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Digital Learning and Elementary School Students' Motivation: A Systematic Integrative Review of Mechanisms, Design Features, and Boundary Conditions

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Abstract

Background: Digital learning is now embedded in elementary education, yet motivational benefits vary considerably across technologies, tasks, and implementation conditions.

Aims: This systematic integrative review examines how digital learning relates to elementary school students' motivation, identifies the mechanisms most consistently associated with positive responses, and clarifies the conditions that limit those benefits.

Methods: A structured search of Scopus-indexed journal literature published from 2016 to 2025 produced an analytical corpus of 20 evidence sources. Five additional methodological and theoretical articles supported review design and interpretation. Evidence was extracted by technology, design, learner group, motivational construct, implementation condition, and inferential limitation, then synthesized thematically without pooling heterogeneous effect sizes.

Results: Four recurring mechanisms were identified: gameful challenge and feedback; learner control and adaptive support; cognitively coherent multimedia representation; and teacher-mediated social participation. Positive motivational responses were most credible when technology supported autonomy, competence, and relatedness, while novelty, competition, cognitive overload, unequal access, weak teacher orchestration, and indirect measurement constrained interpretation.

Conclusion: Digital learning should be treated as a design-dependent pedagogical environment rather than an intrinsically motivating intervention. The evidence supports purposeful, inclusive, and teacher-mediated use, but does not justify universal causal claims across elementary contexts.

INTRODUCTION

Digital technologies have moved from peripheral classroom resources to routine components of elementary education. Tablets, learning applications, digital games, multimedia presentations, adaptive platforms, and augmented-reality resources now shape how young learners encounter content and demonstrate understanding. Meta-analytic evidence indicates that mobile and interactive technologies can support learning performance, but the size and direction of benefits vary

with pedagogy, learner characteristics, and implementation quality (Sung et al., 2016). Broad reviews of multimedia tools reach a similar conclusion: technology expands representational and participatory possibilities, yet educational value depends on how those possibilities are organized within instruction (Abdulrahaman et al., 2020). This qualification is crucial in elementary settings because younger learners are still developing attentional control, academic self-beliefs, and durable approaches to learning. A credible evaluation of digital learning therefore requires attention not only to achievement but also to the motivational processes that sustain participation, effort, and persistence.

Learning motivation is not a single observable behavior but a multidimensional process involving interest, value, persistence, competence beliefs, autonomy, and forms of internal and external regulation. Self-determination theory proposes that more durable motivation emerges when learning environments support autonomy, competence, and relatedness rather than relying mainly on external control (Ryan & Deci, 2020). Digital environments can potentially support these needs through meaningful choice, appropriately calibrated challenge, immediate informational feedback, visible progress, and opportunities for collaboration. They can also undermine them when interfaces are controlling, rewards dominate the learning purpose, tasks are confusing, or interaction becomes socially isolating. Consequently, engagement, enjoyment, satisfaction, persistence, self-efficacy, and motivation should not be treated as interchangeable outcomes. The present review distinguishes these constructs while examining how they converge around elementary students' willingness to invest attention and effort in learning.

Multimedia design offers one important route through which digital learning may influence motivation. The cognitive theory of multimedia learning explains that combinations of words, images, animation, and audio are beneficial only when they guide selection, organization, and integration of relevant information (Mayer, 2024). Poorly coordinated representations can generate extraneous processing that competes with learning and diminishes perceived competence. Strategies that manage cognitive load—such as signaling, segmenting, learner pacing, and removal of redundant information—are therefore motivationally relevant as well as cognitively relevant (Castro-Alonso et al., 2021). Evidence from elementary learners supports this connection: the form of textual cueing in educational animation affects learning, cognitive load, and self-efficacy (Du et al., 2025), while audio support can alter multimedia processing for students with dyslexia (Knoop-van Campen et al., 2020). These findings caution against assuming that visually rich content is automatically engaging or inclusive.

