HYSET: Technological-based physical education learning innovation for strengthening service skills in volleyball

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HYSET: Technological-based physical education learning innovation for strengthening service skills in volleyball

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Abstract.

Background Physical Education learning at the vocational high school level faces the challenge of low active participation and student learning outcomes, especially in the overhand serve material in volleyball.

Objectives This study aims to develop and test the validity of the Hybrid Sports Education Model Teaching Factory (HYSET) learning model, which integrates the Sport Education and Teaching Factory approaches with digital technology support.

Methods This study uses the Research and Development (R&D) method adapted from the Borg & Gall model, which includes the stages of needs analysis, planning, initial product development, expert validation, small group trials, and large group trials. The research subjects comprised 120 tenth-grade students from SMK Negeri Jatiluhur, divided into control and experimental groups. The research instruments include expert validation questionnaires, observation sheets, and volleyball service skill tests. Data were analyzed using a quantitative approach (independent t-test) and descriptive qualitative analysis.

Results The results show that experts deemed the HYSET model feasible, received positive feedback from students, and statistically improved upper serviceability in the experimental group compared to the control group ($p < 0.05$). In conclusion, the HYSET model is practical and relevant for implementation in technology-based PJOK learning in vocational schools, as it can holistically develop students' technical, socio-emotional, and managerial skills.

Conclusion This model can serve as an adaptive learning alternative to the modern sports industry's evolving times and needs.

Keywords: HYSET, sport education, teaching factory, volleyball, service skills, educational technology.

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INTRODUCTION

The practice of Physical Education, Health, and Sports (PJOK) learning in vocational schools still faces various challenges. Based on observations at SMK Negeri Jatiluhur, Purwakarta Regency, many students lack the enthusiasm to actively participate in the learning process, which affects their learning outcomes. This challenge is caused by teachers who find it difficult to change their previous teaching habits in daily PE lessons (Casey & MacPhail, 2018). Teachers also lag in keeping up with technological advancements and are weak in collaborating with colleagues (Bodsworth, 2017). This requires teachers to positively change their attitude, effectiveness, and enthusiasm, but they need guidance from experienced colleagues and researchers (Casey, 2014).

Another challenge is students' suboptimal social-emotional competence, as evidenced by their lack of communication, collaboration, and emotion management skills during the learning activities. From the results of previous learning assessments on the primary ball game material for the 2023/2024 academic year in class X at SMK Negeri Jatiluhur, as shown in charts 1 and 2, the volleyball material scored very low at 70 compared to the basketball game, which scored 80. The highest was football, with a score of 85. Upon further investigation, it was found that students' learning outcomes in volleyball, particularly in the overhand serve, were unsatisfactory. This was due to the PJOK teacher's delivery of volleyball material, especially the overhand serve, being less engaging and teacher-centered, and inappropriate teaching methods. As a result, students were less focused and less active in their learning.

