Ed Process Int J

www.edupij.com

ISSN 2147-0901 (Print), 2564-8020 (Online)

EDUCATIONAL PROCESS
INTERNATIONAL JOURNAL

A Framework for Developing Interactive Animated E-Books: A Thematic Analysis-Based Study

Asma A. Sayed, Terry Lucas

Research Article

Cite this article: Sayed, A. A., & Lucas, T. (2025). A Framework for Developing Interactive Animated E-Books: A Thematic Analysis-Based Study. *Educational Process: International Journal, 16*, e2025244. https://doi.org/10.22521/edupij.2025.16.244

Received March 24, 2025
Accepted May 6, 2025
Published Online June 13, 2025

Keywords: Interactive animated e-books, digital learning, learner engagement, cognitive development, adaptive learning, gamification.

Author for correspondence:
Asma A. Sayed
a_sayyed@asu.edu.jo
Universiti Malaysia Sarawak (UNIMAS), Malaysia.

Abstract

Background/purpose. This study explores the development and implementation of interactive animated e-books as a transformative digital learning tool. It analyzes their pedagogical and cognitive effects on learner participation and understanding. The study is oriented towards how multimedia integration, interactive storytelling, and adaptive learning principles create superior online learning experiences and what are the most important issues and design principles necessary to apply them.

Materials/methods. This study employed a qualitative methodology through thematic analysis of semi-structured expert interviews with digital education experts, multimedia designers, and educators. The study also conducted a systematic analysis of perspectives about design, usability, educational value, and implementation of interactive animated e-books across different learning contexts.

Results. Show that game-like e-books facilitate learning and student participation through gamification, real-time feedback, and customized learning tracks. Important design factors, such as visual design (color palettes, typefaces, motion design), were seen to trigger attention and recall. Yet critical implementation issues were also realized through high development costs, technological limits, insufficient teacher training, and a need for culturally sensitive design.

Conclusion. Interactive animated e-books offer strong pedagogical value in digital education. Their success depends on design frameworks focused on interactivity, user experience, and adaptive learning. Wider adoption requires affordable development, educator training, and AI-driven personalization. Future studies should assess long-term impact and accessibility in diverse, low-resource contexts.

1. Introduction

The educational digital revolution introduced interactive animated e-books as a paradigm-shifting innovation challenging conventional models of learning and offering a very effective platform for learning. The development is a critical milestone in the overall digitalization of human knowledge, revolutionizing how people study and engage with and consume pedagogic materials. Interactive animated e-books facilitate immersive and multisensory learning designed to meet the varied needs of contemporary learners.

The inclusion of multimedia and text-based content allows interactive animated e-books to support active learning contexts through differentiation in terms of pedagogical and cognitive requirements (Çırakoğlu et al., 2022; Nugraini, 2013). Their educational value is not only in presenting information but also in affecting conceptual knowledge and long-term memory recall (Nugraini, 2013). However, despite their potential advantages, too many animated e-books fail to meet standardized design models, restricting their use in formal educational institutions. Though existing literature justifies multimedia learning on a theoretical basis, it tends to be short on practical guidelines for designing and integrating interactive elements (Çırakoğlu et al., 2022; Dunn et al., 2022).

This absence of implementation recommendations is a clear area of research need. Teachers and instructional designers have a great challenge in tailoring these materials to various classroom contexts (Alshaya & Oyaid, 2017; Lim et al., 2020; Rojas-Murillo & Pennathur, 2019). Although interactive animated e-books have great potential to serve as learning tools, their effectiveness is poorly evaluated and calls for systematic examination. Thus, this inquiry aims to fill this gap by examining both the theoretical and practical aspects of interactive animated e-books in learning in Arabic-language educational contexts.

A systematic design model for designing and utilizing interactive animated e-books can be very effective in integrating them into digital learning platforms. Studies have identified interactive digital links to be very important in enhancing learner autonomy and interaction (Nugraini, 2013). Adding animation, audio narration, and interaction through graphical features is effective when it comes to enhancing cognition and early learning in young learners (Rvachew et al., 2017). Animation has also been found to trigger neural activation and supports cognitive development through enhancing interactivity and presence (Sharmila, 2014).

The potential value of interactive animated e-books goes beyond bridging the digital divide. They present multi-sensory learning opportunities that accommodate a large number of different learning styles (Abdinejad et al., 2021; Giacornini et al., 2013; Farmer, 2021). For Arabic language education, in particular, they establish culturally appropriate platforms for learning. The design structure of an e-book exerts a substantial effect on interaction and mental response and has a direct effect on learning effectiveness (Adams, 2007; Hadaya & Hanif, 2019; Koh et al., 2016; Salsberg, 2019). However, a dearth of systematic design guidelines remains a continued obstacle to real-world implementation and instructional uniformity.

Most work focuses on multimedia learning theory at the expense of empirical validation of particular interactive elements. Few studies have evaluated them systematically in terms of their cognitive and pedagogical impacts, hindering wider educational take-up. Most of this work relies on Western education contexts with little insight into how such technologies cross cultural frontiers. In countries such as the Arab world—where linguistic and pedagogical models are very different—such a gap is only amplified.

Overcoming such limitations calls for an in-depth investigation into animation design principles and user-centric interactivity. Researching how these factors contribute to learner motivation,

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

participation, and understanding will foster a connection between theory and application. Assessing current design models will also uncover what works best in long-term knowledge retention. Additionally, exploring best practices in culturally sensitive e-book design for Arabic-speaking learners is part of making digital learning more inclusive and effective.

To optimize the learning value of interactive animated e-books, it is critical to define a systematic framework to standardize their use and to align them with pedagogy. This would enable instructors, developers of educational materials, and policymakers to generate culturally sensitive, student-centered digital materials. These digital materials are made more accessible and help improve student performance through context-sensitive digital tools in areas with unique cognition and local cultural learning needs. By analyzing these facets systematically, this study advances scholarship on educational multimedia technologies and provides groundwork for incorporating animated e-books in formal learning.

2. Literature Review

Digital learning is a paradigmatic approach to incorporating technology into teaching and learning processes to facilitate tailored, adaptive, and engaging educational experiences. The U.S. Department of Education (2016) defines it as encompassing tools and platforms like e-learning systems, virtual classrooms, mobile apps, and digital texts. Of these tools and platforms, it is the interactive e-book that has become a potent tool in the digital learning scheme. It is not just a digitized rendition of printed text but a multimedia-enhanced learner-centric experience adaptable to different cognitive and pedagogical requirements. This review discusses the nexus of digital learning principles and practical applications of interactive e-books on how such tools influence contemporary educational infrastructures.

The evolution of e-books into interactive animated books is a paradigm revolution in information processing and reading in the digital era. E-books were electronic versions of printed books and monographs in electronic form for easy reading on devices (Cintamulya & Murtini, 2025). They were non-interactive and mere scanned or text-based versions. However, with technological progress and digital literacy, e-books have progressed to include more multimedia-supported elements such as hyperlinks and in-stream audio-visual materials to be able to provide a more engaging process of reading (Turčić, 2021). The release of the EPUB 3 specification brought e-book functional possibilities closer by initiating individual and interactive reading through adaptive text representation, interactive images, and synchronized audio-visual media. This is a reflection of growing awareness that e-books are superior to printed matter in view of greater access, flexibility, and interactivity (Turner et al., 2019; Larson, 2015).