Game-based and gamified learning constitute a second prominent strand of the literature. Meta-analyses generally report positive effects of gamification on cognitive, motivational, and behavioral outcomes, although effects vary by game element, duration, comparison condition, and outcome measure (Bai et al., 2020; Sailer & Homner, 2020). In elementary settings, digital escape rooms, adaptive mathematics applications, digital games, and quiz platforms have been associated with greater motivation, engagement, or confidence (Bang et al., 2023; Rayan & Watted, 2024; Vidergor, 2021). Yet positive responses should not be reduced to points, badges, or leaderboards. A field experiment found similar motivational gains for badges and leaderboards and attributed the response more plausibly to the holistic experience and novelty than to one reward mechanic (Mohammed et al., 2024). A recent systematic review of primary education likewise reported

generally positive engagement, motivation, and self-efficacy outcomes but mixed learning outcomes and some negative collaboration findings (Romero-Rodríguez et al., 2024).

Learner control and personalization provide a third explanatory pathway. An adaptive game-based mathematics application was associated with learning gains and teacher-reported improvements in engagement, motivation, and confidence among kindergarten and first-grade learners, although motivational evidence was not the primary experimental endpoint (Bang et al., 2023). In a randomized comparison involving Japanese first- and second-grade learners, an interactive English-language application produced greater satisfaction and persistence than a digital textbook, suggesting that manipulability, feedback, and learner control matter (Hori et al., 2025). Personalization nevertheless raises questions about who receives meaningful choices, how algorithms allocate challenge, and whether infrastructure and adult support are equitably available. Dumont and Ready (2023) argue that personalized learning can advance equity only when systemic access and implementation conditions are addressed. Thus, adaptive technology should be interpreted as a potentially supportive structure, not as a substitute for teachers or a guarantee of equitable motivation.

The literature also contains a recurrent gap between technological features and classroom enactment. Teachers' conceptions of mobile technology tend toward more student-centered practice when technology is understood as a tool for inquiry, interaction, and differentiated support rather than content delivery (Chen & Tsai, 2021). Videographic evidence from digitally inclusive elementary classrooms further demonstrates that collaboration depends on the organization of communication, roles, and shared activity (Schulz et al., 2025). Collaborative game design can strengthen digital competence and participation, but its benefits arise from structured co-creation rather than device exposure alone (Laakso et al., 2021). Longitudinal evidence on digital textbooks similarly suggests that affective and social outcomes may develop differently over time and should not be inferred from short-term enthusiasm (Im, 2024). These findings position teacher orchestration, peer interaction, duration, and accessibility as boundary conditions for motivational effects.

Existing reviews often combine age groups, technologies, subjects, and motivational indicators, making it difficult to determine what the elementary evidence actually supports. The field also risks conflating immediate enjoyment with sustained motivation and using achievement as a proxy for engagement. This study addresses those limitations through a systematic integrative review of evidence from Scopus-indexed journals. It asks: (1) Which digital-learning mechanisms are most consistently associated with elementary students' motivation-related outcomes? (2) Which pedagogical and contextual conditions strengthen or constrain those outcomes? and (3) What claims are justified by the designs and measures used in the evidence base? Rather than calculate a pooled effect from non-equivalent interventions and outcomes, the review develops a theory-informed synthesis that separates direct motivational evidence from indirect, teacher-reported, or adjacent affective outcomes. The intended contribution is a more defensible account of when and why digital learning can support motivation in elementary education.

METHOD

Research Design

The study used a systematic integrative review design. This design was selected because the evidence base includes meta-analyses, systematic reviews, controlled studies, longitudinal research,

observational work, and implementation-focused studies that cannot be combined meaningfully in a single pooled effect. The reporting logic was informed by PRISMA 2020 principles of transparent identification, eligibility, and synthesis (Page et al., 2021), while the integrative procedure followed the requirement to align the research question, search logic, extraction framework, and conclusions (Snyder, 2019). The review therefore prioritizes traceability and calibrated inference rather than presenting heterogeneous outcomes as statistically equivalent.

