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RESEARCH ARTICLE

"Optimizing Smash Techniques: A Novel Training Model for Badminton Athletes"

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ABSTRACT

This article discusses the development of a smash skill training model in badminton, designed to improve the skills of college students aged 18-22 years. This study used a Research and Development (R&D) approach based on the Borg and Gall model, which involves ten stages, from needs analysis to product implementation and dissemination. The model is systematically organized with activities designed based on difficulty levels, ranging from simple to complex movements. Each activity is also equipped with attractive visual illustrations, implementation steps, learning objectives, and supporting media. The results showed that this training model was effective in improving students' smash skills. The effectiveness test was conducted using the pretest-post-test control group design method, showing a significant increase in the experimental group compared to the control group, with an average N-Gain value of 68.28% (moderately effective category). This model focuses not only on technical aspects, such as body position, shuttlecock release angle, and movement coordination, but also on strategy elements such as smash target variation, interval setting, and attacking tactics. This research offers the novelty of integrating stepwise movement formation, analysis of speed and accuracy, and a direct feedback-based learning approach. The resulting model is not only relevant for students but can also be adapted by coaches and sports institutions to develop athletes' skills holistically. In addition, the final product in the form of a guidebook and Android-based application is expected to facilitate the dissemination and application of this model on a wider scale, supporting more innovative and evidence-based badminton sports coaching.

1. INTRODUCTION

Badminton is one of the most popular sports in Indonesia and even the world. Badminton is a competitive sport where players use small, long rackets to hit a shuttle over a net. Badminton can be played with two or four players in two teams. Badminton is a fast-paced sport that requires a high level of skill and coordination (Van Herbruggen et al., 2024).

The game of badminton requires players to be able to combine technical skills, tactical strategies, and physical fitness to achieve peak performance. Badminton is a highly competitive and physically demanding sport that requires athletes to have a combination of speed, agility, and explosive power (Ma et al., 2024).

Core strength training plays an important role in maximizing the performance of badminton athletes. Core muscles in the abdominal, back, and hip regions that can provide stability, allow efficient power transfer between the upper and lower body, and enable rapid changes in direction are all critical components for success in badminton (Ma et al., 2024).

Various badminton training programs and methodologies have been conducted in many countries. One of the concepts to develop athletes in the long term is the concept of Long Term Athlete Development (LTAD), developed by Balyi (1919), has 7 stages of development, namely the Active

Start stage in the age group 0-6 years, the Fundamental stage of age 6-8 (female) 6-9 years (male); Learn to train stage at the age of female athletes 8-11 years son 9 12 years; Train to train stage at the age of girls 11-15 years, boys 12-16; train to compete at the age of girls 15-21 boys 16-23; train to win, the age at this stage for girls 18 years, boys 19 years; Finally is Active for Life, as a stage of athletes remaining active in maintaining fitness, playing an active role for the advancement of the world of sports.

One of the most interesting analyses in badminton is modeling the evolution of positional information about the player and the strokes performed. (Gómez et al., 2020). Among the various techniques in badminton, smash is considered an important skill due to its role in winning points and dominating matches. A powerful and accurate smash not only reflects technical mastery but also demonstrates a player's ability to apply bio-mechanical principles effectively.

Forehand overhead smash is the most dominant skill performed in badminton, where one must position his body in relation to the incoming shuttlecock to produce an accurate smash. Most popularly discussed is, Forehand jump smash which is often considered as the most aggressive skill in badminton (Putra & Mohamad, 2023). Compared to standing smash, jump smash has a higher contact point and a steeper shot, making it easier to break through the defense as it leaves the opponent with less time to be able to return the shuttlecock (Phomsoupha & Laffaye, 2015).

In the highly competitive world of professional badminton, coaches and players are constantly looking for ways to gain an edge over their opponents. Detailed match analysis has become indispensable for identifying key patterns, developing winning strategies, and creating customized training plans. (Lin et al., 2024).

In recent years, competitive badminton requires athletes to perform high-speed, high-intensity movements, examples of which include rapid acceleration, sudden stops, shock effects and changes in direction (L. Zhang et al., 2024).. Various innovative training methods have emerged as a focal point in sports education and performance improvement of badminton athletes. Existing studies have largely focused on isolated aspects, such as biomechanics, muscle strength, or shuttlecock speed (Barnamehei et al., 2021; Deng et al., 2024; Ma et al., 2024; L. Zhang et al., 2024) without holistically addressing the interaction of technical factors without holistically addressing the interaction of technical, physical, and cognitive factors.