With the shifting technology world, schools' use of e-books extended beyond that. Rustika and Permana (2022) found that interactive e-books activate cognitive procedures and independent learning, mainly through animation and game-like features. Similarly, Cahyani and Setyadi (2023) found that synchronized audio-visual features enable comprehension, particularly in the early literacy phase, where attention capture is crucial. A study conducted by Roskos et al. (2014) also makes this concept familiar, demonstrating that interactive reading raises learning levels. Also, dynamic font sizes, text-to-speech, and context-based annotations as flexible reading features foster greater inclusivity by embracing more students, ranging from early learners to older pupils (Muir & Hawes, 2013; Bozkurt et al., 2016). Despite these enhancements, issues persist, particularly concerning usability across platforms and consistency of user experiences (Larson, 2015; Özbay & Ugurelli, 2023).

Multimedia learning has received a lot of focus within educational psychology, especially in supporting cognitive processes during learning. According to Lin (2012) and Mayer and Moreno (2002), Cognitive Load Theory (CLT) gives insight into how cognitive overload is detrimental to learning achievement. In this view, carefully designed multimedia instruction reduces the extraneous

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

cognitive load by presenting the information in a well-structured manner so that the learner can concentrate on intrinsic and germane cognitive loads. Moreno and Mayer (1999) extended this model with the modality principle, where the presentation of information on the auditory and visual channels simultaneously optimizes processing efficiency. Hagiwara (2014) took the same stance, asserting that multimedia approaches in line with CLT strengthen interaction and memory.

At the same time, the Dual Coding Theory (DCT), posited by Mayer and Moreno (2002), assumes that learning will be improved if there is simultaneous verbal and visual processing of information. Alhazmi (2024) conducted a study demonstrating how multimedia inputs lead to enormous vocabulary learning and retention, supporting Mayer's work that using textual and pictorial material directs attention and strengthens memory. Similarly, a study by Kanellopoulou et al. (2019) established empirical evidence that the use of dual-coding principles, such as subtitles in educational videos, assists learners of languages in acquiring new vocabulary. Such blending of Cognitive Load Theory (CLT) and DCT is a general model for developing adequate multimedia learning resources. Mayer (1999) emphasized basic principles of cognition, including the coherence principle that discourages overinformation and the contiguity principle that encourages close temporal integration among related images and text to allow maximum retention and learning effectiveness.

Besides the cognitive benefits of multimedia learning, Whitelegg et al. (2011) further included that multimedia materials infuse motivation and interest into learners because of their compatibility with various learning styles. Relying on this study is a study conducted by Chong and Soo (2021), which legitimized the reason interactive e-books evoke cognitive engagement and are a valuable creative learning source. Wen et al. (2022) further supported this contention as they established that students exposed to interactive learning materials will be more likely to experience behavior shifts that will enhance their performance at school. Strouse and Ganea (2017) also illustrated the roles of electronic books in language acquisition for young children, focusing on the advantageous status of electronic materials over printed ones.

The effectiveness of interactive e-books has also been researched to enhance comprehension and retention skills in individuals of different ages. It was proven by Gohar (2017) that interactive reading material significantly improves the linguistic capacity of children in kindergarten, while López-Escribano et al. (2021) spoke about several pieces of research that evidenced interactive e-books to be effective in enhancing literacy. Their studies revealed that enriched e-books consistently outperformed non-interactive ones in building literacy. ElAdl and Al-Musawi (2020) also extended this by linking the use of e-books to levels of learners' self-efficacy and motivation and the contention that interactive digital materials elicit higher competency perceptions from learners. On the same note, Abdullah et al. (2015) found that children's vocabulary development and engagement levels increased with interactive mobile-based applications.

Despite the clear advantages, worry about overstimulation and cognitive load persists. Xu et al. (2020) warned that while interactive elements improve engagement, too much multimedia content can add to cognitive load, distracting from learning effectiveness. This problem is solved by using sound instructional design so that multimedia components are not used as mere decorations but are fully utilized in terms of pedagogical purpose. Larson (2015) and Bates et al. (2016) also supplemented that educational value comes from the simultaneous balance of interactivity and content presentation without overwhelming the learner.

Limitations in existing research are more likely to be methodological, sample size-based, and context-specific. Lysaght et al. (2018) noted that generalizability remains challenging in emergent social enterprise research because findings are usually context-specific. Rodriguez et al. (2024) argued that oversimplification of limitations to studies or failure to declare them could precisely hinder follow-up studies and practical applications. Similarly, Obeso et al. (2020) addressed

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

knowledge management research needs by noting the need to emphasize context specificity when examining knowledge-sharing processes. Xia et al. (2021) further stated that global knowledge-sharing mechanisms in distributed teams lack sufficient examination, offering an area for future research to explore how collaboration influences innovation performance. Koola (2016) also highlighted methodological shortfalls in healthcare research, specifically in the assessment of cytokines in schizophrenia research, showing how poor methodologies can hinder progress in knowledge.

One response to these demands is that some research proposes models that render research outcomes more empirically relevant. Faridah et al. (2022) proposed a blended learning model to bridge research gaps in adaptability for greater flexibility in educational applications. By addressing these research limitations, future studies can further develop methodology and extend the scope of empirical applications, with the eventual contribution of a more informed understanding of interactive e-books and their utilization in education. While current research provides significant information about the benefits and drawbacks of digital learning materials, continued development in design, accessibility, and instructional effectiveness is necessary for maximizing the potential of interactive e-books in modern education.

3. Methodology

This study adopts a qualitative research design using a thematic analysis approach to explore expert perspectives on the design, pedagogical value, and usability of interactive animated e-books. The qualitative nature of the research aligns with the study's exploratory aim, which seeks to develop a structured framework for designing and applying interactive e-books in diverse educational contexts. Thematic analysis was chosen for its capacity to capture nuanced expert insights and extract recurring patterns from in-depth discussions, offering a contextualized understanding of best practices and design principles.

3.1. Research Design

A qualitative thematic analysis was used. More specifically, this study used an exploratory multiple case study design, a design particularly suited for in-depth analysis of expert views. The purpose of this research was to synthesize expertise from professionals in instructional design, multimedia learning, and e-learning to derive an empirically informed framework for designing interactive animated e-books. In contrast to quantitative designs concerned with generalizability, the qualitative design used in this work gave rich context to how interactivity, aesthetic appeal, and cognition principles affect the effectiveness of such tools in real-world learning contexts.

The process of inquiry was iterative and systematic. It started with the initiation phase in which methodology and scope were well-defined. This was then followed by theme coding and expert interview analysis to allow patterns to be seen in their responses. A preliminary framework for designing interactive animated e-book development was derived on this basis. The framework was then validated to test credibility and usability. The last step was to apply it to instructional contexts to test its pragmatic potential to shape digital learning interventions.

Figure 1 displays this process through a sequential description of initiating the research, undergoing thematic analysis, developing a framework, validating it, and ultimately applying it. It schematically addresses the rational flow of data gathering to generating an instruction model for interactive e-books with validation.