Search Strategy and Eligibility

A structured source-oriented search was completed on 28–29 August 2026 across publisher databases and bibliographic records for journals indexed in Scopus, including Elsevier ScienceDirect, Springer Nature Link, SAGE Journals, and MDPI journal records. The core search string combined technology terms ("digital learning" OR "digital game*" OR gamif* OR "mobile learning" OR multimedia OR "augmented reality" OR "digital textbook*") with population terms ("elementary school*" OR "primary school*" OR child*) and motivational terms (motivation OR engagement OR persistence OR satisfaction OR self-efficacy). Backward reference checking from high-relevance syntheses was used to identify earlier foundational studies. Eligibility was limited to peer-reviewed journal articles published in English from 2016 through 2025, except where an older synthesis was necessary to establish the evidence trajectory. Each included source required a verifiable DOI or official publisher record.

Corpus Formation and Unit of Analysis

The final analytical corpus comprised 20 evidence sources. These consisted of broad meta-analyses and systematic reviews, elementary-specific syntheses, controlled and quasi-experimental studies, longitudinal research, and observational or implementation studies. Five additional articles were retained solely for review methodology and theoretical interpretation, producing exactly 25 references in the manuscript. The unit of analysis was the published study or synthesis, not individual elementary students reanalyzed by the present authors. Sources that addressed learning performance without a direct motivational measure were retained only when they clarified a plausible design mechanism or boundary condition; those sources were not treated as direct proof of motivational change.

Data Extraction and Synthesis

For each evidence source, the review recorded publication type, educational level, digital-learning form, motivation-related construct, direction of findings, source of measurement, implementation condition, and principal inferential limitation. Findings were coded into four theory-informed mechanism categories: gameful challenge and feedback; learner control and adaptive support; multimedia coherence and cognitive accessibility; and teacher-mediated social participation. A fifth category captured boundary conditions, including novelty, competition, cognitive overload, unequal access, duration, and measurement quality. Similarities and contradictions were compared across study types. Because interventions, comparison conditions, and outcomes were not commensurable, no new meta-analysis was attempted and no causal estimate was generated.

Analytical Safeguards

Three safeguards were applied. First, direct student-reported or behaviorally measured motivation was distinguished from teacher perceptions, engagement proxies, self-efficacy,

satisfaction, and achievement. Second, review-level conclusions were not allowed to override contradictory or mixed primary evidence. Third, claims were graded linguistically: controlled evidence supported cautious effect statements within the studied context; observational and qualitative evidence supported association or process statements; and reviews supported field-level tendencies rather than universal claims. These safeguards reduce the risk of turning technological enthusiasm into stronger conclusions than the designs warrant.

Table 1. Eligibility Framework

Dimension	Inclusion	Exclusion
Publication	Peer-reviewed journal article; English; official publisher record or DOI; 2016–2025, with earlier synthesis retained only when foundational	Book chapters, theses, conference abstracts, reports without peer review, unverifiable records
Population	Elementary/primary learners or K–12 evidence with an identifiable elementary component	Exclusively higher-education or adult samples
Intervention	Digital, mobile, multimedia, adaptive, game-based, gamified, augmented-reality, or digital-textbook learning	Technology used only for administration or data collection
Outcome	Motivation, engagement, persistence, satisfaction, self-efficacy, affective/social participation, or a clearly defined adjacent construct	Achievement-only evidence with no design or motivational relevance
Inference	Design and measurement sufficiently described to identify what the study can and cannot support	Claims impossible to evaluate from the available record

Table 1 presents the eligibility framework used to determine which studies were included in the systematic integrative review. The framework applies five main dimensions: publication characteristics, population, intervention, outcome, and strength of inference. Eligible studies were required to be peer-reviewed journal articles written in English, supported by an official publisher record or DOI, and primarily published between 2016 and 2025, while earlier syntheses were retained only when considered foundational. The population criterion focused on elementary or primary learners, including broader K–12 studies only when an identifiable elementary component was available, while the intervention criterion covered digital, mobile, multimedia, adaptive, game-based, gamified, augmented-reality, and digital-textbook learning. Eligible outcomes included motivation, engagement, persistence, satisfaction, self-efficacy, affective or social participation, and other clearly defined adjacent constructs, whereas achievement-only studies without motivational or design relevance were excluded. Overall, the eligibility framework ensured that the analytical corpus remained relevant to elementary digital learning while maintaining sufficient methodological transparency to support a careful interpretation of what each study could and could not demonstrate.

