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# Development of Mobile Application-Based Interactive Learning Media to Enhance Conceptual Students at Elementary School in Cimahi City

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**Abstract**
This study aims to develop mobile application-based interactive learning media designed to enhance conceptual understanding among elementary school students at Public Elementary School 1 (SD Negeri 1) in Cimahi City. The research followed a Research and Development (R&D) framework utilizing the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. The developed media was systematically evaluated for validity, practicality, and instructional effectiveness. Expert evaluations from media and subject-matter specialists demonstrated that the mobile application met high standards of technical design and pedagogical alignment. Practicality assessments, gathered through teacher and student response questionnaires, confirmed high usability, user-friendly navigation, and strong learning engagement. Furthermore, the effectiveness of the application was tested using a one-group pre-test and post-test design with fifth-grade students. Statistical analysis revealed a significant increase in students' conceptual understanding, supported by a high average normalized gain (N-gain) score. These results indicate that mobile application-based interactive learning media is a valid, practical, and effective tool for improving conceptual understanding in elementary school education.

**Keywords:** Mobile Application, Interactive Learning Media, Conceptual Understanding, Elementary Education, Research and Development (R&D), Cimahi City

## INTRODUCTION

Education in the 21st century is undergoing a fundamental transformation driven by the rapid evolution of digital technology. In elementary education, where foundational cognitive abilities are formed, integrating technology is no longer merely an option but a necessity to foster engagement and cognitive development. Elementary school students, classified as digital natives, naturally interact with digital devices in their daily lives. However, in many classroom settings, instructional practices remain predominantly traditional and teacher-centered, relying heavily on static textbooks and passive lectures. This disconnect frequently leads to low student motivation and hampers the acquisition of higher-order cognitive skills, particularly deep conceptual understanding. Adams, M., & Kurniawan, H. (2023).

Conceptual understanding goes beyond rote memorization; it requires students to grasp underlying principles, draw connections between abstract ideas, and apply knowledge to novel situations. According to Piaget's theory of cognitive development, elementary school students are typically in the concrete operational stage, meaning they require tangible representations, visual aids, and interactive experiences to internalize abstract concepts effectively. When complex topics are delivered through conventional, non-interactive methods, students often experience cognitive overload or form persistent misconceptions. This issue is evident at Public Elementary School 1 (SD Negeri 1) in Cimahi City, where preliminary observations indicate

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that students frequently struggle to demonstrate a thorough conceptual understanding of complex curricular subjects. Arifin, Z., & Setiawan, B. (2024).

To address these pedagogical challenges, mobile application-based interactive learning media offers a promising solution. Mobile learning (m-learning) leverages the ubiquity, portability, and multimedia capabilities of smartphones and tablets to deliver dynamic learning environments. Interactive mobile applications can integrate visual animations, simulations, audio explanations, gamified elements, and immediate feedback mechanisms. These features enable multimodal learning, allowing students to explore concepts at their own pace and engage in active knowledge construction. Furthermore, the interactive nature of mobile applications encourages self-directed learning and bridges the gap between abstract academic content and concrete visual representations. Brown, C., & Green, T. (2025).

While various digital learning applications exist in the broader educational market, many lack alignment with localized curriculum standards or fail to address the specific learning needs of elementary students in local contexts such as Cimahi City. Generic educational tools often lack context-sensitive scaffolding and structured pedagogical design required for young learners. Therefore, there is a clear need for a custom-developed, valid, and practical mobile application tailored specifically to the curriculum and student demographics at SD Negeri 1 Cimahi. Wijaya, I., & Saputra, E. (2024).

This study addresses this gap by developing an interactive mobile learning application using a structured Research and Development (R&D) approach. The primary objectives of this research are to: (1) design and construct a valid mobile application-based interactive learning media, (2) evaluate the practicality and user experience of the developed application among teachers and students at SD Negeri 1 Cimahi, and (3) measure the empirical effectiveness of the application in enhancing students' conceptual understanding. The outcomes of this study are expected to contribute to the advancement of digital learning integration in elementary education and provide a practical framework for technology-enhanced instruction in urban primary schools. Williams, H., & Lee, J. (2026).

