 2006). The conceptual and theoretical frameworks can be integrated into the design and use of e-books to enhance the learning experience among learners and developers (Chan et al., 2019). In summary, the development of e-books is multifaceted, and various dimensions interplay to influence education levels. The conceptual integration of interactivity and animation on a theoretical basis is a leap in the learning experience in delivering content to learners (Chen et al., 2007). As a result, more frames will continue to evolve as the developments of e-books continue to change to meet the ever-increasing demands in the world fueled by revolutionary technologies (Coiro, 2021). Interactive animated e-books in education are embedded in a sound theoretical framework that guides their development and use (Cockton, 2020). Two fundamental concepts informed the development: multimedia learning and constructivist theories. The multimedia learning theory is based on the idea that people learn more effectively through words and pictures than through words alone (Creswell, 2008). The theory is based on that individual possessing a split processing channel while learning, where one channel processes visuals, and the other processes words. Hence, using both enhances the learning process. The interactive animated e-books use text, images, animations, and sounds in learning, which ensures that different learning modes are captured, enhancing deeper processing of learning in the visual and auditory processing registry (Daniel & Woody, 2013; Hakak et al., 2019; Gould & Lewis, 1985; Hirose & Creswell, 2023).

Constructivism is another critical theory relevant to designing and using interactive animated e-books (Davis, 2008). It posits that learners build their ideas and understanding of the world by observing a result-driven approach to learning, experimenting, and reflecting on their experiences. For example, interactive animated e-books enable constructivist learning by providing learners with interactive, results-driven e-learning spaces where learners try ideas, experiment, and receive quick and accurate feedback (de Koning et al., 2010). Most interactive animated e-books enable learners to modify variables and undertake simulations and advertising exercises that allow them to learn actively and make sense of discoveries (Dunn et al., 2022). Implementing these and other educational learning theories in e-book design represents a significant and positive shift towards active technology-based learning environments. Therefore, combining these theories with multimedia and animation capabilities in e-book design and development creates engaging learning tools that are also purposeful and effective instructional companions (Etikan et al., 2016; Etta & Kirkorian, 2019). Besides multimedia learning theory and constructivism, cognitive load theory applies to effective e-learning and formative learning experience design in e-books. Cognitive load theory asserts that learning requires effective management of information to control learners' mental cognitive load to avoid overloading, a state that compromises learning (Frye, 2014). E-books can help manage the cognitive load by segmenting information, offering interactive definitions for terms available, and allowing learners to regulate the learning pace (Filsecker & Hickey, 2014).

To sum up, the theoretical background of interactive animated e-books encompasses various educational theories, ranging from multimedia learning theory and constructivism to the cognitive load theory. The above-discussed frameworks inform the design in terms of being technology-oriented and based on the principles of educational psychology and pedagogy. As the type of e-books develops further, these theoretical foundations will remain of great importance in determining the pathway for the e-books' professional development while focusing on addressing student learning issues in the context of the 21st century.

Design Frameworks for Interactive Animated E-books

E-books' progress throughout the digital learning revolution, from essential texts to captivating animations, has been a massive step toward effective teaching. Many ideas have been used to create e-books that offer information and engage users (Galvin, 2015).

Many of these ideas are founded on a detailed knowledge of current educational and technology demands (Han et al., 2000; Gong, 2013). First, e-books are produced with end-user demands in mind since user-centered aspects have dominated their development. Educational resources should be intuitive, adaptive, and accessible to engage learners, according to Pattuelli, Rabina, and Kang et al. (Rao et al., 2003). This informs design aspects like customizable font size, user-directed activities, individualized learning routes, and understandable organization. This ensures learners may profit from the e-book in their natural environment (Reich et al., 2016).

Multimedia should be included in educational e-books. According to Mayer and Moreno's 2002 multimedia learning theory, text combined with visual and aural resources, including images, animations, and audio narration, enhances learning by engaging various sensory channels (Richardson Jr, 1983). Multimedia in e-books should help readers understand and remember complex information, so it must be intentional and cohesive. To replace passive reading with active learning, the book should incorporate interactive and engaging components (Rideot, 2017). Book quizzes, simulations, and exercises may be conducted while reading, according to Rojas-Murillo and Pennathur in 2019 (Harman, 2022). Such examples deepen learning, give quick feedback, and create personal, challenging experiences that may keep students engaged (Robert et al., 2009). Finally, interactive animated e-books emphasize adaptability and customization. Using digital technology to tailor learning materials to individual learners' speed and preferences is a critical advance in educational materials research. Adaptivity creates learning pathways that match students' performance and abilities (Ritchie, 2017).

Ethically, interactive animated e-books are designed for accessibility and inclusiveness to guarantee that all learners may use them. This concept makes e-books accessible to all learners by meeting web accessibility standards. Scalability and sustainability are the most ethical factors for interactive animated e-book design since they allow the books to be updated and extended to suit learning trends. Scalability is based on modularity and open standards, whereas sustainability depends on long-term e-book idling and upgrading (Hansen et al., 2021). Interactive animated e-book design frameworks help create digital learning tools with high-quality information that are attractive, accessible, and meet today's learners' demands. With these design principles in e-book development, educators and developers may use digital technology to enhance learning and foster a learning culture. E-books' evolution from simple digital reproductions of print texts to active content idles content- and pedagogy-focused approaches. Educational content-specific behavioral animation and design concepts drive e-book development. A paradigm change backed by technological innovation makes learning more interesting, engaging, and dynamic (Holmbukt & Son, 2020; Jensen & Konradsen, 2018; Korat & Falk, 2019; Kucirkova, 2022; Nielsen & Budiu, 2012).

Animations in consumer education evolved beyond visual aids to become a crucial part of e-book design (Rogers et al., 2011). Unlike photographs or video, animation creates motion and changes throughout time, making it a viable instructional tool (Roskos et al., 2017). Basic research by Mayer and Moreno on multimedia learning shows that animations may adequately explain complicated processes, illustrate abstract ideas, and engage learners via dynamic representation (Zeller et al., 2020). Using animations in education E-books are based on cognitive theories demonstrating that learners prefer verbal and visual information. Design frameworks direct E-book animations to assure pedagogy rather than decoration (Ruddock, 2005). This involves providing animations related to learning, producing animations that learners can relate to, and repeating animations to grab their attention (Rvachew et al., 2017). Animations help people absorb and integrate information when closely related to signals, texts, or other spoken words according to contiguity, time, and location (Rojas-Murillo & Pennathur, 2019). Along with animation, e-book-specific interactive design ideas have advanced this learning tool (Saffer, 2010). E-book design principles emphasize learner-centered design to provide straightforward, accessible, and pleasant learning tools (Williams & Beam, 2019). engaging components like hyperlinks, quizzes, and simulations make reading an engaging experience. Such design principles support active learning, as students are no longer passive consumers of knowledge (Zhang et al., 2017). Adaptivity and customization are necessary to meet learners' different requirements and styles. This method creates adaptable, tailored learning routes by acknowledging that learners are unique (Sanii, 2020). E-books may leverage student interactions and preferences to tailor material difficulty, presentation style, and learning difficulties to optimize motivation and effectiveness. E-books have changed how we provide instructional information. These advancements demonstrate how e-books may provide immersive, engaging, and customized learning experiences. As this technology advances, these design principles will shape digital learning materials (Ye et al., 2019).