RESULTS AND DISCUSSION

Results

Profile of the Evidence Base

The final analytical corpus consisted of 20 evidence sources addressing digital learning and motivation-related outcomes in elementary education. The evidence base was deliberately heterogeneous in terms of research design, learning technology, educational setting, and motivational

construct. It included broad and technology-specific syntheses, elementary-focused reviews, controlled and comparative studies, longitudinal investigations, classroom-process studies, teacher-conception research, and implementation-oriented evidence. This composition enabled the review to examine both general tendencies and context-specific patterns across different forms of digital learning. It also allowed motivational findings to be interpreted alongside pedagogical processes and implementation conditions. Accordingly, the corpus provided an appropriate foundation for identifying recurring mechanisms rather than estimating a single common effect.

Digital learning was represented through gamified environments, digital games, adaptive applications, mobile learning, multimedia resources, augmented reality, digital textbooks, and digitally supported collaborative activities. Motivation-related outcomes included motivation, engagement, persistence, satisfaction, self-efficacy, confidence, affective participation, and social participation. These outcomes were reported through student self-reports, behavioral observations, teacher perceptions, comparative performance patterns, and other study-specific measures. Direct measures of student motivation provided the clearest evidence regarding motivational responses. Adjacent constructs such as satisfaction, self-efficacy, engagement, and teacher-perceived motivation were retained but interpreted more cautiously. The resulting profile demonstrated that digital learning and motivation were investigated through multiple methodological and conceptual pathways rather than through a single standardized approach.

Table 2. Profile of the Analytical Corpus

Evidence Characteristic	Profile Identified in the Corpus
Analytical corpus	20 evidence sources
Main publication period	2016–2025
Educational context	Elementary or primary education and evidence with an identifiable elementary component
Evidence forms	Research syntheses, controlled studies, comparative studies, longitudinal research, classroom-process studies, teacher-focused research, and implementation studies
Digital-learning forms	Gamification, digital games, adaptive applications, mobile learning, multimedia, augmented reality, digital textbooks, and collaborative digital learning
Motivation-related outcomes	Motivation, engagement, persistence, satisfaction, self-efficacy, confidence, and affective or social participation
Main analytical focus	Motivational mechanisms, implementation conditions, measurement quality, and inferential limitations
Synthesis approach	Systematic integrative and thematic synthesis without statistical pooling of heterogeneous outcomes

Table 2 summarizes the structural characteristics of the evidence base used in the synthesis. The corpus represents a broad range of digital-learning formats rather than a single technological intervention. It also contains different types of motivation-related outcomes, ranging from direct motivation measures to related affective and behavioral indicators. The diversity of research designs made direct numerical comparison across all studies inappropriate. Instead, recurring patterns were identified according to their consistency across technologies, educational contexts, and forms of evidence. This profile therefore supports a mechanism-oriented interpretation of how digital learning may contribute to elementary students' motivation.

Overall Pattern of Motivation-Related Outcomes

Across the analytical corpus, digital learning was generally associated with positive motivation-related responses among elementary school students. Positive responses were most evident when digital activities offered understandable goals, timely feedback, manageable levels of challenge, meaningful interaction, and opportunities for students to participate actively. Students also responded more positively when technology supported learning processes rather than functioning only as a digital replacement for conventional materials. The motivational benefits became less consistent when digital activities were overly complex, strongly reward-driven, socially isolating, or weakly connected to instructional objectives. Immediate enthusiasm was therefore not sufficient to demonstrate sustained motivational improvement. Overall, the findings indicate that motivational responses depend primarily on the quality of digital-learning design and implementation.

