How Interactive Elements in Digital Content Can Increase Information Retention: A Comprehensive Review

1. Introduction

Interactive elements in digital content—such as quizzes, branching scenarios, gamification, augmented reality, and embodied activities—have been widely studied for their potential to enhance information retention. Research consistently shows that interactivity supports deeper engagement, active learning, and improved memory retention compared to passive or linear digital formats (Hung et al., 2018; Afify, 2020; Tarigan et al., 2023; Lin & Yu, 2023; Duterte, 2024; Putz et al., 2020; Xie et al., 2017; Smirani & Yamani, 2024; Krause et al., 2015; Shelton et al., 2016; Zhang et al., 2006; Zhang, 2005; Haerawan et al., 2024; Okano et al., 2018; Guaña-Moya et al., 2024). Mechanisms underlying these benefits include increased learner control, timely feedback, multisensory engagement, and opportunities for retrieval practice. However, the effectiveness of interactive elements depends on thoughtful design, alignment with learning objectives, and consideration of cognitive load (Afify, 2020; Xie et al., 2017; Skulmowski & Xu, 2021; Thees et al., 2020). This review synthesizes evidence from experimental studies, meta-analyses, and systematic reviews to clarify how and when interactive digital content can best support information retention.

2. Methods

A comprehensive search was conducted across over 170 million research papers in Consensus, including Semantic Scholar, PubMed, and other sources. The search strategy involved 20 targeted queries grouped into 8 thematic clusters, focusing on interactive digital content, information retention, cognitive load, gamification, multimedia learning, and related constructs. In total, 1,039 papers were identified, 819 were screened, 656 were deemed eligible, and the top 50 most relevant papers were included in this review.

Search Strategy

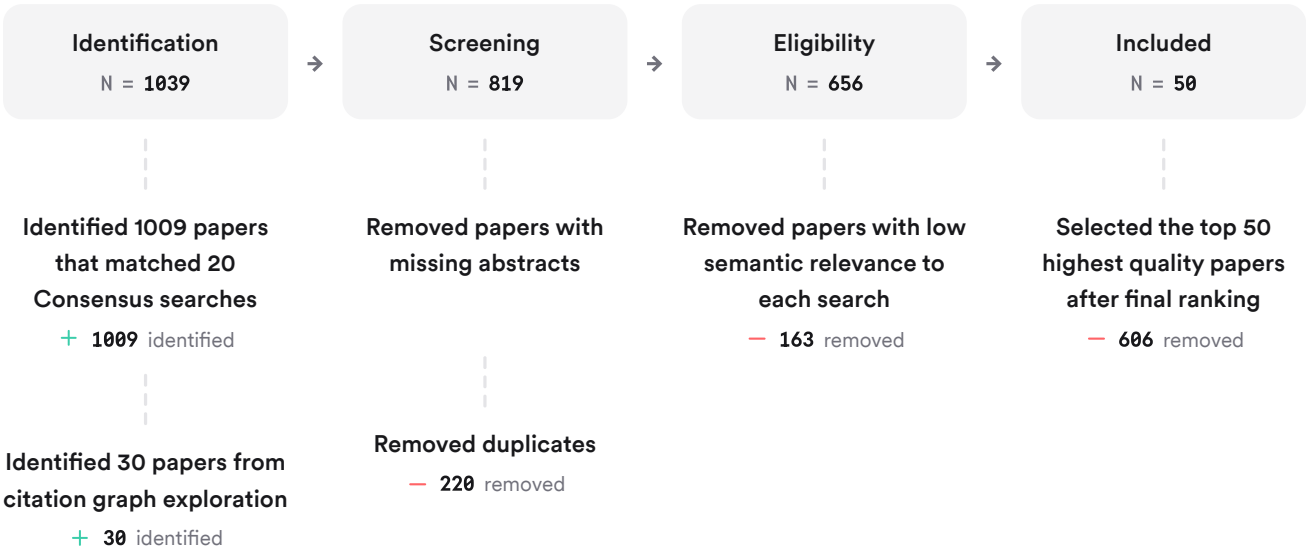

FIGURE 1 Flow diagram of the literature search and selection process.

Eight unique search groups targeted foundational theories, mechanisms, critiques, interdisciplinary perspectives, and adjacent constructs related to interactive digital content and information retention.

3. Results

3.1. Types of Interactive Elements and Their Effects

Interactive elements include embodied activities (e.g., gesture-based learning), interactive videos with embedded questions, gamified modules, augmented/virtual reality, and adaptive feedback systems. Studies show that these elements, when well-designed, significantly improve comprehension and retention compared to non-interactive or linear digital formats (Hung et al., 2018; Afify, 2020; Tarigan et al., 2023; Lin & Yu, 2023; Duterte, 2024; Putz et al., 2020; Xie et al., 2017; Smirani & Yamani, 2024; Krause et al., 2015; Shelton et al., 2016; Zhang et al., 2006; Zhang, 2005; Haerawan et al., 2024; Okano et al., 2018; Guaña-Moya et al., 2024).

