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Development of an E-Module for Physical Education, Sports, and Health Learning in Martial Arts (Karate) for High School Students in Fase E.

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Abstract
Physical Education (PJOK) develops students' physical and character skills through sports like Karate. However, students struggle to learn basic techniques (Kihon, Kata, Kumite) with conventional methods. A multimedia E-Module was developed to enhance understanding, especially for tech-savvy Generation Z students. This R&D study used the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). Conducted at SMA Negeri 2 Padang, data was collected via questionnaires, tests, and observations. The E-Module includes videos, images, and audio for interactive learning. The results show that the PJOK Karate Learning E-Module was successfully developed and tested. The E-Module integrates multimedia elements such as images, videos, and audio to facilitate better comprehension of basic Karate techniques. Validity tests yielded high scores in language (91.67%), content (95%), and media (98.33%), while reliability was confirmed with a Cronbach's Alpha value of 0.638. Practicality assessments from both students and teachers were highly positive, ranging from 84.96% to 100%. Additionally, the E-Module proved highly effective, with student effectiveness scores between 82.32%–85.26% and teacher evaluations ranging from 92%–99%. In conclusion, this study demonstrates that the Karate Learning E-Module is a valid, practical, and effective tool for enhancing students' understanding and performance in Karate. Its multimedia-based approach aligns with the learning preferences of Generation Z, making it a valuable resource for modern PJOK education.

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INTRODUCTION

Physical Education, Sports, and Health focuses primarily on the physical development and skills of students through various sports branches to achieve the goals of national education (Bessa et al., 2021). At every level of education, this subject plays an essential role as a medium to realize national education objectives. PJOK, implemented in all primary and secondary education units in accordance with Government Regulation No. 22 of 2016, aims to shape students' character so that they are physically and mentally healthy while also fostering sportsmanship (Dharmawan et al., 2021; Hoff, 2023; Mueller & Murrell, 1986).

Basic education, as a part of national development in Indonesia, has reached a strategic role and must be capable of facing the challenges of the times, including those influenced by the Industrial Revolution 4.0 (Bakhtiar, 2014). This revolution is characterized by increasing connectivity, digital systems, artificial intelligence, and virtual technologies, which increasingly blur the lines between humans, machines, and other resources. All of these have an impact on education in Indonesia, offering every individual an opportunity to prepare for this new era. One way to prepare is through education starting from the primary to secondary and higher education levels (Lase, 2019).

Physical Education, Sports, and Health is an integral part of the primary and secondary education curriculum (Atradinal, 2017; Atradinal & Ockta, 2024). With proper management, this subject can contribute to students' physical, mental, and social development (Henriksen et al., 2023). Within the physical education curriculum, students are expected to master not only the psychomotor aspect but also the cognitive, affective, and social values that support the achievement of national educational goals.

Karate, as one of the martial arts rooted in Indonesian culture, is a subject taught in PJOK. Karate requires a deep understanding of structured and complex movement techniques (Yang & Jo, 2022). Therefore, teaching karate in PJOK is essential for supporting national education goals encompassing psychomotor, cognitive, affective, and social dimensions (Kusfandari et al., 2022; Mualif et al., 2023; Wicaksono et al., 2020).

The Merdeka Curriculum, implemented at the senior high school level, includes karate content from grade X through grade XII with continuous instruction on basic techniques (Howitt et al., 2023; Stage et al., 2023). These basic techniques include three main aspects: Kihon (fundamentals such as punches, blocks, and kicks), Kata (a structured sequence of movements), and Kumite (sparring or match training).

To teach this material effectively, teachers must possess adequate competence in the relevant skills (Bunteng, 2022; Chandran et al., 2023; Watson et al., 2023). A teacher's ability to deliver content by prioritizing psychomotor, cognitive, affective, and social values is vital to achieving optimal learning. Along with the advancement of science and technology, it is necessary to adapt to these developments to remain globally competitive.