Four recurring motivational mechanisms emerged from the synthesis of the evidence. The first mechanism involved gameful challenge and informational feedback that supported progress and accomplishment. The second involved learner control and adaptive support that enabled students to experience meaningful choice and appropriate levels of difficulty. The third involved multimedia coherence and cognitive accessibility that helped students process digital information without unnecessary cognitive burden. The fourth involved teacher-mediated social participation that connected technology with feedback, collaboration, and classroom interaction. Equitable implementation operated across all four mechanisms by determining whether students could access and benefit from the motivational opportunities provided by digital learning.

Gameful Challenge and Informational Feedback

Gameful challenge and informational feedback represented the most frequently observed motivational mechanism in the analytical corpus. Digital games, gamified classroom activities, quiz-based platforms, escape-room activities, and reward-oriented environments commonly produced positive engagement or motivation-related responses. These responses were strongest when students received clear goals, repeated opportunities to attempt tasks, visible indications of progress, and immediate feedback. Attainable challenge appeared to encourage continued participation because students could experience improvement and accomplishment during the activity. Narrative elements and interactive tasks also strengthened the overall learning experience when they were meaningfully connected to instructional objectives. The combined pattern suggests that the motivational value of gamification depends more on the complete learning experience than on the presence of isolated game elements.

The evidence did not support the assumption that points, badges, rankings, or leaderboards automatically improve motivation. Similar positive responses occurred under different reward structures, indicating that no single game mechanic consistently explained motivational improvement. External rewards appeared most constructive when they communicated learning progress rather than functioning primarily as mechanisms of control or comparison. Excessive competition could reduce collaborative interaction and shift students' attention from mastery toward ranking. Novelty could also temporarily increase enthusiasm and make short-term motivational responses appear stronger than they would be over longer periods. Gameful learning therefore appears most supportive when challenge, feedback, progress, and accomplishment remain central to the learning process.

Learner Control, Adaptation, and Persistence

Learner control and adaptive support formed the second major motivational mechanism identified in the synthesis. Interactive and adaptive applications were associated with greater satisfaction, persistence, confidence, or engagement when students could manipulate content and make meaningful choices. Students appeared more willing to continue learning when digital environments responded appropriately to their current level of knowledge or performance. Responsive difficulty also allowed students to encounter tasks that were challenging without becoming consistently frustrating. Visible progress and immediate responses strengthened students' perception that effort could lead to successful task completion. These characteristics indicate that adaptive digital environments can support motivation when they increase meaningful autonomy while preserving appropriate instructional structure.

Learner control was not beneficial when choice became confusing, superficial, or disconnected from educational goals. Adaptation was also less convincing when students could not understand how or why the digital environment changed the difficulty of learning tasks. Differences in devices, connectivity, adult assistance, language accessibility, and interface design could further determine whether students experienced genuine control. Students with stronger technological resources or external support could therefore receive greater motivational benefits than students facing limited access. Personalization must consequently be evaluated not only according to technological responsiveness but also according to the fairness and comprehensibility of the learning experience. The evidence supports adaptive technology as a potentially useful motivational structure rather than as an automatic guarantee of increased student motivation.

Multimedia Coherence and Cognitive Accessibility

Multimedia coherence and cognitive accessibility represented the third major mechanism identified across the corpus. Digital multimedia could initially attract students' attention through combinations of text, images, audio, animation, and interactive components. Sustained positive responses, however, depended on whether those representations helped students understand the learning material. Clear signaling, manageable segmentation, appropriate pacing, and relevant integration of audio and visual information supported more coherent learning experiences. These design characteristics helped students direct attention toward essential information rather than processing unnecessary or decorative material. Multimedia design therefore contributed to motivation primarily when it enabled students to understand tasks and maintain a sense of competence.

Visually rich materials did not consistently produce stronger motivational outcomes when their presentation generated unnecessary cognitive demands. Excessive animation, redundant information, complicated navigation, and poorly coordinated visual elements could distract students from the intended learning objectives. Such conditions could increase cognitive load and reduce students' confidence in completing digital tasks successfully. Accessibility also influenced whether multimedia resources could be used effectively by students with different learning requirements. Appropriate combinations of audio, visual, and textual representation could improve participation when they were matched to learners' processing needs. The findings therefore indicate that coherent and accessible multimedia design is more motivationally valuable than technological complexity or visual attractiveness alone.