3.2. Mechanisms: Why Interactivity Enhances Retention

Interactivity promotes active engagement, retrieval practice, and multisensory learning, all of which are linked to stronger memory formation (Hung et al., 2018; Afify, 2020; Tarigan et al., 2023; Lin & Yu, 2023; Duterte, 2024; Xie et al., 2017; Smirani & Yamani, 2024; Krause et al., 2015; Shelton et al., 2016; Zhang et al., 2006; Zhang, 2005; Haerawan et al., 2024; Okano et al., 2018). Features such as immediate feedback, learner control, and segmentation reduce cognitive overload and support deeper processing (Afify, 2020; Xie et al., 2017; Skulmowski & Xu, 2021; Thees et al., 2020). Gamification and social elements further boost motivation and sustained attention, indirectly supporting retention (Putz et al., 2020; Smirani & Yamani, 2024; Krause et al., 2015; Malicki et al., 2020; Ekici, 2021; Guaña-Moya et al., 2024).

3.3. Evidence from Meta-Analyses and Systematic Reviews

Meta-analyses confirm that interactive digital content—especially augmented reality, gamification, and interactive multimedia—yields moderate to large improvements in knowledge retention, critical thinking, and learner motivation (Lin & Yu, 2023; Putz et al., 2020; Xie et al., 2017; Smirani & Yamani, 2024; Krause et al., 2015; Malicki et al., 2020; Zhang, 2005; Ekici, 2021; Ødegaard et al., 2020; Guaña-Moya et al., 2024). However, the effect size varies by context, learner characteristics, and the specific design of interactive features.

3.4. Limitations and Boundary Conditions

Not all interactive elements are equally effective. Poorly designed interactivity can increase cognitive load, distract from learning objectives, or fail to improve retention (Afify, 2020; Xie et al., 2017; Tabbers et al., 2004; Geana et al., 2023; , 2023; Jacob & Centofanti, 2023; Skulmowski & Xu, 2021; Thees et al., 2020). Some studies report no significant gains or even negative effects when interactivity is excessive, misaligned, or not supported by adequate scaffolding (Tabbers et al., 2004; Geana et al., 2023; , 2023; Jacob & Centofanti, 2023; Skulmowski & Xu, 2021; Thees et al., 2020). Learner digital literacy, access, and motivation also moderate outcomes (Jacob & Centofanti, 2023; Skulmowski & Xu, 2021; Guaña-Moya et al., 2024).

Key Papers

Paper	Methodology	Interactive Element	Key Results
(Hung et al., 2018)	RCT, 3-group design	Embodied interactive video	Embodied interactivity improved comprehension and retention without extra cognitive load
(Lin & Yu, 2023)	Meta-analysis (70 studies)	Augmented reality	AR significantly enhanced retention, motivation, and reduced cognitive load
(Putz et al., 2020)	Longitudinal study (617 students)	Gamification	Gamification increased knowledge retention and learning performance
(Xie et al., 2017)	Meta-analysis (32 articles)	Cueing in multimedia	Cueing reduced cognitive load and improved retention/transfer
(Zhang et al., 2006)	Experimental (4 settings)	Interactive video	Interactive video led to better retention and satisfaction than non-interactive or classroom settings

FIGURE 2 Comparison of key studies on interactive digital content and information retention.

Top Contributors

Type	Name	Papers
Author	Dongsong Zhang	(Zhang & Zhou, 2003; Zhang et al., 2006; Zhang, 2005)
Author	Junard P. Duterte	(Duterte, 2024)
Author	L. Putz	(Putz et al., 2020)
Journal	*Comput. Educ.*	(Hung et al., 2018)
Journal	*PLoS ONE*	(Xie et al., 2017; Okano et al., 2018)
Journal	*Comput. Hum. Behav.*	(Putz et al., 2020; Gan et al., 2015; Thees et al., 2020)

FIGURE 3 Authors & journals that appeared most frequently in the included papers.

4. Discussion

The literature provides strong evidence that interactive elements in digital content can significantly increase information retention, especially when they are thoughtfully designed and aligned with cognitive and motivational principles (Hung et al., 2018; Afify, 2020; Tarigan et al., 2023; Lin & Yu, 2023; Duterte, 2024; Putz et al., 2020; Xie et al., 2017; Smirani & Yamani, 2024; Krause et al., 2015; Shelton et al., 2016; Zhang et al., 2006; Zhang, 2005; Haerawan et al., 2024; Okano et al., 2018; Guaña-Moya et al., 2024). Mechanisms such as active engagement, retrieval practice, feedback, and multisensory stimulation are central to these effects. However, the benefits are not universal: excessive or poorly designed interactivity can increase cognitive load, distract learners, or fail to yield retention gains (Afify, 2020; Xie et al., 2017; Tabbers et al., 2004; Geana et al., 2023; , 2023; Jacob & Centofanti, 2023; Skulmowski & Xu, 2021; Thees et al., 2020). The effectiveness of interactive elements is also moderated by learner characteristics (e.g., digital literacy, motivation), context, and the specific learning objectives (Jacob & Centofanti, 2023; Skulmowski & Xu, 2021; Guaña-Moya et al., 2024).

