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Enhancing Handball Shooting Skills: The Effectiveness of a Website-Based Training Model for Youth Athletes

Muhamad Arif[1ABCDE], Slamet Sukriadi[2ABCD], Dicky Reva Apriana Sanga Dwi[3ABCD] and Gilang Ramadan[4ABCD]

[1]Universitas Negeri Jakarta
[2]Universitas Negeri Jakarta
[3]Universitas Muhammadiyah Kuningan
[4]Universitas Muhammadiyah Gorontalo

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Corresponding Author: Muhamad Arif, e-mail: marif@unj.ac.id
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Abstract

Objectives. This study aimed to explore the development and supportive role of a website-based training model designed to complement coach-led instruction and improve handball shooting skills in athletes aged 15–17. Traditional training methods have limitations in engagement and consistency, which the web-based model seeks to mitigate by enhancing athlete–coach interaction and accessibility.

Materials and Methods. The study employed a Research and Development (R&D) design, following the Borg and Gall model, with a pre-test and post-test design. The experimental group (n = 20) used the website-based model under coach supervision, while the control group (n = 20) followed conventional training methods. Data was collected through shooting accuracy tests, surveys, interviews, and observations.

Results. The results revealed that the experimental group demonstrated a significantly greater improvement in shooting accuracy, with an N-Gain of 63.90% (95% CI [58.7, 69.1]; $p < .001$), compared to the control group's N-Gain of 24.62% (95% CI [20.3, 29.0]). The website-based model was found to be supportive and effective in standardizing improvements and providing flexible, coach-assisted interactive training. However, challenges such as athlete resistance to new methods and technology access issues were identified.

Conclusions. The study highlights the potential of digital tools in sports training, emphasizing the need for blended implementation with traditional coaching and continued development to address technical and accessibility challenges. Further research should be conducted to investigate the long-term integration, scalability, and coach-mediated implementation of this training model across various sports and age groups.

Keywords: website-based training, handball shooting skills, youth sports training, digital learning tools, athletic performance improvement.

Introduction

Handball is a dynamic and physically demanding sport that requires athletes to master various technical skills to perform effectively. Among these, shooting is one of the most critical skills as it directly impacts an athlete's ability to score (Nopianto et al., 2021; Onell et al., 2023). At the junior level, athletes aged 15-17 are often still developing the necessary technical foundations to excel in shooting. While there are established methods of training in place, particularly for shooting, many of these techniques have not kept pace with advances in technology (Uylas et al., 2024). Traditional training methods, such as repetitive drills, tend to focus on isolated skills but often lack engagement and fail to simulate match conditions. These limitations hinder the development of the all-rounded, dynamic shooting abilities needed for competitive play (Muttib et al., 2024; Uylas et al., 2024). Furthermore, traditional approaches often underutilize digital tools that could assist coaches in providing personalized, data-driven feedback. In response, the integration of technology in sports training, especially web-based platforms, presents an innovative solution that

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promises to support and enhance the coach-led process, increasing engagement and standardizing athlete progress. This study examines the development of a website-based handball shooting training model for athletes aged 15–17 years, aiming to overcome the limitations of conventional methods by offering a more interactive and personalized coach-assisted approach.

Research on skill acquisition in sports has highlighted the importance of not only physical but also cognitive and psychological factors in developing proficiency (Akyüz et al., 2019; Saavedra & Saavedra, 2020). Specifically, shooting techniques in handball require complex coordination of upper and lower body movements, as well as acute perceptual-cognitive abilities, including the ability to anticipate the goalkeeper's movements and make split-second decisions. Several studies have explored the biomechanics and kinematics of handball shooting, emphasizing the importance of technique, strength, and power in executing accurate shots (Belčić et al., 2023; Dahl & Tillaar, 2021). Furthermore, it has been shown that strength training and power development in the lower limbs and core significantly enhance shot velocity and accuracy (Gómez-Ferolla et al., 2024). While traditional training methods such as blocked drills and strength training have shown some success, they often fail to account for the dynamic nature of actual match situations, where athletes must make decisions under pressure and with varied defensive challenges (Apidogo et al., 2023). The increasing adoption of digital tools, particularly web-based platforms, offers a promising avenue to address these shortcomings by supplementing existing coach-directed sessions rather than replacing them.