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

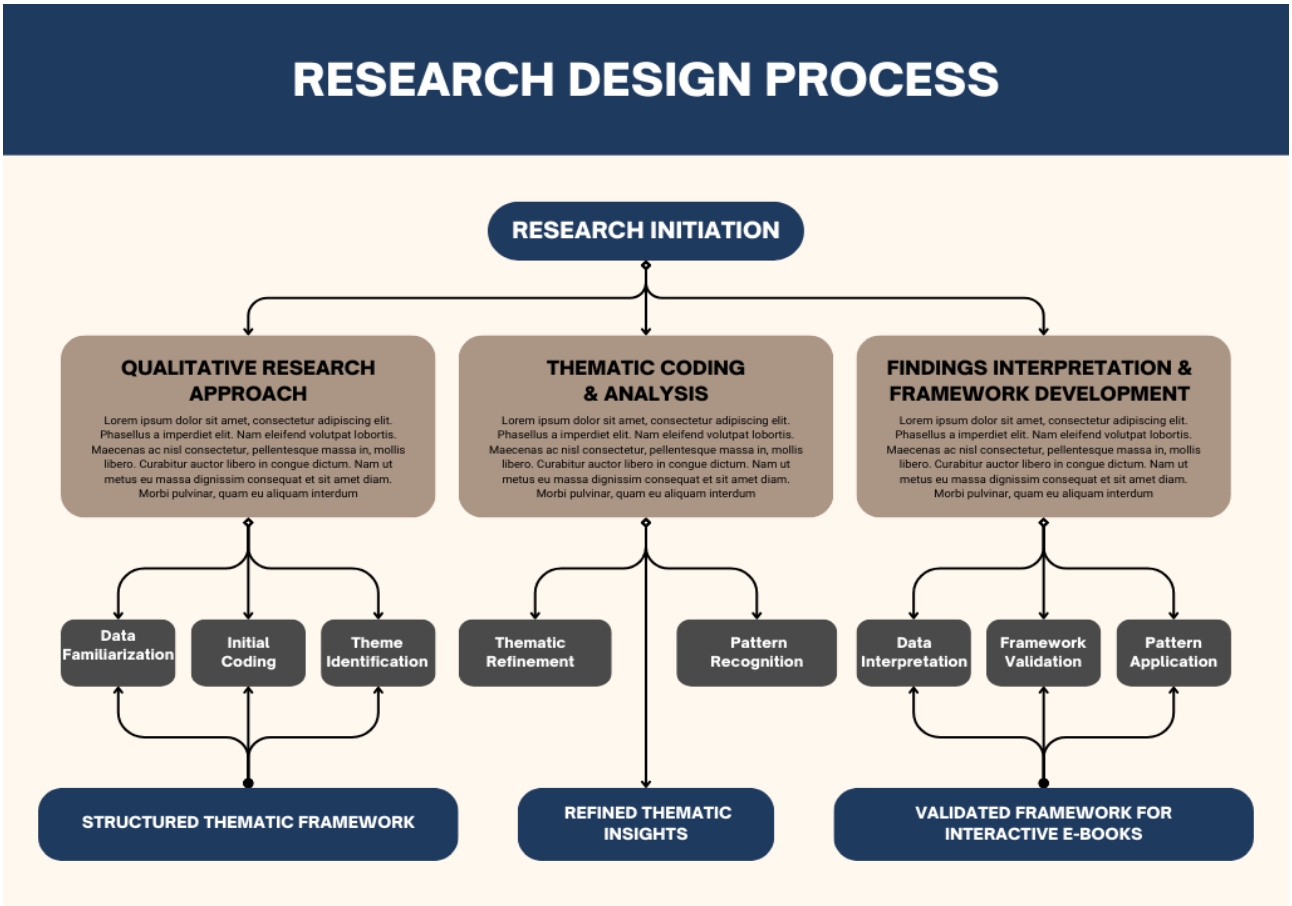

Figure 1. Research Design Process.

3.2. Data Collection

The data were gathered through semi-structured interviews with expert participants who were purposively selected. The technique was used for its capacity to balance structure and flexibility, allowing researchers to discuss predefined themes while also permitting users to present their professional experience in depth. The format of an interview provided detailed discussions of design strategies, instruction strategies, and techniques for user interaction in relation to the animated e-book context.

The purposive sampling technique was used to choose six digital learning, multimedia education, and instructional design experts. The subjects were selected on their qualifications and experience in designing, assessing, or incorporating interactive e-books in a range of educational contexts. Their experience involved academic scholarship, educational leadership in technology, and practical design experience to guarantee a diverse and knowledgeable group in terms of usability, engagement, and instructional effectiveness.

An interview protocol was crafted to facilitate the data collection process. It featured a total of ten open-ended questions related to major aspects of multimedia design principles, animation techniques, interactive components, strategies for enhancing cognitive engagement, and implementation issues. Two independent experts in educational technology reviewed the interview protocol to establish clarity of language, appropriateness to context, and conformity to purposes of study.

The interviews also investigated how interactive features impact pedagogic effectiveness, particularly in non-Western education systems, where cultural, linguistic, and instructional models might be very different to Western systems. Such a direction was critical for assessing the

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

transferableness and adaptableness of design principles to Arabic-speaking and multicultural learning environments.

All interviews were conducted online and recorded with the informed consent of the participants. Transcripts were crafted and anonymized to meet ethical requirements. The responses yielded detailed and context-driven information about existing design constraints, pedagogic issues, and avenues for potential improvements. The findings fed directly into the framework presented in this study to maximize usability and effectiveness in interactive animated e-books.

Even though there were only six participants involved, the richness and applicability of their professional experience made for full and valuable data. This is in line with the values of qualitative research, which value depth over breadth and seek data sufficiency rather than statistical representativeness.

3.3. Data Analysis

Thematic analysis was employed as the main strategy for coding and interpreting the qualitative data gathered through expert interviews. This strategy was useful in allowing researchers to interrogate the narratives in an organized and significance-oriented manner but in a flexible manner capable of capturing refined underlying themes and insights. The process was iterative in a cyclical pattern, with it starting with a detailed familiarity with transcripts of the interviews. During this phase, the materials were examined in a meticulous and careful manner through annotation to grasp the extent and variability in every expert's response. This preliminary immersion facilitated the development of a preliminary view of evolving themes and set the direction for more in-depth analysis.

The data was then systematically coded following familiarization. Segments of transcripts were categorized in relation to repeated ideas and common meaning. The codes represented designs in relation to design quality, cognitive value, and usability of interactive animated e-books. Similar ideas were gathered and coded into more general thematic categories as coding continued. This process enabled researchers to spot how experts differed in approaching design issues, assessing user experience, and projecting pedagogical effectiveness.

The coding was followed by an ongoing process of fine-tuning emerging themes. This process entailed re-examining data to test consistency in interpretations and making modifications to groupings to align with the overarching purposes of the study. Specific attention went toward how experts made sense of interactivity to engage learners, what visual and aesthetic decisions might influence cognitive processing, and what it meant to align educational materials with learning theory. The analysis also underscored experts' difficulty in applying interactive e-books to real-world classroom scenarios in areas with a low infrastructural capacity and training environment.

Five primary thematic dimensions were derived from this thorough review, each identifying a significant component of effective interactive e-book design. These are interactivity and engagement, aesthetic and visual design, principles of cognition and learning, implementation issues, and improvement strategies. Each theme represented a different aspect through which the educational potential and practical implementation of interactive animated e-books might be known and optimized.

A visual overview of the process is shown in Figure 2 to facilitate transparency and replicability of the analysis. The figure details how the data were worked through step by step—from familiarity and initial coding through to theme development and framework building. This format supplied a clear progression through to the conceptual building blocks of the framework presented in this investigation. By systematically recording expert insights, the analysis is assured of academic rigor

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

and is able to add practical utility to educators, designers, and policymakers striving to enhance digital learning tools.