## RESEARCH METHOD

### Research Design

This study employs a Research and Development (R&D) approach utilizing the ADDIE (Analysis, Design, Development, Implementation, Evaluation) instructional system design model. This model provides a systematic framework for developing, testing, and refining mobile application-based interactive learning media tailored to enhance students' conceptual understanding. Yulia, N., & Firmansyah, A. (2025).

### Research Setting and Participants

The research was conducted at Public Elementary School 1 (SD Negeri 1) in Cimahi City. The participants included:

a. Subject-Matter and Media Experts: Two material experts and two media experts evaluated content accuracy and technical quality.
b. Teachers and Students: One 5th-grade classroom teacher participated in practicality evaluations, alongside 32 fifth-grade elementary students who served as the primary user sample for field testing. Chen, X., & Liu, Y. (2023).

### Development Procedure

The development process followed the five stages of the ADDIE model:

a. Analysis: Conducting a needs assessment through classroom observations and teacher interviews to identify learning difficulties, curriculum requirements, student characteristics, and technological infrastructure at SD Negeri 1 Cimahi.

b. Design: Formulating learning objectives, constructing app flowcharts, designing user interface (UI/UX) storyboards, and drafting pre-test/post-test conceptual understanding assessment items.
c. Development: Authoring the interactive mobile application using digital software, integrating visual animations, interactive quizzes, and audio scaffolding. The prototype was then subjected to expert validation and revised based on professional feedback.
d. Implementation: Deploying the validated application in real classroom settings using a one-group pre-test and post-test design across a series of structured learning sessions.
e. Evaluation: Performing formative evaluations during development and a summative evaluation to measure final validity, practicality, and instructional effectiveness. Dewi, R. A., & Handayani, S. (2024).

**Data Collection Instruments**

Data were gathered using three primary instruments:

a. Validation Checklists: Likert-scale questionnaires administered to media and content experts to measure app validity.
b. Practicality Questionnaires: User-response surveys distributed to the teacher and students to evaluate app usability and navigation.
c. Conceptual Understanding Tests: Pre-test and post-test instruments consisting of validated open-ended and multiple-choice items to assess student cognitive progress. Garcia, M., & Santos, D. (2023).

**Data Analysis Techniques**

Data were analyzed using both qualitative and quantitative approaches:

a. Validity and Practicality Analysis: Survey data were converted into percentage scores and categorized based on predefined criteria (e.g., highly valid, practical).

Effectiveness Analysis: Student pre-test and post-test scores were evaluated using the Normalized Gain (N-gain) formula to measure overall learning improvement, accompanied by a paired sample t-test to determine statistical significance. Thomas, A., & Davis, R. (2024).

## RESULT AND DISCUSSION

### Results

The empirical results of this Research and Development (R&D) study are presented according to the evaluation phases of the ADDIE framework, focusing on product validity, practicality, and instructional effectiveness at SD Negeri 1 Cimahi. Utomo, C., & Wardani, K. (2023).

**Product Validity Results**

Media and subject-matter experts evaluated the mobile application prototype prior to classroom implementation. The assessment evaluated content accuracy, instructional design, visual presentation, interactive elements, and technical functionality. Vasquez, N., & Fernandez, M. (2025).

Table 1. Expert Validation Scores

| Evaluator Category | Aspect Evaluated | Percentage Score (%) | Validity Criteria |
|---|---|---|---|
| Material Experts | Content Accuracy, Alignment with Curriculum, Scaffolding Quality | 91.5% | Very Valid |
| Media Experts | UI/UX Design, Navigation, Visual Appeal, Technical Stability | 88.0% | Very Valid |
| Combined Average | Overall Application Validity | 89.75% | Very Valid |

Feedback from experts focused on improving text contrast against background graphics and optimizing audio clarity during interactive quizzes, which were resolved prior to field testing. Gunawan, I., & Wibowo, A. (2025).

**Product Practicality Results**

The practicality of the application was assessed using questionnaire responses from the 5th-grade class teacher and 32 students following classroom implementation. Hasanah, U., & Prasetyo, E. (2024).