Teacher-Mediated Social Participation

Teacher-mediated social participation emerged as the fourth major motivational mechanism in the evidence base. Digital learning produced different outcomes depending on how teachers framed tasks, organized participation, provided feedback, and facilitated classroom interaction. Technology appeared more supportive when teachers used it for inquiry, communication, differentiated assistance, and collaborative problem solving. Collaborative activities were particularly meaningful when students were given clear roles and opportunities to explain, create, test, discuss, or revise learning products. These conditions enabled digital environments to support social participation rather than simply increasing individual screen exposure. Teacher facilitation therefore influenced whether digital technologies became active learning environments or passive delivery systems.

Access to the same digital platform did not guarantee meaningful collaboration among students. Learners could remain socially isolated when digital tasks were organized mainly as parallel individual activities without reciprocal interaction. Competition could also weaken social participation when ranking became more important than cooperation or shared accomplishment. Structured communication and teacher-supported collaboration were therefore necessary to convert technological connectivity into meaningful relatedness. Teacher decisions regarding grouping, feedback, task purpose, and classroom routines became part of the motivational experience itself. The evidence consequently positions teacher orchestration as a central mechanism rather than as a secondary implementation factor.

Boundary Conditions and Strength of Inference

Five recurring boundary conditions influenced the interpretation of motivational outcomes across the analytical corpus. The first condition was novelty, which could temporarily increase enthusiasm during students' initial exposure to unfamiliar digital activities. The second condition involved extrinsic rewards and competition, which could either support progress or redirect attention toward external comparison. The third condition was cognitive overload caused by excessive information, complex interfaces, or poorly coordinated multimedia representation. The fourth condition concerned access and accessibility, including devices, connectivity, language demands, disability support, and availability of adult assistance. The fifth condition involved measurement quality because motivation, engagement, enjoyment, satisfaction, persistence, self-efficacy, achievement, and teacher perceptions represented related but non-equivalent outcomes.

The strength of motivational inference differed substantially across the included evidence. The strongest evidence occurred when motivation was measured directly, comparison conditions were meaningful, and the digital-learning activity was described with sufficient detail to identify the relevant pedagogical mechanism. Interpretation became weaker when motivation was inferred solely from achievement or digital-system usage. Teacher perceptions also provided useful contextual information but could not automatically substitute for students' own motivational experiences. Short intervention periods further limited conclusions about whether initial enthusiasm developed into sustained motivation. The overall evidence therefore supports positive but conditional motivation-related responses rather than a universal causal effect of digital learning.

Table 3. Motivational Mechanisms, Design Conditions, Psychological Pathways, and Main Risks

Mechanism	Key Design Conditions	Primary Psychological Pathway	Main Risks
Gameful challenge and informational feedback	Attainable challenge, clear goals, progress information, narrative, repeated attempts, timely feedback	Autonomy and competence	Novelty effects, controlling rewards, excessive competition, ranking orientation
Learner control and adaptation	Meaningful choice, manipulability, pacing, responsive difficulty, visible progress	Autonomy and competence	Opaque adaptation, unequal support, inappropriate difficulty, product dependence
Multimedia coherence and cognitive accessibility	Signaling, segmenting, relevant audio-visual integration, manageable pacing, accessibility	Competence	Redundancy, distraction, interface complexity, cognitive overload
Teacher-mediated social participation	Scaffolding, formative feedback, collaborative roles, communication, shared inquiry	Relatedness and competence	Passive delivery, isolated screen use, weak classroom orchestration
Equitable implementation	Device access, connectivity, inclusive design, accessibility support, sustained assistance	Autonomy, competence, and relatedness	Digital divide, disability barriers, unequal assistance, short-term implementation

Table 3 integrates the main mechanisms identified across the analytical corpus with their corresponding design conditions and psychological pathways. The synthesis indicates that motivational outcomes are associated more closely with the organization of learning experiences than with specific categories of technology. Gameful and adaptive environments primarily support autonomy and competence when they provide attainable challenge, feedback, meaningful choices, and understandable progress. Multimedia design primarily supports competence when information is presented coherently and without unnecessary cognitive burden. Teacher-mediated participation contributes to competence and relatedness by connecting digital activities with meaningful communication, collaboration, and instructional support. Equitable implementation operates across all mechanisms because differences in access and accessibility can determine whether students experience these motivational opportunities at all.