The smash is the last attack blow to get numbers. Badminton World Federation (BWF) has rules about counting numbers by using a rally point system. This system will require a player to play with an attacking pattern so that a blow is needed with full speed, aggressively and carefully. The target area in smash shots is often directed at empty areas of the opponent's defense and also at the opponent's body. Conditions like this will be easily predicted by the opponent where the direction of the blow will be carried out so that the training model carried out tends to be in empty areas of defense such as the right and left side areas. Whereas there are other target areas that are rarely done by many players, namely targets in the opponent's body area. The target of the blow to the body area will also make it difficult for the opponent to return the blow we do.

The strength of the smash can be done with full strength and speed and can also be done with half the strength, this is done as a tactic so that the smash that the opponent is able to return goes wrong so that on the next occasion it will be more likely to kill the opponent's game. To get the desired smash shot results, the correct smash shot technique is needed. The more quality technical skills an athlete has, the better the results will be. Badminton games will be influenced by the evolution of the intensity of the game, this is very necessary movement patterns associated with increased strength or mobility in the arms and shoulders, legs and back (Hung et al., 2020).

Smash is one of the most relevant keys to success for scoring critical points in badminton matches (Hassan, 2017). At the 2015 world badminton championships, smash shots performed during rallies showed a large number of shots performed in the final match (Valldecabres et al., 2017).

The results of pre-research conducted by researchers on 4 Student League badminton championships in Indonesia which were held from 2019-2022. Researchers collected data on 16 men's singles student athletes. From the data obtained, it was recorded that the total forehand smash strokes were 425 strokes with details of the strokes reaching 50% (215) strokes, smash returned

26% (112) strokes, smash out 17% (75) strokes, smash concerning 7% (23) strokes. This data illustrates that the smash ability still needs to be improved.

Referring to the description above, it has explained that it is very important for novice athletes to master smash shots well, where the body position has an influence on the shuttle kock release angle and clear height for offensive players, so that an athlete can do it comfortably. (Li et al., 2017).

Various previous studies have been conducted on various badminton training methods (Barnamehei et al., 2021; Deng et al., 2024; Gómez et al., 2020; Lin et al., 2024; Ma et al., 2024; Malwanage et al., 2022), but specifically about smash shots (Koike & Hashiguchi, 2014; Rusdiana et al., 2021; Rusydi et al., 2015; C. Zhang, 2021; Pan et al., 2024). There is still a lack of discussion in terms of training models, especially for university students or those aged 19 23.

Despite its significance, training methods to master smash in badminton often lack a structured and evidence-based approach, especially in integrating modern pedagogical models and sports science principles, especially in college students. In this article, the researcher tries to develop models of smash technique training in badminton games that are more directed, starting from the initial to the final attitude and starting from easy movements to complex movements. The results are expected to know the description of smash training models that can be applied in training in accordance with the principles of playing badminton in general. The characteristics of the model developed by the researcher differ from previous studies in several ways:

1) The training model developed includes basic smash technique training.
2) The research subjects were systematically introduced to various types of basic technique exercises that were more varied from understanding the basic concepts of the model to very detailed movements.
3) The subjects of this study are categorized as student athletes with ages between 18-22 years, because technically in playing badminton, they have not shown motor skills, especially smash shots correctly, so that the training process is carried out with a psycho motor aspect approach.
4) The developed model incorporates a variety of training plans required for field tests into a basic technique training model.
5) Thorough deepening and mastery is given from the time the research subject does a very basic model introduction to a very complex series of movements.
6) The resulting product is summarized in a badminton smash technique development model.

By providing a structured and scientifically based training model, this study seeks to contribute to the advancement of badminton coaching practices, thereby promoting the development of skilled players. The findings of this study will have implications for coaches, athletes and sporting institutions aiming to optimize training methodologies and improve competitive performance in the sport of badminton.

2. MATERIALS AND METHODS

This research uses qualitative and quantitative approaches, which are approaches with the aim of finding answers to the problems that have been formulated in this study. The Research and development (R&D) model are a research method used in developing and validating products used in education and learning skills (Ipang & Heri, 2014). This development research was conducted at Jakarta State University and Yogyakarta State University. The implementation time of this research and development, starting in October 2024 until December 2024. Small group trial in September 2024 at Yogyakarta State University. Large group test in October 2024 at Jakarta State University, involving 31 partisipant for experiment and 31 partisipant for Control in October-November 2024 at Jakarta State University. The characteristics of the model developed are the development model of badminton smash training. This means developing forms of smash training in badminton games with various variations and will produce a product that can be a guide and demand for coaches, badminton sports lecturers.

Model developed

Stroke techniques in badminton games can be divided into three types of shots, namely from above the head such as smash, lob, chop, side blows such as drives and shots from below such as serves, drops, netting. In order to play badminton well, a player must be able to hit the shuttlecock, each of which has a different direction and speed.