The fast growth of digital education has transformed the book format. E-books have evolved into a versatile instructional tool. E-book design has been successfully implemented in many circumstances. They illustrate the effectiveness of e-books in education and how to apply the fundamental ideas (Zipke, 2017). Interactive animated e-books in scientific teaching are a good technique. Many studies have shown that e-books, including simulations of scientific ideas, interactive quizzes to assess learning, animations, and instructional films, assist students in grasping complicated content. The multimedia-based approach gives students access to many resources. E-books for language learning integrate audio and video information to be interactive (Zhang-Kennedy et al., 2017). Modern Arabic e-books provide pronunciation and interactive visual keys for grammatical issues.

This design fosters linguistic and cultural development. Multimedia learning shows that improved presenting formats improve knowledge.

E-books also show promise for personalizing learning. They may be adaptive books that use an algorithm to adjust exercise difficulty based on student performance and preferences. An adaptive math e-book provides practice problems that fit the learner's ability level. It also provides rapid feedback and tips to

build a tailored, mastery-based learning environment at an individual pace. Integrating accessibility features into e-books shows inclusion. E-books with picture alternative text, screen reader compatibility, and flexible font sizes make education accessible to all students, including those with impairments. This design technique enhances learners' use of e-books. The universal design may also be used in educational technologies. The case studies and examples above demonstrate e-books' versatility. Interactivity, multimedia, adaptability, and accessibility make these technologies helpful for varied learning requirements. As technology advances and innovation grows, e-books may provide more and better services.

Figure 1 shows a complete design framework for creating interactive animated e-books for digital education. Understand educational and technical demands and employ user-centered design, multimedia, and interactive components to engage learners (Pattueli & Rabina; Kang et al.; Rao et al., 2003; Reich et al., 2016). The approach emphasizes adaptability and personalization to tailor e-book material to learners' speed and preferences (Rideot, 2017; Harman, 2022; Ritchie, 2017). Ethical issues, including ease of access, inclusiveness, scalability, and sustainability, are addressed to make e-books accessible to all learners and adaptable to changing educational needs (Hansen et al., 2021).

Animation and interactive design enhance learning. Cognitive theories suggest learners benefit from verbal and visual information, so animations explain complex processes and visualize abstract concepts. Hyperlinks, quizzes, and simulations make reading an active learning experience (Saffer, 2010; Williams & Beam, 2019; Zhang et al., 2017; Sanii, 2020). The flowchart shows how interactive animated e-books may be used in scientific and language instruction (Zipke, 2017; Zhang-Kennedy et al., 2017). The framework concludes by urging technological innovation to produce more immersive, engaging, and customized learning experiences (Ye et al., 2019).

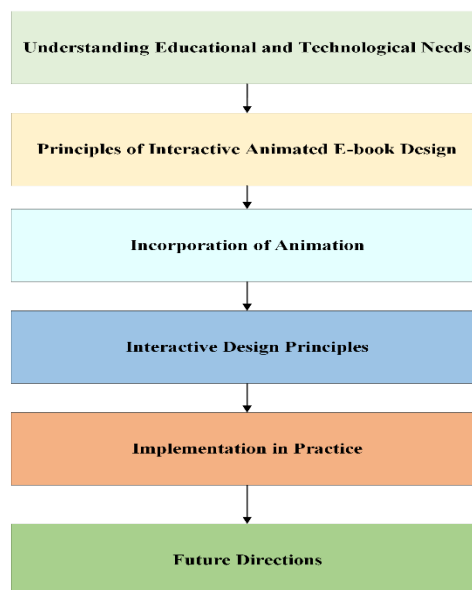


Fig. 1: Study Design Framework for Interactive Animated E-books in Educational Contexts.

Source: Author.

Educational Efficacy of Interactive Animated E-books

One must understand how such tools affect learning results to analyze IBM's educational effectiveness. Many studies show the benefits of interactive animated e-books for learning. These resources are unique because they incorporate multimedia technologies to accommodate diverse learning styles and preferences. Mayer and Moreno's cognitive theory of multimodal learning states that "both words and pictures are used" to improve learning. Interactive animated e-books that employ text, graphics, music, and animations may also contain interactive tasks to make the content more engaging.

Studies across areas have shown these e-books' instructional value. For instance, e-books with animations of complex scientific processes boosted student science comprehension. According to Lowe and Schnotz (Han et al., 2000), text animations, explanatory text, and interactive chances assist learners in visualizing an idea and how it happens. Interactive animated e-books include various features that provide learners with immediate feedback. Language learning has significantly improved due to interactive activities and pronunciation trainers providing quick feedback and corrections. The interactive feature of animated e-books makes them more versatile. An adaptable e-book may be created via one-on-one coaching and changing material and difficulty levels based on learners' knowledge. Permission to concentrate on areas of difficulty enhances comprehension, according to Rojas-Murillo and Pennathur (Galvin, 2015). Several studies have linked interactive animated e-books to high student engagement and motivation. Interactive components make learners more excited about learning, which improves knowledge (Guernsey et al., 2012).

Empirical data shows that interactive animated e-books improve learning. Multimedia, interaction, and flexibility may improve comprehension, engagement, and motivation in interactive e-books, enhancing learning. Since education technology constantly changes, further study will show how interactive animated e-books might help students. This research has discovered and integrated the educational literature to show that interactive animated e-books improve learning outcomes across domains. Comparing conventional and contemporary e-books in educational contexts is crucial to the debate over interactive animated e-books' usefulness. These comparisons demonstrate how much interaction and animation affect schooling. Text-based conventional e-books are direct digitizations of printed content. Alsalhi et al. said classic e-books were helpful since they were reproducible, portable, distributeable, and handy. The first phase in digitalizing publishing is traditional e-books (Frye, 2014). They make reading more accessible than ever. Despite the capabilities of standard e-books, the contents are stagnant and do not interest pupils. Visual aids improve student engagement, making this problematic in teaching (Etta & Kirkorian, 2019).

Interactive animated e-books, which include animations, video, audio narrations, and interactive quizzes, constitute a significant advancement in educational technology. The multimedia is not for pleasure but to invoke educational features that apply cognitive and learning theories to help students understand the information. Since human cognitive processing is two-channel, Mayer and Moreno found that combining verbal and visual information improves learning (de Koning et al., 2010). Different teaching modes have shown that interactive animated e-books overcome numerous textbook problems. Scientists use animations to explain complex topics that are hard to visualize in writing. Eds Lowe & Schnotz say dynamic imagery in these e-books helps students remember and grasp knowledge by showing processes or occurrences. Another topic in which interactive animated e-books are more effective is language (Davis, 2008). Clickable audio pronunciations, grammatical tasks, and vocabulary games help language learners. Due to quick feedback, learners may practice using these e-books, unlike conventional ones. Interactive animated e-books' flexibility is another distinctive hallmark of individualized learning. Content difficulty and presentation styles may be adjusted based on student performance and adaptability (Hussain & Al Saadi, 2019; Whitchurch, 2008; Kesim & Yildirim, 2017; Lev, 1962). All learners learn at various speeds; therefore, it improves learning outcomes.