Web-based training systems have the potential to provide athletes with real-time feedback, personalized drills, and the flexibility to practice at their convenience. Technologies like wearable sensors, depth cameras, and automated video analysis systems have been successfully applied in various sports to monitor technique and improve performance (Gençoğlu & Gümüş, 2020; Zhao & Lu, 2024). These systems offer the advantage of providing objective, repeatable measures of key performance variables, such as shooting velocity, and can track progress over time without the need for constant in-person coaching. By integrating such technologies into training models, athletes can receive immediate feedback on their performance, allowing for more effective skill refinement and improved match preparation. Moreover, these platforms can be used to simulate game-like conditions, providing athletes with a more realistic and engaging training experience (Bhakti et al., 2024; Schrapf et al., 2017). However, the question remains whether these technological solutions can outperform traditional methods in improving shooting performance in handball, particularly for adolescent athletes.

This study posits that the implementation of a website-based training model can support and enhance the handball shooting skills of athletes aged 15–17 years when integrated with coach guidance. The hypothesis centers on the idea that a web-based system, which offers individualized training programs, real-time feedback, and contextualized practice scenarios, will serve as a supportive mechanism to enhance coach-led instruction, improving athlete engagement and shooting accuracy. The focus of the study is to develop, validate, and test this model in a real-world setting, using both a control group (traditional training) and an experimental group (coach-supervised, web-based training). By addressing the existing gap in the literature regarding the integration of technology into handball training, this research aims to contribute valuable insights into how digital tools can be used to improve skill acquisition in young athletes.

The importance of this study lies in its potential to address several limitations inherent in traditional training approaches. First, traditional methods often fail to individualize training programs to account for variations in athlete maturity, playing position, and physical characteristics (Akinci & Ateş, 2023; Havolli et al., 2020). In contrast, web-based systems can provide personalized feedback based on objective data, which can be adjusted for factors such as the athlete's age, size, and strength (Gençoğlu & Gümüş, 2020; Zhang et al., 2025), hereby assisting coaches in tailoring training intensity and focus. Additionally, while repetitive drills are effective in the short term, they tend to lack the variability and decision-making challenges present in actual match play (Apidogo et al., 2023). Web-based platforms can simulate such match conditions, allowing athletes, under coach direction, to practice under more realistic constraints, such as shooting under pressure or making quick decisions based on opponent movements (Sahli et al., 2024; Schrapf et al., 2017). Finally, the integration of strength and power training with shooting practice is often neglected in conventional methods, but web-based platforms can incorporate strength assessments and drills that complement shooting practice, thereby promoting more holistic development of the athlete's skills in coordination with the coach's program (Abod & AlHaddad, 2022; Dahl & Tillaar, 2021).

While web-based training systems have shown promise in other sports, there is limited research on their specific application to handball. Therefore, the research aims to fill this gap by developing and testing a website-based shooting model tailored to adolescent handball players that operates as an adjunct to conventional training. This study will focus on the practical application of web-based tools, investigating their feasibility and supportive contribution in a real-world training context. Through a carefully designed research methodology, including pre-tests and post-tests, expert validation, and iterative testing phases, the study will provide comprehensive insights into the potential benefits of digital training tools for handball shooting. It is expected that the findings will contribute to the growing body of knowledge on digital sports training, highlighting the advantages of integrating web-based tools with traditional, coach-guided programs.

