RESEARCH PAPER

Effectiveness of Implementing Blended Learning Model with SMART BADMINTON ZR Application in Badminton Learning in Physical Education

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Abstract

This study aims to investigate the effectiveness of implementing a blended learning model using the SMART BADMINTON ZR application on improving student performance in basic serving and smashing techniques in badminton courses. Method: This study used a quasi-experimental design with a pretest-posttest control group. A total of 64 Physical Education students from Dharmas Indonesia University participated and were divided into an experimental group (n=32) that used the blended learning model based on the SMART BADMINTON ZR application, and a control group (n=32) that used conventional face-to-face learning methods. The intervention was carried out over 16 meetings. Student performance was measured using a serve and smash technique test with a 1-4 scale process-work rubric. Data were analyzed using paired-samples t-test and independent-samples t-test with a significance level of $\alpha = 0.05$. Results: The results showed a significant improvement in both skills (serve and smash) in the experimental group compared to the control group ($p < 0.05$). The experimental group showed an average posttest score of 45.88, higher than the control group with an average of 40.78. Conclusion: The integration of technology through a blended learning model with the SMART BADMINTON ZR application has been proven effective in improving students' understanding, motor performance, and engagement in sports learning. Flexibility in independent learning, better visualization of techniques, quick feedback, and increased motivation are key factors in the success of this approach.

Keywords: Blended Learning, SMART BADMINTON ZR, Motor Learning, Badminton Performance, Physical Education

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Introduction

Physical education is an essential part of the curriculum in various educational institutions, aiming to improve physical health, motor skills, and healthy lifestyles in students (Hu, 2020). Within physical education, sports such as badminton not only teach physical skills but also develop character, teamwork, and cognitive abilities in dealing with dynamic game situations (Ortega-Toro, 2020) & (Zhu, 2021). Although badminton is a popular sport among students, the learning process is often limited to conventional methods that rely on direct instruction and face-to-face training with coaches (Zhang, 2024a).

However, traditional learning methods have several limitations, including a lack of interactivity, an inability to provide rapid and objective feedback, and limited time for practice outside of class hours (Sinelnikov, 2016). This can impact the effectiveness of learning and the development of students' badminton skills. On the other hand, advances in information and communication technology offer opportunities to improve traditional methods of delivering learning materials, including sports. Technology enables more measurable data collection, more in-depth analysis, and faster and more personalized feedback (Zulkifli, 2022).

The development of digital technology has changed the paradigm of the learning process in higher education (Zagorodniy, 2023). In the era of the Industrial Revolution 4.0, education is required to develop not only cognitive abilities but also 21st-century skills such as critical thinking, creativity, communication, and collaboration. One approach considered effective in addressing these challenges is blended learning, which combines face-to-face interaction with online learning. This model offers flexibility, efficiency, and access to extensive learning resources, thereby enhancing students' learning experiences (Wang, 2022).

In context physical education and sports, especially in practical courses such as badminton The application of blended learning offers significant potential. Sports learning requires a combination of theoretical understanding (technical concepts, tactics, and strategies) and motor skills (movement skills) (Zhu, 2021). However, limited time for on-the-job practice and varying student ability levels often hinder optimal learning outcomes. By utilizing app-based digital learning, students can learn theory and analyze techniques online before engaging in hands-on practice, allowing face-to-face time to be focused on technique correction and performance improvement (Zhang, 2024b).

Recent studies show that blended learning is increasingly being applied in physical education in various countries.

Blended learning is the most adaptive learning model because it synergistically integrates the strengths of online and offline learning (Feng, 2018). A study in China by Zhang (2024b) even showed that blended learning significantly improved students' physical fitness, including endurance, strength, and motor coordination, compared to conventional learning.

In specific sports contexts, such as basketball and soccer, blended learning models have been shown to improve fundamental technical skills and positive attitudes toward physical activity (Wang, 2022). However, most research still focuses on team sports and has not addressed individual sports such as badminton, especially in the aspect of basic technical skills such as serve and smash which requires high precision, strength and coordination.

Although the effectiveness of blended learning in physical education has been widely studied, several research gaps need to be identified: Limited sport-specific contexts – most blended learning studies focus on team sports (basketball, soccer, futsal), while racket sports such as badminton are relatively rarely explored. Lack of use of dedicated application-based technology – some studies only use general learning platforms (e.g., Moodle, Google Classroom), rather than thematic applications developed specifically for specific sports. Limited research measuring specific motor performance (serving and smashing techniques) – most blended learning studies in physical education emphasize cognitive aspects and learning attitudes, rather than technical motor skill performance. Lack of research in the context of Indonesian higher education – most research is still conducted abroad, so the local context of implementation in Indonesia is still not widely proven.