Interactive animated e-books may not have the same impact, and their effectiveness will rely on their design, learning preferences, and other variables affecting education. E-books may improve learning if produced according to excellent pedagogy and tailored to learners' requirements (Dunn et al., 2022). In conclusion, comparing conventional versus interactive animated e-books using examples from diverse educational contexts shows that the latter has better development and engagement. They make learning more diversified and exciting by using multimedia and interactive aspects, meeting current education demands (Etikan et al., 2016). dynamic animated e-books are a significant advancement in educational materials and education, allowing for a more dynamic, engaging, and person-oriented approach that may improve outcomes. The accessibility, engagement, and cognitive load management of interactive animated e-books in digital education are of significant academic interest. Discovering how interactive e-books might improve learning performance requires studying these factors (Etta & Kirkorian, 2019).

Educational advantages of interactive animated e-books include accessibility. These books remove the physical barrier to learning and make education more accessible since they are digital. Digital methods may disseminate interactive e-books abroad, making them accessible to students without a library or bookshop access. E-books may also be interactive for students with impairments since digital forms are adaptive. Universal design and learning concepts include text-to-speech, customizable font sizes and contrasts, and other keyboard-command interface possibilities. Interactive animated e-books also hold potential for engagement. Multimedia, such as video, music, and animation, keep learners interested. Cognitive theory's Multimedia Principle says humans process visual and aural information via two channels. Interactive e-books draw users in by delivering the same content in text and multimedia versions. Quizzes and other interactive components reinforce the interface's dynamic aspect by providing rapid feedback. Managing cognitive load in interactive animated e-books is more complicated. Cognitive load theory says learners can only digest so much new knowledge. Since interactive e-books use text, voice, and graphics to teach reading information to new learners, they lighten the auditory and visual cognitive load. Interactive e-books should be carefully constructed to minimize cognitive overload, which occurs when too much information is given at once or when interactive components distract the student. Thus, cognitive load management requires a careful design that links multimedia aspects of e-books to learning goals and reduces unnecessary content. In conclusion, interactive animated e-books are unique learning resources that provide accessibility, engagement, and cognitive load management. They make reading easier, engage students, and strategically control cognitive load, making them essential teaching tools. More study and development in this field of educational technology is required to realize this potential, which relies on careful and good e-book design and execution. Drawbacks (Galvin, 2015).

Interactive animated e-books need technological and pedagogical expertise. Technically, such e-books involve graphic design, animation, programming, and user interface design skills. E-books that work on many platforms, each with constraints, are harder. Ensuring hardware and software function well together is difficult for developers. Multimedia and interactive elements should support learning goals. When multimedia and animation grab attention instead of supporting it, cognitive overload is a serious concern. Developing interactive animated e-books for learners requires a comprehensive understanding of mental processes. New and growing study on interaction animated e-books. To begin with, many studies have tiny sample sizes or short durations, making it hard to generalize conclusions. Second, technology advances quickly, making study conclusions obsolete. Finally, longitudinal studies are needed to demonstrate the advantages of these e-books. Test scores and completion rates dominate research, which neglects personal participation, satisfaction, and drive. Understanding the consequences of multimedia apps requires a complete investigation (Groß-Mlynek et al., 2022).

Critics should replace the inexplicable delight of interactive animated e-books with caution about equality and access. These materials promote learning, but their reliance on technology disadvantages students without the necessary gadgets and internet access. The digital gap will worsen education inequities, requiring initiatives to guarantee all students can access these resources. Digitization of materials may make instructors obsolete and limit the advantages of interpersonal learning. E-books provide individualized learning, but they are not human. Thus, they should be seen as complementary instruments in an educational plan. Finally, interactive animated e-books have enormous potential to revolutionize education, but their creation, implementation, and research are complex. An honest and critical attitude is essential to unlocking these materials' full potential and ensuring they positively impact education.

Table 2 compares standard and interactive animated e-books in educational terms. Digital copies of printed content and traditional e-books are accessible and convenient but lack engagement and flexibility (Frye, 2014; Etta & Kirkorian, 2019). Interactive animated e-books use animations, audio narrations, and interactive quizzes to engage and motivate students (Guernsey et al., 2012; Kelley & Kinney, 2017). Cognitive theories imply that learning is more successful when information is given verbally and visually (Mayer & Moreno, 2002; de Koning et al., 2010). These sophisticated e-books support this. Additionally, interactive animated e-books may be tailored to individual learners' interests and performance levels (Hussain & Al Saadi, 2019; Whitchurch, 2008). However, developing and implementing these complex e-

books requires visual design and programming skills and risks cognitive overload owing to excessive multimedia (Groß-Mlynek et al., 2022). Despite these obstacles, interactive animated e-books provide more attractive, accessible, and practical learning experiences than regular e-books.

Table 2: Comparative Analysis of Traditional E-books and Interactive Animated E-books in Educational Settings.

| Aspect | Traditional E-books | Interactive Animated E-books | Citations |
|----------------------------------|---|--|---|
| Accessibility | Limited adaptability for learners with disabilities | Enhanced accessibility with features like text-to-speech, adjustable text sizes | Frye (2014), Etta & Kirkorian (2019) |
| Engagement | Relatively static, less engaging | High engagement with multimedia elements and interactive components | Guernsey et al. (2012), Kelley & Kinney (2017) |
| Cognitive Load Management | It can be overwhelming due to the dense text | Balances cognitive load with multimedia integration | Mayer & Moreno (2002), de Koning et al. (2010) |
| Learning Outcomes | Improved access to reading material | Enhanced understanding, engagement, and motivation; better learning results | Han et al. (2000), Lowe & Schnotz, Rojas-Murillo & Pennathur (Galvin, 2015) |
| Adaptability | Limited personalization | Personalized learning experiences with adaptive content | Hussain & Al Saadi (2019), Whitchurch (2008) |
| Implementation Challenges | Technical limitations | Requires expertise in graphic design, animation, and programming; risk of cognitive overload | Groß-Mlynek et al. (2022) |

Future Directions

E-book design and technology are proliferating, offering new opportunities to enhance education. Looking forward, various trends and areas of potential study and implementation cannot guarantee the role of interactive animated e-books in education and become future realities. Current technology and future developments provide a few potential options for interactive animations to remain valid.

Augmented reality in e-books is the most intriguing breakthrough. According to Avila et al., AR compilers are swiftly merging with popular e-book design and editing software suites. Therefore, AR education is still on hold. AR can accurately overlay instructional information in a user-friendly area, immersing pupils. History may be reconstructed as animated sceneries in the reader's room, while molecular education can show pupils a complicated, multi-dimensional molecular form. This makes learning more realistic and lets pupils try new things. AI is becoming a trend in customization (Hojeiji et al., 2021; Tsybulsky & Muchnik-Rozanov, 2019; Karacalli & Korur, 2014; Rideout, 2017; Lim et al., 2020; Etta & Kirkorian, 2019; Çırakoğlu et al., 2022).

