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A Web-Based Digital Module for Underhand Volleyball Serve Learning in High School Physical Education

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ABSTRACT

Learning motor skills is a primary objective of Physical Education, yet students often experience difficulties mastering the underhand volleyball serve because of limited practice time, large class sizes, and insufficient individualized feedback. Web-based learning resources may help address these challenges by providing flexible access to instructional materials and practice guidance. This study aimed to develop and evaluate a web-based digital module for underhand volleyball serve learning in high school Physical Education. A Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) was employed. The module was developed using Google Sites and included instructional content, demonstration videos, guided practice activities, and evaluation tasks. Validation was conducted by subject-matter and media experts using Aiken's V. Practicality was assessed through student response questionnaires, while preliminary effectiveness was examined using a one-group pretest–posttest design involving 50 Grade XI students. Expert evaluation indicated high validity, with Aiken's V values of 0.88 for content and 0.90 for media aspects. Student responses demonstrated high practicality, yielding an average score of 91%. The mean underhand serve performance score increased from 61.10 on the pretest to 84.40 on the posttest. The average N-gain score was 0.60, indicating a moderate level of improvement, and 84% of students achieved the learning mastery criterion. The web-based digital module demonstrated strong validity, high practicality, and promising preliminary effectiveness in supporting underhand volleyball serve learning. The module can serve as a supplementary resource for blended Physical Education instruction. Further research employing control groups and retention measures is recommended to strengthen evidence of effectiveness and long-term learning outcomes.

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1. INTRODUCTION

Motor skill learning is a central goal of school Physical Education because it supports students' physical competence, coordination, confidence, and active participation in learning. Through repeated

and structured movement experiences, students develop not only technical skills but also attention, planning, decision-making, and self-regulation during physical activity (Apidogo et al., 2021; Canepa et al., 2020). In curriculum-based Physical Education, motor learning also provides observable indicators of achievement and helps teachers guide students toward progressive mastery of specific movement tasks (Apidogo et al., 2022; Putra et al., 2025).

In volleyball instruction, the serve is a fundamental skill because it initiates play and influences students' early experience of control and success. For beginners, the underhand serve is commonly introduced before more complex serving techniques because it requires lower force production and simpler coordination than overhand or jump serves (Putri et al., 2025; Saad et al., 2020). Mastering the underhand serve helps students develop basic ball control, movement coordination, and confidence before progressing to more advanced volleyball skills (Saad et al., 2020).

Although the underhand serve is often considered a basic skill, students frequently experience difficulties during learning. The movement requires a stable stance, controlled ball toss, accurate timing between toss and contact, and an effective follow-through to direct the ball across the net (Kordi et al., 2013; Putra et al., 2025). Beginners often make errors in stance alignment, toss consistency, contact timing, and follow-through because these components must be integrated into a smooth and coordinated movement pattern (Kordi et al., 2013; Mone, 2026). These difficulties can become more persistent when students do not receive sufficient corrective feedback or opportunities for repeated practice.

In actual school settings, Physical Education teachers often face limited lesson time, large class sizes, and differences in students' movement abilities. These conditions reduce the amount of individualized feedback that teachers can provide during practice (Putri et al., 2025; Yulianti et al., 2024). As a result, some students repeat incorrect movement patterns, while others need more challenging practice but receive limited guidance. The limited use of varied learning media can also reduce students' motivation and restrict their access to clear demonstrations outside class time (Putra et al., 2025).

Technology-supported learning offers one possible solution to these instructional constraints. Digital learning resources allow students to access explanations, demonstrations, practice cues, and formative assessments repeatedly and independently. In motor learning, repeated observation and clear performance cues can help learners understand movement sequences and refine their execution (Harris et al., 2018; Ugrinowitsch et al., 2019). Digital modules can also support self-paced learning because students can review difficult sub-steps, compare their movements with model demonstrations, and use structured feedback to guide correction (Atienza, 2024; Dewanti et al., 2024; Qu et al., 2025).