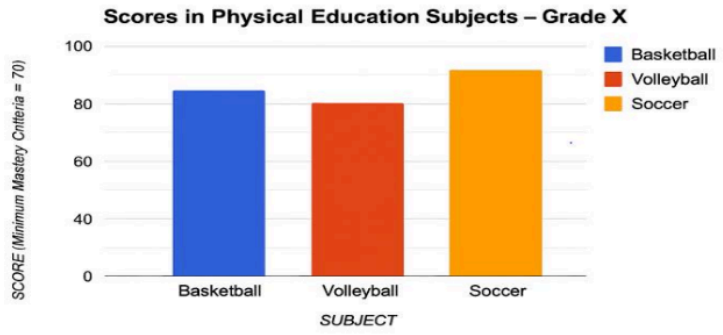

Figure 1 Chart 1 Scores of Grade X students in PE subjects

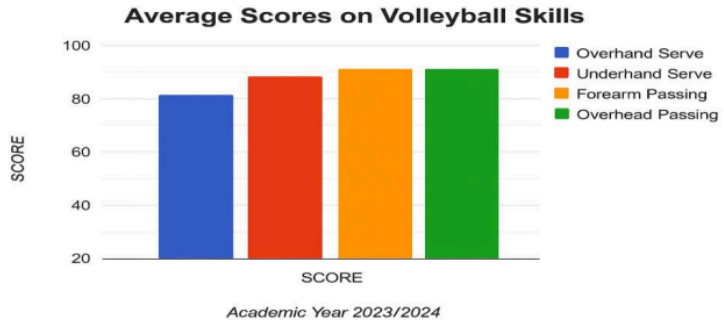

Figure 2 Average scores of various volleyball skills

These issues necessitate an effort to encourage teachers to implement more engaging, effective, and efficient learning relevant to the needs and challenges of the current technological advancement era. This aligns with what Chodzko-Zajko (2023) stated, that a change is needed to encourage teachers to use new methods, such as curriculum innovation, cooperative and integrated learning, and strategic educational management that utilizes technology. The trend of innovative learning in PE is currently popular, including the use of gamified learning models, which have been proven to stimulate students to express higher task orientations such as competence and aggressiveness (Soriano-Pascual et al., 2022). Then, the use of dynamic hybrid models that focus on perception, learning outcomes, satisfaction, and motivation (C. Wang et al., 2023).

Integrating technology, particularly digital and information technology, necessitates systematic modifications that not only replace traditional teaching methods but also alter the way students learn and make the learning process more engaging. Sargent & Casey, (2021) demonstrate that digital technology (DigiTech) can enhance instruction effectiveness by optimizing class time and preparing students for sports-related assessments. In addition to accurately identifying each individual's athletic abilities, facilitating structured data analysis, and providing real-time feedback to enhance learning outcomes, information technology and technology help students learn better (L. Z. Lee et al. 2021). Numerous tools can facilitate personalized learning pathways, optimize learning time, and increase student motivation. The items mentioned include the reversed classroom model, biosensor diagnostics, AI-based performance monitoring, gamified fitness platforms, and mobile applications (Li et al., 2025). These tools also enable students with physical or motivational challenges to participate in traditional physical education classes (Han et al., 2024).

Recent advancements in artificial intelligence (AI), including augmented reality (AR), virtual reality (VR), and the Internet of Things (IoT), have facilitated more personalized and needs-based education in physical education. This has eliminated numerous previous obstacles and opened up new methods of teaching physical education (Cao et al., 2022; X. Y. Zhang & Cheng, 2017). In PE learning, the prevalence of collaborative approaches, such as hybrid, enables instructors to be constructive, providing students with opportunities to practice skills and receive feedback (Salters & Scharoun Benson, 2022). Personalized learning, self-assessment, and student engagement are all improved by this technology. In addition to these benefits, the utilization of technology also raises concerns regarding its ease of use, compatibility with

instructional methodologies, and longevity (Yao, 2024; Lee, 2021). Another concern is the institutional support and teacher readiness that emerge during implementation (Marron & Coulter, 2021).

The researchers endeavored to further develop the HYSET (Hybrid Sports Education Model Teaching Factory) learning model in response to the issue. In the current era of technological and informational advancements, Hyset is a cutting-edge learning model that integrates the Sport Education Model and the Teaching Factory to establish a profound, interactive, and pertinent learning environment. HYSET guarantees that learners acquire the technical and managerial skills required in the contemporary sports industry and the sports skills, particularly the overhand serve in volleyball, through technology, problem-solving, and experiential learning. The primary objective of HYSET is to provide students with the necessary sports skills through genuine competitive contests and incorporate social-emotional competencies and pertinent management skills, thereby stimulating their holistic development.

Students in the HYSET model are confronted with game and managerial scenarios that necessitate applying critical thinking and strategies to surmount obstacles during matches, such as the execution of an effective overhand serve in volleyball or the management of a team. Also, HYSET guarantees that technology is an indispensable component of the educational process. Technology is employed in HYSET to analyze student performance, provide visual feedback, and simulate match circumstances. This approach enhances students' athletic abilities and familiarises them with the technological tools employed in the contemporary sports industry. The objective of this investigation is to evaluate the validity of the HYSET learning model that has been developed. The development is anticipated to result in a learning model that can be implemented in the overhead serve material of volleyball. Furthermore, it functions as an alternative solution to address the requirements of learning models in physical education and can enhance the learning outcomes of students in volleyball.