The primary goal of this study is to explore whether a web-based training model can offer a supportive and engaging complement to traditional handball shooting training for adolescent athletes. The novelty of this research lies in the use of a web-based platform to deliver personalized training, monitor progress, and provide contextualized practice opportunities, working alongside coaches to enhance learning outcomes. The study also aims to assess the broader applicability of such digital training models, with the potential for their implementation in other sports or training settings. By providing evidence on the supportive function of web-based systems in improving shooting skills, this research could inform future practices in sports

training, particularly for young athletes. Ultimately, the goal is to enhance the quality of training, improve performance, and make training more accessible and engaging for athletes at all levels through collaboration between technology and coaching.

Materials and Methods

This research employs a Research and Development (R&D) design, specifically using the Borg & Gall model, which is well-suited for creating and validating applied training interventions in sports. The R&D design follows a structured, iterative process that includes several stages, such as problem identification, design and prototyping, validation, testing, and final implementation. This methodology is particularly relevant for developing and testing a coach-assisted, website-based training model for handball shooting skills targeted at athletes aged 15–17. In this section, we describe the steps involved in the design, development, and testing of the model, as well as the methods used for data collection, fidelity assessment, and analysis.

Research Design

The first phase of the research focused on identifying the need for an engaging and supportive training model to improve shooting skills in young handball athletes. Existing training methods were found to be inadequate in addressing the needs of athletes aged 15–17, especially regarding engagement and skill variability. This gap informed the creation of a website-based platform designed to complement, not replace, coach-led instruction. The research team gathered insights from athletes, coaches, and stakeholders through surveys, interviews, and observations to identify training challenges and expectations (Kozieł et al., 2024). In the design phase, the team incorporated domain knowledge, including biomechanics, strength, power, and perceptual skills, into the training model, guided by pedagogical frameworks such as the tactical-game approach and representative learning design (Juliantine & Setiawan, 2022). The prototype was validated by nine experts, ensuring its technical and pedagogical soundness (Zhao & Lu, 2024). After revisions, the model was tested with 40 participants (20 in the coach-supervised web-based group and 20 in the control group), focusing on how digital support enhanced the existing coaching process.

Research Site and Duration

The research was conducted in DKI Jakarta province, targeting handball athletes aged 15–17 who were actively participating in school teams and handball clubs. This geographic focus ensured diversity in training environments and coaching styles. The study lasted for 12 weeks, with the intervention phase running for eight consecutive weeks. Initially, a pilot trial was conducted to refine the web interface, followed by a full implementation phase. Each training session was delivered under the supervision of certified handball coaches (minimum 5 years' experience, Level II coaching license). This multi-phase approach ensured comprehensive data collection and consistency of implementation.

Participants and Sampling Methodology

The participants were 40 handball athletes aged 15–17 years, selected using purposive sampling to ensure uniformity in skill and age criteria. The experimental group (n = 20) participated in the coach-mediated, website-based training, while the control group (n = 20) continued with conventional sessions. Coaches maintained weekly digital logs and session checklists to ensure fidelity to the training protocol. Participants were drawn from multiple schools and clubs within DKI Jakarta, ensuring variation in playing experience and minimizing sampling bias.

Data Collection Methods

Various data collection methods were utilized to evaluate the supportive impact of the coach-mediated, web-based model. A standardized shooting accuracy test was administered, where each participant took five shots, and accuracy scores were compared between pre-test and post-test results (Dahl & Tillaar, 2021). Surveys and semi-structured interviews were conducted with both athletes and coaches to capture perceptions of usability, engagement, and coach–athlete interaction. Observations focused on the fidelity of training delivery, including how consistently coaches followed the online modules and how athletes responded to feedback. All training sessions were documented through a digital logbook integrated into the platform. This mixed-methods design provided both quantitative outcomes and qualitative insights (Apidogo et al., 2023). Table 1 presents the intervention description based on the TIDieR framework.

Data Analysis

Data from the accuracy tests, surveys, interviews, and observations were analyzed using both qualitative and quantitative approaches. Open-ended responses were thematically analyzed to capture athlete and coach experiences. Quantitatively, N-Gain analysis measured improvement in shooting accuracy between pre- and post-tests. Independent sample t-tests ($p < .001$) and Cohen's d effect sizes (with 95% confidence intervals) were computed to assess magnitude and precision of differences (Gençoğlu & Gümüş, 2020; Iacono et al., 2021) The analysis emphasized the supportive contribution of the web-based training in enhancing coaching effectiveness and athlete engagement.