Web-based digital modules are particularly relevant for school Physical Education because they can be accessed across devices without requiring additional application installation. Compared with printed materials or isolated instructional videos, web-based modules can organize explanations, videos, practice tasks, and evaluation activities into a coherent learning sequence. This structure supports blended learning, in which students study key concepts and demonstrations outside class while using face-to-face sessions for guided practice and teacher feedback (Chi, 2022; Dewanti et al., 2024; Hendri et al., 2021). Such an approach can extend learning time, reduce repeated teacher explanations, and provide students with consistent references for independent practice.

Previous studies have shown that video modeling, multimedia instruction, and digital modules can support skill learning and student engagement in Physical Education and volleyball contexts (Apidogo et al., 2022; Canepa et al., 2020; Mohamed & Abdel-bary, 2021; Saad et al., 2020). However, several limitations remain. Many studies focus on broader volleyball competencies or different learner populations, while fewer studies develop and validate structured web-based modules specifically for underhand serve learning in high school Physical Education. In addition, some digital learning products are reported without transparent expert-validation evidence, practicality data from target users, or preliminary effectiveness results that reflect real classroom constraints (Fauzi et al., 2024; Kasih et al., 2023).

This gap indicates the need for a practical and validated web-based learning module that focuses specifically on underhand volleyball serve learning in high school Physical Education. Such a module should combine accurate technical content, clear demonstrations, progressive practice tasks, and evaluation activities that support both teacher-led and independent learning. It should also be evaluated not only for learning outcomes but also for content validity, media quality, and student practicality, because these aspects determine whether the product is feasible for classroom use (Astuti, 2023; Karunamoorthy et al., 2024).

Accordingly, this study aimed to design, develop, and validate a web-based digital module for learning the underhand volleyball serve in high school Physical Education. The study was guided by the following research questions: (1) How valid is the web-based digital module based on subject-matter and media expert evaluation? (2) How practical is the module based on student responses after implementation? (3) What preliminary improvement in students' underhand serve performance occurs after using the module? Based on the instructional design and motor learning principles embedded in the module, this study hypothesized that students' underhand serve performance would improve after learning with the web-based digital module.

2. METHODS

2.1 Research Design

This study used a Research and Development (R&D) approach to produce and evaluate an educational product for Physical Education learning. The product was a web-based digital module designed to support high school students' learning of the underhand volleyball serve. The development process followed the ADDIE model, which consists of analysis, design, development, implementation, and evaluation. This model was selected because it provides a systematic framework for identifying learning needs, designing instructional content, developing media, implementing the product with target users, and revising the product based on empirical feedback (Rianti et al., 2023; Sun & Khamcharoen, 2025).

The analysis stage identified student needs, curriculum demands, and classroom constraints in underhand serve instruction. The design stage determined learning objectives, module structure, practice flow, media components, and evaluation activities. The development stage produced a Google Sites-based module containing explanations, demonstration videos, guided drills, and assessment components. The implementation stage involved expert validation and limited classroom use by target users. The evaluation stage examined validity, practicality, and preliminary effectiveness and used qualitative feedback to revise the module (Kurniawan & Tangkudung, 2017; Sutopo & Setiadi, 2020).

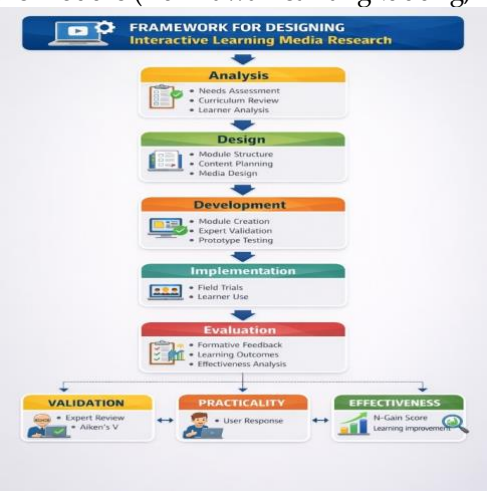

Figure 1. Framework for designing interactive learning media research

2.2 Participants

The participants were Grade XI students from classes XI-8 and XI-9 at SMAN 4 Surabaya, with a total sample of 50 students. The participants were selected because they had received basic volleyball instruction and represented the target users of the developed module. Students were involved in the practicality test and the one-group pretest-posttest implementation. Subject-matter experts and media experts were also involved to assess content accuracy, instructional quality, interface design, navigation, readability, and technical suitability.

