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Implementing e-Learning–Based Science Media for Straight Motion at the Junior-High Level: A Literature-Based Review

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Abstract

This study reviews how e-learning media can be designed to support junior-high students' understanding of straight motion (kinematics) in science classes. Using a narrative literature review, we searched scholarly sources on lower-secondary physics and online/blended instruction, emphasizing 2018–2022 publications and Indonesian implementations during and after the COVID-19 shift; inclusion required relevance to straight motion (e.g., motion graphs, constant velocity/acceleration), explicit use of e-learning platforms or digital resources (e.g., Zoom/Meet, Google Classroom/WhatsApp, Quizizz/Kahoot!, simulations/visualizations), and reportable classroom practices or outcomes. Evidence was extracted on context, platforms, activity structures, representational foci, and reported affordances/constraints, then synthesized thematically. The findings indicate that sequences are most effective when pedagogy not platform novelty drives design: brief multimodal explanations interleaved with questioning and peer talk, layered visuals that explicitly link narratives of motion to position–time, velocity–time, and acceleration–time graphs, and frequent low-stakes retrieval to surface misconceptions about slopes, areas, units, and terminology. Videoconferencing is beneficial when used for short, dialogic segments rather than prolonged lectures; game-based quizzing improves engagement and provides rapid diagnostic feedback; and visualizations/simulations help reduce representational load. Effectiveness is conditional on access and structure, with bandwidth/device constraints and limited oversight of hands-on work as recurrent barriers. This review contributes topic-specific, context-aware design heuristics for straight motion at the junior-high level. Implications include adopting lightweight, bandwidth-resilient "explain–check–discuss" playbooks; curating shared banks of visuals and formative items focused on motion-graph interpretation; providing teacher professional development on discourse moves that elevate student voice; and prioritizing equity-minded participation monitoring to guide iterative improvement.

Keywords: E-learning; Instructional media; Junior high school; Science education; Student engagement.

INTRODUCTION

Kinematics particularly straight motion poses persistent challenges for lower-secondary learners because it requires students to coordinate multiple representations (verbal descriptions, equations, and motion graphs) while managing cognitive load and linking abstract quantities to visible motion. Well-designed e-learning media can reduce these barriers by pairing words and visuals, segmenting and signaling essential information, and providing worked examples and guided practice that make change-over-time relations more concrete; these design moves are strongly supported by contemporary multimedia learning research and syntheses (e.g., contiguity, signaling, modality/prioritizing audio-visual over text-heavy slides) (Mayer, 2020; Noetel et al., 2022). Yet even with digital affordances, difficulties with motion-graph interpretation and with connecting position–velocity–acceleration remain common across school levels, indicating the need for explicit instruction that bridges narrative, symbolic, and graphical representations (e.g., documented misconceptions about slopes/areas, confusion of variables, and "graph as picture" errors)(Becker et al., 2023; Dwi Sundari et al., 2023; Sarkity et al., 2022).

The rapid pivot to remote learning during COVID-19 accelerated adoption of synchronous video (Zoom/Meet), learning-management systems, and lightweight messaging tools in Indonesia and worldwide. A crucial distinction emerged between hastily assembled emergency remote teaching and well-designed online learning; the former emphasized access continuity but often lacked deliberate pedagogy, structured interaction, and assessment coherence (Bond et al., 2021; Bozkurt & Sharma, Ramesh, 2020; Hollister et al., 2022). In Indonesia, unequal device ownership and intermittent connectivity especially beyond urban centers onstrained participation and assessment, making instructional design choices (e.g., bandwidth-robust activities, asynchronous supports) decisive for equity (Azevedo et al., 2021; Hujjatusnaini et al., 2022; Theobald et al., 2020). These conditions imply that effectiveness hinges not on technology per se but on intentionally blended sequences that combine concise explanation, interactive discussion, and timely feedback while remaining resilient under local infrastructure constraints (Nur Fitri Mutmainah & Silvi Lailatul Mahfida, 2021; Purba, 2021; A. I. Wang & Tahir, 2020).

Within science and STEM education, active and interactive designs reliably outperform lecture-dominant routines and can narrow achievement gaps when implemented with fidelity an implication especially salient for abstract topics like straight motion that benefit from frequent checks for understanding and dialogic sense-making (Fung et al., 2022; Katai & Iclanzan, 2023; L. Li, 2022). Synchronous platforms can build social, cognitive, and teaching presence when used for short, focused exposition interleaved with questioning and small-group discussion; conversely, long online lectures risk disengagement (Gouvea, 2021; F. Li, 2022; Singh et al., 2022). Complementing live sessions, game-based student-response systems (e.g., Kahoot!/Quizizz-type tools) provide low-stakes retrieval practice and immediate feedback that improve performance and classroom dynamics while surfacing misconceptions rapidly for re-teaching (Åhman et al., 2021; Anane, 2024; Mubarok et al., 2025).