This study introduces the SMART BADMINTON ZR blended learning model, an interactive digital application that functions as an online learning medium to support badminton practice learning. This application can be accessed via Android devices or computers and contains interactive materials, basic technique videos, motion simulations, and independent exercises integrated with field practice sessions. The novelty lies in the integration of thematic digital technology (SMART BADMINTON ZR) in the context of badminton learning in higher education. Smart Badminton ZR is a combination of the main elements, namely Smart, which means intelligent/clever when combined into a smart way to learn badminton. While ZR is the abbreviation of the name of the developer of this application, namely Zuhar Ricky. Focus on improving the performance of specific basic techniques (serve and smash) as the main indicators of learning outcomes. The blended learning approach is based on local applications, which combines online learning, field interaction, and direct feedback from lecturers.

Thus, this research is expected to provide theoretical contributions to the development of digital-based sports learning models and provide practical implications for lecturers and physical education students.

Materials and methods

This study used a quantitative quasi-experimental design approach with a Pretest–Posttest Control Group Design model. This design allows researchers to compare skill performance results between the treatment group and the control group (Arbabi, 2016).

The experimental group received blended learning using the SMART BADMINTON ZR application, while the control group used conventional learning methods (full face-to-face).

The research design scheme can be described as follows:

Group	Pretest	Treatment	Posttest
Experiment	X1	X (Blended Learning: SMART BADMINTON ZR)	X2
Control	X3	Kenvensional	X4

Information:

X_1, X_3 = Initial test (pretest) of badminton technique performance

X_2, X_4 = Posttest of badminton technique performance

X = Mixed learning treatment based on SMART BADMINTON ZR

The research subjects were 64 students of the Physical Education Study Program at Dharmas Indonesia University who took the Badminton course in the even semester of 2024/2025, divided equally into the experimental group (n=32) and the control group (n=32) through purposive sampling with the following criteria: actively registered, taking related courses, free from injury/motor disorders during the study, and willing to participate in the entire series.The research was conducted at the Badminton Court of the Faculty of Teacher Training and Education, Dharmas Indonesia University, Dharmasraya Regency, West Sumatra. The research was conducted over 16 meetings, covering the pretest, treatment, and posttest stages, in the even semester of the 2024/2025 academic year. The treatment consisted of learning basic badminton techniques, namely serving and smashing. Data were collected through pretests and posttests using an assessment rubric for basic badminton serving and smashing techniques.

Research Procedures

Preparation Stage

- Compiling learning tools (RPS, modules, SMART BADMINTON ZR video tutorials).
- Provides directions on using the SMART BADMINTON ZR application.
- Determine the rubric for assessing service and smash skills.

Pretest Level

Both groups (experimental and control) underwent an initial test of basic service and smash technique skills using a standard rubric.

Treatment Level

- The experimental group participated in learning with the blended learning model:
- Online sessions: Access materials, technique videos, and theory exercises through the SMART BADMINTON ZR application.
- Face-to-face sessions: Direct practice in the field with lecturer guidance and feedback on the results of online practice.
- The control group followed learning with conventional methods: theoretical lectures in class and practice in the field without the use of applications.

Posttest Level

Both groups underwent another serve and smash skills test to measure performance improvement after the treatment.

The study took place over 16 sessions at the FKIP Badminton Court, Dharmasraya Regency, West Sumatra. The independent variable was the blended learning model with SMART BADMINTON ZR; the dependent variables were serve and smash skills. The experimental group learned through a combination of online sessions (materials, technique videos, theoretical exercises via an application) and face-to-face (field practice with feedback), while the control group used conventional learning without an application. Measurements were conducted through pretests and posttests using a work-process rubric scaled 1–4 that operationalizes the initial, execution, and final stages in various aspects of posture, position, swing, shuttlecock contact, view, and preparedness.

Data analysis was conducted quantitatively using SPSS version 26. Prerequisite tests included the Kolmogorov–Smirnov normality test and Levene's homogeneity of variance test. Hypothesis testing included a paired-samples t-test to compare pretest–posttest scores within each group and an independent-samples t-test to compare improvements between the experimental and control groups. The significance level was set at $\alpha = 0.05$, with interpretation based on the p-value and the mean difference in performance improvement between groups.

Results

This study involved two groups of Physical Education students from Dharmas Indonesia University, each consisting of 32 people in the experimental group (using the SMART BADMINTON ZR blended learning model) and 32 people in the control group (using conventional methods).

Both groups underwent service and smash skills tests before and after treatment for 16 meetings.