The study was conducted after permission was obtained from the school. Students were informed about the purpose and procedures of the study before participating. Participation was voluntary, and student responses were used for research purposes without identifying individual students. For school-based implementation, informed consent or assent procedures were applied according to the school's requirements.

2.3 Instruments

Data were collected using validation sheets, student response questionnaires, observation notes, and an underhand serve performance assessment rubric. The validation sheets were used by subject-matter and media experts to evaluate the feasibility of the module. The subject-matter validation focused on curriculum alignment, accuracy of underhand serve content, clarity of technical explanations, suitability of learning activities, and alignment between objectives and assessment. The media validation focused on interface design, navigation, readability, visual quality, video clarity, and technical functionality.

The student response questionnaire measured practicality through three aspects: ease of use, clarity of presentation, and attractiveness of the module. The questionnaire used a structured rating scale, and students were also allowed to provide comments or suggestions. Instrument reliability was addressed through item review before implementation and internal consistency analysis for questionnaire data. The reliability index was interpreted using a minimum acceptable criterion of 0.70 for internal consistency.

Underhand serve performance was assessed using a rubric that included four main components: (1) initial stance and body alignment, (2) ball hold and toss control, (3) arm swing and contact timing, and (4) follow-through and ball direction. Each component was scored using a graded performance scale, and the total score represented the student's underhand serve performance. When more than one assessor was involved, inter-rater reliability was checked before the final score was used for analysis.

2.4 Procedure

The research procedure followed the ADDIE stages. First, a needs analysis was conducted through lesson observation, teacher discussion, curriculum review, and student questionnaires. Second, the module design was prepared by arranging learning objectives, content sequence, demonstration materials, practice tasks, and evaluation activities. Third, the prototype was developed using Google Sites and reviewed internally before expert validation. Fourth, subject-matter and media experts evaluated the module using structured validation sheets and provided revision suggestions. Fifth, the revised module was implemented with Grade XI students to collect practicality data and pretest-posttest performance data.

During implementation, students completed a pretest to measure initial underhand serve performance. They then used the web-based digital module as a learning support during volleyball instruction. The module provided access to explanations, videos, guided practice tasks, and evaluation activities. After the learning activities, students completed a posttest using the same performance assessment criteria and filled in the practicality questionnaire. Expert and student comments were used to refine the final version of the module.

2.5 Data Analysis

Quantitative data from expert validation were analyzed using descriptive statistics and Aiken's V to determine the degree of expert agreement. The Aiken's V values were interpreted as evidence of content and media validity. Student practicality data were analyzed using percentage scores for each aspect and the average practicality score. Qualitative data from expert and student comments were summarized descriptively and used as the basis for product revision.

Pretest and posttest performance scores were analyzed descriptively using mean scores, mastery percentages, and normalized gain (N-gain). The N-gain formula was: g = (posttest score - pretest score) / (maximum score - pretest score). The N-gain value was used to describe the proportional improvement in student performance after using the module. The criteria used to interpret N-gain are presented in Table 1.

Table 1. N-Gain Interpretation Criteria

N-Gain Score Range (g)	Improvement Category
g >= 0.70	High
0.30 <= g < 0.70	Moderate
g < 0.30	Low

Table 2. Performance Assessment Rubric for Underhand Serve

Component	Assessment focus
Initial stance and body alignment	Feet position, balance, and body orientation before serving
Ball hold and toss control	Stable ball position, controlled release, and appropriate toss height
Arm swing and contact timing	Backward swing, forward swing, and contact with the ball at the correct moment
Follow-through and ball direction	Continuation of arm movement, body control, and direction of the served ball

3. FINDINGS AND DISCUSSION

3.1 Findings

3.1.1 Results of Needs Analysis

The needs analysis identified a mismatch between the instructional demands of underhand volleyball serve learning and the learning conditions in class. Initial observation, teacher discussion, and student questionnaires indicated that underhand serve instruction was mostly delivered through verbal explanation and direct teacher demonstration. Approximately 68% of students reported difficulty understanding the sequence of the underhand serve, especially arm swing coordination and ball contact timing. In addition, approximately 72% of students stated that they needed learning media that could be accessed outside class hours.

