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Empowering Primary School Science Education: The Impact of LMS-Integrated E-Worksheets on Conceptual Understanding and Learning Outcomes

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Abstract: This study developed and evaluated Learning Management System (LMS)-integrated e-worksheets to enhance fifth-grade students' self-efficacy and conceptual understanding in science education. Using a Research and Development approach with the ADDIE model, the instructional material underwent expert validation, practicality assessment, and effectiveness testing. Validation results demonstrated high content and media validity (90.75%), while practicality scores from teachers and students reached 91%. Implementation significantly improved students' self-efficacy (95.5%) and conceptual understanding, with paired t-tests revealing statistically significant pre-post gains ($p < 0.001$). The findings indicate that purposefully designed LMS-integrated e-worksheets can effectively support blended learning environments, fostering both cognitive mastery and psychological empowerment in young learners. This research provides evidence-based guidance for integrating accessible digital platforms into elementary science instruction to create more student-centered and effective learning experiences.

Keywords: Conceptual Understanding; Elementary Education; E-Worksheets; Learning Management System; Self-Efficacy

Introduction

Primary school science education is essential for establishing scientific literacy, nurturing innate curiosity, and providing young learners with the conceptual frameworks necessary to understand their environment (Berastegui-Martínez & López-Cassà, 2026). As educational frameworks increasingly prioritise profound conceptual understanding and the practical application of scientific ideas, educators have the persistent issue of providing teaching that is both captivating and adaptable to varied learning speeds (Gautam & Kanwar, 2025). Traditional classroom methods, although fundamental, frequently lack the flexibility, interactivity, and structured practice required to maintain students' engagement and reinforce their comprehension of abstract scientific principles (Chen et al., 2026). The swift incorporation of digital learning technology into educational systems has created new opportunities for rethinking pedagogical methods. Learning Management Systems (LMS) have arisen as adaptable platforms that host organised information, facilitate asynchronous access, and promote ongoing interaction between educators and learners (Etzold et al., 2026).

Despite the extensive use of LMS across many educational tiers, the deliberate incorporation of purpose-built digital instructional resources—such as e-worksheets remains inadequately investigated in elementary science settings (Rust & Motz, 2026). Numerous current digital resources are either adapted from secondary or tertiary educational materials or fail

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to correspond with the cognitive and developmental requirements of younger students (Lee et al., 2026). Moreover, empirical research has predominantly concentrated on technological adoption rather than on the impact of strategically integrated LMS-supported materials on cognitive acquisition and emotional learning characteristics (Huda, 2026). There is an urgent requirement for instructional strategies that successfully convey scientific content while simultaneously fostering students' confidence, self-regulation, and preparedness to tackle progressively intricate subjects (Ferdiansyah et al., 2025).

This study fills this gap by developing and assessing an LMS-integrated e-worksheet tailored for fifth-grade science education (Ramadhan & Sumarni, 2025). The content is based on blended learning methods and organised into interactive, self-paced modules, focusing on fundamental ecological concepts while incorporating formative practice and reflective prompts. The main aim of this study is to analyse the effect of LMS-integrated e-worksheets on primary students' comprehension of science and overall learning outcomes, specifically focusing on quantifiable enhancements in academic self-efficacy and knowledge retention. This research seeks to align digital pedagogy with curriculum standards and developmental learning trajectories, providing evidence-based insights on utilising technology-enhanced instructional materials to empower primary science education and foster equitable, student-centered learning environments (Setiawan et al., 2026).

Method

Research Design

This study utilises a Research and Development (R&D) methodology to systematically design, produce, and assess Learning Management System (LMS)-integrated e-worksheets for elementary scientific instruction. The ADDIE paradigm (Analysis, Design, Development, Implementation, and Evaluation) functions as a structural framework, guaranteeing iterative refinement and empirical validation of the educational output prior to ultimate deployment (Satrio et al., 2025).

Development Procedure

The product development follows five sequential phases Analysis: Curriculum mapping is performed to synchronise learning objectives with national standards. A needs assessment determines pedagogical deficiencies, technological preparedness, and student attributes to guide material development.