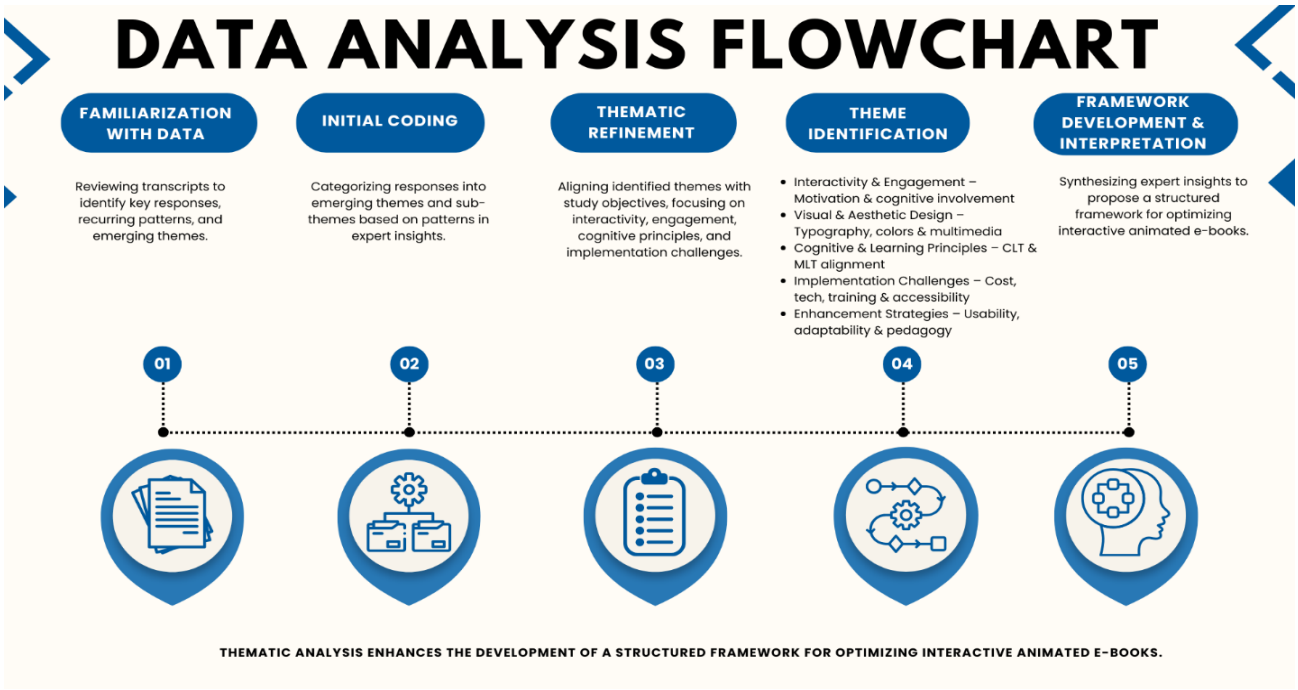

Figure 2. Data Analysis Process for Thematic Coding of Expert Interviews.

3.4. Validity and Reliability

Numerous validation measures were utilized at each step of the research process to guarantee the credibility and integrity of this qualitative study. These measures were crucial in ensuring consistency and transparency in data analysis and final framework development.

One of the main strategies was triangulation, by which information derived through different expert participants was compared and cross-checked. By examining similar patterns in several sources in concert, the study minimized individual bias and generated findings representing a wider, multi-perspective view of the design and implementation of interactive animated e-books.

Apart from triangulation, expert validation was also utilized to improve the accuracy of the thematic interpretations. Following the initial coding and theme development process, participants were asked to discuss and review preliminary findings and offer feedback. Their feedback ensured that the emerging themes indeed represented their professional perspectives and hands-on experience. The feedback process also prevented potential misinterpretation and provided additional insight to the analysis.

The intercoder agreement was also put in place to ensure the reliability of coding. A subset of data was coded independently by several researchers, who later compared their categorizations to bring their interpretations into line. This comparison helped to ensure consistency through the data and nullify potential subjectivity on the part of individual researchers.

Ethical integrity was also a cornerstone of this study. Each participant was fully informed about the purpose of the research, their right to withdraw at any time, and how data would be utilized. Voluntary participation was encouraged, and all responses to interviews were anonymized to ensure confidentiality and prevent identification of any participant. These steps ensured ethical integrity in the research and encouraged an open and frank discussion in a protected environment.

Through these integrated efforts, the study created a transparent and sound analytical process. The validation processes verified the credibility of findings and strengthened the methodological

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

integrity of the thematic framework used to advance interactive animated e-books in varied educational contexts.

4. Results and Discussion

4.1. Interactivity and Engagement

Interactivity was repeatedly cited by learners as a key to effective digital learning, especially when it is aimed at younger learners. The experts were in consensus that most e-books today fall short of real interactivity and are more like digitized textbooks rather than exciting, immersive tools. This disconnect between potential and actual design impacts learner motivation and restricts cognitive activation to effect deeper learning. Visual attractiveness—such as animations, bright colors, and interactive touchpoints—was noted by learners to be important in engaging and holding children's interest.

Even with multimedia capabilities at their fingertips, numerous existing implementations of e-books have failed to take advantage of these capabilities. Experts criticized most digital e-books for being stagnant and lacking worthwhile opportunities for active interaction between learners and the book. Clickable objects, drag-and-drop exercises, and interactive stories were named as critical to enhancing active learning and sustained interest. The tools turn learning into a process of exploratory participation instead of passive consumption.

Repeated emphasis was also put on incorporating game elements and instant feedback. The participants described how rewards, sound bites and animated feedback such as clapping or supportive vocal feedback serve to strengthen learning through positive reinforcement. This is consistent with earlier work identifying game-based learning environments with motivational potential (e.g., Mayer, 2014). Additionally, feedback systems that adapt according to responses by learners (adaptive feedback) were considered to be important in supporting self-correcting, reflection, and perseverance.

A recurring idea was also the value of personalization. Experts cited that e-books should have a range of entry points for learners to access information through animation, text, or narration. This aligns with the principles of differentiated instruction to enable learners with different preferences and needs to access information in their best-suited manner. Multi-sensory integration in this context—merging visual, auditory, and tactile feedback—was viewed to facilitate deeper understanding and retention of information.

Nonetheless, most experts are concerned that e-books have failed to exploit these potentialities. They rely disproportionately on fixed content and have minimal facilities for learner interaction or feedback. To address this, participants strongly recommended the inclusion of adaptive learning structures, interactive storytelling, and scaffolded feedback systems. These tools not only increase engagement but also align with constructivist learning principles, allowing learners to become active agents in their educational journey.

The findings clearly underscore a gap between the theoretical capabilities of interactive e-books and their practical execution. Table 1 summarizes key insights from participants related to this theme. It emphasizes the urgent need for e-book development practices to shift from static digital replication to thoughtfully designed interactive environments that enhance motivation, autonomy, and learning outcomes.