However, conventional teaching methods that rely on physical demonstrations and verbal explanations are often insufficient for conveying complex techniques. Many students struggle to understand technical movements that require clear visual observation and accurate imitation. This negatively impacts motivation and the effectiveness of PJOK learning. Ineffective instruction can hinder learning outcomes and reduce students' interest and participation in sports activities.

This phenomenon presents an opportunity to develop more innovative teaching materials, such as creating engaging and accessible e-modules for students. These e-modules will meet the needs of Generation Z, who are more interested in interactive digital media and have easier access to technology. E-modules can utilize multimedia elements such as text, images, and well-structured videos, and be designed interactively to enhance student engagement in the learning process.

A relevant study by Muhammad Zaenudin Diharjo on PJOK teachers' selection of learning materials in high schools revealed that although karate is taught, students' understanding of the basic techniques remains suboptimal. Only 12.5% of the total score for martial arts content indicates a gap in teachers' competence in delivering the material effectively. This highlights the need for a new instructional approach, particularly through the use of structured and engaging e-modules, to improve students' comprehension of basic karate techniques.

Furthermore, it is crucial for the education system to adapt to technological advancements and the habits of a generation that is more digitally literate. Generation Z, accustomed to digital technologies, tends to grasp content more easily when presented through interactive media. Therefore, developing well-designed and accessible e-modules is highly relevant in this context.

This study aims to develop and test the effectiveness of a PJOK e-module focused on karate, which is expected to improve students' technical understanding, particularly of basic techniques. Additionally, the study will evaluate the impact of using e-modules on students' practical skills and the extent to which technology can enhance their motivation and engagement in learning.

The results of this research are expected to contribute to the development of a more innovative PJOK curriculum aligned with the needs of today's generation. These findings will also enrich the educational literature with empirical evidence on the effectiveness of e-modules in teaching complex physical skills. Furthermore, this study aims to provide practical recommendations and policy insights for educators and education policymakers regarding the integration of digital media into school-based learning.

METHODS

This study employs Research and Development (R&D) methodology based develop a PJOK e-module for karate and test its effectiveness. The ADDIE model (Analysis, Design, Development, Implementation, Evaluation) (Li & Cheong, 2023) is implemented through five stages: (1) Needs analysis identifying students' difficulties in mastering basic karate techniques (Kihon, Kata, Kumite) through conventional methods; (2) Product design comprising module structure (cover page, glossary, concept map, multimedia-integrated learning materials, and assessments) tailored for Generation Z learners; (3) Prototype development of PDF-based e-module with embedded multimedia (audio, video) accessible via QR code/link; (4) Implementation through field trials involving small and large groups at SMA Negeri 2 Padang with Phase E students as research subjects; and (5) Formative and summative evaluation assessing product validity, practicality, and effectiveness. Research instruments include observation (learning process monitoring), interviews (preliminary needs assessment), questionnaires (validator assessments and student feedback), knowledge tests (karate material mastery), and documentation (field notes). Qualitative data (expert feedback) is analyzed descriptively, while quantitative data (questionnaire scores) is processed using Likert scale (Ridwan & Irawan, 2018) and converted to qualitative (Saputra et al., 2022). The research schedule spans 10 weeks, commencing with needs analysis (weeks 1-2), design

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(weeks 3-4), prototype development (weeks 5-6), implementation (weeks 7-8), and final evaluation (weeks 9-10). This procedure adapts the ADDIE model according to Triansyah (2018) and

RESULT AND DISCUSSION

1. **E-Module Development**

The developed Physical Education, Sports, and Health (PJOK) E-Module for martial arts (Karate) was created using the ADDIE model, which consists of five key stages: Analysis, Design, Development, Implementation, and Evaluation. The process began with a needs analysis, which identified students' difficulties in understanding basic karate techniques—Kihon, Kata, and Kumite—through conventional teaching methods. Additionally, SMA Negeri 2 Padang was selected as the target school due to observed low student engagement, with 85% of students reporting monotonous teaching methods. The material focused specifically on karate, as preliminary tests revealed only 12.5% mastery among students. The final product is an interactive e-module designed to enhance learning effectiveness and engagement in martial arts education.