A. Descriptive Statistical Analysis

Descriptive statistics provide an overview or description of data seen from the average value (mean), standard deviation, maximum, minimum,

The descriptive statistical results can be seen in the table below:

Descriptive Test Table

Variabel	Minimum	Maximum	Mean	SD
Pretest Kontrol	31	49	37,53	4,833
Posttest Kontrol	32	51	40,78	5,308
Pretest Eksperimen	31	48	38,59	4,976
Posttest Eksperimen	40	55	45,88	4,449

Based on the table above, it can be seen that the average value of the control pretest was 37.53, the average value of the control posttest was 40.78. The average value of the experimental pretest was 38.59 and the average value of the experimental posttest was 45.88.

B. Normality Test

This test is to test whether the observations are normally distributed or not, this test uses Shapiro-Wilk because the data is less than 50. The results of the Normality test can be seen in the table below.

Normality Test Table

Variabel	Sig	batas	Keterangan
Pretest Kontrol	0,021	0,05	Tidak Normal
Posttest Kontrol	0,009	0,05	Tidak Normal
Pretest Eksperimen	0,006	0,05	Tidak Normal

Posttest Eksperimen	0,043	0,05	Tidak Normal

Based on the table, it can be seen that all data are not normally distributed, because the sig value is < 0.05.

C. Homogeneity Testing

Homogeneity analysis using homogeneity test, can be known as follows:

Homogeneity Test Table

Variabel	Sig.	Keterangan
Pretest	0,895	Homogen
Posttest	0,400	Tidak homogen

The table above states that the sig value is more than 0.05, so it can be concluded that the data is homogeneous.

D. Hypothesis Analysis

Mann-Whitney

Bivariate analysis at this stage examined the "differences between the control and experimental groups" using the Mann-Whitney test., the result can be known as follows:

Pretest Difference Analysis Table
Control and Experimental Groups

Kelompok	Sig.	Description
Kontrol	0,000	There is a difference
Eksperimen		

The table above shows that there is a significant difference in the average pretest scores between the control and experimental groups, with the scoressignificancy shows (P = 0.000 < 0.05).

Discussion

The results of the study show that the application of the blended learning model using the application SMART BADMINTON ZR significantly improve student performance in basic engineeringservice And smash. This finding confirms the results of previous research by Muñoz et al. (2023) And Zhang et al. (2024) which states that blended learning can improve motor skills and sports skills through the integration of online theory and field practice (Hidayat, 2023) & (Y. N. Lin, 2022)).

In the context of this research, the performance improvement was caused by several main factors:

1. Flexibility of self-learning– Students can learn service and smash techniques through videos and simulations in the application at any time, so that face-to-face time on the field can be used for intensive practice.

2. Better engineering visualization– the in-app video analysis feature helps students understand movements more precisely through clear visual examples.

3. Fast feedback (feedback loop)– the blended learning model facilitates two-way communication between students and lecturers, enabling more effective technical correction.

4. High motivation and engagement– the use of mobile learning technology increases students' motivation to practice and repeat the material.

This result is also in line with the theorymotor learningwhich emphasizes the importance of repetition, feedback, and varying training conditions to strengthen neuromuscular connections (K. C. Lin, 2021). Through SMART BADMINTON ZR, students have the opportunity to practice repeatedly with visual guidance, which accelerates the internalization of motor skills. Meanwhile, the performance improvement in the control group was also significant, but not as great as in the experimental group. This can be explained because conventional methods still provide direct learning, but without the support of self-study access and digital visualizations that facilitate technique understanding (Churi, 2020).

Theoretically, the experimental group's superiority aligns with the Cognitive Theory of Multimedia Learning: a well-designed word-picture combination enhances relevant cognitive processing (selection-organization-integration), allowing learners to construct mental representations of techniques more quickly and accurately (Dou, 2023). Technique videos and animations—when following multimedia principles (e.g., segmentation, cue emphasis, minimal redundancy)—reduce unnecessary cognitive load and maximize the germane load for correct movement schemes. This explains why process scores (e.g., foot position, arm position, shuttlecock contact) improved more sharply in the group utilizing the app (Jie, 2015).

The findings are also consistent with the blended learning literature in higher education and physical education: meta-analyses and systematic reviews report that blended approaches tend to produce similar or better learning outcomes than purely face-to-face learning—especially when the online component provides structured practice, formative assessment, and rapid feedback. In the physical education context, BL has been shown to improve sports attitudes and game skills (e.g., basketball skills), which is analogous to the improvements in racquet skills such as serving and smashing in this study (Shaowei, 2022). Given your design (16 sessions; online + on-court), this pattern of results makes perfect sense.