Design: Instructional architecture and assessment tools are systematically organised. Digital content is created and structured into modular topics, with multimedia components and interactive prompts designed for fifth-grade cognitive abilities.

Development: Expert validation is performed by subject-matter and media specialists to assess material correctness, instructional design, linguistic clarity, and contextual relevance. Feedback is methodically integrated to enhance the product (Apriyani et al., 2022).

Implementation: The content is subjected to systematic field testing: individual assessments to pinpoint usability concerns, small-group evaluations to examine collaborative dynamics, and restricted classroom implementation to monitor instructional progression. Successful iterations are subsequently executed in comprehensive classroom environments.

Evaluation: Practicality is evaluated by stakeholder questionnaires, whilst learning effectiveness is quantified using approved psychometric and cognitive tools. Information from this phase guides the ultimate product enhancement.

Participants and Setting

The study encompasses fifth-grade students and classroom teachers from three elementary schools chosen for their curriculum alignment and infrastructural preparedness for digital learning. Participants exhibit varied academic competency levels to guarantee thorough usability testing and broadly applicable effectiveness results.

Instruments and Data Collection

Data collecting incorporates both qualitative and quantitative methodologies. Validation Sheets: Systematic rubrics finalised by subject matter and media specialists to assess theoretical integrity and technological design. Practicality Questionnaires: Likert-scale surveys distributed to educators and students to evaluate usability, accessibility, and time efficiency. Self-Efficacy Questionnaire: A validated questionnaire that assesses students' confidence in executing science activities, persevering through challenges, and applying acquired concepts. Conceptual Understanding Assessment: Parallel pre-test and post-test instruments with multiple-choice, short-answer, and essay questions linked with Bloom's cognitive taxonomy (interpreting, exemplifying, classifying, summarising, inferring, comparing, and explaining).

Qualitative feedback is obtained via open-ended expert commentary, educator observations, and student reflections during trial phases.

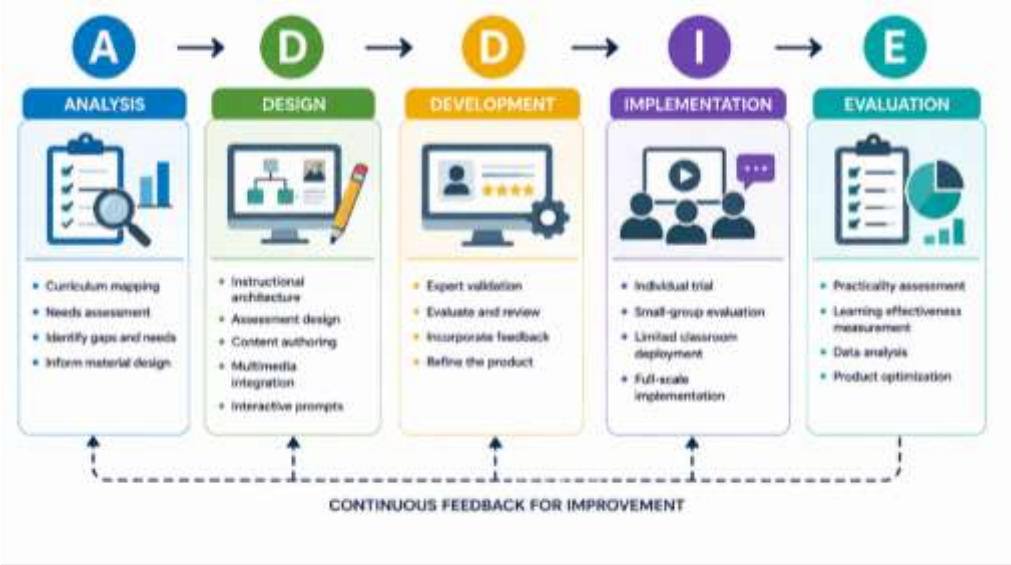

Figure 1. ADDIE Model Development Procedure

Data Analysis Techniques

Quantitative data from validation and practicality instruments are examined by descriptive statistics. Scores are transformed into percentage indices and evaluated against established feasibility thresholds (e.g., ≥81% signifying good validity/practicality). Self-efficacy results are assessed using cumulative percentage scoring. To assess the effect on conceptual comprehension, pre-test and post-test scores are subjected to necessary normality and homogeneity tests. A paired sample t-test is conducted to determine statistically significant learning improvements, with significance established at $p < 0.05$. Qualitative feedback from validators and practitioners is thematically analysed to inform iterative product modifications before final implementation.