For physics specifically, interactive visualizations and simulations help students link everyday motion to formal constructs, enabling rapid, feedback-rich exploration of parameter changes (e.g., manipulating constant-velocity vs. uniformly accelerated motion) and strengthening representational competence. Empirical work documents gains in understanding, attention, and motivation when simulations and multimodal explanations anchor practice, suggesting a promising role for such media in lower-secondary kinematics (Banda & Nzabahimana, 2021; Najib et al., 2022; Solvang & Haglund, 2022). In the Indonesian literature, designs that blend online interaction with structured tasks such as blended/project-based learning and interactive digital modules have improved motivation, retention, and achievement in science, reinforcing the value of e-learning mediations when aligned with clear goals and assessment (Ndoa & Jumadi, 2022; Susanti et al., 2022; Yustina et al., 2020). Together these strands suggest a practical recipe for straight-motion instruction at the junior-high level: brief multimodal explanations, guided interpretation of motion graphs, opportunities for peer talk, and iterative formative assessment calibrated to local connectivity and device constraints (Duijzer et al., 2019; Gok & Gok, 2023; Hariroh et al., 2024).

At the same time, motion-graph competence remains a chronic bottleneck: studies report persistent misconceptions in interpreting slopes/areas, confusion between position and velocity, and difficulty coordinating multiple graphs even among older students, indicating that generic "technology use" is insufficient without purposeful representational scaffolds (e.g., explicit linking of trajectory narratives to s–ts\text{–}ts–t, v–tv\text{–}tv–t, and a–ta\text{–}ta–t graphs; structured prompts for explanation) (Prada Núñez et al., 2022; Sarkity et al., 2022; Susac et al., 2018). In turn, multimedia design principles that reduce extraneous load (signaling, segmentation) and increase generative processing (prompted explanations, example–practice cycles) are directly relevant to the design of e-learning sequences for straight motion (Cavanagh & Kiersch, 2023; Chen & Yen, 2021; Mutlu-Bayraktar et al., 2019).

Despite the rapid diffusion of online platforms and a robust general literature on online/active learning, two gaps remain for Indonesian junior-high straight motion: (i) much of the evidence synthesizes online learning at a general level or focuses on higher-education cohorts, whereas lower-secondary kinematics presents distinctive representational hurdles requiring topic-specific guidance; and (ii) Indonesian reports often document single tools (e.g., a platform case) rather than integrated, pedagogy-first designs that combine synchronous interaction, multimedia visualization, and game-based formative assessment under real-world bandwidth/device constraints (Ediyanto, 2020; Nurjanah et al., 2024; Sasmita et al., 2023).

Addressing these gaps, the present review consolidates international and Indonesian evidence on e-learning media for teaching straight motion in junior-high contexts, critically appraises the affordances and limitations of videoconferencing, visual/simulation resources, and game-based quizzing for developing representational competence, and derives actionable design heuristics that teachers and schools can adapt for planning, implementation, and iterative improvement in routine practice.

METHODS

This study adopts a narrative literature review to synthesize evidence on the implementation of e-learning–based science media for the junior-high topic of straight motion. The choice of a narrative approach is appropriate because the literature spans heterogeneous sources (empirical classroom reports, design descriptions, and practitioner accounts) and varies widely in methodology, context, and outcome measures. The review focuses on lower-secondary physics (SMP/junior high) and privileges studies that explicitly address representational demands in kinematics (e.g., interpreting position–velocity–acceleration relationships, motion graphs) under online or blended delivery.

The search strategy combined purposive database queries and iterative chaining. We queried scholarly search engines and indexing services (e.g., Google Scholar, DOAJ/Scopus-indexed journals' sites, institutional repositories) using Boolean combinations of terms related to level, topic, and medium: "junior high" OR "SMP" AND "straight motion" OR "kinematics" OR "motion graph" AND "e-learning" OR "online learning" OR "Zoom/Meet/Google Classroom/WhatsApp" OR "Quizizz/Kahoot!". Given the surge of online instruction during COVID-19, we emphasized publications from approximately 2018–2022 while including earlier anchor works when necessary to contextualize design principles. Reference lists of included papers were scanned (backward chaining), and "cited by" functions were used to locate recent, closely related studies (forward chaining).