Interactive animated e-books have applications beyond education. These materials give flexibility and accessibility that conventional resources cannot in homeschooling, digital learning platforms, and lifelong learning. Over time, these e-books may create accessible, organized settings for students to engage with instructional information from anywhere in the world. For individual learning, interactivity may make fact-based, boring information simpler to obtain and consume by adapting to the student's interest and knowledge. Interactive animated e-books provide several study opportunities. Longitudinal research might reveal how these materials affect learning and engagement over time. Using AR and AI to create and

distribute educational material may also reveal best practices and principles for future e-book generations. Research should also examine varied applications in fields other than education (Lee, 2020; Al-Bulushi & Al-Amari, 2014).

Figure 2 summarizes the growth and future of interactive animated e-books in education. Interactive animations' fast growth and new potential in e-book design and technology are discussed. The merging of AR with AI is seen as a significant achievement. AR technology overlays instructional information on the user's surroundings, boosting learning via immersive animations. However, AI personalizes e-books to meet learners' demands. It shows how interactive animated e-books may be used outside of schooling. These e-books are flexible and accessible for homeschooling, digital, and lifetime learning. These e-books are ideal for distance and self-directed learning since they adapt to the learner's pace and interests.

Interactive animated e-books need further study and development. Longitudinal studies are required to determine how these e-books affect learning outcomes, while AR and AI research will provide best practices for e-book design. It is also noted that these e-books may expand knowledge and life beyond school. In conclusion, technical, pedagogical, and multidisciplinary advancements seem promising for the future generation of interactive animated e-books. Educationalists, designers, and researchers can advance digital education by adopting the best models and exploring new areas of inquiry that improve human-centered learning and global access.

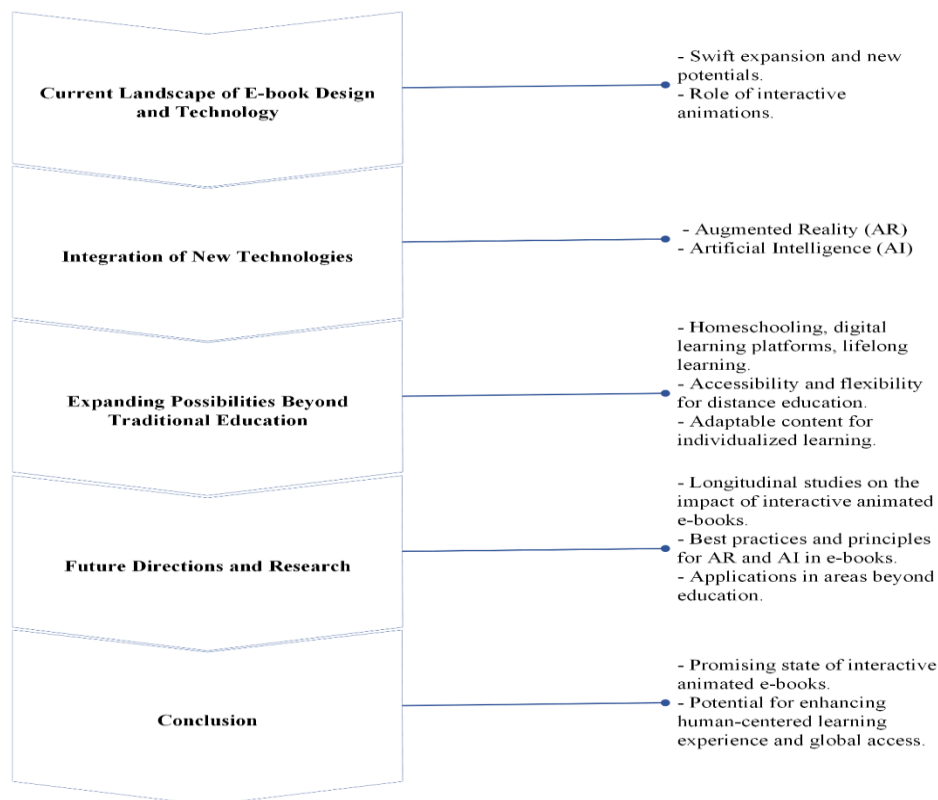


Fig. 2: Evolution and Future Trends in Interactive Animated E-books for Education.

Conclusions

Using interactive animated e-books in teaching is transformational. Significantly, such tools may transform education, not just digitize information. This analysis illuminated the pros and cons of integrating such advanced resources into learning environments, stressing the potential to improve engagement, diversity, and customization. Multimedia inclusion, interactive design, and individualized learning adjustment have led to the rise of interactive animated e-books as instructional technology. Multimedia and cognitive load theory increase educational outcomes empirically. Successfully using interactive animated e-books requires complicated technological infrastructure, pedagogical problems, and continuing industry

understanding research. Educators may mix interactive animated e-books with modern methods to rethink instructional tactics. Designers are urged to tackle the technological and cognitive obstacles of generating fully interactive instructional material. Policymakers might concentrate on digital inequalities to provide kids equitable access to chances and encourage development that affects new learning patterns.

Advanced technology and expansion potential make interactive animated e-books a promising educational tool. Augmented reality and AI-driven customization may make learning environments more inclusive and controllable. Increasing research will allow e-book use in many fields. In educational settings, interactive animated e-books are becoming integrated places. The fast development and adoption of e-books signal a more interactive, responsive, and accommodating future for learners. Thus, educators, designers, and politicians encourage these changes. New possibilities in the future will make it hard for students to distinguish between school and life. The future of learning is within their grasp and encourages innovation. In conclusion, interactive animated e-books in education have several advantages. E-books' complexity and possibilities allow compliance evaluation and demonstrate how dynamic, fair, and innovative educational activities may increase access.