Figure 1. Interactive cover design

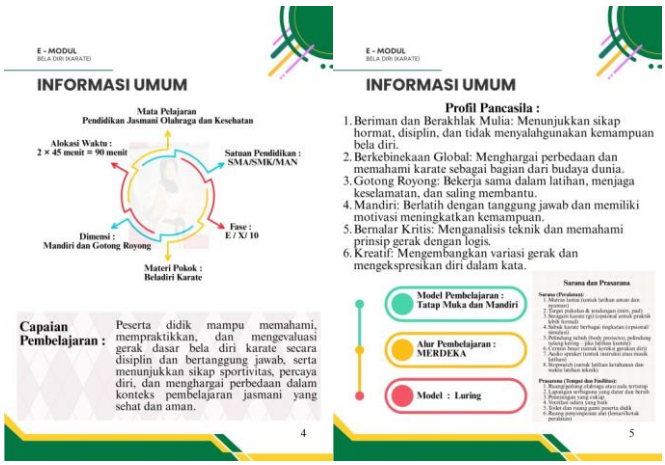

Figure 2. User guidelines and introductory content

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Figure 3. Core learning materials with embedded multimedia

Figure 4. QR code accessibility

2. Expert Validation

Three validation aspects showed excellent results:

Table 1. Expert Validation Results

Validator	Score	Percentage	Category
Language Expert	55	91.67%	Very Valid
Content Expert	57	95.00%	Very Valid
Media Expert	59	98.33%	Very Valid

Visualized in Figure 5, all validation scores exceeded 90%, confirming the module's readiness for implementation.

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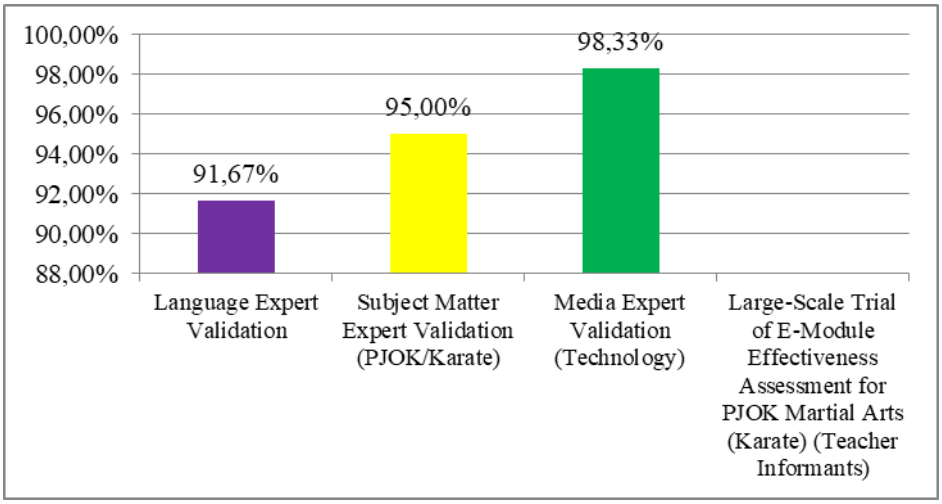

Figure 5. Histogram Skor Validasi E-Modul oleh Para Ahli

3. Validity and Reliability Testing

The validity testing of the product in this study used Pearson correlation to assess the relationship between evaluations from three experts: a language expert, a subject matter expert (PJOK/Karate), and a media/technology expert. The correlation test results indicated significant relationships between the assessments provided by these experts. The validation between the Language Expert and the Subject Matter Expert yielded a correlation value of 0.354 with a significance level of 0.000 (below 0.05), confirming a significant relationship between their evaluations. Similarly, the Language Expert and Media Expert showed a correlation of 0.378 with a significance of 0.005, also indicating a significant relationship. Meanwhile, the Subject Matter Expert and Media Expert had a stronger correlation of 0.535 with a significance of 0.040, which was also significant. These results demonstrate that the validation assessments from the experts were well interconnected, confirming the instrument's validity. The following table presents the correlation results between the tested variables:

Table 2. Results of expert assessment

Variable	Language Expert Validation	Subject Matter Expert Validation	Media Expert Validation
Language Expert	1	0.354	0.378
Subject Matter Expert	0.354	1	0.535
Media Expert	0.378	0.535	1

Furthermore, a reliability test was conducted to ensure the internal consistency of the instrument. The Cronbach's Alpha test resulted in a value of 0.638 for the three tested variables (language expert, subject matter expert, and media expert). Although the ideal threshold is above 0.7, a Cronbach's Alpha value above 0.6 indicates adequate internal consistency, suggesting that the instrument is sufficiently reliable for measuring the intended variables. The following table presents the reliability statistics:

Table 3. Reliability Assessment Results

Cronbach's Alpha	Number of Items
0.638	3

In conclusion, the validity and reliability tests confirm that the research instrument is of good quality, with significant validity and acceptable reliability for the study.

4. Small-Scale Trial

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A small-scale trial was conducted to evaluate the practicality and effectiveness of the PJOK E-Module on martial arts (karate), involving 25 students and 1 PJOK teacher. The assessment focused on two key aspects: practicality (ease of use and accessibility) and effectiveness (learning outcomes). Both participants provided scored evaluations, confirming the module's usability and its potential to improve students' understanding of karate techniques. The results will guide further refinements before broader implementation.

Table 4. Small-Scale Trial Results

Aspect	Students' Rating	Teachers' Rating
Practicality	84.96%	84.00%
Effectiveness	82.32%	92.00%

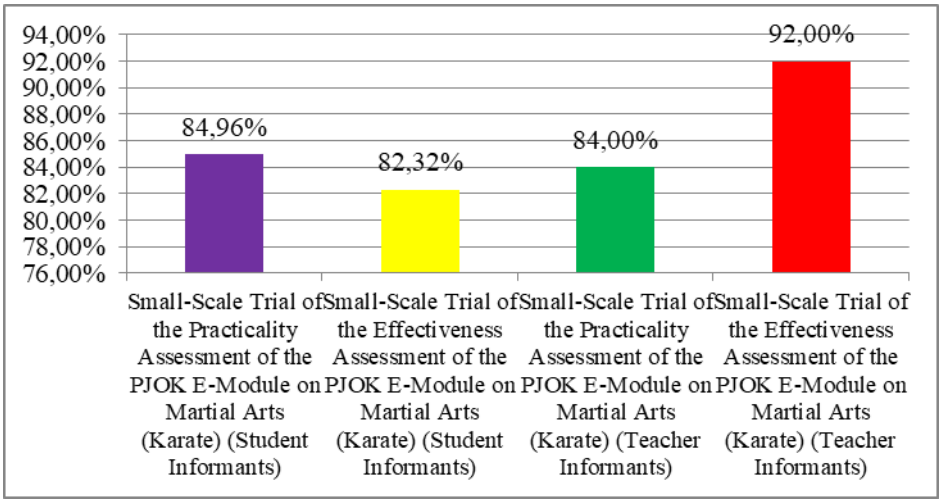

Figure 6. illustrates these outcomes

5. Large-Scale Trial

A large-scale trial was conducted to evaluate the practicality and effectiveness of the PJOK E-Module on martial arts (karate), involving 57 students from various schools and 2 supervising PJOK teachers. The assessment focused on two main aspects: practicality (ease of use, accessibility, and implementation) and effectiveness (learning outcomes and engagement). Both students and teachers provided scored evaluations, offering comprehensive feedback to refine the module before full-scale deployment. The results further validated the module's usability and educational impact in diverse school settings.