Inclusion required that a source (i) concern science/physics learning at the junior-high level or a closely comparable setting, (ii) describe or evaluate e-learning media or platforms relevant to straight motion (e.g., synchronous explanation and discussion, simulation/visualization, game-based formative assessment), and (iii) report concrete classroom practices, learner responses, or learning outcomes that could inform design. We excluded opinion pieces without classroom detail, studies unrelated to physics/science pedagogy, and reports that focused exclusively on infrastructure without instructional implications. Screening proceeded in two passes (title/abstract, then full text), with eligibility decisions recorded to ensure transparency and replicability of judgments.

For each eligible source, we extracted bibliographic data and coded pedagogically relevant features: educational level and context; platform/media used (e.g., Zoom/Meet for multimodal exposition and dialogue; Google Classroom/WhatsApp for task distribution and feedback; Quizizz/Kahoot! for low-stakes retrieval practice); activity structures (explain–check–discuss cycles, worked examples, guided practice, peer talk); focal concepts in straight motion (constant velocity vs. uniformly accelerated motion, graph interpretation); reported affordances (e.g., visual clarity, interaction, immediate feedback) and constraints (e.g., connectivity, device access, limited oversight for practical work); and any outcomes or teacher/student perceptions pertinent to engagement and understanding. Data were organized in a comparative evidence table to enable cross-study patterning of design choices and their reported effects.

Synthesis was thematic and explanatory rather than statistical. We clustered findings around recurring design problems making the abstract visible, sustaining interaction online, and integrating formative assessment—and mapped how different media choices addressed (or failed to address) those problems in routine practice. Where studies presented complementary strengths (e.g., synchronous platforms for presence and dialogue, quiz tools for rapid feedback, simulations for representational linkage), we derived composite design heuristics calibrated to bandwidth and device constraints common in the Indonesian context. We also attended to signals of equity (participation distribution, persistence) and feasibility (prep time, teacher moves) to ensure the resulting guidance is decision-useful for schools.

Quality assurance emphasized methodological transparency and relevance to the review question. Because the included literature is methodologically diverse, we did not compute metaanalytic effects; instead, we appraised each study's clarity of context, alignment between goals and measures, and plausibility of inferences, and we gave greater interpretive weight to studies with clear task descriptions, traceable assessments, or triangulated evidence. As a literature-based study using publicly available sources, formal ethics approval was not applicable. All efforts were made to report procedures and criteria with sufficient detail to permit replication or extension by subsequent reviews in similar domains.

RESULTS AND DISCUSSION

The reviewed literature converges on a consistent pattern: e-learning media for junior-high kinematics are most effective when they reduce representational complexity, sustain interaction, and embed frequent formative checks. Across sources, designs that paired concise explanations with visualizations (e.g., animated vectors, layered motion diagrams, or simple simulations) and then cycled quickly into sense-making activities (brief problem solving, short oral justifications, or poll-style checks) yielded better comprehension of straight motion than prolonged online lecturing. These effects were strongest when teachers explicitly bridged everyday trajectories and formal representations connecting stories of motion to position–time, velocity–time, and acceleration–time graphs so that students learned to interpret slopes and areas rather than treating graphs as pictures. Conversely, implementations that emphasized platform novelty over pedagogy (long monologues, dense slides, or unstructured breakout rooms) reported uneven engagement and fragile understanding, particularly under bandwidth constraints. In short, technology acted as an amplifier of the underlying lesson architecture: when the pedagogy was purposeful, tools like videoconferencing, quiz apps, and lightweight chat systems amplified learning; when the pedagogy was diffuse, the same tools amplified disengagement.

These conclusions align with and extend several strands of prior research. First, they are consistent with large-scale syntheses showing that active learning outperforms lecture-dominant routines and narrows gaps for underserved learners; the patterns we summarize short exposition, elicitation of student ideas, rapid feedback mirror the mechanisms highlighted in active-learning meta-analyses (Deslauriers et al., 2019; Theobald et al., 2020; van Alten et al., 2019). Second, the salience of dual-coded visuals and segmented explanations corroborates multimedia learning theory and its recent meta-meta synthesis: pairing words and graphics, signaling what to attend to, and sequencing information to avoid overload were repeatedly associated with clearer graph interpretation and fewer symbol-sense errors (Beege et al., 2021; Sweller et al., 2019; van Eerde & Klingsieck, 2018). Third, the observed benefits of low-stakes, game-based quizzing during or after live sessions reinforce evidence that retrieval practice improves near-term performance and classroom dynamics online; Quizizz/Kahoot-type tools surfaced misconceptions about units, slopes, and kinematics vocabulary quickly enough to inform re-teaching within the same lesson (Gomez et al., 2023; Kenney & Bailey, 2021; A. I. Wang & Tahir, 2020). Fourth, our emphasis on structured, dialogic use of videoconferencing (brief explanations interleaved with questioning, revoicing, and peer talk) is congruent with classroom-process studies: without such structure, synchronous platforms risk "Zoomed-out" attention; with it, they support social, cognitive, and teaching presence that sustains on-task behavior (Katai & Iclanzan, 2023; Shi et al., 2021; Y. Wang & Stein, 2021). Fifth, the conditional nature of effectiveness observed here positive when pedagogy is tight and access is adequate, negative when either is weak matches Indonesian studies reporting that blended designs and interactive modules raise motivation and retention, provided that tasks are well-scaffolded and connectivity is sufficient (Beege et al., 2021; Çeken & Taşkın, 2022; Rey et al., 2019). Finally, the finding that explicit representational scaffolding is non-negotiable resonates with research on persistent motion-graph misconceptions and the need to teach how to read slopes/areas conceptually rather than procedurally (Amin et al., 2020; Klein et al., 2019; Susac et al., 2018).