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

Table 1. Thematic Analysis of Interactivity and Engagement in Interactive Animated E-Books

Theme	Key Findings	Supporting Quotes
Lack of True Interactivity	Many e-books resemble traditional textbooks and lack engaging interactive elements.	- "Children are attracted by illustration, circular shapes, and bright colors." (P25) - "Current designs are more like news websites, not interactive tools." (P25)
Need for Active Participation	Clickable elements, drag-and-drop activities, and interactive storytelling enhance engagement.	- "Interactivity should allow children to explore content through clicks and audio explanations." (P19) - "Interactive buttons help children connect concepts." (Aya)
Gamification as Motivation	Game-like elements, rewards, and point systems sustain interest and motivation.	- "Educational games enhance interaction and make learning fun." (P24) - "Adding applause or voiceovers for correct answers improves engagement." (P17)
Immediate Feedback	Real-time feedback reinforces correct responses and guides learning. Adaptive feedback supports diverse needs.	- "Interactivity should provide instant feedback to help children understand their mistakes." (P6) - "Immediate feedback encourages participation and comprehension." (P19)
Customization & Personalization	E-books should adapt to different learning styles, offering text, animations, and audio options.	- "The design should be flexible to suit different learning preferences." (P19)
Multi-Sensory Integration	Combining visuals, audio, and tactile elements improves engagement and comprehension.	- "Children should be able to touch parts of images and hear explanations." (P5) - "Simple animations and interactive visuals capture attention." (P31)
Current E-Book Limitations	Many existing e-books rely on static text and images, failing to engage learners dynamically.	- "Children are used to motion and pop effects, which should be integrated." (P3) - "Long texts and static images do not align with cognitive design principles." (P27)

4.2. Visual and Aesthetic Design

Visual and aesthetic design emerged as a significant determinant of user engagement and learning effectiveness in interactive animated e-books. According to the experts, design choices such as color schemes, typography, and layout directly influence how children perceive and interact with digital content. Vibrant color palettes and clear, sans-serif fonts were widely recommended for their ability to attract attention and facilitate readability, particularly among early learners. Participants

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

emphasized that consistency in visual design is crucial, noting that abrupt shifts between cartoon-style graphics and realistic images can interrupt the flow of learning and cause cognitive confusion.

Several experts raised concerns about the underutilization of visual design in current e-books. Many digital materials were described as overly text-based and lacking the visual stimulation needed to maintain learner interest. This shortfall restricts the potential for cognitive engagement in interactive e-books, where younger users are more dependent on visual information to build meaning. Successful visual narration based on consistent design was also cited as necessary not only to engage but to facilitate understanding and recall of abstract or complex ideas.

The use of animation and motion graphics was another area of particular importance. The group concurred that animation is more than a mere ornament; it is an instructional tool capable of clarifying abstract ideas and aiding in thinking. Strategically employed animated segments were described as engendering immersive experience and recall. But participants also cautioned against overwhelming the student with too much movement or badly crafted animations that cause a build-up in cognitive load and take away from instructional goals. Finding a balance between movement and clarity is necessary to gain effective interaction.

Apart from interaction and understanding, accessibility was cited as a major factor to be considered. Experts noted a dearth of e-books with features to support different learning requirements—text-to-speech functionality, resizable fonts, or customizable interfaces. This non-flexibility is not only restrictive in terms of usability but is also against principles of inclusive design. Respondents encouraged a less technically driven and more empathetic design of visuals, with a focus on emotionally engaging content and hierarchical designs to lead learners naturally through information.

Table 2 is a synthesis of such findings and highlights the significance of coherent aesthetic strategies in interactive animated e-book design. Effective visuals have the potential to enhance attention, consolidate understanding, and maintain motivation. The results also support prevailing design principles, including Mayer's Cognitive Theory of Multimedia Learning, according to which good-quality visual input facilitates learning when it is in sync with the learner's capacity.

Ultimately, the results highlight that visual and aesthetic design is not merely an accessory to content but a fundamental component of digital pedagogy. Upcoming e-books must move beyond basic color and font choices to adopt comprehensive, learner-centered design strategies that account for engagement, comprehension, and accessibility. This ensures a more inclusive, effective, and emotionally engaging learning experience for diverse learner populations.

Table 2. Visual and Aesthetic Design Elements in Interactive Animated E-Books

Theme	Key Findings	Supporting Quotes
Impact of Color and Typography	Bright, engaging colors and readable fonts enhance children's attention and comprehension.	- "Children love bright colors such as yellow, red, green." (P1) - "Sans-serif fonts are more readable for children." (P19)
Consistency in Artistic Style	A unified visual style prevents confusion and enhances learning flow.	- "Lack of uniformity in visual style disrupts learning." (P31) - "Mixing cartoon and realistic images is illogical." (P5)

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

Role of Motion Graphics and Animation	Well-integrated animations enhance engagement and aid concept understanding.	- "Animated content improves attention and comprehension." (P19) - "Movement helps children grasp abstract concepts better." (P24)
Psychological Effects of Design	Visual aesthetics influence children's motivation and learning experience.	- "Dull colors fail to motivate students." (P7) - "Children need engaging visuals to avoid distractions." (P25)
Challenges in Visual Design	Inconsistent styles, over-reliance on static text, and lack of accessibility options hinder effectiveness.	- "E-books should include balanced text-to-image ratios." (P12) - "More accessibility features are needed for diverse learners." (P19)

4.3. Cognitive and Conceptual Learning Principles

Cognitive and conceptual learning principles play a fundamental role in shaping the educational value of interactive animated e-books. According to the participants, one of the primary limitations of conventional e-books lies in their static nature—long passages of text and immobile images fail to engage learners or support deep conceptual understanding. In contrast, interactive formats that incorporate multimedia elements were viewed as more effective in facilitating comprehension, particularly for abstract concepts. Participants emphasized that younger learners, in particular, benefit from content that is not only visually stimulating but also structured in a way that supports incremental learning.

A strong consensus emerged around the effectiveness of animation and multisensory learning approaches. Respondents consistently noted that animated sequences capture attention more effectively than static visuals and allow complex or abstract ideas to be communicated in a more accessible and engaging format. Rather than overwhelming students with dense content, animations can illustrate cause-and-effect relationships, sequence, and transformation—key processes in concept internalization.

Moreover, the participants stressed the importance of scaffolded learning, in which information is presented progressively, building upon prior knowledge in small, coherent steps. This strategy echoes principles of theory in cognitive development and is also a reflection of best instructional design. Organizing information in a sequential, step-by-step format was viewed as essential to engaging learners and strengthening conceptual integration throughout.

The discussion also confirmed strong correspondence between established educational principles and participant observations, notably Dual Coding Theory (DCT) and Vygotsky's Zone of Proximal Development (ZPD). Experts pointed out that pairing visual and audio components—key to DCT—deepens retention and recall through engaging multiples paths of cognition. The same principles in ZPD validate the notion that learners derive most benefit when instructional materials are a step above existing levels but provided with suitable assistance and interactivity.

One other critical factor brought forward was the worth of learning personalization. By offering multiple forms of representation—text, audio, animation—interactive e-books can accommodate a wider range of learning preferences and cognitive abilities. This is particularly beneficial in inclusive learning environments where students may vary significantly in terms of their prior knowledge, language skills, and cognitive development stages.

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

Table 3 summarizes the key findings related to cognitive and conceptual learning principles. It reinforces the central claim that static digital materials are insufficient for promoting meaningful learning experiences. Instead, educational impact is significantly enhanced when interactivity, scaffolded sequencing, and multisensory integration are employed purposefully. These findings strongly advocate for the development of e-books that are informed by cognitive learning theory and designed to support deep, lasting understanding.