METHOD

Participant

The subjects used in this study were 120 students from the 10th grade of SMK Negeri Jatiluhur. The subjects were randomly divided into two groups of sixty students.

Research Design.

This research uses the Research and Development (R&D) method adapted from the Gall et al. (2007) consisting of 10 stages, including (1) research and data collection, (2) planning, (3) initial product development, (4) initial field trials, (5) revising trial results, (6) main field trials, (7) refining the product from field trials, (8) field implementation trials, (9) final product refinement, and (10) dissemination and implementation as outlined in the figure 3. According to the objectives of this study, the research steps used only go up to the main field trial stage.

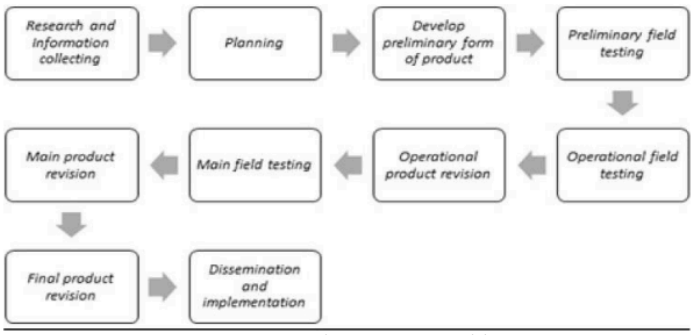

Figure 3 Development stages model

Development Procedure.

The next step is the stages involved in model development. The research and model development in this study uses the model development steps developed by Gall et al. (2007), which include:

1. Research and Data Collection

   The first step in this research was conducted through a literature review and field study by examining the latest theories, concepts, and research findings to support the preliminary field study. Subsequently, a

needs analysis of the problems encountered in the field was carried out, which serves as the basis for formulating the research problem.

2. Model Development Planning

The next step is to design a model to be used as a draft for the initial product design, which will be incorporated into a learning model for testing. The design is expected to become a product that can be developed systematically, effectively, and efficiently. The developed hybrid-based learning model product must be consulted with experts through expert judgment tests, specifically someone who is an expert in physical education, testing and measurement, and volleyball. The development of the HySET model concept considers the elements of Experiential Sports Learning, Problem-Solving Management, and Technological Enhancement in Learning. This model includes learning stages that integrate technology and experiential sports learning.

3. Development of the initial product draft

At this stage of developing the initial product draft, it is designed and tailored to the characteristics of tenth-grade vocational high school students. The model design is based on the stages of performing the underhand pass in volleyball, which include the preparatory phase, the execution phase, and the follow-through phase. Each phase has interconnected sub-movements, starting from the preparation, execution, and follow-through, which will determine the quality of the volleyball serve. At this stage, the draft model is developed based on a hybrid set approach, utilizing the principles of learning technology and real competition match experiences. Then, model validation is conducted based on expert reviews of the learning model to validate the components of the developed learning model. The experts involved are specialists in testing and measurement, physical education, and volleyball. The results of the experts' evaluation will be used as input to refine the design of the volleyball service learning model before it is tested on a small group.

4. Initial Field Trial/Small Scale

The next stage is a limited or small-scale product test, which involves an initial field test of the product design, limited in both the substance of the design and the parties involved. The small group trial was implemented with 30 students at SMK Negeri Jatiluhur. The results of this trial were obtained from questionnaire data and field notes as material to improve the learning model before it is tested on a larger group with a higher number of respondents.

5. Main Field Trial/Large Scale

This large-scale trial was conducted on 120 students from SMK Negeri Jatiluhur from different classes and majors, consisting of 60 students in the control group and 60 in the experimental group.