Results

The study compared the outcomes of a coach-supervised, web-based training model and traditional methods in improving handball shooting skills among athletes aged 15–17. The experimental group showed improvement ($M_{pre} = 8.90$, $SD = 2.22$; $M_{post} = 15.90$, $SD = 1.82$; 95% CI [6.2, 8.4], $p < .001$, Cohen's $d = 1.55$). In contrast, the control group showed smaller gains ($M_{pre} = 7.05$, $SD = 3.07$; $M_{post} = 10.15$, $SD = 3.07$; 95% CI [2.4, 3.5], $p < .001$, Cohen's $d = 0.62$). These findings highlight that the web-based model effectively supported the coaching process and provided more consistent improvement across athletes.

The pre-test and post-test results for both groups are summarized in Table 2.

Table 1. Intervention Description (TIDieR Framework)

TIDieR Item	Description of the Intervention
1. Brief Name	Website-Based Handball Shooting Skills Training Model
2. Why (Rationale)	Designed to enhance engagement, feedback, and flexibility in handball shooting practice through digital support, complementing coach-led instruction.
3. What (Materials)	The website-based platform included instructional videos, interactive quizzes, real-time feedback modules, and a coach dashboard for monitoring athlete progress.
4. Who Provided	Certified handball coaches (Level II certification, ≥5 years of experience) supervised both in-person and online components of the program.
5. How (Mode of Delivery)	Delivered via an interactive website accessible on both desktop and mobile devices. Sessions integrated video-based demonstrations, digital assignments, and immediate performance feedback.
6. Where (Setting)	Conducted across selected handball clubs and school training facilities in DKI Jakarta Province, Indonesia. Athletes performed digital modules at home or in computer labs, and on-site sessions on the training field.
7. When and How Much	The intervention ran for 8 consecutive weeks with 3 sessions per week. Each session lasted 60 minutes (30 minutes field practice + 30 minutes digital module).
8. Tailoring (Personalization)	Individual training load, drill difficulty, and feedback content were adjusted based on baseline shooting test results and weekly progress analytics.
9. Fidelity (Adherence and Monitoring)	Fidelity was tracked using digital session logs, attendance records, and weekly supervision checklists completed by coaches. System-generated data were reviewed to ensure consistency in delivery.
10. Modifications (Adaptations)	After the pilot phase, interface navigation and visual clarity were refined based on user feedback. Content sequencing and feedback prompts were adjusted to improve usability.
11. Planned Assessment of Adherence	System analytics automatically recorded athlete engagement and completion rates. Coaches conducted regular check-ins and qualitative feedback sessions to ensure adherence.
12. Actual Implementation	The model was fully implemented with 40 athletes divided into experimental and control groups. Coaches followed structured lesson plans and logged session outcomes through the platform.

Table 2. Summarizes the pre-test and post-test results

Group	Pre-test Minimum	Pre-test Maximum	Pre-test Average	Pre-test Standard Deviation	Post-test Minimum	Post-test Maximum	Post-test Average	Post-test Standard Deviation
Experimental	5	13	8.90	2.2219	13	19	15.90	1.8160
Control	2	4	7.05	3.0689	12	16	10.15	3.0655