Integrated Mechanism of Digital Learning and Student Motivation

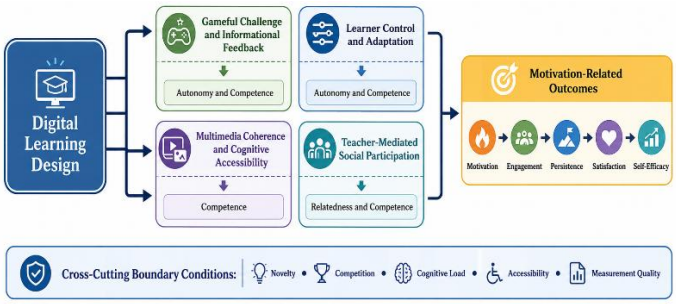

Figure 1. Integrated Mechanism of Digital Learning and Elementary Students' Motivation

Figure 1 presents the integrated mechanism developed from the recurring patterns identified across the analytical corpus. The model demonstrates that technology exposure itself does not constitute the principal pathway through which digital learning is associated with motivation. Instead, digital design becomes motivationally meaningful through gameful challenge, learner control, coherent multimedia representation, and teacher-mediated social participation. These mechanisms primarily influence students' experiences of autonomy, competence, and relatedness and are subsequently reflected in motivation-related outcomes. The operation of these mechanisms is simultaneously shaped by novelty, competition, cognitive load, accessibility, and measurement quality. The model therefore represents digital learning as a conditional pedagogical environment in which motivational outcomes depend on the interaction among technology, instructional design, learners, teachers, and implementation context.

Integrated Results

Taken together, the findings demonstrate that digital learning is not a single or inherently motivating educational intervention. Its motivational potential depends on whether technological features are translated into meaningful pedagogical experiences for elementary learners. Challenge, feedback, learner control, coherent representation, social participation, and equitable access emerged as the most important recurring conditions across the evidence base. The same technological feature could support motivation under well-designed conditions but weaken it when implementation increased competition, confusion, overload, or exclusion. Motivation-related outcomes should therefore be interpreted as products of interactions among learners, tasks, technology, teachers, peers, and contextual conditions. The overall synthesis supports digital learning as a promising but conditional environment for strengthening elementary students' motivation rather than as a universal motivational treatment.

Discussion

The synthesis clarifies that digital learning is not a unitary intervention. Its motivational value lies in how specific affordances are converted into psychologically meaningful experiences. Gameful challenge, adaptation, multimedia representation, and collaboration can support autonomy, competence, and relatedness, but the same affordances can become controlling, confusing, or excluding. This pattern is consistent with self-determination theory, which predicts that motivation depends on need-supportive conditions rather than the novelty or modernity of a delivery medium (Ryan & Deci, 2020). The most defensible interpretation is therefore relational: motivation emerges from the interaction among learner, task, technology, teacher, peers, and context.

A major implication is that technology labels provide weak guidance for practice. "Gamification," "multimedia," "mobile learning," and "personalization" each include designs with different levels of choice, feedback, competition, pacing, and social interaction. The meta-analytic record shows positive average tendencies, but averages conceal mechanisms and boundary conditions (Bai et al., 2020; Sailer & Homner, 2020; Sung et al., 2016). Elementary-specific studies make the mechanism more visible: a digital escape room may motivate because it combines challenge, narrative, social coordination, and accomplishment (Vidergor, 2021), while an application may support persistence because it offers meaningful control and immediate response (Hori et al., 2025). Schools should therefore evaluate design features and instructional use rather than select tools based primarily on platform category or promotional claims.