Instrument validitas Model

The model validity instrument assesses the extent to which the HYSET model design meets relevant pedagogical and learning content standards. The components assessed in this instrument include five main aspects. First, the appropriateness of the material and its usefulness, which measures the relevance of the model's content to the needs of the learners and its ability to enhance learning outcomes. Second is linguistic accuracy, which evaluates the clarity and precision of the language used to prepare the materials and learning guides. Third is the quality of motor skills, which assesses how the model can guide learners to develop psychomotor abilities, particularly in overhand serve skills optimally. Fourth, safety and security ensure that all activities within the model adhere to safety principles in physical education. Fifth is internalized character, which measures the extent to which the model encourages the formation of character values such as cooperation, discipline, and sportsmanship.

Meanwhile, the model usage instrument is used during field implementation to assess the quality of execution and the direct impact of the HYSET model on the learning process and experiences of students. The components assessed in this instrument are similar to those in the validity instrument, including material relevance and usefulness, grammatical accuracy, quality of movement skills, safety and security, and internalized character. Evaluation through this instrument helps assess the actual implementation level of the model and provides feedback on both technical efficiency and the acceptance of the model by students and teachers. Thus, both instruments serve as an important foundation in ensuring that the HYSET model is theoretically valid and practically effective in the classroom.

Volleyball Skills Test Instrument

The skill test used in performance assessment is an evaluation method employed to measure students' skills in volleyball based on applying the skills taught in the context of actual matches. Instrument validation is conducted before the test instrument is used in the research. The validity technique used in this study is

construct validity (expert judgment) with experts in Physical Education, testing and measurement, and experts in volleyball sports.

Data Analysis

The data analysis used in this research and development employs qualitative and quantitative analysis techniques. The qualitative analysis technique is used to analyze data from experts in the form of input, comments, critiques, and suggestions. The results of the data analysis serve as the basis for refining product development. Quantitative analysis techniques or effectiveness tests use statistical data analysis, specifically the independent samples t-test, using the SPSS statistical application. Both tests are complemented by prerequisite tests such as normality and homogeneity. The t-test is conducted to determine the level of difference in pretest and posttest scores within the same group, as well as the difference between the control group and the experimental group.

RESULTS AND DISCUSSION

Results

HYSET was developed by integrating competition-based PE with project-based industrial education. In HYSET, students take on the role of sports participants and as managers, coaches, referees, sports event organizers, sports marketing agencies, home industry merchandise, IT development, etc., mimicking real-world dynamics. Here are some concepts from HYSET: 1) Competition-Based Learning Just like in the Sport Education Model (SEM), students will engage in sports activities that mimic a seasonal structure. Each student takes on different roles, from player and coach to manager, and participates in realistically designed competition simulations. 2) Project-Based Learning Adopting the principles of Teaching Factory, HYSET incorporates industrial project elements where students must design, manage, and execute projects related to sports management, such as organizing tournaments, managing facilities, or creating business strategies in sports. 3) The Use of Technology in Skill Development: Technology is central to HYSET. Students use technological tools such as video-based performance analysis, virtual match simulations, and project management software to develop their technical and managerial skills. 4) Integration of Theory and Practice: HYSET emphasizes the balance between theory and practice. Students will learn sports theories, game strategies, team management, and social-emotional skills, which will be directly applied in real projects and match simulations. 5) Collaboration with Industry HYSET collaborates with industry partners, including sports clubs, sports organizations, and related companies, to provide real-world experiences. Students can intern, learn directly from industry practitioners, and gain insights into the dynamics of the working world.

Technology Integration

Vocational school students, especially in this digital era, are highly interested in technology. They are accustomed to using technological devices in their daily activities, including learning. Therefore, using information and communication technology (ICT) becomes an important part of vocational school learning. By understanding these characteristics, educators in vocational schools can design relevant teaching methods that are engaging and effective in developing students' cognitive, social, and emotional competencies.