Result and Discussion

Product Validation Outcomes

The LMS-integrated e-worksheets were subjected to expert validation to evaluate content quality and media design. Validation was performed by three subject-matter experts and two media professionals with a standardised Likert-scale instrument. The results demonstrated substantial validity across all assessed dimensions.

Table 1. Validation Result

Validation Aspect	Mean Score (%)	Category
Content Appropriateness	88.00	Very Valid
Presentation Quality	92.00	Very Valid
Language Clarity	91.00	Very Valid
Contextual Relevance	92.00	Very Valid
Overall Material Validity	90.75	Very Valid
Graphic/Media Design	95.00	Very Valid

All facets surpassed the 81% benchmark for "Very Valid" categorisation, affirming the product's theoretical and instructional integrity before field deployment.

Practicality Assessment

Practicality was assessed by questionnaires distributed to educators and fifth-grade pupils after successive trial stages (individual, small-group, and restricted-classroom trials). Responses demonstrated significant user approval.

Table 2. Practicality Result

Respondent Group	Mean Score (%)	Category
Students	94	Very Practical
Teachers	88	Very Practical
Overall Practicality	91	Very Practical

Participants indicated that the e-worksheets were available on many platforms, user-friendly, and conducive to autonomous learning. Educators observed less preparation time and enhanced ability to track student progress via the LMS interface.

Effectiveness: Self-Efficacy and Conceptual Understanding

The effectiveness was assessed using two instruments: a validated self-efficacy questionnaire and corresponding pre-test/post-test evaluations of science concept mastery.

Self-Efficacy Outcomes

The aggregated self-efficacy scores of students across 13 categories (e.g., task persistence, confidence in resolving challenging tasks, resilience following setbacks) exhibited consistently elevated levels.

Table 3. Self Efficacy Outcomes Result

School	Mean Self-Efficacy (%)	Category
School A	96	Very Effective
School B	95	Very Effective
School C	95	Very Effective

Paired-sample t-tests were employed to analyse pre-test and post-test results in order to ascertain learning gains. The following is a summary of descriptive and inferential statistics.

Conceptual Understanding Gains

Table 4. Conceptual Understanding Gains Result

School	Pre-test Mean (%)	Post-test Mean (%)	Gain (%)	*t*	*df*	*p*
School A	74.04	93.96	+19.92	−10.59	22	<0.001
School B	75.18	94.11	+18.93	−14.62	27	<0.001
School C	75.00	94.00	+19.00	−13.85	25	<0.001

All comparisons demonstrated statistically significant enhancements ($p < 0.001$), with impact sizes reflecting substantial practical significance. Mastery rates (scores ≥75%) rose from roughly 48% at the pre-test to 100% at the post-test among the participating classes.

Summary of Key Findings

The LMS-integrated e-worksheets satisfied stringent validity standards in content, presentation, language, and contextual aspects. Both educators and learners evaluated the product as exceptionally useful for both classroom and independent utilisation. Implementation resulted in considerable, statistically significant improvements in students' self-efficacy and conceptual comprehension of ecological science subjects. The blended learning framework integrating pre-class digital interaction with in-class collaborative application—facilitated active, student-centered learning while maintaining curriculum consistency.