Table 5. Large-Scale Trial Results

Aspect	Students' Rating	Teachers' Rating
Practicality	86.60%	100.00%
Effectiveness	85.26%	99.00%

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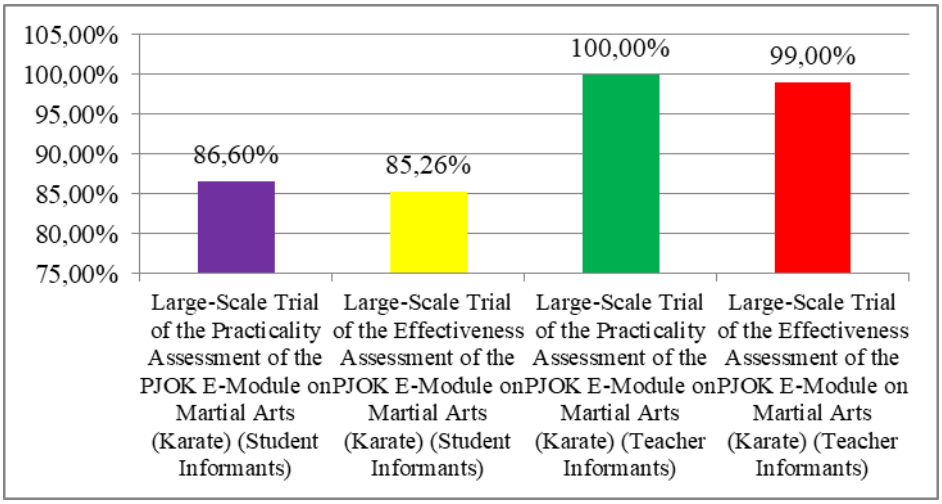

Figure 7.shows comparative performance

DISCUSSION

This study successfully developed an e-module for Physical Education, Sports, and Health (PJOK) learning, focusing on karate martial arts material for high school students in Phase E. The e-module was developed using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. During the development process, a needs analysis was conducted, identifying six key factors to ensure the module aligns with student characteristics and learning needs. The first factor was the need for creative media capable of integrating PJOK theory and practice, given that conventional methods currently used are considered less engaging and difficult to access. The second factor was the importance of media that suits Generation Z's characteristics, who tend to be more interested in technology and interactive digital media.

The selection of karate material was based on interviews with PJOK teachers, which revealed that students often struggle to understand basic karate techniques through conventional teaching methods. Therefore, this e-module was developed to offer a more modern, technology-based approach to address the shortcomings of traditional methods.

The e-module development stages included designing a module structure consisting of six main components: a cover, usage instructions, general information, learning objectives, core material (essence, history, basic techniques), and evaluation. Each component was designed to provide a comprehensive and in-depth learning experience for students.

A crucial aspect of this module's development was multimedia integration. The e-module includes illustrative images to explain various karate techniques and video demonstrations of basic movements to help students master the techniques more easily. Additionally, the module features interactive Canva-based elements equipped with QR codes, allowing students to access further materials and exercises conveniently. These multimedia features are highly relevant, as Generation Z, being tech-savvy, absorbs visual and interactive learning materials more effectively (Astawa & Astuti, 2020; Quezada et al., 2021).

After development, the e-module was validated by three experts to assess content quality, language, and media. The validation results were highly satisfactory, with the following scores: language expert (Dr. Yenni Hayati) 91.67%, karate material expert (Septri, M.Pd) 95%, and media technology expert (Dr. Junil Adri) 98.33%. The high validation scores indicate that the module meets technical and pedagogical feasibility standards.

Statistical tests were conducted to measure inter-rater consistency and instrument reliability. The inter-rater correlation coefficient showed significant results ($r=0.354–0.535$; $p<0.05$), indicating consistency among expert assessments. Additionally, instrument reliability reached $\alpha=0.638$, though not yet at an ideal level, suggesting that some improvements are still needed.