The use of technology in skill development plays a central role in HYSET. Students use technological tools such as video-based performance analysis, virtual match simulations, and Android applications that can be used on Android/iOS smartphones, tablets, or laptops for project management to develop their technical and managerial skills. HySET is designed for vocational school teachers and students to digitally integrate sports competencies, managerial skills, and 21st-century skills. The main features of this application include Interactive learning modules (videos, infographics, and e-books), a Team and role management system (captain, referee, journalist, commentator), Digital rubric-based assessments (cognitive, psychomotor, affective), Real-time learning reflection and feedback, Student activity score recap and portfolio, and school e-learning system. Usage is done by opening the HySET Application, through the link https://hyset.my.id/ and entering the username and password provided by the school. click "Login". If the prospective user does not have an account yet, click "Register".

The design of the volleyball learning model product is developed based on the existing curriculum and theories. The scope of the product design consists of: 1) the applicable curriculum, 2) the product systematics, 3) the developed product framework. After developing the main product, the researchers conducted product validation using the content validation method with experts. There are three experts who validated this product, namely learning experts, volleyball experts, and basic movement (motoric) experts. The validation by learning experts was carried out by having the experts fill out a validation questionnaire related to the developed

product. The questionnaire has 5 indicators with 18 assessment criteria. Based on Table 2, the overall result indicates that the developed product is deemed suitable for use, albeit with some noted improvements. Thus, according to the expert's validation, this product is suitable for testing.

Table 1. Features of the Hyset Android App

HySET Model Component	Features in the HySET Android Application	Supporting Function
Sport Education	Student Roles & Responsibilities Game Simulation	Simulates real-world roles in sports and tournament settings
Teaching Factory	Upload Practice Documentation Collaborative Assessment	Creates authentic experiences similar to those in the sports or media industry
Hybrid Learning	Digital Modules Discussion Forum Reflective Journal	Provides flexible, technology-based learning opportunities
Holistic Assessment	Cognitive, Affective, and Psychomotor Rubrics	Supports process-oriented assessment, not just outcome-based evaluation

Table 2. Expert Validation Results Data

Aspect	Description
Relevance and Usefulness of Material	Feasible
Language Accuracy	Feasible
Quality of Motor Skills	Feasible
Safety and Security	Feasible
Internalized Character Values	Feasible

Product Testing

Product testing is conducted three times. The initial test was conducted with a small number of subjects, the field test was conducted with a large number of subjects, and the operational test was used to assess the effectiveness of the developed product. The initial/small group trial was conducted with 30 students as subjects and assisted by two teachers as observers. Table 3 presents the five results of the observers' observations during the implementation of the model in actual learning.

In addition to observing the implementation of the model items, the researchers also gathered information from the students as subjects through simple questions. This is to understand the feelings of the students while engaging with the developed model (see table 4). Based on the responses from the students, positive results were obtained, where the majority of participants were able to perform, felt happy, did not feel bored, and even tended to want to repeat it again. Thus, the developed model can be tested on a large group. However, there are several points noted by the researchers and observers to improve the product after the small group trial.

Table 3. Recapitulation Observation Results During Small Group Trial

Aspect	Score Obtained	Maximum Score	Percentage (%)	Remarks
Relevance and Usefulness of Material	52	60	86.67%	Very Good
Language Accuracy	31	36	86.11%	Very Good
Quality of Motor Skills	64	72	88.89%	Very Good
Safety and Security	20	24	83.33%	Very Good
Internalized Character Values	21	24	87.50%	Very Good
Total	188	216	87.04%	Very Good

Table 4. Recap of Student Responses to the HYSET Model

Questions	Yes	No	Total	Percentage (%)
Were you able to perform the movements demonstrated by the teacher?	30	0	30	100%
Was the HySET application easy to access?	30	0	30	100%
Was the material presented in the HySET application easy to understand?	30	0	30	100%
Did you feel happy while learning?	30	0	30	100%
Did anyone feel bored during the lesson?	28	2	30	100%
Would you like to learn using this method again?	30	0	30*	100%

Main Trial

The main trial was conducted after making technical improvements according to the notes from the small group trial. The large group trial was also assisted by two observers tasked with observing the learning process during the implementation of the model. Table 5 presents the results of the observers' observations during the implementation of the model in actual learning during the large group trial. The results of the large group trial on the implementation of the HYSET learning model show a very high feasibility level across all

assessed aspects. The assessment was conducted on five main aspects that reflect the quality of content, language, motor skill performance, safety, and character values instilled through the learning process.