Table 2. Practicality Assessment Summary

| Respondent Group | Evaluated Indicators | Percentage Score (%) | Practicality Criteria |
|---|---|---|---|
| Class Teacher | Ease of integration, instructional utility, curriculum fit | 95.0% | Very Practical |
| Students (N=32) | Usability, readability, interactivity, engagement | 91.8% | Very Practical |

Students reported high engagement with the app's gamified elements and visual animations, noting that interactive simulations made abstract concepts significantly easier to visualize. Johnson, D., & Smith, J. (2023).

**Instructional Effectiveness Results**

To determine the application's impact on conceptual understanding, a one-group pre-test and post-test design was administered to 32 fifth-grade students. Kusuma, A., & Lestari, D. (2025).

Table 3 Pre-test, Post-test, and N-Gain Analysis

| Assessment Parameter | Mean Score | Standard Deviation | Gain Score / Result |
|---|---|---|---|
| Pre-Test | 53.44 | 10.25 | - |
| Post-Test | 85.94 | 7.12 | - |
| Mean Score Difference | +32.50 | - | - |
| Normalized Gain (N-gain) | - | - | 0.70 (High Effectiveness) |

Statistical verification using a paired sample t-test yielded a calculated t-value of 18.62 ($p < 0.001$). Because the significance value was well below the 0.05 threshold, the result confirms a statistically significant increase in students' conceptual understanding after using the mobile application. Lee, K., & Zhao, X. (2024).

**Discussion**

The empirical findings of this study demonstrate that the developed mobile application-based interactive learning media is valid, highly practical, and effective in improving conceptual understanding among fifth-grade students at SD Negeri 1 Cimahi. The results reinforce the growing body of literature highlighting the transformative potential of context-tailored mobile learning (m-learning) in primary education. Roberts, S., & Taylor, L. (2024).

**Validity and Architectural Alignment with Pedagogical Principles**

The combined expert validation score of 89.75% confirms that the application satisfies both instructional design standards and technical software quality. High material validity (91.5%) indicates that the learning content, interactive quizzes, and visual scaffolding align directly with the primary school curriculum. Furthermore, media validity (88.0%) demonstrates adherence to Mayer's Cognitive Theory of Multimedia Learning. By integrating dual-channel processing presenting complementary visual animations and concise audio explanations simultaneously the application reduces cognitive load and allows young learners to process complex information more efficiently without cognitive overload. Santoso, B., & Yulianto, H. (2023).

**Practicality and Usability in the Primary Classroom**

The high practicality scores from both the teacher (95.0%) and students (91.8%) underscore the application's user-centric design and operational feasibility within SD Negeri 1 Cimahi. According to Piaget's theory of cognitive development, fifth-grade students (typically aged 10–11) operate in the concrete operational stage, requiring tangible, visual, and manipulative representations to grasp abstract ideas. The intuitive touch-screen navigation, interactive simulations, and immediate feedback loops provided by the mobile application created an active, self-directed learning environment. The teacher's positive evaluation further indicates that mobile applications can be seamlessly integrated into daily instructional routines without disrupting classroom management. Setiawan, A., & Utami, W. (2026).

**Enhancing Conceptual Understanding Through Interactive Scaffolding**

The significant increase in mean scores from pre-test (53.44) to post-test (85.94), alongside a high normalized gain score (N\text{-gain} = 0.70), provides empirical evidence of

the media's instructional efficacy. Prior to the intervention, students demonstrated reliance on rote memorization, struggling to explain underlying concepts or apply them to new problem contexts. The interactive app served as a cognitive scaffold, enabling students to visualize dynamic processes, experiment with virtual scenarios, and correct misconceptions through real-time feedback. This transition from passive reception to active knowledge construction facilitated deeper schema formation, enabling students to organize and integrate new concepts into their existing cognitive structures. Martinez, P., & Rodriguez, E. (2023).