Table 3. Cognitive and Conceptual Learning Principles in Interactive Animated E-Books

Theme	Key Findings	Supporting Quotes
Limitations of Static Content	Static materials fail to support conceptual understanding due to lack of interactivity and visual engagement.	"Long texts and static pictures do not achieve learning goals." (P5). "The current framework lacks interactivity and engaging design." (P24)
Effectiveness of Animated Content	Animations help visualize complex concepts, making learning more engaging and effective.	"Animations capture attention and improve comprehension." (P19). "Animated content must be appropriate and not distracting." (P28)
Scaffolded Learning Approach	Content should be structured progressively, starting with simple concepts before advancing.	"Information should be organized to follow a logical learning path." (P19). - "Gradual content progression aligns with cognitive learning principles." (P5)
Multisensory Learning Benefits	Engaging multiple senses (visual, auditory) enhances information retention and accessibility.	"Using sight and sound together makes learning easier to absorb." (P25). "Providing multiple interaction options benefits all students." (P22)
Theoretical Support	Dual Coding Theory (DCT) and Zone of Proximal Development (ZPD) reinforce the effectiveness of multimedia learning.	"Combining verbal and visual content improves memory and comprehension." (P22)

4.4. Challenges in Implementation

Despite the promise of interactive animated e-books in enhancing digital learning, their implementation remains constrained by several significant challenges. One of the most pressing issues identified by participants was technical compatibility. Many current e-books fail to function smoothly across different devices, with inconsistencies noted between mobile and desktop platforms. This limitation becomes particularly acute in regions with underdeveloped technological infrastructure, where learners often rely on basic or shared devices. The absence of adaptive and responsive design frameworks was regarded as a hindrance to equal access and, in particular, in low-resource learning contexts.

Financial sustainability is another important obstacle. Experts have pointed out that generating and updating such quality interactive e-books involves heavy human and material capital investments. Incorporating sophisticated capabilities such as gamification, simulations, or virtual

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

reality implies very large production expenses, making such tools unavailable to most institutions. Some of the participants suggested relying on open-source software and state-supported programs to alleviate these costs to encourage greater take-up. Without deliberate investment, such tools' scalability and long-term sustainability are in doubt.

Alongside technological and economic constraints, teacher competence and cultural fit were found to be critical implementation issues. Teachers are generally poorly equipped with the necessary training to incorporate e-books in an engaging manner in their instructional activities. This competence gap contributes to low utilization or inappropriate utilization of digital materials. The audience highlighted a need for continuous professional development courses, workshops in digital pedagogy, and peer mentorship programs to build teacher competence and self-efficacy in adopting interactive materials.

Cultural relevance also proved to be a significant factor. According to the experts, many existing interactive e-books draw heavily from Western educational models that may not align with the linguistic, social, or pedagogical realities of learners in other contexts. This misalignment can diminish learner engagement and limit the educational impact of the material. For Arabic-speaking regions, in particular, participants called for the development of e-books that are linguistically and culturally localized, incorporating native language features, relevant cultural references, and region-specific educational needs. Creating such context-sensitive materials is essential for inclusive and effective implementation.

Table 4 summarizes the key implementation challenges identified in this study. It highlights the interplay between infrastructure limitations, cost barriers, teacher preparedness, and cultural misalignment. Addressing these factors will require coordinated efforts from policymakers, technology developers, educators, and curriculum designers. Only through such integrated strategies can interactive animated e-books fulfill their potential as inclusive, adaptable, and pedagogically sound learning tools across diverse educational environments.

Table 4. Challenges in the Implementation of Interactive Animated E-Books

Theme	Key Findings	Supporting Quotes
Technical Limitations	Incompatibility across devices and lack of infrastructure hinder accessibility in many regions.	- "E-books should be optimized for both mobile and desktop use." (P31) - "Some formats do not work well on certain devices, limiting usability." (P17)
High Development Costs	Financial constraints and the need for specialized expertise make development expensive.	- "Developing e-books requires significant financial and human resources." (P8) - "The cost of technologies such as virtual reality is a major barrier." (P32)
Lack of Teacher Training	Teachers require professional development to integrate interactive e-books in classrooms effectively.	- "Teachers need proper training to use interactive books effectively." (P12) - "Simplified designs and structured training programs are essential for adoption." (P28)
Cultural Adaptation Issues	Many e-books are designed for Western learners and lack culturally relevant content.	- "Current designs fail to reflect local culture and language needs." (P10) - "Interactive e-books should support Arabic cultural identity and multilingual features." (P13)

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

4.5. Strategies for Enhancing Interactive Animated E-Books

Experts participating in the study identified a range of strategic enhancements necessary to improve the design and pedagogical effectiveness of interactive animated e-books. A primary recommendation was the integration of adaptive learning pathways, allowing e-books to adjust dynamically based on the learner's performance and needs. By embedding responsive quizzes, differentiated content levels, and performance-sensitive progression mechanisms, learners can engage with neither easy nor difficult material. This individualized approach supports deeper comprehension and sustained engagement and encourages learners to move at their own pace without feeling overwhelmed or under-challenged.

Another core strategy involved enhancing the feedback mechanisms within interactive e-books. Participants highlighted the importance of real-time, meaningful feedback, which is not limited to indicating right or wrong answers but also includes scaffolded explanations and guiding hints. Such feedback was essential to keeping learners engaged while promoting metacognitive reflection and reinforcing learning outcomes. Alongside this, gamification features—points, progress bars, rewards, and visual encouragement—were promoted strongly. These are used to encourage a motivational learning environment for the purposes of maintaining persistence and attention.

The user interface and overall learning experience were also prioritized for improvement. Respondents cited intuitive navigation, clean layout design, and reduced cognitive load as critical capabilities for younger users. The reduced distractions of a simple interface along with clear instructions facilitate concentrating on what is to be learned and not on how a platform works. Multimodal interaction capabilities such as animation, voice-over narration, interactive imagery, and other sensory-based materials were also requested by respondents to accommodate varied learning styles and aid in retaining information.

Table 5 captures expert recommendations for enhancing interactive animated e-books. Differentiated instruction paths and adaptive content design featured prominently in these recommendations as a way to facilitate personalized learning. Feedback systems providing explanatory information—rather than just validation—were highlighted as means to build deeper comprehension. Gamification was reiterated as a way to boost users' motivation and interaction. Lastly, user-centered design principles such as intuitive navigation and multimodal support were identified as essential for accessibility and usability.

These are consistent with learner-focused pedagogic models and highlight requirements for interactive e-books to move beyond mere digital pages. By adopting these strategies, developers and educators can build more inclusive, engaging, and effective digital learning resources that address various learner needs and educational contexts.

Table 5. Thematic Analysis of Strategies for Enhancing Interactive Animated E-Books.

Theme	Key Findings	Supporting Quotes
Personalized Learning Pathways & Adaptive Content	Customizable difficulty levels, differentiated instruction, and adaptive quizzes enhance learner engagement.	- "E-books should allow learners to control the pace of learning and choose interaction methods that suit them." (P19) - "Providing multiple pathways based on learner progress ensures better comprehension." (P24)

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

Effective Use of Immediate Feedback	Real-time feedback mechanisms help learners identify and correct mistakes instantly, enhancing learning outcomes.	- "Immediate feedback helps children know if they are on the right track and guides them through hints rather than marking answers incorrect." (P17) - "For early learners, interactive e-books should include feedback that promotes learning rather than punishment." (P6)
Gamification for Engagement	Incorporating rewards, point systems, and motivational features improves engagement and encourages self-directed learning.	- "Adding applause, badges, and interactive rewards makes learning more enjoyable and keeps students motivated." (P16) - "Game-like elements help sustain interest and encourage continued interaction with the content." (P24)
User Experience Optimization	A well-structured interface, intuitive navigation, and multimodal learning support accessibility and engagement.	- "E-books should integrate audio narration, animations, and touch-based interactions to support different learning styles." (P5) - "Navigation should be simple and intuitive so that learners can focus on the content, not on how to use the book." (P22)

5. Discussion

The findings of this study emphasize the central role of interactivity and engagement in enhancing the educational effectiveness of interactive animated e-books. Participants consistently reported that most current e-books resemble static digital textbooks, lacking dynamic elements that stimulate cognitive processing. Features such as clickable objects, drag-and-drop activities, and interactive storytelling were identified as essential for sustaining learner attention and fostering meaningful learning experiences. These interactive components support engagement and align with theoretical frameworks such as Cognitive Load Theory (CLT) and the Multimedia Learning Theory (MLT), both of which stress the value of reducing extraneous cognitive load and optimizing content delivery through dual-channel processing.

