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Development and evaluation of an interactive karate e-module for elementary physical education

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ABSTRACT

This study aimed to develop a valid, practical, and effective Physical Education, Sports, and Health (PESH) E-Module on karate for Phase C elementary school students. A Research and Development approach employing the ADDIE model was adopted. The E-Module was validated by content, media, and language experts, while practicality was evaluated through teacher and student questionnaires. Its effectiveness was examined using a quasi-experimental nonequivalent control group design with pre-test and post-test assessments. The E-Module achieved an overall validity score of 92.67%, teacher practicality ratings of 95.2–98.4%, student responses of 80–97%, and an N-Gain of 80% in the experimental group, outperforming the control group (43%). The developed E-Module is a valid, practical, and effective digital learning resource that enhances elementary students' karate learning outcomes and supports technology-enhanced Physical Education.



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Introduction

The integration of digital technology has enhanced the use of interactive learning resources in education. In Physical Education, Sports, and Health, these resources facilitate movement skill acquisition by supporting repeated observation, guided practice, and independent learning (B. A. Al Rasyid & Nurharini, 2025; Risma et al., 2025). Compared with conventional printed materials, digital learning resources offer greater flexibility by integrating text, images, animations, and videos that facilitate independent and continuous learning inside and outside the classroom. Previous studies have consistently demonstrated that multimedia-based learning improves student engagement, conceptual understanding, and learning outcomes across diverse educational settings (Engelia & Wardana, 2025; Pohan et al., 2026). Nevertheless, evidence regarding the application of such digital resources in elementary martial arts instruction remains limited, indicating the need for learning media specifically designed to address the characteristics of movement-based learning in primary education.

Within elementary school Physical Education, karate is included in the Indonesian Merdeka Curriculum as a learning topic that develops not only fundamental movement competence but also discipline, self-control, responsibility, and sportsmanship. Effective karate instruction requires students to repeatedly observe movement demonstrations, receive guided practice, and obtain continuous feedback to achieve correct technique execution. However, classroom implementation is frequently constrained by limited instructional time, the availability of visual learning resources, and the dependence on teacher demonstrations that cannot always accommodate individual learning needs. Consequently, students often experience difficulty reviewing and practicing

fundamental karate techniques independently, resulting in less optimal mastery of movement skills (Gumara et al., 2023; Tarigan, 2026). These instructional constraints highlight the need for a digital learning resource that supports repeated practice while remaining aligned with curriculum requirements.

Previous research has confirmed that various forms of digital learning resources, including interactive multimedia, mobile learning, video-assisted instruction, and electronic modules, contribute positively to students' motivation, engagement, motor skill acquisition, and academic achievement in Physical Education (Afif & Komari, 2024; Bafirman et al., 2023; W. Rasyid et al., 2024). Multimedia learning theory further explains that integrating verbal explanations with meaningful visual representations enhances cognitive processing and improves knowledge retention (Ariski et al., 2024; Safmelita et al., 2026). Although these findings demonstrate the educational benefits of technology-enhanced learning, existing studies have primarily examined general Physical Education content, physical fitness, or sports instruction at secondary and higher education levels. Consequently, evidence concerning the development and comprehensive evaluation of digital learning media specifically designed for elementary karate instruction remains scarce.

Despite these advances, several important research gaps remain. First, only a limited number of studies have developed and empirically evaluated karate-specific digital instructional materials for Phase C elementary school students within the Merdeka Curriculum. Second, previous studies have predominantly focused on learning outcomes while paying limited attention to comprehensive product evaluation through the dimensions of validity, practicality, and effectiveness, which constitute essential indicators of educational product quality (Čavala et al., 2014; Pinto-Escalona et al., 2022; Prihastuti et al., 2025). Third, existing digital learning resources generally provide instructional videos or multimedia content separately, without integrating curriculum alignment, structured learning sequences, formative assessment, character education, and independent learning support into a unified learning environment. These limitations indicate the need for a comprehensive digital instructional resource capable of addressing both pedagogical and technological demands in elementary karate education.