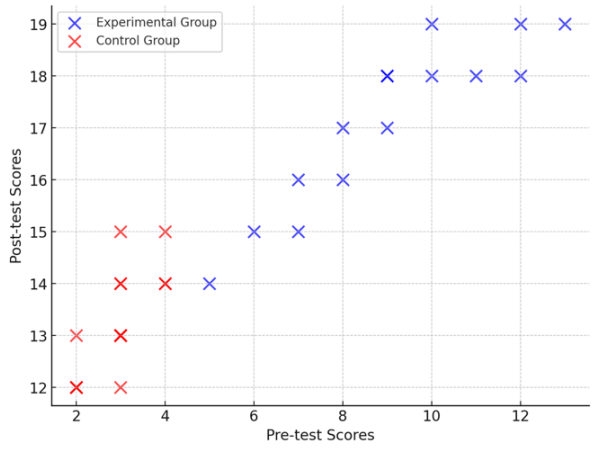

Fig. 1. Pre-Test vs Post-Test Score: Experimental vs Control Group

N-Gain analysis was used to assess improvement. For the experimental group, the N-Gain was 63.90% (95% CI [58.7, 69.1]), categorized as "sufficiently effective," showing

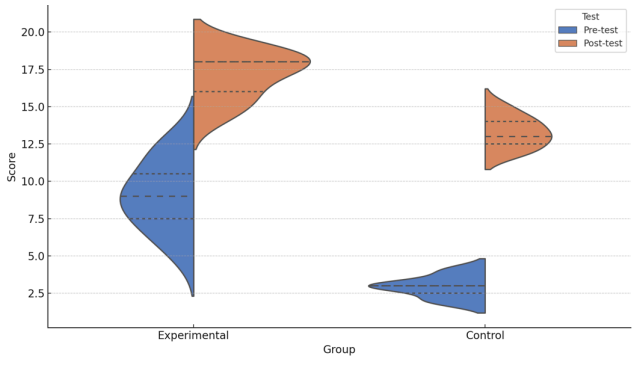

Fig. 2. Distribution of Pre-Test and Post-Test Score

consistent progress under coach supervision. In contrast, the control group had an N-Gain of 24.62% (95% CI [20.3, 29.0]). Effect size analysis confirmed large improvement (Cohen's d = 1.55) for the experimental group, compared with a medium effect (d = 0.62) for the control group. This suggests that the web-based model acted as a valuable adjunct to conventional training.

Table 3 presents the N-Gain results for both groups.

Table 3. Presents the N-Gain results

Group	Mean N-Gain (%)	SE	SD
Experimental	63.90	3.28873	14.70765
Control	24.62	2.92635	13.08703

Normality and homogeneity tests were performed to ensure the data met the assumptions for parametric analysis. The normality test using Kolmogorov-Smirnov and Shapiro-Wilk tests showed that both the experimental and control groups' data were normally distributed, as the significance values were greater than 0.05, allowing for the use of parametric tests like the t-test. The homogeneity test indicated that the variances between the two groups were equal, with a significance value of 0.672 (greater than 0.05), confirming that an independent sample t-test could be used. The independent sample t-test revealed a significant difference between the experimental and control groups ($t(38) = 6.42$, $p < .001$), confirming that the coach-assisted, web-based model supported significantly greater improvement in shooting skills. The experimental group demonstrated higher improvement with less score variation and a higher N-Gain, confirming the model's supportive role in promoting consistent skill acquisition.

Discussion

The results indicated that the experimental group, which used the website-based model, experienced a significantly higher improvement in shooting skills than the control group that employed conventional methods. Consistent with this, the coach-supervised platform showed large improvements (e.g., $p < .001$; large effect sizes reported in Results), indicating a supportive contribution of the website to coach-led practice rather than a replacement. The findings reflect the growing potential of integrating technology into sports training, especially for youth athletes who are in the critical stages of skill development. Nevertheless, we interpret these gains within a blended-learning frame in which coaching remains central. However, while the digital model provided notable advantages, several challenges must be addressed for broader adoption and effectiveness.

Effectiveness of the Website-Based Model

The significant improvement observed in the experimental group, with a mean N-Gain of 63.90%, together with large standardized effects (e.g., Cohen's d reported in Results) and $p < .001$, aligns with findings that technology-enhanced training can benefit performance when integrated with coaching (Gençoğlu & Gümüş, 2020; Zhao & Lu, 2024). The N-Gain value of 63.90% in the experimental group is a strong indicator of enhanced training consistency under coach mediation, as it shows that athletes improved at a higher rate than those in the control group (24.62%). Accordingly, we interpret the website as a complementary tool that supports coach-led instruction rather than a superior stand-alone alternative.