References

- [1] Abdinejad, M., Ferrag, C., Qorbani, H. S., & Dalili, S. (2021). Developing a simple and cost-effective markerless augmented reality tool for chemistry education. *Journal of Chemical Education*, 98(5), 1783–1788. <https://doi.org/10.1021/acs.jchemed.1c00173>.
- [2] Adams, R. (2007). Decision and stress: cognition and e-accessibility in the information workplace. *Springer Universal Access in the Information Society*, 5(4), 363–379. <https://link.springer.com/article/10.1007/s10209-006-0061-9>
- [3] Ainsworth, E. A. (2008). Rice production in a changing climate: a meta-analysis of responses to elevated carbon dioxide and ozone concentration. *Global Change Biology*, 14(7), 1642-1650. <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2486.2008.01594.x>
- [4] Al Matalka, M. M., Al Dwakat, M., Migdadi, M. R. N., & Al Naqbi, S. H. (2022). The effect of an interactive e-book on teaching arabic language skills to non-native speakers. *Journal of Hunan University (Natural Sciences)* , 49(09), 1186-1201.
- [5] Al Saadi, K., Lane-Kelso, M., Al Hafeedh, A., Al Sheithani, Z., & Al Wishahi, M. (2017). Are We Ready for E-Books? Omani University Students' Uses and Perceptions of E-Books. *Turkish Online Journal of Educational Technology-TOJET*, 16(2), 11-25.
- [6] Al-Balushi, S. M., M., & Al-Aamri, S.S. (2014). The effect of environmental science projects on students environmental knowledge and science attitudes. *International Research in Geographical and Environmental Education*, 23(3), 213-227. <https://doi.org/10.1080/10382046.2014.927167>
- [7] Aliagas, C., & Margallo, A. M. (2017). Children's responses to the interactivity of storybook apps in family shared reading events involving the iPad. *Literacy*, 51, 44–52. <https://onlinelibrary.wiley.com/doi/abs/10.1111/lit.12089>
- [8] Allanwood, G., & Beare, P. (2014). *Basics interactive design: User experience design: Creating designs users really love*. A&C Black.
- [9] Almekhlafi, A. G. (2020). Designing and Creating Digital Interactive Content Framework: Description and Evaluation of the Almekhlafi Digital Interactive Content Model. *Science Education International*, 31(2), 130-141. <https://doi.org/10.33828/sei.v31.i2.1>
- [10] Alsalmi, N., R., A-Qatawneh, S., Eltahir, M., Althunibat, F., & Aljarrah, K. (2020). The role of academic electronic books in undergraduate students' achievement in higher education. *Heliyon*, 6, 11. <https://doi.org/10.1016/j.heliyon.2020.e05550>
- [11] Alshaya, H., & Oyaid, A. (2017). Designing and Publication of Interactive E-Book for Students of Princess Nourah Bint Abdulrahman University: An Empirical Study. *Journal of Education and Practice*, 8(8), 41-57.
- [12] Ambarita, C., Simanullang, R., & Sirait, D. (2021). The development of e-book-problem based learning media. In *Proceedings of the 3rd International Conference on Innovation in Education, Science and*

- Culture, ICIESC 2021, 31 August 2021, Medan, North Sumatera Province, Indonesia.* DOI 10.4108/eai.31-8-2021.2313720
- [13] Anuradha, K. T., & Usha, H. S. (2006). E-books access models: an analytical comparative study. *The Electronic Library*, 24 (5), 662-679
<https://www.emerald.com/insight/content/doi/10.1108/02640470610707268/full/html>
- [14] Aristov, M. M., Moore, J. W., & Berry, J. F. (2021). Library of 3D Visual Teaching Tools for the Chemistry Classroom Accessible via Sketchfab and Viewable in Augmented Reality. *Journal of Chemical Education*, 98(9), 3032-3037. <https://doi.org/10.1021/acs.jchemed.1c00460>
- [15] Arslan-Ari, I. (2018). Learning from instructional animations: How does prior knowledge mediate the effect of visual cues?. *Journal of Computer Assisted Learning*, 34(2), 140-149. <https://doi.org/10.1111/jcal.12222>
- [16] Arslan-Ari, I., & Ari, F. (2017). Ordóñez de Pablos, P., Tennyson, RD, & Kytras, MD (eds): Assessing the role of mobile technologies and distance learning in higher education. *TechTrends*, 61(3), 308-309. <https://link.springer.com/article/10.1007/s11528-017-0174-4>
- [17] Artal, R., & Rubenfeld, S. (2017). Ethical issues in research. *Best Practice & Research Clinical Obstetrics & Gynaecology*, 43, 107-114.
- [18] Aydın, G. (2015). The effects of computer-aided concept cartoons and outdoor science activities on light pollution. *International Electronic Journal of Elementary Education*, 7(2), 143-156.
- [19] Babinčáková, M., & Bernard, P. (2020). Online experimentation during COVID-19 secondary school closures: Teaching methods and student perceptions. *Journal of chemical education*, 97(9), 3295-3300. <https://doi.org/10.1021/acs.jchemed.0c00748>
- [20] Bengtsson, M. (2016). How to plan and perform a qualitative study using content analysis. *NursingPlus Open*, 2, 8-14.
- [21] Bevan, N. (1998). ISO 9241: Ergonomic requirements for office work with visual display terminals (VDTs)-Part 11: Guidance on usability. *Tc*, 159, 61. https://www.academia.edu/50348939/EVALUATION_MODEL_FOR_THE_USABILITY_OF_WEB_BASED_LEARNING_MANAGEMENT_SYSTEMS_WITH_USER_PROFILE
- [22] Bhab Bhabha, H. (1994). *17 Frontlines/Borderposts: Displacements: Cultural identities in question*, Indiana University Press.
- [23] Billingsley, G., Smith, S., Smith, S., & Meritt, J. (2019). A Systematic Literature Review of Using Immersive Virtual Reality Technology in Teacher Education. *Journal of Interactive Learning Research*, 30(1), 65-90.
- [24] Bizzocchi J. & Tanenbaum T. (2011). *Well read: Applying close reading techniques to gameplay experiences. Well played 3.0: Video games, value and meaning*, 3. ETC Press.
- [25] Bodemer, P., R., Feuerlein, I., & Spada, H. (2004). The active integration of information during learning with dynamic and interactive visualisations. *Learning and instruction*, 14(3), 325-341. <https://www.sciencedirect.com/science/article/pii/S0959475204000350>
- [26] Botha, M., & Weilbach, L. (2019). Design guidelines to develop e-textbook readers: A Task-technology Fit approach. *FOREWORDS: SACLA 2019 PROCEEDINGS*, pp.1-17. https://www.researchgate.net/profile/Morne-Botha-2/publication/352151962_Design_guidelines_to_develop_e-textbook_readers_A_task-technology_fit_approach/links/60bb441b458515218f90ab61/Design-guidelines-to-develop-e-textbook-readers-A-task-technology-fit-approach.pdf
- [27] Boynton, S. (2022). *But Not the Hippopotamus*. New York, NY: Boynton Bookworks. <https://www.amazon.com/But-Not-Hippopotamus-Boynton-Board/dp/0671449044>
- [28] Bozkurt, A. & Bozkaya, M. (2015). Evolution criteria for interactive e-books for open and distance learning. *International Review of Research in Open and Distributed Learning*. 16(5),58-28.
- [29] Bozkurt, A., & Bozkaya, M. (2013b, Ocak). Interactive e-book: Yesterday, today and tomorrow. *Academic Informatics Conference, Antalya*, 375-381. <https://www.irrodl.org/index.php/irrodl/article/view/2218/3409>
- [30] Brinkmann, S. (2014). Interview. In *Encyclopedia of critical psychology* (pp. 1008-1010):Springer.