The results offer empirical evidence for the viability and effectiveness of purposefully planned, LMS-integrated instructional resources in primary science education. The results indicate that purposefully designed LMS-integrated e-worksheets can facilitate the transition of primary scientific instruction from a passive, teacher-centered approach to an active, self-regulated learning experience (Sari et al., 2024). The elevated validity and practicality ratings affirm that digital resources associated with developmental and curricular criteria are both theoretically robust and easily implementable in daily classroom activities. This addresses a significant need in elementary education, where the incorporation of technology is often obstructed by materials that lack pedagogical foundation, age-appropriate support, or explicit instructional guidance. The robust concordance between expert validation and practitioner input demonstrates that the product effectively integrates academic rigour with classroom applicability, implying authentic scalability across comparable primary school environments (Ni Luh Putu Gautami et al., 2025).

The significant enhancement in students' self-efficacy highlights the psychological aspect of technology-augmented education. The e-worksheets likely facilitated repeated mastering experiences and diminished performance anxiety by offering structured, self-paced access to interactive content (Ibnusaputra et al., 2026; Mayasari et al., 2023). When young learners can explore intricate ecological topics at their own pace, receive instantaneous digital feedback, and interact with graphically supported tasks, their perception of personal competence improves positively. This emotional shift is especially crucial in early STEM education, as self-doubt frequently leads to academic disengagement. Fostering confidence at this fundamental level establishes the basis for enduring academic resilience, intrinsic motivation, and a more robust scientific identity (Apriyani et al., 2022; Hannah, 2026).

The significant improvements in conceptual comprehension demonstrate the instructional effectiveness of the blended learning framework integrated into the intervention. The LMS platform facilitated pre-class engagement with foundational knowledge, thereby converting synchronous classroom time into an environment for application, collaborative enquiry, and advanced thinking (Kahe, 2025; Syafar et al., 2024). The e-worksheets served as cognitive scaffolding, deconstructing abstract ecological links into digestible, interactive steps that corresponded with the developmental skills of young learners. The statistically substantial benefits observed before and after demonstrate that when digital tools are intentionally integrated rather than merely added, they can enhance information retention, conceptual transfer, and analytical thinking. This challenges the presumption that novice scientific learners necessitate solely tangible, instructor-directed teaching; rather, it posits that facilitated digital exploration can proficiently augment and enrich experience learning (Baugher, 2025; Sindi et al., 2026).

These results have significant implications for curriculum creation, instructional strategy, and educator professional growth. Successful acceptance of

educational technology is contingent more upon pedagogical alignment, intuitive use, and emotional support than on the sophistication of the platform. The experiment illustrates that when educators own readily available, curriculum-based digital resources, instructional demands diminish and student engagement increases (Buabeng & Amo-Darko, 2025; Fitrah et al., 2025; Lord et al., 2024). Nonetheless, the study's concentration on a singular scientific unit and urban educational environments necessitates prudence in extrapolating the results. Future implementations must assess longitudinal effects, varied socioeconomic and infrastructural contexts, and cross-platform adaptation. Furthermore, examining the moderating effects of teacher digital literacy, family involvement, and institutional support on outcomes would yield a more thorough comprehension of technology integration across the ecosystem (Nurul Aini et al., 2025).

This investigation demonstrates that LMS-integrated e-worksheets are not simply digital versions of old worksheets, but rather instructional tools that enhance cognitive mastery and psychological empowerment concurrently. Aligning technical capabilities with developmental learning pathways and emotional requirements can render primary science education more accessible, adaptable, and better suited to the challenges of modern digital learning settings.

Conclusion

This study illustrates that intentionally designed LMS-integrated e-worksheets can function as an effective and significant instructional tool for improving elementary scientific teaching. The generated material satisfied stringent criteria for validity and practicality, affirming its conformity with curricular objectives, developmental suitability, and classroom applicability. Significantly, its implementation correlated with considerable enhancements in students' academic self-efficacy and conceptual comprehension of ecological science, demonstrating that technology-enhanced resources—when based on robust pedagogical frameworks and blended learning principles—can concurrently foster cognitive mastery and emotional growth in young learners. These findings validate the potential of incorporating accessible digital platforms such as Teachmint into basic scientific education, providing a scalable framework for promoting student-centered, adaptable, and efficient learning environments. Future research should investigate longitudinal effects, wider contextual relevance, and the moderating influences of teacher competence and institutional support to further enhance and expand these promising results.

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