A possible explanation for the observed improvement is the platform's flexible, on-demand modules that extend coach-led practice, enabling athletes to train outside scheduled sessions (Iannaccone et al., 2020; Zhao & Lu, 2024). The ability to review instructional media repeatedly supports skill retention (Juliantine & Setiawan, 2022; Sha'lan, 2022). This flexibility enhances the learning experience, particularly for young athletes with fixed schedules. Importantly, the website structured homework and feedback loops, which may have increased adherence and practice volume under coach oversight (Gençoğlu & Gümüş, 2020). Furthermore, the website-based model's design, which includes interactive elements and real-time feedback, likely contributed to the higher engagement observed. Traditional drills can be monotonous and reduce adherence (Apidogo et al., 2023; Foretić et al., 2022). In contrast, the platform's interactive tasks—paired with coach feedback—appeared to sustain motivation and reinforce correct technique execution.

Challenges in Implementation and Athlete Resistance

While the model was effective, some athletes were reluctant to shift parts of training to a technology-mediated format, being accustomed to the hands-on nature of coach-led practice (Zhao & Lu, 2024). This reluctance is reported elsewhere, where athletes prefer familiar, social in-person contexts (Apanasenko & Tyshchenko, 2024; Madruga-Parera et al., 2025). In this study, hesitancy reduced as coaches actively mediated platform use and clarified expectations, highlighting the importance of change management. However, this resistance does not undermine the observed gains. Instead, it suggests that the best approach is blended delivery, where digital modules extend and structure coach-led sessions (Juliantine & Setiawan, 2022) Prior work indicates that combining digital tools with face-to-face coaching yields a more holistic experience (Gençoğlu & Gümüş, 2020). Our fidelity procedures (coach supervision and session logs) likely supported smoother adoption. Moreover, resistance can be reduced by emphasizing personalization, progressive loading, and clear coach feedback loops. Virtual check-ins and coach dashboards can further increase engagement and accountability, consistent with guidance to keep tools accessible and aligned with athlete needs (Akbar et al., 2024; Schrapf et al., 2017).

Technical Barriers and Accessibility Issues

Another significant challenge was the need for stable connectivity and adequate devices. In settings with limited resources, these requirements may hinder use, creating inequities in access to structured practice (Zhao & Lu, 2024). This is particularly relevant for athletes in developing regions or lower-SES contexts. To address this challenge, offline-capable modules, low-data video, and downloadable practice packs can improve reach (Benešová & Drozdová, 2024; Nadhem et al., 2020). Partnerships for loaner devices

and club-based access points may help bridge gaps (Gençoğlu & Gümüş, 2020). Expert validation supported feasibility; subsequent UI and interactivity refinements during R&D iterations improved usability (Zhao & Lu, 2024).

The model's successful validation supports its potential for broader application. However, further development is needed to improve scalability, contextual adaptation, and integration with club workflows. Expanding to additional handball skills (e.g., passing, defending) and embedding load-management/injury-risk features would align performance gains with athlete safety (Gkagkanas et al., 2023). While the findings are promising, future work should include longitudinal follow-up on match-level outcomes, testing in other sports and age bands, and experiments that vary the intensity of coach mediation to identify optimal blends of digital and in-person delivery. Process evaluations (e.g., fidelity/adherence) and cost-effectiveness analyses would further inform scale-up.