Taken together, the synthesis yields several practice-ready implications. Teachers should design lessons around "explain–check–discuss" cycles that last only a few minutes each; use layered visuals to connect narrative descriptions to sss–ttt, vvv–ttt, and aaa–ttt graphs; and build recurring retrieval moments with 4–6 well-targeted items to diagnose kinematics misconceptions in real time. Schools can standardize lightweight playbooks that are robust under bandwidth constraints: pre-class microvideos (≤5 minutes) to front-load representations; a 30–40-minute live segment with planned questioning and equitable turn-taking; and a short, game-based check to consolidate terms, units, and interpretations. Departments should curate shared banks of visuals and quiz items focused on slope, area, and multiple-representation linking, and provide brief professional development on discourse moves (wait time, probing, revoicing) that elevate student voice online. For equity, teachers should monitor participation distribution and use simple talk protocols to ensure that quieter students contribute during discussion. At policy level, investment should prioritize bandwidth-resilient resources (static-first visuals with optional animation; offline-capable assessments) over feature-rich but fragile tools.

The novelty of this review lies in its topic-specific, context-aware synthesis: rather than discussing online learning generically, it integrates videoconferencing, multimedia visualization, and game-based retrieval into coherent design heuristics explicitly tailored to straight motion and to Indonesian junior-high realities (limited bandwidth/devices, heterogeneous classes). It also foregrounds representational competence (how students coordinate sss–ttt, vvv–ttt, aaa–ttt graphs) as the central design target, translating multimedia and active-learning principles into concrete moves (layered signaling on graphs, slope/area interpretation prompts, rapid misconception checks) that teachers can operationalize immediately.

Several limitations should be acknowledged. This is a narrative rather than a statistical meta-analysis; effect magnitudes were not aggregated and publication bias cannot be ruled out. The included studies are methodologically heterogeneous and vary in reporting quality, which constrains causal inference. Many classroom reports are single-site, short-duration implementations with limited control of confounds (access differences, concurrent interventions). Access and language filters may have excluded relevant non-English or non-indexed studies. Finally, platform names can shift faster than underlying pedagogy; recommendations should therefore be read as design patterns, not endorsements of specific tools.

Future work should compare alternative micro-sequences for the same concept (e.g., constant velocity vs. uniformly accelerated motion) using common assessments; experimentally vary signaling/segmentation on motion graphs; and model which combinations of explanation, interaction, and retrieval maximize both learning and participation under real bandwidth/device constraints. Multi-school quasi-experiments with teacher-log triangulation and student-level covariates would help identify the most efficient levers for improving representational competence in straight motion at scale.

CONCLUSION

This review concludes that e-learning media can support junior-high students' understanding of straight motion when pedagogy not platform novelty drives design. Effective sequences reduce representational complexity, sustain interaction, and embed frequent formative checks: brief, multimodal explanations interleaved with questioning and peer talk; layered visuals that explicitly link everyday trajectories to position–time, velocity–time, and acceleration–time graphs; and low-stakes retrieval moments (e.g., Quizizz-type checks) to surface misconceptions about slopes, areas, units, and kinematics vocabulary in real time. In bandwidth-constrained Indonesian settings, these moves are best operationalized through lightweight, resilient playbooks that combine short pre-class microvideos, a focused synchronous segment (Zoom/Meet) organized around "explain–check–discuss" cycles, and concise post-lesson consolidation. The review's contribution is a topic-specific, context-aware set of design heuristics that translate multimedia and active-learning principles into actionable routines for lower-secondary kinematics, with immediate implications for teacher planning, departmental resource curation (shared banks of visuals and items), and equity-minded participation monitoring. While effect magnitudes were not meta-analyzed, the convergent evidence across heterogeneous studies supports adopting these patterns as a pragmatic baseline; future work should experimentally compare alternative micro-sequences and test their robustness across schools and access conditions to strengthen causal claims and guide scale-up.

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