Gamification also emerged as a powerful motivational tool. The respondents noted that reward systems, point scores, and feedback systems enhance persistence and fun in learning in digital learning activities. The above findings indicate that game-like elements in e-book design have the potential to enhance motivation, learner autonomy, and retention when properly balanced in learning goals.

The visual and aesthetic design elements were also imperative to grab and sustain user attention. The respondents stressed that clear typography, consistent design, and saturated color schemes improve readability and learner concentration, especially among younger users. The use of motion graphics and strategically positioned animations was also a primary strategy in supporting conceptual learning and sustained learner attention. However, uneven visual styles—such as the combination of cartoon characters and realist images—were found to be disruptive to the instructional flow. These

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

findings align with previous literature in stating that visual coherence and hierarchy are essential in effective instructional design.

The investigation highlighted a number of ongoing implementation barriers. Technical constraints, in particular related to device compatibility and internet access, were viewed as major obstacles in low-resource communities. E-books are in most areas either unavailable for mobile devices or inconsistently accessible due to infrastructural shortcomings. Meanwhile, economic constraints remain a challenge to mainstream uptake, especially when sophisticated features like virtual reality are involved and necessitate greater development and maintenance expenditures.

One of the most important barriers is also a lack of teacher preparation. Most teachers are not adequately trained to use interactive digital materials in a way that is integrated into their instructional approach. Therefore, even if good materials are in place, their potential goes unrealized. Additionally, cultural inappropriateness in much of what is currently available was cited as a problem. Most materials are geared to Western rather than local pedagogic models, without sufficient mapping to meet Arabic-speaking learners' linguistic and cultural requirements. This suggests localizing materials in language, narration, cultural framing, and learning expectations.

In overcoming these obstacles, several practical recommendations are proposed in the study. First, adaptive paths of learning can enable learners to work at their own speed with individual needs accommodated. Second, real-time feedback coupled with guided hints and conceptual descriptions can solidify learning through instantaneous actionable feedback. Third, the judicious use of gamification through tracking progress and interactive rewards can sustain motivation and participation. Lastly, user experience (UX) design is a necessity, as interfaces are intuitive, navigation is easy and smooth, and accessibility features accommodate different learners.

Combined, these results add to the developing body of work on learning with technology by reiterating the significance of evidence-based and user-centered design in digital learning tools. They are consistent with a move away from fixed digitized materials towards more dynamic, interactive, and engaging learning contexts suited to cognitive, motivational, and cultural diversity.

6. Conclusions

This work emphasizes the essential significance of interactivity, engagement, and thoughtful visual design when creating and executing effective interactive animated e-books. The findings corroborate that most available digital learning materials are deficient in dynamic elements supporting motivation and cognition. Gamification, interactive narratives, real-time feedback, and adaptive learning flows were cited as key to supporting user experience and learning performance. These findings inform the establishment of a formal design framework to facilitate personalized, student-focused digital learning environments to support individual demands of contemporary learners.

While they have great pedagogical potential, interactive animated e-books are also plagued by numerous technological access difficulties, high development costs, limited teachers' preparedness, and mismatch with local culture. Specific barriers to access in low-resource areas are limited device compatibility and a lack of adequate infrastructure. A lack of teachers' training programs and adherence to Western-based teaching models also curtail their application among non-Western learners, in particular Arabic-speaking ones. The solution involves holistic strategies such as government investing in digital infrastructure, open-source development promotion, and localizing e-book materials to meet varied cultural and linguistic requirements.

A number of actionable recommendations are derived based on what was found. These are incorporating adaptive learning systems to let learners move through learning at their own rates, real-time feedback to support scaffolding of understanding, and game-based elements to maintain

https://doi.org/10.22521/edupij.2025.16.244 Published online by Universitepark Press

engagement. Intuitive design and multimodal interaction are also suggested to enhance usability and accessibility, especially for younger or varied learners.

In the future, studies will need to investigate how e-books affect knowledge retention and acquisition in the long term. Investigating the integration of artificial intelligence to enable real-time personalization and intelligent content adaptation represents a promising avenue. Ultimately, the findings of this study contribute to the evolving discourse on digital pedagogy and support the development of inclusive, engaging, and effective digital learning environments.

Declarations

Author Contributions. Dr. Asma A. Sayed and Dr. Terry Lucas contributed equally to this study's conceptualization, design, data collection, analysis, and writing. Both authors collaborated in conducting expert interviews, performing thematic analysis, and developing the framework for interactive animated e-books. All authors read and approved the final manuscript.

Conflicts of Interest. The authors declare no conflict of interest.

Funding. This research did not receive a specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethical Approval. This study was reviewed and approved by the relevant ethics committee. All procedures followed ethical guidelines. Informed consent was obtained from all participants, and confidentiality was ensured throughout the research.

Data Availability Statement. All data supporting the findings of this study are included in the manuscript. No additional data are required beyond what is provided in the main text and supplementary materials.

Acknowledgements. The authors thank the expert participants who contributed valuable insights during the interviews. Special appreciation is extended to the educational and design institutions that supported this research. The authors also acknowledge their respective universities' guidance and academic support.

References

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.

Abdullah, N., Ghalebandi, S., & Hajar, R. (2015). How do young children engage with mobile apps? Cognitive, psychomotor, and affective perspective. *Computers & Education, 87*, 385-395. https://doi.org/10.1016/j.compedu.2015.07.005

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

Alhazmi, K. (2024). The effect of multimedia on vocabulary learning and retention. *World Journal of English Language, 14*(6), 390. https://doi.org/10.5430/wjel.v14n6p390

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. https://www.iiste.org/Journals/index.php/JEP/article/view/36115

Bates, C., Klein, A., Schubert, B., McGee, L., Anderson, N., Dorn, L., … & Ross, R. (2016). E-books and e-book apps: considerations for beginning readers. *The Reading Teacher, 70*(4), 401-411. https://doi.org/10.1002/trtr.1543

Bozkurt, A., Okur, M., & Karadeniz, A. (2016). Use of digital books at academic level: perceptions, attitudes and preferences of post-graduate students. *Journal of Human Sciences, 13*(1), 663. https://doi.org/10.14687/ijhs.v13i1.3534

Cahyani, A. G., & Setyadi, D. (2023). Development of Instagram Filters in Interactive E-Books Mathematics Learning Build a Flat Side Space. *JTMT: Journal Tadris Matematika*, *4*(02), 158-171.

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

Chong, Y. & Soo, H. (2021). Evaluation of first-year university students' engagement to enhance student development. *Asian Journal of University Education, 17*(2), 113. https://doi.org/10.24191/ajue.v17i2.13388

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

Cintamulya, I., & Murtini, I. (2025). Optimization of Critical Thinking by Empowering Collaboration and Communication Skills through Information Literacy-Based E-Books: In STEM integrated Problem-Based Learning. *European Journal of Educational Research, 14*(1), 151-166.