The aspect of material relevance and usefulness received a score of 58 out of a maximum score of 60, with a percentage of 96.67%. This reflects that the learning material presented in the HYSET model is highly relevant to students' needs and contextual to the physical education teaching practices in vocational schools. Next, the grammatical aspect received a percentage of 94.44%, indicating that the use of language in the materials and instructions is very clear, easy to understand, and appropriate for the developmental level of the students. This is important to ensure there are no comprehension barriers due to the wording of the materials. In terms of the quality of movement skills, a score of 68 out of 72 (94.44%) was obtained, indicating that the HYSET model is able to facilitate students in mastering basic movements, particularly the overhand serve in volleyball, very well. The aspect of security and safety, which is an important element in physical education learning, received a high score of 95.83%. This indicates that all activities in the model have been designed and implemented with optimal consideration of student safety principles.

Meanwhile, the internalized character aspect received a percentage of 87.50%. Although slightly lower than other aspects, this score still falls within the "very good" category, indicating that the model has successfully instilled character values such as sportsmanship, cooperation, and responsibility, although there is still room for further improvement in strengthening affective values. Overall, the average score across all aspects reached 92.59%, categorized as "very good." This result indicates that the HYSET model is not only suitable for broader use but also has great potential in improving the quality of physical education learning, both technically, pedagogically, and in character development for students.

Table 5. Recapitulation of the Main Test Results

Aspect	Score Obtained	Maximum Score	Percentage (%)	Remarks
Relevance and Usefulness of Material	58	60	96.67%	Very Good
Language Accuracy	34	36	94.44%	Very Good
Quality of Motor Skills	68	72	94.44%	Very Good
Safety and Security	23	24	95.83%	Very Good
Internalized Character Values	21	24	87.50%	Very Good
Total	200	216	92.59%	Very Good

The results of the descriptive statistical analysis show a difference in the average gain score between the control class and the experimental class in learning volleyball service skills (Table 6). The control group, which did not use the HYSET learning model, recorded an average (mean) score of 2.74, with a standard deviation of 10.00, and a standard error of 1.2905. Meanwhile, the experimental group that received the intervention through the HYSET model showed an average gain value of 48.43, with a standard deviation of 13.03 and a standard error of 1.6818. The average score difference of 5.69 points between the two groups indicates that the implementation of the HYSET model has a positive effect on improving students' skills, particularly in serving in volleyball. Although this data does not yet indicate statistical significance, the average score difference serves as an initial indication of the practical impact of the HYSET model intervention. The difference in standard deviation between the two groups also indicates that the variation in learning outcomes in the experimental group is slightly higher, which can be interpreted as this model providing more room for student expression and skill development in a broader and more individualized manner. This result reinforces the suspicion that hybrid and contextual-based models like HYSET are capable of creating more meaningful, flexible and responsive learning tailored to the needs of each student.

To determine whether there was a statistically significant difference in gain scores between the control group and the experimental group in mastering overhand volleyball serving skills, of the Kolmogorov-Smirnov normality testand Levene's Test for Equality of Variances was first conducted. The results of the Kolmogorov-Smirnov normality test show a significance value greater than 0.05. Thus, it can be concluded that the data from the control group and the experimental group are normally distributed. Furthermore, a statistical test to determine whether there is a difference between the control group and the experimental group was conducted using the T-test (T Independent Sample Test) presented in the following Table 7.