Teachers reported that limited lesson time and large class sizes made it difficult to provide individual feedback to every student. As a result, some students repeated technical errors during practice. The needs analysis therefore supported the development of a digital learning module that presents underhand serve material visually, systematically, and flexibly.

3.1.2 Results of Product Development

The product developed in this study was a Google Sites-based digital learning module for underhand volleyball serve learning. The module was designed as a supplementary learning resource for face-to-face Physical Education lessons and independent learning outside class. It contained five main menus: Introduction, Material, Learning Videos, Exercise, and Evaluation.

The Introduction menu presented learning objectives and an overview of the underhand serve. The Material menu explained the technical components of the underhand serve, including starting position, movement execution, and final position. The Learning Videos menu provided demonstrations of correct technique. The Exercise menu included guided practice tasks, while the Evaluation menu was used to assess students' understanding and performance. Figure 2 shows the learning menu structure of the developed module.

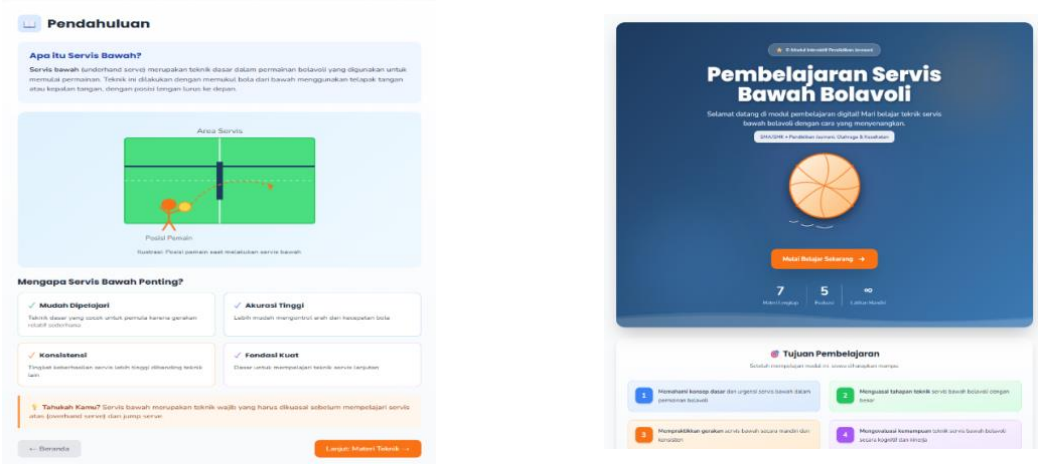

Figure 2. Learning menu structure

3.1.3 Results of Expert Validation

Expert validation assessed the feasibility of the digital module from subject-matter and media perspectives. The subject-matter expert evaluated curriculum alignment, technical accuracy, clarity of content, and suitability of learning activities. The media expert evaluated interface display, navigation, readability, visual and video quality, and layout consistency.

The validation results indicated that the module met the highly valid category in both aspects. The subject-matter expert score was 90% with Aiken's V = 0.88, while the media expert score was 92.5% with Aiken's V = 0.90. The results are presented in Table 3.

Table 3. Results of Digital Module Validation by Experts

Validation Aspect	Score (%)	Aiken's V	Category
Subject Matter Expert	90	0.88	Highly Valid
Media Expert	92.5	0.90	Highly Valid

3.1.4 Results of Practicality Testing

The practicality test involved 50 students from classes XI-8 and XI-9 as target users of the web-based module. Practicality was assessed through student responses regarding ease of use, clarity of presentation, and attractiveness of the module. The results showed high practicality across all assessed aspects. Ease of use received 91.2%, clarity of presentation received 88.6%, and attractiveness received 93.4%. The average practicality score was 91%, which was categorized as very practical. The results are presented in Table 4.