To address these gaps, this study developed a Physical Education, Sports, and Health E-Module on karate using the ADDIE instructional design model, which was selected because it provides a systematic framework for designing, developing, implementing, and evaluating technology-enhanced learning resources. The developed E-Module integrates structured instructional materials, original movement illustrations, instructional videos, formative exercises, interactive navigation, and safety guidelines within a digital flipbook specifically designed for Phase C elementary school students. Unlike previous studies that primarily emphasized learning effectiveness, this study comprehensively evaluates the developed product through expert validity, user practicality, and instructional effectiveness using expert judgment, teacher and student responses, and quasi-experimental analysis. This integrated evaluation provides stronger empirical evidence regarding both the educational quality and classroom applicability of the developed instructional product (Martínez-Rodríguez et al., 2016; Mueller et al., 2016; Witmer & Lambert, 2023).

The novelty of this study lies in the development and comprehensive evaluation of a curriculum-aligned interactive karate E-Module specifically designed for elementary school students within the Merdeka Curriculum. The module integrates multimedia learning components, including original movement demonstrations, instructional videos, sequential practice activities, character education values, and formative assessments into a single digital learning environment (Adam & Lindel, 2024; Agostinete et al., 2020; ChaabeNe et al., 2012). Beyond presenting a new instructional product, this study contributes to the literature by demonstrating that the integration of educational product development with comprehensive evaluation of validity, practicality, and effectiveness provides a more robust framework for assessing digital learning media in Physical Education. Therefore, the findings are expected to contribute theoretically to multimedia learning research in movement education while offering practical guidance for teachers seeking effective technology-based resources to improve elementary karate instruction.

Method

This study employed a Research and Development (R&D) approach to develop and evaluate a Physical Education, Sports, and Health E-Module on karate for Phase C elementary school students. The development process followed the ADDIE instructional design model, comprising the Analysis, Design, Development, Implementation, and Evaluation phases. The ADDIE model was selected because it provides a systematic and iterative framework for designing, developing, validating, and refining digital learning resources. To evaluate the instructional effectiveness of the developed product, a quasi-experimental Nonequivalent Control Group Design was incorporated, as this design enables the comparison of learning outcomes between students receiving the developed E-Module and those experiencing conventional instruction under authentic classroom conditions.

During the analysis phase, a needs assessment was conducted through classroom observations, semi-structured interviews with Physical Education teachers, and curriculum document analysis to identify instructional problems, learner characteristics, and curriculum requirements. The findings revealed that students experienced difficulties mastering fundamental karate techniques due to limited opportunities for repeated demonstrations and the absence of interactive visual learning resources. These findings informed the design of an E-Module aligned with the learning outcomes of the Merdeka Curriculum for Phase C elementary students. The instructional structure included learning objectives, concept maps, learning materials, practice activities, formative assessments, original illustrations, instructional videos, QR codes, and interactive navigation. The prototype was subsequently developed using Canva and FlipHTML5 before being evaluated by three experts specializing in instructional content, educational media, and language. The validators assessed the product using structured validation instruments, and revisions were undertaken based on their recommendations to improve the content, language clarity, and interface design before classroom implementation.

The implementation stage consisted of a pilot test followed by field implementation at UPT SDN 12 Api-api during the 2025/2026 academic year. The experimental group comprised 20 fifth-grade students who learned using the developed E-Module, while the control group consisted of 16 students who received conventional instruction. Both groups completed pre-test and post-test assessments following four instructional sessions. Product validity was analyzed descriptively using percentage scores obtained from expert validation, whereas practicality was measured through teacher and student response questionnaires. Learning effectiveness was evaluated using the Normalized Gain (N-Gain) index because it measures the magnitude of learning improvement between pre-test and post-test scores. Prior to comparing learning outcomes, the data were tested for normality using the Shapiro–Wilk test and homogeneity using Levene's test. Depending on the results of these assumption tests, either an independent-samples t-test or the Mann–Whitney U test was employed to determine significant differences in learning gains between the experimental and control groups. Qualitative feedback from the expert validators was analyzed descriptively and used to refine the final version of the E-Module.