The findings also refine the role of teacher facilitation. Teachers do more than introduce a device; they define the purpose of the task, calibrate difficulty, connect feedback to learning, protect students from unproductive competition, and organize interaction. Teacher conceptions influence whether mobile technology becomes a student-centered resource (Chen & Tsai, 2021), and classroom video evidence shows how participation depends on communicative structures (Schulz et al., 2025). Professional learning should consequently focus on motivational design decisions: when to offer choice, how to provide informational feedback, how to scaffold collaboration, how to monitor cognitive load, and how to recognize when a digital task is producing compliance rather than autonomous engagement.

Equity is inseparable from motivational interpretation. A learner cannot experience meaningful autonomy when access is intermittent, interface demands exceed reading ability, assistive support is absent, or adult help is unavailable. Accessibility evidence involving students with dyslexia demonstrates that modality decisions influence processing and participation (Knoop-van Campen et al., 2020). Personalized learning may widen rather than narrow opportunity gaps if better-resourced students receive more stable devices, connectivity, feedback, and enrichment (Dumont & Ready, 2023). For this reason, evaluations should disaggregate findings by prior achievement, disability, language background, socioeconomic context, and support conditions wherever sample size permits.

For researchers, the central priority is construct precision. Future studies should predefine whether they are measuring intrinsic motivation, identified regulation, self-efficacy, behavioral engagement, satisfaction, persistence, or enjoyment. Multi-informant data can be useful, but teacher reports, system logs, student questionnaires, and observations should not be collapsed into one undifferentiated motivation score. Longer follow-up periods are needed to separate novelty from durable change, and comparison conditions should control for time on task, teacher attention, and content. Mixed-method designs can explain why statistically similar outcomes arise from different learner experiences, while adequately powered cluster-randomized or longitudinal studies can strengthen causal inference in authentic classrooms.

LIMITATIONS AND FUTURE RESEARCH

This review has four limitations. First, it is a systematic integrative synthesis of a bounded, verified corpus rather than an exhaustive bibliometric census of every Scopus record; database-export replication may identify additional eligible studies. Second, the corpus combines reviews, experiments, longitudinal work, and implementation studies, so evidence weights are not equivalent. Third, several sources measure adjacent constructs such as self-efficacy, satisfaction, competence, collaboration, or teacher-perceived engagement rather than intrinsic motivation directly. Fourth, publication bias and the rapid evolution of digital products may overrepresent positive and short-lived responses. These limitations are addressed through calibrated language and explicit separation of direct from indirect motivational evidence, but they cannot be eliminated by narrative synthesis alone.

CONCLUSION

Digital learning can support elementary school students' motivation when its design creates meaningful choice, attainable challenge, informational feedback, coherent representation, and socially supported participation. The strongest recurring mechanisms are not technological in themselves; they are psychological and pedagogical processes enabled—or obstructed—by

technology. Gameful activities can increase enthusiasm, adaptive applications can strengthen persistence, multimedia can make relationships visible, and collaborative tools can support relatedness. Each benefit, however, depends on task quality, teacher orchestration, accessibility, duration, and measurement integrity.

Accordingly, schools should avoid treating digital adoption as evidence of motivational improvement. Decisions should be guided by whether a tool supports autonomy without abandonment, competence without overload, and relatedness without coercive competition. Researchers should distinguish immediate enjoyment from sustained motivation and report the implementation conditions necessary to reproduce an effect. Under those conditions, digital learning is best understood as a promising but conditional pedagogical environment—not a universal motivational treatment.

AUTHOR CONTRIBUTION STATEMENT

A. Alfiani Damayanti: Conceptualization, methodology, literature search, data screening, data extraction, evidence synthesis, visualization, and writing—original draft preparation. Eka Fitriana HS.: Conceptualization, methodology validation, supervision, interpretation of findings, quality assurance, and writing—review and editing. Both authors contributed to the critical revision of the manuscript, approved the final version for publication, and agreed to be accountable for the integrity and accuracy of the work.

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