The result of Levene's Test on table 8 showed a significance value of 0.167, which is greater than the critical value of 0.05 (Sig. > 0.05). This indicates that the variances between the two groups are homogeneous, and thus the assumption of equal variances is met. Accordingly, the interpretation of the t-test is based on the row "Equal variances assumed." The Independent Samples t-Test revealed a t-value of -2.485, with degrees of freedom (df) = 118 and a two-tailed significance (Sig. 2-tailed) of 0.016. Since this p-value is less than 0.05 ($p < 0.05$), it can be concluded that there is a statistically significant difference between the gain scores of the

experimental and control groups. The mean difference between the groups is -5.693, meaning the experimental group achieved a higher gain score than the control group. The 95% confidence interval for the mean difference ranges from -10.281 to -1.106, suggesting that this difference is both consistent and unlikely to have occurred by chance. the findings demonstrate that the HYSET learning model had a significantly greater impact on improving students' overhand volleyball serving skills compared to conventional teaching methods.

Table 6. Descriptive Statistical Analysis

	Group	N	Mean	Standard Deviation	Standard Error Mean
Gain	Control	60	42.7400	10.0000	1.2905
	Experiment	60	48.4300	13.0300	1.6818

Table 7. Normality Test Result

Group	Statistic	df	Sig. (p-value)
Experiment	0.083	60	0.200
Control	0.093	60	0.115

Table 8. Independent Sample Test

Test	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
al variances assumed	1.942	0.167	-2.485	118	0.016	-5.69	2.31	-10.28 to -1.11
Equal variances not assumed	1.942	0.167	-2.485	112.680	0.016	-5.69	2.31	-10.28 to -1.11

Discuss

The results of this study indicate that the HYSET learning model has model validity that has been developed and proven through a series of development stages based on expert evaluation and field tests on two scales (small and large). This model is valid in content and effective in its implementation, as evidenced by high observation scores from observers and significant improvements in students' skill scores. The developed HYSET model combines two main approaches: the Sport Education Model (SEM), which emphasizes competition-based learning experiences, and the Teaching Factory, which promotes project-based learning principles. The SEM model is a suitable choice as it can enhance student motivation by providing opportunities for higher physical activity levels (Perlman, 2012; Choi et al., 2021; Manninen & Campb 2021). Furthermore, the SEM model can create a content-focused learning environment, allowing students to increase their engagement, enjoyment, and social interaction in physical education lessons (Gil-Arias et al., 2020; J. Zhang et al., 2024).

Furthermore, in developing the HYSET model, which integrates digital technology into PE learning, this integration has proven capable of creating a contextual, interactive, and relevant learning environment that meets the needs of the current s ts industry. Goodyear (2020) states that digital technology can be integrated into physical education lessons to upport, develop, and expand learning in the physical, cognitive, social, and affective domains. This concept aligns with the findings of Rohayati et al. (2022), where the integration of virtual reality technology can meet learning needs by influencing students' cognitive and affective abilities and bringing them closer to concrete understanding. Furthermore, Alam & and Mohanty (2023) explain that integrating digital technology in PE learning creates various interaction patterns to enhance the educational experience, thereby meeting students' needs for better development; furthermore, in line with the findings of Chodzko-Zajko (2023), which emphasize the importance of transforming sports pedagogy towards a more innovative and technology-adaptive approach.

The use of technology in the HYSET model has become one of the key pillars that distinguishes this model from conventional approaches. Digital technology, such as motion analysis videos, virtual simulations, and the HySET Android application, has proven capable of increasing student engagement, providing real-time feedback, and supporting more accurate and holistic assessments. These results are consistent with a study by Kuleva (2024), which states that VR-based interventions can enhance performance, knowledge retention, and adherence to training regimens by providing realistic scenarios.

Quantitative analysis shows that the experimental group using the HYSET model had a significantly higher increase in upper service skill scores compared to the control group. With $p = 0.016$ (< 0.05) in the Independent Sample Test t-test, it can be concluded that applying the HYSET model significantly contributes to improving basic volleyball movement skills. This finding supports the view of Sargent & Casey (2021)that digital technology plays an important role in making PJOK learning more engaging and personalized. The use

of interactive features such as digital rubric assessments, role and team systems, and learning reflections strengthens cognitive and psychomotor aspects and students' affective and socio-emotional dimensions.