Results and Discussions

The present study aimed to develop and evaluate a Physical Education, Sports, and Health (PESH) E-Module on karate for Phase C elementary school students using the ADDIE development model. The product evaluation consisted of three sequential stages, namely expert validation, practicality testing, and effectiveness testing. The results are presented in five sections covering expert validation, overall product validity, teacher and student practicality, and learning effectiveness.

Table 1. Expert Validation Results by Evaluation Aspect

Validation Aspect	Percentage (%)	Category
Content	93.00	Very Valid
Language	96.00	Very Valid
Media and Design	89.00	Very Valid

Table 1 presents the results of expert validation conducted to assess the quality of the developed E-Module. Language validation achieved the highest percentage (96%), followed by content validation (93%), while media and interface design obtained 89%. All validation aspects were classified as very valid, indicating that the E-Module fulfilled the required standards regarding instructional content, language clarity, and digital media design prior to classroom implementation.

Table 2. Overall Validity of the Developed E-Module

Validator	Aspect	Percentage (%)	Category
Expert 1	Content	93.00	Very Valid
Expert 2	Media and Design	89.00	Very Valid
Expert 3	Language	96.00	Very Valid
Overall Mean	-	92.67	Very Valid

The overall validation results are summarized in Table 2. The developed E-Module achieved an average validation score of 92.67%, indicating a very valid product according to all three expert validators. Following expert review, several minor revisions related to language, original illustrations, and interface navigation were incorporated before proceeding to the implementation stage. Overall, the findings demonstrate that the E-Module met the quality standards required for classroom application.

Table 3. Teacher Practicality Evaluation

School	Percentage (%)	Category
Pilot School	98.40	Very Practical
Research School	95.20	Very Practical

Teacher responses regarding the practicality of the E-Module are shown in Table 3. Both teachers participating in the pilot implementation and the main study rated the E-Module as very practical, with percentages of 98.4% and 95.2%, respectively. These findings indicate that teachers considered the E-Module easy to operate, compatible with instructional objectives, suitable for classroom time allocation, and capable of facilitating student engagement during karate learning activities.

Table 4. Student Practicality Evaluation

Student Group	Percentage (%)	Category
Pilot Group	97.00	Very Good
Experimental Class	80.00	Very Good
Control Class	67.47	Fair

As presented in Table 4, students who learned using the developed E-Module provided highly positive evaluations. The pilot group achieved the highest response (97%), while students in the experimental class reported an overall practicality score of 80%, both categorized as very good. In contrast, students in the control class recorded a lower response (67.47%), categorized as fair. The difference suggests that the E-Module provided a more interactive and engaging learning experience than conventional instruction.

Table 5. Effectiveness of the Karate E-Module

Group	Pre-test Mean	Post-test Mean	N-Gain (%)	Category
Experimental	49	89	80	Effective
Control	49	71	43	Less Effective

Table 5 summarizes the effectiveness of the developed E-Module based on students' learning outcomes. Both groups demonstrated equivalent baseline achievement, with identical mean pre-test scores (49). Following the intervention, the experimental group achieved a substantially higher post-test mean (89) and an N-Gain of 80%, categorized as effective, whereas the control group obtained a post-test mean of 71 with an N-Gain of 43%, categorized as less effective. These findings demonstrate greater learning improvement among students who received instruction using the developed E-Module than those taught through conventional learning methods.

The developed karate E-Module demonstrated excellent content quality, achieving an overall validity score of 92.67%, comprising 93% for content, 96% for language, and 89% for media design. These findings indicate that the module fulfilled essential requirements regarding instructional accuracy, linguistic clarity, and multimedia presentation before classroom implementation. The highest score in language validity suggests that the learning materials were appropriate for the cognitive and reading characteristics of Phase C elementary students, while the media aspect indicates that only minor revisions were required. This finding supports Kuśnierz et al., (2025), who emphasized that systematic instructional design improves the quality of digital learning materials, and is consistent with Muñoz-Vásquez et al., (2023); Pekel et al., (2023), who identified content validity and usability as essential criteria for educational products. Similar studies have also shown that expert validation enhances the pedagogical quality and instructional feasibility of digital learning resources before implementation (Katić et al., 2012; Tai et al., 2019).