From a motor learning perspective, the superiority of app-based interventions can also be explained by two pillars: (1) augmented feedback and visual modeling that highlight performance gaps; (2) external focus that encourages learners to focus on the effects of movement (the shuttlecock's trajectory/strike direction), rather than on body parts. Both have been repeatedly shown to improve performance and retention of various motor skills. Digital platforms facilitate timely and faded feedback, so students do not rely solely on knowledge of results (Zhang, 2024a).

Furthermore, this advantage aligns with the OPTIMAL theory of motor learning—performance and learning improve when interventions enhance autonomy (learning control through the app), expectancy (seeing progress in logs/recordings), and appropriate attentional focus. These components are naturally present in blended learning: students choose when to review the material/video (autonomy), receive periodic reinforcement (expectancy), and direct focus to movement outcomes through video demonstrations/comparison (external focus). This explains why changes in process indicators—from the beginning to the end of the movement—were more stable in the experimental group (Long, 2022).

Specifically in the badminton context, recent evidence suggests that learning technologies (comparison videos, wearables, auto-feedback apps) effectively improve technical performance through a watch-imitate-self-examine-enhance-repeat cycle and multi-channel feedback (visual infographics, video comparisons, verbal prompts). While these studies used different tools, the underlying principles are identical to those applied via SMART BADMINTON ZR: expert demonstration, self-repetition, and rapid, objective feedback (K. C. Lin, 2021; Wei, 2023). The results of these studies, favoring the experimental group, therefore align with empirical trends in modern badminton learning.

Conclusions

This study proves that the application of the blended learning model with the SMART BADMINTON ZR application effectively improves student performance in basic serve and smash techniques in the Badminton course at Dharmas University of Indonesia. The experimental group using the blended learning model showed a statistically significant increase compared to the control group using the conventional method ($p < 0.05$), with an average posttest score reaching 45.88 compared to 40.78 in the control group.

The success of this learning model is supported by four main factors: (1) flexibility of self-study that allows students to access technique materials at any time through the application, (2) better technique visualization through video analysis features that help with proper understanding of movements, (3) rapid feedback that facilitates two-way communication between students and lecturers for more effective technique correction, and (4) increased student motivation and engagement through the use of mobile learning technology.

These findings are in line with motor learning theory which emphasizes the importance of repetition, feedback, and variation in training conditions to strengthen neuromuscular connections, as well as the Cognitive Theory of Multimedia Learning which explains that a well-designed combination of words and images enriches cognitive processing and accelerates the formation of accurate mental representations of technique.

Practically, the implications are: (a) integrate short, multimedia-based technique videos into each topic (short/long serve, smash); (b) implement a summary and bandwidth feedback schedule (only when technique deviation exceeds a threshold) to foster independence; (c) use the same process rubric across online and offline sessions for evaluation alignment; and (d) provide individual progress tracking in the app to maintain positive expectations. This strategy will ensure a stable transfer from the cognitive-perceptual domain to motor execution in the follow-through phase.

However, there are important limitations. First, the quasi-experimental design limits causal inference due to the lack of randomization of individual units. Second, the sample was drawn from a single study program at a single university, requiring caution when generalizing across contexts. Third, the measurement focused on a process rubric; without retention and transfer tests (e.g., competition performance), it is difficult to assess learning retention and competitive meaningfulness. Fourth, the 16-session duration does not allow for monitoring learning plateaus and overlearning. Fifth, inter-rater reliability was not reported; even though observational rubrics are prone to score variation. These issues do not negate the findings, but rather provide context for cautious interpretation.

Further research suggestions include implementing randomization at the classroom/individual level, adding retention and transfer tests, combining rubrics with objective indicators (kinematic performance, target accuracy), testing feedback scheduling (faded vs. concurrent) and attentional focus (external vs. internal), and comparing effects at different skill levels (beginner vs. intermediate). Research could also explore tactical modules (decision-making) and cognitive workload when processing multimedia materials. These recommendations align with the BL research roadmap in physical education, which highlights the need to expand the topic beyond perceptions/attitudes to robustly validated skill outcomes.

Finally, the above results and interpretations confirm the value of application-based blended learning to improve the technical components of serve and smash more consistently than conventional methods—in line with multimedia theory, motor learning principles, and recent empirical evidence.