Conclusions

This study evaluated a coach-assisted, website-based training model for handball shooting in athletes aged 15–17. The experimental group showed greater improvements (e.g., N-Gain = 63.90%; Results report $p < .001$ and large effect sizes) when the platform was integrated with coach supervision, compared to the control group (24.62%). The model's flexibility supported structured at-home practice and feedback loops, which may enhance learning. Interpreting these findings within a blended-learning framework, we position the website as a supportive adjunct to coach-led training, not a replacement. Remaining challenges include athlete adoption and equitable technology access. Future work should refine offline capability, examine long-term and match-level outcomes, and test scalability across contexts and sports. This study contributes to evidence on digital tools that augment coaching in youth sport.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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Покращення навичок виконання кидків у гандболі: Ефективність використання моделі тренування на основі веб-технологій для юних спортсменів

Мухамад Аріф[1ABCDE], Сламет Сукріаді[2ABCD], Дікі Рева Апріана Санґа Дві[3ABCD], Гілянґ Рамадан[4ABCD]

[1]Державний університет Джакарти
[2]Державний університет Джакарти
[3]Університет Мухаммадія Кунінґан
[4]Університет Мухаммадія Ґоронтало

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 3 табл., 2 рис., 31 джерело.

Мета дослідження. Мета цього дослідження полягала у вивченні розвитку та допоміжної ролі моделі тренування на основі веб-технологій, розробленої для доповнення тренерських вказівок та поліпшення навичок виконання кидків

у гандболі серед спортсменів віком 15–17 років. Традиційні методи тренувань мають обмеження щодо залученості та послідовності занять, які використання моделі на основі веб-технологій спрямовано мінімізувати шляхом підвищення взаємодії між спортсменами та тренерами й забезпечення доступності.

Матеріали та методи. У дослідженні застосовано метод науково-дослідних та дослідно-конструкторських робіт за моделлю Борга і Галла із претестовим та посттестовим дизайном. Експериментальна група (n = 20) під керівництвом тренера використовувала модель на основі веб-технологій, тоді як контрольна група (n = 20) дотримувалася традиційних методів тренування. Збір даних здійснювався за допомогою тестів на точність виконання кидків, опитувань, інтерв'ю та спостережень.

Результати. Результати показали, що експериментальна група продемонструвала суттєвіше поліпшення показників у точності виконання кидків, з нормалізованим приростом (N-Gain) 63.90% (95% ДІ [58.7, 69.1]; p < .001), порівнюючи з N-Gain 24.62% (95% ДІ [20.3, 29.0]) у контрольній групі. Встановлено, що модель на основі веб-технологій підтримує та ефективно сприяє стандартизації поліпшень, забезпечуючи гнучке інтерактивне навчання за допомогою тренера. Однак визначено проблемні питання, як-от опір спортсменів застосуванню нових методів та труднощі із доступом до технологій.

Висновки. Дослідження підкреслює потенціал цифрових інструментів у спортивному тренуванні, наголошуючи на необхідності комбінованого впровадження з традиційним тренерським підходом та постійного розвитку для розв'язання проблем технічного характеру та доступності. Необхідно провести подальші дослідження з метою вивчення довгострокової інтеграції, масштабованості та тренерсько-опосередкованого впровадження цієї моделі тренувань у різних видах спорту та вікових групах.

Ключові слова: тренування на основі веб-технологій, навички виконання кидків у гандболі, тренування молоді у спорті, цифрові навчальні інструменти, поліпшення спортивної результативності.

Information about the authors:

Arif, Muhamad: marif@unj.ac.id, https://orcid.org/0009-0003-8733-0730; Department of Recreation Sports, Universitas Negeri Jakarta, Jakarta 13220, Indonesia.

Sukriadi, Slamet: slametsukriadi@unj.ac.id, https://orcid.org/0009-0007-3406-9240; Department of Physical Education, Universitas Negeri Jakarta, Jakarta 13220, Indonesia.

Dwi, Dicky Reva Apriana Sanga: dickyreva@gmail.com, https://orcid.org/0000-0001-9221-1777; Deparment of Physical Education, Universitas Muhammadiyah Kuningan, West Java 45511, Indonesia.

Ramadan, Gilang: gilangramadan@umgo.ac.id, https://orcid.org/0000-0002-4208-0067; Department of Sports Science, Universitas Muhammadiyah Gorontalo, Gorontalo 96181, Indonesia.

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