One of the main strengths of HYSET is the development of students' non-technical competencies, such as collaboration, leadership, decision-making, and team management skills, which are reflected in simulated roles such as coaches, managers, referees, and sports commentators. This form of holistic learning supports the development of character, soft skills, and student work readiness, as stated by Salters & Scharoun Benson (2022) that the positive response from students, both in small and large group trials, indicates that integrating social-emotional aspects and real-life experiences through match simulations successfully created an enjoyable and engaging learning atmosphere.

Although the results of this study indicate the effectiveness of the HYSET model, several challenges still need to be addressed. Among them are teachers' readiness to adopt technology, the need for intensive training for application use, and institutional support in providing infrastructure and policies that foster learning innovation. Marron & Coulter (2021) emphasize the importance of systemic support for successfully adopting technology in physical education. In addition, the expert validation results also provided notes for improvement on the initial product, indicating that the development of the learning model is iterative and requires continuous reflection and evaluation. Technology and organization enable physical education teachers' readiness to use and integrate wearable technology in physical education (Almusawi et al., 2021). Then, X. Wang (2024) recommends enhancing teachers' ability to acquire intelligent aids and promoting the three-way teaching modality "teacher-AI-student" while considering the influence of various aspects.

CONCLUSION

This research concludes that the HYSET learning model is a valid and effective pedagogical innovation for improving overhand serve skills in volleyball among vocational high school students. This model has proven feasible based on expert validation and field tests, both on a small and large scale, with perfect observation scores and student responses. Integrating the Sport Education and Teaching Factory approaches in the HYSET design allows for the creation of a competitive, collaborative, and contextually relevant learning environment with the sports industry. Using digital technology as an integral part of this model also enhances learning effectiveness through performance analysis, match simulations, and assessments based on Android applications. In addition to strengthening psychomotor aspects, this model also contributes to developing students' social-emotional and managerial skills. The statistical analysis results show a significant improvement in the overhead serve ability in the experimental group compared to the control group. Thus, it can be concluded that the HYSET model empirically positively impacts students' learning outcomes in the context of physical education in vocational high schools (SMK). The results of this study provide several significant practical implications in the context of physical education learning at the Vocational High School (SMK) level. The HYSET model offers teachers an innovative and adaptive learning approach in line with the times, particularly in digital technology. Teachers act as facilitators and learning managers who integrate competitive, collaborative, and contextual aspects into sports classes. The HYSET Android application allows teachers to manage classes more effectively through digital rubric-based evaluations, real-time student performance monitoring, and role management in match simulations.

This study demonstrates success in developing and testing the validity of the HYSET model, but several limitations need to be considered. First, this study only reached the main field trial stage; thus, it has not yet covered the full implementation and dissemination of the model in various school contexts. These limitations hinder the understanding of the adaptability of the HYSET model in broader learning contexts, such as in other educational levels, schools outside Purwakarta, or in conditions with more limited resources. Second, the focus of the model evaluation is still limited to the aspects of validity and effectiveness regarding volleyball service skills, without conducting longitudinal measurements of the long-term impact of learning on other aspects such as student character development, sustainability of technology use, or managerial skills outside the sports context. Third, the use of digital technology in the HYSET model is viewed positively by students and teachers. However, this study has not explored technology implementation challenges, such as infrastructure constraints, teacher digital literacy, or technical application barriers in the field. Additionally, measuring effectiveness emphasizes quantitative data (skill scores) without being balanced by more in-depth qualitative data such as interviews or case studies.

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AUTHOR CONTRIBUTION STATEMENT

RH plays a role in the planning of the study concept, determination of methods, preparation of instruments, data collection and processing, and manuscript writing. AO is responsible for determining the study issues, managing samples and instruments, data collection, and data analysis as well as manuscript writing. Lastly, BS is involved in the planning of the study concept, determination of methods, preparation of instruments, data collection and processing, and manuscript writing.

CONFLICT OF INTEREST AND FUNDING

The authors declare that there is no conflict of interest

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