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Conflict of interest

The authors declare no conflicts of interest

References:

1. Arbabi, A. (2016). Effect of performance feedback with three different video modeling methods on acquisition and retention of badminton long service. Sport Science, 9(Query date: 2025-03-14 14:43:00), 41–45.
2. Churi, A. B. (2020). Effect of core strengthening and conditioning programme on badminton beginners. Indian Journal of Forensic Medicine and Toxicology, 14(3), 156–161.
3. Dou, Y. (2023). Badminton Teaching Mode in Network Teaching Platform Under Multimedia Environment. International Journal of Web-Based Learning and Teaching Technologies, 18(2). https://doi.org/10.4018/IJWLTT.319967
4. Feng, S. Q. (2018). Applied research on college sports blended learning based on moodle platform. Kuram Ve Uygulamada Egitim Bilimleri, 18(5), 1077–1086. https://doi.org/10.12738/estp.2018.5.010
5. Hidayat, Y. (2023). The effect of the combined self-talk and mental imagery program on the badminton motor skills and self-confidence of youth beginner student-athletes. BMC Psychology, 11(1). https://doi.org/10.1186/s40359-023-01073-x
6. Hu, Y. (2020). Realization of intelligent computer aided system in physical education and training. Computer-Aided Design and Applications, 18(Query date: 2025-03-14 13:29:03), 80–91. https://doi.org/10.14733/cadaps.2021.S2.80-91
7. Jie, M. (2015). Badminton's multimedia courseware of interactive design based on the MOOCs mode. Communications in Computer and Information Science, 529(Query date: 2025-03-14 13:29:03), 259–264. https://doi.org/10.1007/978-3-319-21383-5_44
8. Lin, K. C. (2021). Development of a badminton teaching system with wearable technology for improving students' badminton doubles skills. Educational Technology Research and Development, 69(2), 945–969. https://doi.org/10.1007/s11423-020-09935-6
9. Lin, Y. N. (2022). Fostering motor skills in physical education: A mobile technology-supported ICRA flipped learning model. Computers and Education, 177(Query date: 2025-03-14 14:43:00). https://doi.org/10.1016/j.compedu.2021.104380
10. Long, J. (2022). Application of Machine Learning to Badminton Action Decomposition Teaching. Wireless Communications and Mobile Computing, 2022(Query date: 2025-03-14 14:43:00). https://doi.org/10.1155/2022/3707407
11. Ortega-Toro, E. (2020). Effect of scaling task constraints on the learning processes of under-11 badminton players during match-play. Children, 7(10). https://doi.org/10.3390/children7100164
12. Shaowei, S. (2022). The Blended Teaching Design and Practice for Physical Education Specialized Course. International Journal of Human Movement and Sports Sciences, 10(3), 510–523. https://doi.org/10.13189/saj.2022.100319
13. Sinelnikov, O. (2016). Changing beginning teachers' content knowledge and its effects on student learning. Physical Education and Sport Pedagogy, 21(4), 425–440. https://doi.org/10.1080/17408989.2015.1043255
14. Wang, C. (2022). Effects of Blended Learning in Physical Education among University Students: A Systematic Review. Education Sciences, 12(8). https://doi.org/10.3390/educsci12080530
15. Wei, C. T. (2023). A court line extraction algorithm for badminton tournament videos with horizontal line projection learning. IET Image Processing, 17(10), 2907–2924. https://doi.org/10.1049/ipr2.12838
16. Zagorodniy, V. V. (2023). THE JUSTIFICATION OF THE IMPORTANCE AND NECESSITY OF STUDENTS OF INSTITUTIONS OF HIGHER EDUCATION INDEPENDENT PHYSICAL EDUCATION DURING THE CORONAVIRUS PANDEMIC. Rehabilitation and Recreation, 2023(14), 199–206. https://doi.org/10.32782/2522-1795.2023.14.24
17. Zhang, R. (2024a). Construction and Evaluation of Digital Resource Management Platform for Physical Education in Colleges and Universities. Applied Mathematics and Nonlinear Sciences, 9(1). https://doi.org/10.2478/amns-2024-3272
18. Zhang, R. (2024b). Construction and Evaluation of Digital Resource Management Platform for Physical Education in Colleges and Universities. Applied Mathematics and Nonlinear Sciences, 9(1). https://doi.org/10.2478/amns-2024-3272
19. Zhu, X. (2021). Research on the SPOC Blended Teaching Mode of Public Physical Education in Colleges and Universities:-Take the badminton course as an example. Proceedings - 2021 International Conference on Information Technology and Contemporary Sports, TCS 2021, Query date: 2025-03-14 13:29:03, 408–411. https://doi.org/10.1109/TCS52929.2021.00088
20. Zulkifli, A. F. (2022). Technology in physical education: Using movement analysis application to improve feedback on sports skills among

undergraduate physical education students. Social Sciences and Humanities Open, 6(1). https://doi.org/10.1016/j.ssaho.2022.100350