Field trials were conducted to test the e-module's effectiveness and practicality in classrooms, both on a small and large scale. In the small-scale trial involving 25 students and 1 teacher, the results showed that practicality reached 84.96% for students and 84% for teachers, while effectiveness reached 82.32% for students and 92% for teachers. In the large-scale trial involving 57 students and 2 teachers, practicality increased to 86.6% for students and 100% for teachers, while effectiveness reached 85.26% for students and 99% for teachers. A comparative analysis between small- and large-scale trials showed significant improvement, with practicality increasing by 1.64% and effectiveness by 2.94%. Furthermore, the consistency of assessments between teachers and students was very high, with a correlation of 0.82, indicating alignment in perceptions of the module's quality.

From the field trials, it was found that students highly appreciated certain components of the e-module. Video demonstrations of techniques were rated as the most beneficial by 94% of students, followed by interactive quizzes, which were appreciated by 89% of students. This demonstrates that students highly value multimedia elements that present material visually and interactively. However, some challenges were also identified during implementation. About 15% of students experienced bandwidth limitations that hindered their access to videos and multimedia materials, while 8% needed additional guidance to better understand the module.

Based on these findings, several refinements to the e-module are necessary. One is the addition of respondent demographic data in trials to provide a clearer picture of student characteristics. Additionally, a pretest-posttest comparison analysis should be included to measure improvements in students' knowledge and skills after using the e-module. Another refinement would be adding screenshots of the e-module interface to provide a clearer representation of its design. For further development, it is recommended to create a lightweight version of the e-module for use in areas with limited internet connectivity. Moreover, a supplementary module for teachers is essential to help them utilize the e-module more effectively in classroom instruction.

Overall, the developed e-module meets the criteria of validity, practicality, and effectiveness as an innovative learning medium for karate material in high schools. The success of this e-module demonstrates that technology can enrich students' learning experiences and overcome the limitations of conventional methods. The results also prove that proper multimedia integration enhances students' understanding of the material (Alobaid, 2021; Sadagheyani et al., 2021).

This e-module also successfully addresses the challenge of developing learning media that aligns with the characteristics of tech-savvy Generation Z. Therefore, it is hoped that this e-module can serve as a learning supplement for PJOK teachers across Indonesia, especially in schools with limited infrastructure and professional karate instructors. The implementation of this e-module is expected to enrich PJOK learning with a more creative and interactive approach, enabling students to learn in a more enjoyable and effective manner.

CONCLUSIONS

The development of the Physical Education, Sports, and Health (PJOK) E-Module on martial arts (Karate) for high school students (Phase E) followed the ADDIE-based Research and Development (R&D) model, encompassing needs analysis, design, development, implementation, and evaluation. Designed to enhance students' understanding of basic Karate techniques, the E-Module integrates multimedia elements (images, videos, and audio) to simplify the visualization of complex movements. The module demonstrated excellent validity in language (91.67%), content (95%), and media (98.33%), with a Cronbach's Alpha reliability score of 0.638, indicating adequate internal consistency. Practicality tests, conducted through small-scale (25 students, 1 teacher) and large-scale trials (57 students, 2 teachers), yielded high practicality scores from students (84.96% and 86.60%, respectively) and teachers (84% and 100%). Effectiveness tests revealed significant improvements in students' technical understanding, with scores of 82.32% (small-scale) and 85.26% (large-scale), while teacher assessments reached 92% and 99%, confirming the module's success in boosting engagement, motivation, and mastery of Karate techniques.

CONFLICTS OF INTEREST STATEMENT

Regarding this study, the author declares that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

Study concept and design: Martinel Prihastuti. Acquisition of data: Syahrial Bakhtiar. Analysis and interpretation of data: Nurul Ihsan. Drafting the manuscript: Martinel Prihastuti. Critical revision of the manuscript for important intellectual content: Atradinal. Statistical analysis: Septri Septri.

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