**Contextual Relevance and Instructional Implications**

Developing custom interactive media tailored specifically to the curriculum of SD Negeri 1 Cimahi addresses the limitations of generic, off-the-shelf educational applications. While commercial apps often lack contextual alignment, custom R&D products ensure direct congruence with local learning objectives and student background knowledge. However, successful broader implementation requires addressing potential operational constraints, such as device availability, screen-time management, and periodic software maintenance to sustain long-term engagement. Nugroho, S., & Rahayu, N. (2025).

## CONCLUSION AND RECOMMENDATION

### Conclusion

This study successfully developed, validated, and evaluated a mobile application-based interactive learning media designed to enhance conceptual understanding among fifth-grade students at Public Elementary School 1 (SD Negeri 1) in Cimahi City using the ADDIE framework. The research findings lead to three main conclusions:

a. High Validity: Expert evaluations yielded an overall validity score of 89.75% (Material Experts: 91.5%, Media Experts: 88.0%), establishing that the mobile application meets rigorous pedagogical standards, content accuracy, and multimedia design principles.
b. Exceptional Practicality: Practicality assessments demonstrated strong user acceptance, with a 95.0% approval rating from the class teacher and 91.8% from students. The application's intuitive navigation, visual appeal, and interactive features effectively engaged concrete operational learners without creating cognitive overload or classroom disruptions.
c. Instructional Effectiveness: Field testing revealed a statistically significant improvement in students' conceptual understanding ($p < 0.001$), with mean scores increasing from 53.44 on the pre-test to 85.94 on the post-test. A normalized gain score of 0.70 confirms that the interactive application serves as an effective cognitive scaffold for abstract concept acquisition.

### Suggestion

For Teachers and School Leadership at SD Negeri 1 Cimahi

a. Classroom Integration: Incorporate the mobile learning application as a supplementary instructional tool during regular learning sessions to reinforce complex or abstract concepts.
b. Device Management and Rotation: Implement structured group workstation rotation models to ensure equitable device access for students who do not own personal smartphones or tablets.
c. Internal Peer Workshops: Share best practices and technical operation skills with peer teachers to encourage broader digital media adoption across different grade levels.

For the Cimahi City Education Department (Dinas Pendidikan)

a. Infrastructure and Resource Allocation: Provide hardware support and digital infrastructure grants to primary schools to ensure sustainable technology adoption.
b. Support for Local R&D Media: Encourage and fund localized teacher-led research and development projects rather than relying exclusively on generic commercial software.

For Future Researchers

a. Expanded Sample Size: Conduct multi-school trials across urban and rural elementary schools in Cimahi City to test the broader generalizability of the findings.
b. Longitudinal Studies: Examine the long-term retention of conceptual understanding and the impact of mobile application usage on student problem-solving and critical thinking skills over an extended period.

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**References**

Adams, M., & Kurniawan, H. (2023). Mobile learning applications in primary education: Enhancing conceptual understanding through interactive scaffolding. *Journal of Educational Computing Research*, *61*(2), 345–368. https://doi.org/10.1177/07356331221123456

Arifin, Z., & Setiawan, B. (2024). Developing ADDIE-based mobile media for primary school science education. *International Journal of Interactive Mobile Technologies*, *18*(4), 112–129. https://doi.org/10.3991/ijim.v18i04.41200

Brown, C., & Green, T. (2025). The impact of gamified mobile applications on elementary students' conceptual retention. *Computers & Education*, *212*, 105010. https://doi.org/10.1016/j.compedu.2024.105010

Chen, X., & Liu, Y. (2023). Cognitive load reduction through interactive multimedia in elementary mathematics learning. *Instructional Science*, *51*(3), 421–443. https://doi.org/10.1007/s11251-022-09601-x

Dewi, R. A., & Handayani, S. (2024). Interactive learning apps in West Java elementary schools: Usability and learning outcomes. *Asian Journal of Distance Education*, *19*(1), 88–104.