- [31] Bryan, S. J., Campbell, A., & Mangina, E. (2018). Scenic spheres-an AR/VR educational game. In *2018 IEEE Games, Entertainment, Media Conference (GEM)* (pp. 1-9). IEEE. <https://ieeexplore.ieee.org/abstract/document/8516456/>
- [32] Byrne, M. D., Catrambone, R. & Stasko, J. T. (1999). Evaluating animations as student aids in learning computer algorithms. *Computers & Education*, 33(4), 253-278. <https://cpb-us-w2.wpmucdn.com/sites.gatech.edu/dist/b/1555/files/2020/09/ByrneCatramboneStasko1999.pdf>
- [33] Campbell, C., & Martin, D. (2010). Interactive whiteboards and the first-year experience: Integrating Es into pre-service teacher education. *Australian Journal of Teacher Education*, 35(6), 68-75. <https://search.informit.org/doi/abs/10.3316/informit.862530055682282>
- [34] Carroll, J. J., Dickinson, I., Dollin, C., Reynolds, D., Seaborne, A., & Wilkinson, K. (2004, May). Jena: implementing the semantic web recommendations. In *Proceedings of the 13th international World Wide Web conference on Alternate track papers & posters* (pp. 74-83). <https://dl.acm.org/doi/abs/10.1145/1013367.1013381>
- [35] Carruth, D. W. (2017). Virtual reality for education and workforce training. In *2017 15th international conference on emerging e-learning technologies and applications* (pp. 1-6). IEEE. <https://ieeexplore.ieee.org/abstract/document/8102472/>
- [36] Casselden, B., & Pears, R. (2020). Higher education student pathways to ebook usage and engagement, and understanding: Highways and cul de sacs. *Journal of Librarianship and Information Science*, 52(2), 601-619.
- [37] Cavanaugh, T. W. (2006). *The digital reader: Using e-books in K-12 education*. ISTE (Interntl Soc Tech Educ).
- [38] Chan, S.C.H., Wan, C., L., J. & ko, S. (2019). Interactivity, active collaborative learning, and learning performance: The moderating role of perceived fun by using personal response systems. *The International Journal of Management Education*, 17(1), 94-102. <https://doi.org/10.1016/j.ijme.2018.12.004>
- [39] Chen, H., Yu, C., & Chnag, C. (2007). E-home book system: A web-based interactive education interface. *Computers and Education*. 49 (2). <https://doi.org/10.1016/j.compedu.2005.05.003>
- [40] Chen, X., Crooks, S., & Ford, S. (2013). Note taking on e-text with digital note taking tools. Paper Presented at the Proceedings of the 2013 *Information Technology & Teacher Education (SITE) International Conference* (pp.303-308), New Orleans-LA. <https://www.learnstechlib.org/p/48118/>
- [41] Cherry, J.E. (2014). Technology integration in education: An examination of technology adoption in teaching and learning by secondary teachers in Minnesota. [PhD dissertation, University of Minnesota, USA]. <https://hdl.handle.net/11299/162926>
- [42] Christ, T., Wang, X. C., Chiu, M. M., & Cho, H. (2019). Kindergartener's meaning making with multimodal app books: The relations amongst reader characteristics, app book characteristics, and comprehension outcomes. *Early Childhood Research Quarterly*, 47, 357-372. <https://www.sciencedirect.com/science/article/pii/S0885200619300055>
- [43] Çırakoğlu, N., Toksoy, S. E., & Reisoğlu, İ. (2022). Designing, Developing, and Evaluating an Interactive E-Book Based on the Predict-Observe-Explain (POE) Method. *Journal of Formative Design in Learning*, 6(2), 95-112.
- [44] Cockton, G. (2020). Usability diverges, media converges, design reemerges. *Journal of Usability Studies (JUS)*, 15(2), 63-70.
- [45] Coiro, J. (2021). Toward a multifaceted heuristic of digital reading to inform assessment, research, practice, and policy. *Reading Research Quarterly*, 56(1), 9-31. <https://ila.onlinelibrary.wiley.com/doi/abs/10.1002/rrq.302>
- [46] Creswell, J. W. (2008). *Educational research: planning, conducting, and evaluating quantitative*. Prentice Hall.
- [47] Creswell, J. W., & Tashakkori, A. (2007). Developing publishable mixed methods manuscripts. *Journal of Mixed Methods Research*, 1(2), 107-111.
- [48] Crowe, S. (2019). *Iterative eLearning development with SAM*. <https://www.alleninteractions.com/sam-process>

- [49] Dalton, B., & Palincsar, A. (2013). *Investigating Text-Reader Interactions in the Context of Supported E-Text*. Springer. https://link.springer.com/chapter/10.1007/978-1-4419-5546-3_34
- [50] Daniel, D., & Woody, W. (2013). E-textbooks at what cost? Performance and use of electronic v. print texts. *Computers & Education*, 62, 18-23. <https://www.sciencedirect.com/science/article/pii/S0360131512002448>
- [51] Davis, L. W. (2008). The effect of driving restrictions on air quality in Mexico City. *Journal of Political Economy*, 116(1), 38-81. <https://www.journals.uchicago.edu/doi/abs/10.1086/529398>
- [52] de Koning, B. B., Tabbers H. K., Rikers, R. M. J. P., & Paas, F. (2010). Attention guidance in learning from a complex animation: Seeing is understanding? *Learning and Instruction*, 20(1), 111-122. <https://www.sciencedirect.com/science/article/pii/S0959475209000103>
- [53] Dunn, P. K., Brunton, E. A., & Farrar, M. B. (2022). Your online textbook is ready: a shareable, interactive online textbook in response to COVID-19 lockdowns. *International journal of mathematical education in science and technology*, 53(3), 582-593. <https://www.tandfonline.com/doi/abs/10.1080/0020739X.2021.1983051>
- [54] Edwards, V., Pemberton, L., Knight, J., & Monaghan, F. (2002) Fabula: A bilingual multimedia authoring environment for children exploring minority languages. *Language Learning and Technology*, 6(2), 59-69. https://scholarspace.manoa.hawaii.edu/bitstream/10125/25160/1/06_02_edwards.pdf
- [55] El-Assaad, M. (2014). Five must-have Arabic EBook readers. Arabnet. <https://www.arabnet.me/english/editorials/technology/apps/five-must-have-arabic-e-book-readers>
- [56] Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1-4.
- [57] Etta, R., & Kirkorian, H. (2019). *Children's learning from interactive eBooks: Simple irrelevant features are not necessarily worse than relevant ones*. Frontiers. <https://doi.org/10.3389/fpsyg.2018.02733>
- [58] Farmer, K. (2021). *The Benefits of Using Animation for Learning and Development*. <https://boldcontentvideo.com/2021/06/29/the-benefits-of-using-animation-for-learning-and-development/>
- [59] Filsecker, M. & Hickey, D. T. (2014). A multilevel analysis of the effects of external rewards on elementary students' motivation, engagement and learning in an educational game. *Computers and Education*, 75, 136-148. <https://doi.org/10.1016/j.compedu.2014.02.008>
- [60] Frechette, C., & Moreno, R. (2010). The roles of animated pedagogical agents' presence and nonverbal communication in multimedia learning environments. *Journal of Media Psychology: Theories, Methods, and Applications*, 22(2), 61.
- [61] Frye, S. K. (2014). *The implications of interactive eBooks on comprehension*. Rutgers The State University of New Jersey-New Brunswick. <https://search.proquest.com/openview/9b2a04c50b4d29a93037e368288898ac/1?pq-origsite=gscholar&cbl=18750>
- [62] Galvin, R. (2015). How many interviews are enough? Do qualitative interviews in building energy consumption research produce reliable knowledge?. *Journal of Building Engineering*, 1, 2-12.
- [63] Giacornini, C., Wallis, P., Lylo, H., Haaland, W., Davis, K., & Comden, D. (2013). Exploring E-Textbooks at the University of Washington: What We Learned and What Is Next. Seattle, WA: University of Washington Press. <https://www.danskeforlag.dk/media/1608/033-rapport-fra-uw-information-tech-exploring-etextbooks-at-the-university-of-washington-aug-2013-040315.pdf>
- [64] Gong, C., Chen, G., Wang, X., Zhang, X., & Huang, R. (2013). The functions of e-textbooks for utilizing in K-12 classes: A case study in Beijing. Paper Presented at the Proceedings of the 2013 IEEE 13th International Conference on Advanced Learning Technologies (pp. 479-480), Beijing-China. <https://ieeexplore.ieee.org/abstract/document/6601994/>
- [65] Gould, J. D., & Lewis, C. (1985). Designing for usability: key principles and what designers think. *Communications of the ACM*, 28(3), 300-311. <https://dl.acm.org/doi/abs/10.1145/3166.3170>