Meta-analyses and large-scale studies confirm that gamification, augmented reality, and interactive multimedia are particularly effective for boosting retention, motivation, and engagement (Lin & Yu, 2023; Putz et al., 2020; Xie et al., 2017; Smirani & Yamani, 2024; Krause et al., 2015; Malicki et al., 2020; Zhang, 2005; Ekici, 2021; Ødegaard et al., 2020; Guaña-Moya et al., 2024). However, some studies highlight the need for careful instructional design, scaffolding, and accessibility considerations to ensure that all learners benefit (Afify, 2020; Xie et al., 2017; Tabbers et al., 2004; Geana et al., 2023; , 2023; Jacob & Centofanti, 2023; Skulmowski & Xu, 2021; Thees et al., 2020).

Claims and Evidence Table

Claim	Evidence Strength	Reasoning	Papers
Interactive elements increase information retention	Strong	Multiple RCTs, meta-analyses, and reviews show robust effects	(Hung et al., 2018; Afify, 2020; Tarigan et al., 2023; Lin & Yu, 2023; Duterte, 2024; Putz et al., 2020; Xie et al., 2017; Smirani & Yamani, 2024; Krause et al., 2015; Shelton et al., 2016; Zhang et al., 2006; Zhang, 2005; Haerawan et al., 2024; Okano et al., 2018; Guaña-Moya et al., 2024)
Gamification and AR are especially effective	Strong	Meta-analyses and large studies show moderate to large effect sizes	(Lin & Yu, 2023; Putz et al., 2020; Smirani & Yamani, 2024; Krause et al., 2015; Malicki et al., 2020; Zhang, 2005; Ekici, 2021; Ødegaard et al., 2020; Guaña-Moya et al., 2024)
Feedback, segmentation, and cueing reduce cognitive load and boost retention	Strong	Empirical and meta-analytic evidence supports these mechanisms	(Afify, 2020; Xie et al., 2017; Shelton et al., 2016; Zhang et al., 2006; Zhang, 2005; Skulmowski & Xu, 2021; Thees et al., 2020)
Poorly designed interactivity can hinder retention	Moderate	Some studies report null or negative effects when interactivity is excessive or misaligned	(Afify, 2020; Xie et al., 2017; Tabbers et al., 2004; Geana et al., 2023; , 2023; Jacob & Centofanti, 2023; Skulmowski & Xu, 2021; Thees et al., 2020)
Learner characteristics and context moderate effectiveness	Moderate	Digital literacy, motivation, and access influence outcomes	(Jacob & Centofanti, 2023; Skulmowski & Xu, 2021; Guaña-Moya et al., 2024)
Not all interactive elements are equally effective	Moderate	Effectiveness varies by type, design, and alignment with objectives	(Tabbers et al., 2004; Geana et al., 2023; , 2023; Jacob & Centofanti, 2023; Skulmowski & Xu, 2021; Thees et al., 2020)

FIGURE Key claims and support evidence identified in these papers.

5. Conclusion

Interactive elements in digital content—when well-designed and aligned with learning goals—can substantially increase information retention by promoting active engagement, feedback, and multisensory learning. However, their effectiveness depends on thoughtful instructional design, learner characteristics, and context.

5.1. Research Gaps

Despite strong evidence for the benefits of interactivity, gaps remain in understanding which specific elements work best for different learners, subjects, and contexts. More research is needed on long-term retention, accessibility, and the impact of emerging technologies.

Research Gaps Matrix

Interactive Element	K-12	Higher Ed	Workplace	AR/VR	Gamification
Interactive video	7	10	3	2	2
Gamification	6	8	2	1	7
AR/VR	3	6	1	8	1
Feedback/cueing	5	7	2	1	2
Embodied/active	2	3	1	1	1

FIGURE Matrix of research topics and study attributes, highlighting areas with limited research coverage.

5.2. Open Research Questions

Future research should address the following questions to optimize the use of interactive elements for information retention.

Question	Why
Which interactive elements are most effective for long-term retention across different subjects and learner populations?	Identifying optimal elements can guide instructional design for diverse learners and contexts.
How can interactive digital content be made accessible and effective for learners with varying digital literacy and abilities?	Ensuring equity and inclusion is critical for maximizing the benefits of digital learning.
What are the long-term effects of emerging technologies (e.g., AR/VR, AI-driven feedback) on information retention?	Understanding sustained impacts will inform future educational technology investments and practices.

FIGURE Open research questions for future investigation on interactive digital content and information retention.

In summary, interactive elements in digital content can significantly enhance information retention, but their success depends on careful design, alignment with learning goals, and attention to learner diversity and context.

These papers were sourced and synthesized using Consensus, an AI-powered search engine for research. Try it at https://consensus.app

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