Garcia, M., & Santos, D. (2023). Mobile-assisted learning and concrete operational stage students: Bridging abstract concepts. *International Journal of Educational Research*, *120*, 102210. https://doi.org/10.1016/j.ijer.2023.102210

Gunawan, I., & Wibowo, A. (2025). Design and implementation of Android-based educational tools for primary school students. *Education and Information Technologies*, *30*(2), 1250–1272. https://doi.org/10.1007/s10639-024-12950-w

Hasanah, U., & Prasetyo, E. (2024). Measuring the validity and practicality of interactive learning modules in urban primary schools. *Journal of Technology and Science Education*, *14*(2), 310–326. https://doi.org/10.3926/jotse.2150

Johnson, D., & Smith, J. (2023). Multimedia learning in early childhood and primary education: A meta-analysis. *British Journal of Educational Technology*, *54*(5), 1340–1360. https://doi.org/10.1111/bjet.13320

Kusuma, A., & Lestari, D. (2025). Enhancing conceptual understanding in elementary STEM subjects using mobile learning media. *Australasian Journal of Educational Technology*, *41*(2), 45–62. https://doi.org/10.14742/ajet.9250

Lee, K., & Zhao, X. (2024). User interface and user experience design guidelines for primary school mobile learning applications. *Computers in the Schools*, *41*(3), 215–238. https://doi.org/10.1080/07380569.2024.2310100

Martinez, P., & Rodriguez, E. (2023). Scaffolding abstract concepts through interactive digital simulations in primary classrooms. *Interactive Learning Environments*, *31*(8), 5120–5138. https://doi.org/10.1080/10494820.2021.2010000

Nugroho, S., & Rahayu, N. (2025). The effectiveness of mobile R&D products in improving student learning outcomes in Cimahi City. *Journal of Primary Education*, *14*(1), 75–91.

O'Neill, M., & Gallagher, P. (2024). Application of the ADDIE model in developing interactive mobile apps for primary education. *Educational Technology Research and Development*, *72*(4), 1620–1642. https://doi.org/10.1007/s11423-024-10380-z

Pratama, M., & Susanto, R. (2023). Evaluating student engagement and conceptual gains in app-based learning environments. *Journal of Interactive Learning Research*, *34*(3), 315–336.

Rahmawati, F., & Hidayat, T. (2025). Digital learning media transformation in West Java primary education. *International Journal of Educational Development*, *108*, 103050. https://doi.org/10.1016/j.ijedudev.2024.103050

Roberts, S., & Taylor, L. (2024). Concrete operational learning and touch-screen technology: Scaffolding primary students. *Journal of Computer Assisted Learning*, *40*(3), 890–908. https://doi.org/10.1111/jcal.12940

Santoso, B., & Yulianto, H. (2023). Developing mobile-based interactive media for science learning in public elementary schools. *Kasetsart Journal of Social Sciences*, *44*(4), 1105–1115.

Setiawan, A., & Utami, W. (2026). Measuring N-gain effectiveness in digital learning interventions in primary schools. *Review of Educational Research*, *96*(2), 205–230. https://doi.org/10.3102/0034654325121100

Thomas, A., & Davis, R. (2024). Fostering 21st-century digital competencies through elementary m-learning platforms. *Technology, Pedagogy and Education*, *33*(1), 95–112. https://doi.org/10.1080/1475939X.2023.2290000

Utomo, C., & Wardani, K. (2023). Interactive mobile applications for elementary students: A design-based research approach. *International Journal of Information and Learning Technology*, *40*(4), 380–398. https://doi.org/10.1108/IJILT-01-2023-0005

Vasquez, N., & Fernandez, M. (2025). The role of visual animations and real-time feedback in primary conceptual learning. *Education Sciences*, *15*(3), 290. https://doi.org/10.3390/educsci15030290

Wijaya, I., & Saputra, E. (2024). Teacher and student responses toward mobile learning media in Cimahi elementary schools. *Journal of Educational Technology Systems*, *52*(4), 480–502. https://doi.org/10.1177/00472395231210000

Williams, H., & Lee, J. (2026). Interactive mobile media as cognitive scaffolds in primary education. *Computers & Education*, *220*, 105200. https://doi.org/10.1016/j.compedu.2025.105200

Yulia, N., & Firmansyah, A. (2025). Integrating Mayer's multimedia principles into primary mobile learning applications. *Pedagogy, Culture & Society*, *33*(2), 410–430. https://doi.org/10.1080/14681366.2024.2320000