- [66] Groß-Mlynek, L., Graf, T., Harring, M., Gabriel-Busse, K., & Feldhoff, T. (2022). Cognitive Activation in a Close-Up View: Triggers of High Cognitive Activity in Students During Group Work Phases. In *Frontiers in Education* (Vol. 7). Frontiers.
- [67] Guernsey, L., Levine, M., Chiong, C., & Severns, M. (2012). pioneering literacy. *the Digital Wild West: Empowering Parents and Educators. Report. The Joan Ganz Cooney Center*. URL: http://www.joanganzcooneycenter.org/wpcontent/uploads/2012/12/GLR_TechnologyGuide_final.pdf
- [68] Hadaya, A., & Hanif, M. (2019). The impact of using the interactive e-book on students' learning outcomes. *International Journal of Instruction*, 12(2), 709-722.
- [69] Hakak, S., Kamsin, A., Tayan, O., Idris, M. Y. I., & Gilkar, G. A. (2019). Approaches for preserving content integrity of sensitive online Arabic content: A survey and research challenges. *Information Processing & Management*, 56(2), 367-380. <https://www.sciencedirect.com/science/article/pii/S0306457316305118>
- [70] Hulme, R., Cracknell, D., & Owens, A. (2009). Learning in third spaces: developing trans-professional understanding through practitioner enquiry. *Educational Action Research*, 17(4), 537-550. <https://www.tandfonline.com/doi/abs/10.1080/09650790903309391>
- [71] Hung, M. C., Talley, P. C., Kuo, K. M., & Chiu, M. L. (2020). Exploring cloud-based bookstore continuance from a deconstructed task–technology fit perspective. *Journal of Theoretical and Applied Electronic Commerce Research*, 16(3), 356-376.
- [72] Hunter, J. D. (2010). *To change the world: The irony, tragedy, and possibility of Christianity in the late modern world*. Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780199730803.001.0001>
- [73] Hussain, R. M. R., & Al Saadi, K. K. (2019). Students as designers of e-book for authentic assessment. *Malaysian Journal of Learning and Instruction*, 16(1), 23-48.
- [74] Hwang, G. J., Tu, N. T., & Wang, X. M. (2018). Creating interactive E-books through learning by design: The impacts of guided peer-feedback on students' learning achievements and project outcomes in science courses. *Journal of Educational Technology & Society*, 21(1), 25-36.
- [75] Ihmeideh, F. M. (2014). The effect of electronic books on enhancing emergent literacy skills of pre-school children. *Computers & Education*, 79, 40-48. <https://www.sciencedirect.com/science/article/pii/S0360131514001596>
- [76] Jensen, L., & Konradsen, F. (2018). A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies*, 23(4), 1515-1529. <http://dx.doi.org/10.1007/s10639-017-9676-0>
- [77] Jerald, J. (2015). *The VR book: Human-centered design for virtual reality*. Morgan & Claypool. <https://dl.acm.org/doi/abs/10.1145/2792790>
- [78] Kang, Y.Y., Wang, M-J., & Lin, R. (2009). Usability evaluation of e-books. *Displays* 30 (2), 49-52. <https://www.sciencedirect.com/science/article/pii/S0141938208000826>
- [79] Karacalli, S. & Korur, F. (2014). The effects of project-based learning on students' academic achievement, attitude, and retention of knowledge: The subject of 'Electricity in our lives'. *School of Science and Mathematics*, 114(5), 224-235. <https://doi.org/10.1111/ssm.12071>
- [80] Karakuş, U. (2006). The effect of experimental method at students? Success level while teaching climate subject in geography (Unpublished PhD Thesis). Gazi University, Ankara. <https://dergipark.org.tr/en/pub/rigeo/article/638453>
- [81] Kelley, E. S., & Kinney, K. (2017). Word learning and story comprehension from digital storybooks: Does interaction make a difference? *Journal of Educational Computing Research*, 55, 410-428. <https://journals.sagepub.com/doi/abs/10.1177/0735633116669811>
- [82] Kesim, M., & Yıldırım, H. (2017). A Literature Review and Content Analysis on Interactive E-Books. *Interactive Learning Environments*, 1(3), 2. <https://library.iated.org/view/KESIM2017ALI>
- [83] Kirby, K. & Anwar, M. (2020). An application of activity theory to the 'problem of e-books.' *Heliyon*, 6(9). <https://doi.org/10.1016/j.heliyon.2020.e04982>