Table 4. Results of the Digital Module Practicality Test by Students (n = 50)

Practicality Aspect	Percentage (%)	Category
Ease of use	91.2	Very Practical
Clarity of presentation	88.6	Very Practical
Attractiveness of the module	93.4	Very Practical
Average	91.0	Very Practical

3.1.5 Results of Preliminary Effectiveness Testing

Preliminary effectiveness was examined using a one-group pretest-posttest design. The average pretest score was 61.10, while the average posttest score was 84.40. Class XI-8 improved from 61.40 to 83.60, and class XI-9 improved from 60.80 to 85.20. The pretest and posttest results are presented in Table 5.

The normalized gain analysis showed a moderate improvement. The average N-gain score was 0.60, with class XI-8 obtaining 0.57 and class XI-9 obtaining 0.62. The N-gain results are presented in Table 6.

Learning mastery was also examined after module implementation. A total of 42 out of 50 students achieved the mastery criterion, while 8 students had not yet achieved it. The overall mastery percentage was 84%. The mastery results are presented in Table 7.

Table 5. Pretest and Posttest Results for Volleyball Underhand Serve Skills

Class	Average Pretest	Average Posttest
XI-8	61.40	83.60
XI-9	60.80	85.20
Average	61.10	84.40

Table 6. Results of N-Gain Analysis of Volleyball Underhand Serve Skills

Class	N-Gain	Category
XI-8	0.57	Moderate
XI-9	0.62	Moderate
Average	0.60	Moderate

Table 7. Percentage of Learning Mastery for Volleyball Underhand Serve Skills

Category	Number of Students	Percentage (%)
Achieved	42	84.0
Not yet achieved	8	16.0
Total	50	100

3.2 Discussion

The findings of this study indicate that the developed web-based digital module is a feasible instructional resource for supporting underhand volleyball serve learning in high school Physical Education. The high validity scores obtained from subject-matter and media experts demonstrate that the module successfully met instructional, technical, and pedagogical requirements. Content validity is particularly important in motor skill learning because students rely on accurate demonstrations, clear explanations, and structured learning sequences to understand and execute movement patterns effectively. The expert validation results suggest that the module appropriately aligned learning objectives, instructional materials, practice activities, and assessments with the competencies required for mastering the underhand volleyball serve. According to instructional design theory, learning materials that are systematically organized and aligned with curriculum objectives contribute to greater learning effectiveness and learner engagement (Chi, 2022; Hendri et al., 2021).

The positive practicality results further indicate that students perceived the module as easy to use, attractive, and helpful during the learning process. The average practicality score of 91% suggests that the module was well accepted by its intended users. This finding is consistent with previous studies showing that digital learning resources can increase student motivation and engagement by providing flexible access to instructional content and opportunities for self-paced learning (Dewanti et al., 2024; Pratama et al., 2024). In Physical Education settings, where lesson time is often limited and teachers must manage large groups of students simultaneously, web-based learning materials can extend learning opportunities beyond classroom hours. Students can repeatedly access explanations

and demonstrations, allowing them to review difficult movement components independently and at their own pace. Such flexibility is particularly valuable in motor learning because repeated exposure to performance models can strengthen cognitive representations of movement patterns and improve skill execution (Harris et al., 2018).

The improvement in students' underhand serve performance following module implementation also provides evidence of the module's potential instructional value. The increase in mean scores from pretest to posttest and the moderate N-gain value (0.60) indicate meaningful learning progress among participants. Although the study employed a one-group pretest–posttest design, the observed improvement suggests that the combination of structured explanations, demonstration videos, guided practice tasks, and evaluation activities may have facilitated students' acquisition of the underhand serve technique. This finding supports previous research demonstrating that multimedia learning environments and video-based instruction can enhance motor skill acquisition by providing visual demonstrations that complement verbal explanations (Mohamed & Abdel-Bary, 2021; Saad et al., 2020). Visual modeling allows learners to observe critical movement components repeatedly, helping them understand the coordination required for successful performance.