The practicality results indicate that the E-Module was highly feasible for classroom use, with teacher responses reaching 98.4% during the pilot implementation and 95.2% during the field implementation. These scores suggest that the module was easy to operate, compatible with instructional objectives, and capable of supporting efficient lesson delivery within limited instructional time. The integration of multimedia elements enabled teachers to reduce repetitive demonstrations while allowing students to review learning materials independently. These findings agree with previous studies reporting that technology-supported instructional materials improve teaching efficiency and facilitate classroom management (Henriques-Neto et al., 2020; Malisoux et al., 2013; Orhan et al., 2024). Furthermore, the results reflect usability principles and support evidence that multimedia learning resources improve instructional effectiveness in Physical Education settings (Daniels & Thornton, 1990; Farahbakhsh et al., 2018; Hsu et al., 2021).

Students also perceived the E-Module positively, as reflected by response scores of 97% in the pilot group and 80% in the experimental class, compared with only 67.47% in the control class. These findings suggest that interactive multimedia created a more engaging learning experience than conventional instruction. The

combination of videos, illustrations, and sequential explanations enabled students to repeatedly observe and practice fundamental karate techniques independently, thereby increasing learning engagement. This result is consistent with Fasola et al., (2021) Cognitive Theory of Multimedia Learning, which explains that meaningful integration of visual and verbal information enhances understanding and retention. Likewise, Demonstrated that multimedia environments facilitate deeper cognitive processing, while previous studies in Physical Education reported higher student motivation and engagement through technology-supported instruction (Litwiniuk et al., 2023; Rutkowski et al., 2019).

The effectiveness findings further confirm the instructional value of the developed E-Module. Although both groups began with the same pre-test mean (49), the experimental group achieved a post-test mean of 89 with an N-Gain of 80%, whereas the control group obtained a post-test mean of 71 and an N-Gain of 43%. These results indicate substantially greater learning improvement among students using the E-Module. The improvement can be attributed to repeated access to multimedia demonstrations that supported observational learning and independent practice. This finding supports Chau, (2021) Social Cognitive Theory, which highlights observation as a key mechanism for skill acquisition, who emphasized the importance of visual feedback and repeated practice in motor learning. Comparable findings have been reported in recent studies demonstrating that multimedia-based instruction significantly improves motor skill acquisition in Physical Education (Ditzen-Janotta et al., 2026; Kotarska et al., 2019).

The findings demonstrate that the developed karate E-Module satisfied the three primary quality indicators of educational product development, namely validity (92.67%), high practicality (95.2–98.4% teacher responses; 80–97% student responses), and effective learning improvement (N-Gain = 80%). These results indicate that multimedia-based digital learning resources can overcome instructional limitations in elementary Physical Education by supporting independent learning, repeated movement observation, and more interactive classroom experiences. Such outcomes are aligned with current educational trends emphasizing student-centered and technology-enhanced learning environments (Fedotova, 2025; Pinto-Escalona et al., 2024). Nevertheless, this study was conducted in a single school with a relatively small sample and a short intervention period. Future research should examine the long-term implementation of the E-Module across broader educational contexts while evaluating additional outcomes such as psychomotor performance, learning motivation, and self-regulated learning.

Conclusions

This study successfully developed a Physical Education, Sports, and Health (PESH) E-Module on karate for Phase C elementary school students using the ADDIE development model. The findings demonstrated that the developed E-Module met the three principal quality criteria of educational product development. The product achieved a very high level of validity (92.67%) based on expert evaluations of content, language, and media design, indicating that it is pedagogically appropriate for classroom use. Furthermore, the E-Module was perceived as highly practical by both teachers and students, reflecting its usability and suitability for supporting the teaching and learning process. The effectiveness evaluation also revealed that students who learned using the E-Module achieved substantially greater learning improvement than those receiving conventional instruction, as evidenced by a higher N-Gain score (80% versus 43%). Therefore, the developed karate E-Module can be considered a valid, practical, and effective digital learning resource for improving elementary school students' learning outcomes in Physical Education while supporting more interactive, independent, and technology-enhanced learning experiences.

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