Çırakoğlu, N., Toksoy, S. E., & Reisoğlu, İ. (2022). Designing, Developing, and Evaluating an Interactive E-Book Based on the Predict-Observe-Explain (POE) Method. J*ournal of Formative Design in Learning, 6*(2), 95-112. https://doi.org/10.1007/s41686-022-00071-3

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

ElAdl, A. & Al-Musawi, A. (2020). Effects of students attitudes towards using e-books on their self-efficacy and academic motivation. Eur*opean Journal of Educational Research,* volume-9-2020(volume-9-issue-3-july-2020), 1167-1176. https://doi.org/10.12973/eu-jer.9.3.1167

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

Faridah, E., Kasih, I., Nugroho, S., & Aji, T. (2022). The effectiveness of blended learning model on rhythmic activity courses based on complementary work patterns. *International Journal of Education in Mathematics Science and Technology, 10*(4), 918-934. https://doi.org/10.46328/ijemst.2618

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/

Giacornini, C., Wallis, P., Lylo, H., Haaland, W., Davis, K., & Comden, D. (2013). Exploring E-Textbooks at the University of Washington: What WeLearned 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

Gohar, R. (2017). The impact of a proposed interactive e-book on developing english language skills of kindergarten children. *International Journal of Internet Education, 16*(1), 1-33. https://doi.org/10.21608/ijie.2017.16057

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.

Hagiwara, A. (2014). Effect of visual support on the processing of multiclausal sentences. *Language Teaching Research, 19*(4), 455-472. https://doi.org/10.1177/1362168814541715

Kanellopoulou, C., Kermanidis, K., & Γιαννακουλόπουλος, A. (2019). The dual-coding and multimedia learning theories: film subtitles as a vocabulary teaching tool. *Education Sciences, 9*(3), 210. https://doi.org/10.3390/educsci9030210

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

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

Koola, M. (2016). Methodological issues in cytokine measurement in schizophrenia. *Indian Journal of Psychological Medicine, 38*(1), 6-9. https://doi.org/10.4103/0253-7176.175086

Larson, L. (2015). E-books and audiobooks. *The Reading Teacher, 69*(2), 169-177. https://doi.org/10.1002/trtr.1371

Lin, H. (2012). Effects of multimedia vocabulary annotations on vocabulary learning and text comprehension in esp classrooms., 172-176. https://doi.org/10.14705/rpnet.2012.000047

López-Escribano, C., Montesino, S., & García-Ortega, V. (2021). The impact of e-book reading on young children's emergent literacy skills: an analytical review. *International Journal of Environmental Research and Public Health, 18*(12), 6510. https://doi.org/10.3390/ijerph18126510

Lysaght, R., Roy, M., Rendall, J., Krupa, T., Ball, L., & Davis, J. (2018). Unpacking the foundational dimensions of work integration social enterprise. *Social Enterprise Journal, 14*(1), 60-70. https://doi.org/10.1108/sej-11-2017-0061

Mayer, R. (1999). Research-based principles for the design of instructional messages. *Document Design, 1*(1), 7-19. https://doi.org/10.1075/dd.1.1.02may

Mayer, R. & Moreno, R. (2002). Aids to computer-based multimedia learning. *Learning and Instruction, 12*(1), 107-119. https://doi.org/10.1016/s0959-4752(01)00018-4

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

Moreno, R. & Mayer, R. (1999). Cognitive principles of multimedia learning: the role of modality and contiguity. *Journal of Educational Psychology, 91*(2), 358-368. https://doi.org/10.1037/0022-0663.91.2.358

Muir, L. & Hawes, G. (2013). The case for e-book literacy: undergraduate students' experience with e-books for course work. *The Journal of Academic Librarianship, 39*(3), 260-274. https://doi.org/10.1016/j.acalib.2013.01.002

Obeso, M., Hernández-Linares, R., Fernández, M., & Bedia, A. (2020). Knowledge management processes and organizational performance: the mediating role of organizational learning. Journal of Knowledge Management, 24(8), 1859-1880. https://doi.org/10.1108/jkm-10-2019-0553

Özbay, İ. & Ugurelli, Y. (2023). Changing children's literature in the digital age: digital books. *International Journal of Education and Literacy Studies, 11*(1), 68-85. https://doi.org/10.7575/aiac.ijels.v.11n.1p.68

Rodriguez, J., Finkenstaedt-Quinn, S., Watts, F., & Nardo, J. (2024). Self-reported limitations in chemistry education research: providing specific and contextualized limitations supports researchers and practitioners. *Journal of Chemical Education, 101*(7), 2602-2607. https://doi.org/10.1021/acs.jchemed.4c00217

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. https://doi.org/10.1016/j.ergon.2019.102871

Roskos, K., Burstein, K., Shang, Y., & Gray, E. (2014). Young children's engagement with e-books at school. *Sage Open, 4*(1). https://doi.org/10.1177/2158244013517244

Rustika, P., & Permana, N. (2022). Annibuku: interactive e-book to measure problem-solving ability in the digital era. *International Conference on Research and Development (Icorad), 1*(2), 181-187. https://doi.org/10.47841/icorad.v1i2.37

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.* https://doi.org/10.1016/j.ijcci.2017.01.002

Salsberg, A. (2019). The 12 principles of animation. Lesley University. https://lesley.edu/article/the-12-principles-of-animation

Strouse, G., & Ganea, P. (2017). Parent–toddler behavior and language differ when reading electronic and print picture books. *Frontiers in Psychology,* 8. https://doi.org/10.3389/fpsyg.2017.00677

Turčić, M. (2021). Why do we digitize books instead of knowledge? *Acta Graphica Journal for Printing Science and Graphic Communications, 30*(1), 35-41. https://doi.org/10.25027/agj2017.28.v30i1.200

Turner, K., Hicks, T., & Zucker, L. (2019). Connected reading: a framework for understanding how adolescents encounter, evaluate, and engage with texts in the digital age. *Reading Research Quarterly, 55*(2), 291-309. https://doi.org/10.1002/rrq.271

Wen, C., Huang, C., Chang, P., Yang, T., You, H., Ning, H., … & Tsao, K. (2022). Application of the electronic book to promote self-directed learning in medical technologist continuing education: a cross-sectional study. *BMC Medical Education, 22*(1). https://doi.org/10.1186/s12909-022-03724-w

Whitelegg, E., Scanlon, E., & Hatzipanagos, S. (2011). Multimedia motion: motivating learners. Research in Learning Technology, 5(1). https://doi.org/10.3402/rlt.v5i1.10554

Xia, H., Li, J., Weng, J., Zhang, Z., & Gao, Y. (2021). Collaborative knowledge sharing in global distributed teams: antecedents of innovation performance. *Journal of Knowledge Management, 25*(10), 2523-2539. https://doi.org/10.1108/jkm-10-2020-0763

Xu, Y., Yau, J., & Reich, S. (2020). Press, swipe and read: do interactive features facilitate engagement and learning with e-books? *Journal of Computer Assisted Learning, 37*(1), 212-225. https://doi.org/10.1111/jcal.12480

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

About the Contributor(s)

Dr. Asma A. Sayed, is affiliated with the Faculty of Applied and Creative Arts at Universiti Malaysia Sarawak (UNIMAS), Malaysia, and the Faculty of Art & Design at Applied Science Private University (ASU), Jordan. Her research focuses on digital pedagogy, visual storytelling, and interactive multimedia in education.
Email: 20010222@siswa.unimas.my / a_sayyed@asu.edu.jo
ORCID: https://orcid.org/0000-0002-2917-902X

Dr. Terry Lucas is a faculty member at the Faculty of Applied and Creative Arts, Universiti Malaysia Sarawak (UNIMAS), Malaysia. His academic work centers on multimedia learning design, interactive technology in education, and student engagement in virtual environments.
Email: lterry@unimas.my
ORCID: https://orcid.org/0000-0003-1954-2427