From a motor learning perspective, the effectiveness of the module can be explained through the principles of observational learning and feedback-guided practice. Action observation has been shown to facilitate motor skill acquisition because observing correct movement patterns activates cognitive and neural processes associated with motor planning and execution (Harris et al., 2018). The instructional videos embedded in the module enabled students to repeatedly observe the correct underhand serve technique, including stance, ball toss, arm swing, and follow-through. Repeated observation may have strengthened students' understanding of movement mechanics and reduced common performance errors. Furthermore, the guided practice activities encouraged learners to actively apply the observed techniques, reinforcing the connection between cognitive understanding and physical execution.

The findings also support the growing body of literature emphasizing the role of technology-enhanced learning in Physical Education. Traditional Physical Education instruction often depends heavily on teacher demonstrations and verbal explanations, which may not adequately address individual differences in learning pace and skill development. Digital learning modules can complement classroom instruction by providing individualized learning opportunities and consistent access to instructional materials (Atienza, 2024; Dewanti et al., 2024). In the present study, students reported that the module helped them better understand the movement sequence and allowed them to revisit instructional content whenever needed. These benefits align with blended learning approaches, which integrate digital resources with face-to-face instruction to optimize learning experiences and maximize instructional time (Chi, 2022).

Another important contribution of this study is its focus on a specific volleyball skill within a high school context. Previous studies have frequently examined digital learning interventions in broader Physical Education settings or focused on general volleyball competencies (Apidogo et al., 2022; Kasih et al., 2023). In contrast, the present study developed a targeted learning resource specifically designed to address the challenges associated with learning the underhand volleyball serve. By concentrating on a single foundational skill, the module was able to provide detailed explanations, focused demonstrations, and progressive practice activities that directly addressed common learner difficulties. This targeted approach may explain the favorable responses from both experts and students.

Despite these positive findings, several limitations should be acknowledged. First, the use of a one-group pretest–posttest design limits the ability to establish causal relationships between module use and learning outcomes. Improvements in performance may have been influenced by factors such as regular practice, teacher feedback, or increased familiarity with the assessment procedures. Second, the study did not include retention testing, making it impossible to determine whether the observed improvements were maintained over time. Motor learning research emphasizes the importance of

retention measures because long-term performance stability is a key indicator of successful skill acquisition (Ugrinowitsch et al., 2019). Third, the implementation was limited to a single school and a relatively small sample, which may restrict the generalizability of the findings.

Future studies should employ more rigorous experimental designs, such as randomized controlled trials or quasi-experimental approaches with comparison groups, to strengthen evidence regarding the effectiveness of web-based modules in Physical Education. Researchers should also include delayed retention tests and transfer assessments to examine the long-term impact of digital learning interventions on motor skill development. Furthermore, expanding implementation across different schools and educational contexts would provide greater insight into the scalability and applicability of web-based learning resources for volleyball instruction and other Physical Education competencies.

4. CONCLUSION

This study developed and evaluated a web-based digital module for learning the underhand volleyball serve in high school Physical Education using the ADDIE development model. The findings demonstrated that the module achieved high validity based on expert evaluation (Aiken's V = 0.88–0.90), high practicality according to student responses (91%), and promising preliminary effectiveness, as reflected by the increase in students' performance scores from pretest (M = 61.10) to posttest (M = 84.40), a moderate N-gain score (0.60), and an 84% learning mastery rate. These results suggest that the module can serve as a feasible supplementary learning resource for supporting blended learning and enhancing students' acquisition of underhand volleyball serve skills. However, the findings should be interpreted cautiously because the study employed a one-group pretest–posttest design without a control group, involved participants from a single school, and did not include retention measures to examine long-term learning outcomes. Therefore, future research is recommended to use more rigorous experimental or quasi-experimental designs with comparison groups, larger and more diverse samples, and delayed retention tests to provide stronger evidence regarding the effectiveness, sustainability, and generalizability of web-based digital learning modules in Physical Education contexts.

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