- [84] Kirkorian, H. L., Choi, K., Yoo, S. H., & Etta, R. A. (2022). The impact of touchscreen interactivity on US toddlers' selective attention and learning from digital media. *Journal of Children and Media*, 16(2), 188-204. <https://www.tandfonline.com/doi/abs/10.1080/17482798.2021.1944888>
- [85] Koh, J. H.L., Chai, C.S. & Lim, W. Y. (2016). Teacher professional development for TPACK-21CL: Effects on teacher ICT integration and student outcomes. *Journal of Education Computing Research*, 55(2), 172-196. <https://doi.org/10.1177/0735633116656848>
- [86] Korat, O., & Falk, Y. (2019). Ten years after: Revisiting the question of e-book quality as early language and literacy support. *Journal of Early Childhood Literacy*, 19(2), 206-223. <https://journals.sagepub.com/doi/abs/10.1177/1468798417712105>
- [87] Korat, O., Mahamid, N., Hassunah Arafat, S., & Altman, C. (2022). What contributes to word learning and story retelling of Arabic-speaking children? Investigation of an e-book reading intervention. *Literacy Research and Instruction*, 61(2), 158-176. <https://www.tandfonline.com/doi/abs/10.1080/19388071.2021.1921891>
- [88] Kruschke, J. K. (2001). Toward a unified model of attention in associative learning. *Journal of mathematical psychology*, 45(6), 812-863.
- [89] Kucirkova, N. (2019). Children's reading with digital books: Past moving quickly to the future. *Child Development Perspectives*, 13(4), 208-214. <https://srcd.onlinelibrary.wiley.com/doi/abs/10.1111/cdep.12339>
- [90] Kucirkova, N. (2022). Children's agency and reading with story-apps: considerations of design, behavioural and social dimensions. *Qualitative Research in Psychology*, 19(1), 66-90. <https://www.tandfonline.com/doi/abs/10.1080/14780887.2018.1545065>
- [91] Kucirkova, N., Littleton, K., & Cremin, T. (2017). Young children's reading for pleasure with digital books: six key facets of engagement. *Cambridge Journal of Education*, 47(1), 67-84. <https://www.tandfonline.com/doi/abs/10.1080/0305764X.2015.1118441>
- [92] Kwasu, I. A., Yalams, S. M., & Ema, E. (2016). Using design & animation concepts to produce animated instructional resources that can facilitate open distance learning in science and technology education. *Journal of Education and Practice*, 7(17), 166-170.
- [93] Lee, J.S. Balckwell, S., Drake, J. & Moran, K. A. (2014). Taking a leap of faith: Redefining teaching and learning in higher education through project-based learning. *Interdisciplinary Journal of Problem-Based Learning*, 8(2), 19-34. <https://doi.org/10.7771/1541-5015.1426>
- [94] Lev, D. S. (1962). The Supreme Court and Adat Inheritance Law in Indonesia. *The American Journal of Comparative Law*, 11(2), 205-224.
- [95] Murage, V. M. (2021). An Analysis of Trends in Digital Book Publishing Amongst Educational Publishers in Kenya: a Case Study of Longhorn Publishers (Doctoral dissertation, University of Nairobi).
- [96] Levy, R. (2008). 'Third spaces' are interesting places: Applying third space theory to nursery-aged children's constructions of themselves as readers. *Journal of Early Childhood Literacy*, 8(1), 43-66.
- [97] Lujanovic, N. (2020, April). Whom we should blame for bad e-book?(sociological perspective of evaluation, selection and reception of e-book). In *Épijournal de Géométrie Algébrique*, pp.1-9.
- [98] Mayer, R. E., & Moreno, R. (2002). Animation as an aid to multimedia learning. *Educational Psychology Review*, 14(1), 87-99. <https://link.springer.com/article/10.1023/A:1013184611077>
- [99] Mkhize, M.V. (2019). Mathematics anxiety among pre-service accounting teachers. *South African Journal of Education*, 39(3), 1-14. <https://doi.org/10.15700/saje.v39n3a1516>
- [100] Rao, H., Monin, P., & Durand, R. (2003). Institutional change in Toque Ville: Nouvelle cuisine as an identity movement in French gastronomy. *American journal of sociology*, 108(4), 795-843. <https://www.journals.uchicago.edu/doi/abs/10.1086/367917>
- [101] Reich, S.M., Yau, J.C., & Warschauer, M. (2016). Tablet-based eBooks for young children: What does the research say?. *Journal of Developmental & Behavioral Pediatrics*, 37(7), 585-591.
- [102] Richardson Jr, R. C. (1983). *Literacy in the open-access college*. Jossey-Bass Publishers, Inc.
- [103] Rideot, V. (2017). The common sense census: Media use by kids age zero to eight.: Common Sense Media. \

- [104] Ritchie, J. (2017) The 12 Principles of Animation (With Examples). *Idea Rocket*; <https://idearocketanimation.com/13721-12-principles-of-animation-gifs/>
- [105] Robert, P., Onyike, C. U., Leentjens, A. F., Dujardin, K., Aalten, P., Starkstein, S., ... & Byrne, J. (2009). Proposed diagnostic criteria for apathy in Alzheimer's disease and other neuropsychiatric disorders. *European Psychiatry*, 24(2), 98-104.
- [106] Rogers, Y., Sharp, H., & Preece, J. (2011). *Interaction Design: Beyond Human-Computer Interaction* (3rd ed.). John, Wiley & Sons. <http://oro.open.ac.uk/29638/>
- [107] Rojas-Murillo, S., & Pennathur, P. R. (2019). Selection of key visual cues in real and virtual environments for assembly tasks. *International Journal of Industrial Ergonomics*, 74, 102871.
- [108] Roskos, K., Brueck, J., & Lenhart, L. (2017). An analysis of e-book learning platforms: Affordances, architecture, functionality and analytics. *International Journal of Child-Computer Interaction*, 12, 37-45.
- [109] Ruddock, A. (2005). Let's Kick Racism Out of Football—and the Lefties Too! Responses to Lee Bowyer on a West Ham Web Site. *Journal of sport and social issues*, 29(4), 369-385. <https://journals.sagepub.com/doi/10.1177/0193723505280665>
- [110] Rvachew, S., Rees, K., Carolan, E., & Nadig, A. (2017). Improving emergent literacy with school-based shared reading: Paper versus ebooks. *International Journal of Child-Computer Interaction*, 12, 24-29.
- [111] Saffer, D. (2010). *Designing for interaction: creating innovative applications and devices*. New Riders.
- [112] Salsberg, A. (2019). The 12 principles of animation. *Lesley University*. <https://lesley.edu/article/the-12-principles-of-animation>
- [113] Sanii, B. (2020). Creating augmented reality USDZ files to visualize 3D objects on student phones in the classroom. *J. Chem. Educ.*, 97, 253-257. <https://pubs.acs.org/doi/10.1021/acs.jchemed.9b00577>
- [114] Wang, F., Wijaya, T. T., Habibi, A., & Liu, Y. (2022). Predictors Influencing Urban and Rural Area students to Use Tablet Computers as Learning Tools: Combination of UTAUT and TTF Models. *Sustainability*, 14(21), 13965. <https://doi.org/10.3390/su142113965>
- [115] Williams, C. & Beam, S. (2019). Technology and writing: Review of research. *Computers and Education*, 128, 227-242. <https://doi.org/10.1016/j.compedu.2018.09.024>
- [116] Winograd, T. (1997). From computing machinery to interaction design. *New York*. http://echo.iat.sfu.ca/library/winograd_97_computing_machinery.pdf
- [117] Ye, X. D., Chang, Y. H., & Lai, C. L. (2019). An interactive problem-posing guiding approach to bridging and facilitating pre-and in-class learning for flipped classrooms. *Interactive Learning Environments*, 27(8), 1075-1092. <https://www.tandfonline.com/doi/abs/10.1080/10494820.2018.1495651>
- [118] Zeller, D., Bohrmann-Linde, C., & Kläger, S. (2020). Digital learning tools for teaching “Alternative Solar Cells with Titanium Dioxide”(ALSO-TiO₂)-a contribution to sustainable development education. *World Journal of Chemical Education*, 8(1), 29-39.
- [119] Zhang, T., Niu, X., & Promann, M. (2017 July). Assessing the user experience of e-books in academic libraries. *College & Research Libraries*, 78(5), p.578. <https://crl.acrl.org/index.php/crl/article/view/16713/18220>. (Accessed: 23 December 2022). doi: <https://doi.org/10.5860/crl.78.5.578>.
- [120] Zhang-Kennedy, L., Abdelaziz, Y., & Chiasson, S. (2017). Cyberheroes: The design and evaluation of an interactive ebook to educate children about online privacy. *International Journal of Child-Computer Interaction*, 13, 10-18. doi: <https://doi.org/10.1016/j.ijcci.2017.05.001>
- [121] Zipke, M. (2017). Preschoolers explore interactive storybook apps: The effect on word recognition and story comprehension. *Education and Information Technologies*, 22, 1695–1712. <https://link.springer.com/article/10.1007/s10639-016-9513-x>