The model design in this Badminton Smash training model development research, using the model from Borg & Gall (1983: 772) which consists of ten steps:

1) Research and information gathering-Includes review of literature, classroom observation, and preparation of a report of the state of the art.
2) Planning-Includes defining skills, stating objectives determining course sequence, and small-scale feasibility testing.
3) Develop preliminary form of product-Includes preparation of instructional materials, handbooks, and evaluation devices.
4) Preliminary field testing- Interview, observational and questionnaire data collected and analyzed.
5) Main product revision-Revision of product as suggested by the preliminary field-test results.
6) Main field testing-Conducted. Quantitative data on subjects pre-course and post-course performance are collected. Results are evaluated with respect to course objectives and are compared with control group data, when appropriate.
7) Operational product revision-revision of product as suggested by main field-test results.
8) Operational field testing-Conducted. Interview, observational and questionnaire data collected and analyzed.
9) Final product revision-Revision of product as suggested by operational field-test results.
10) Dissemination and implementation-Report on product at professional meetings and in journals. Work with publisher who assumes commercial distribution. Monitor distribution to provide quality control.

Meanwhile, the design of the badminton smash training model consists of the following activities: 1) Formation of motion in the initial attitude, starting from the formation of the position of the feet, body and arms; 2) Motion formation in the attitude of execution or when in contact with the shuttlecock, starting from the movement of the legs, arms and body; 3) Formation of motion in the final posture, starting from the position of the legs, arms and body; 4) Formation of overall motion / combination of movements or the formation of overall coordination of movements.

The quantitative test instrument used in this study used the badminton smash test (Saleh Anasir, 2010) with a validity level of 0.926 and reliability of 0.90. This instrument score test will be used as a benchmark or equivalent to scoring test instruments.

Assessment method:

- The score is obtained according to the target of the punch, namely the score area 5,4,3,2,1. (See: Figure 1)
- Score 0 if the shot falls outside the target area. – Score 0, if the bait does not hit the testee's racket (not hit).
- If the shuttlecock falls on the line between the two targets, the largest value is taken.
- If the pass is bad, the testee is allowed to refuse and the pass is repeated.
- The treatment was 20 times, with 10 from the right box and 10 from the left box.

The necessary facilities are: 1. Badminton court, 2. Racket. 3. Kok 4. Stationery and assessment blanks, 5. Technical executives: 6. Target supervisors, and feeders.

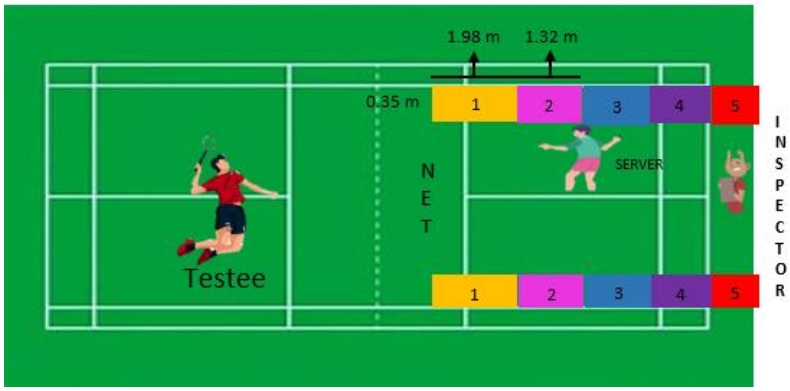

Figure 1.Target of the punch

3. RESULTS AND DISCUSSION

In accordance with the stages of the Borg & Gall research and development model, the results of each stage are reported as follows:

a. Information gathering

Based on the theory of model development that the author makes the basis for designing product manufacturing, namely first conducting a needs analysis study. The main objectives to be expressed at this stage are as follows:

1) How important is the development of a badminton smash skill training model.
2) What obstacles and support are encountered in developing this badminton smash skill model. The needs analysis was carried out by conducting preliminary studies in the form of literature studies and empirical studies through observations and interviews as well as the personal experience of researchers as coaches, academics and also badminton sports observers.
3) Based on the results of the needs analysis that has been carried out, there are several important points that make the basis for the need to develop this badminton smash skill training model, namely:
    a. All participants have received material about badminton smash when they were in school starting from elementary and middle school, but most still find it difficult to understand and master badminton smash skills. This is because the material provided is not in accordance with the stages of motion and characteristics of students, so that students are less than optimal in receiving training material.
    b. The process of providing training materials still focuses on the group, although it is felt that it is good for the affective formation of students, but individual understanding and skills seem to be lacking.
    c. There is no training model that is structured according to the stages of motion training and can flexibly be done anywhere and anytime.

b. Research Planning

In this stage, researchers carry out planning to develop model products. Based on the results of the needs analysis obtained, it is necessary to develop a smash skill training model that is in accordance with the stages of motion training, systematic, structured, and can be flexibly applied during training. In the planning stage of this research, the researchers formed a team according to their field of expertise and prepared several facilities needed during the training, such as: 1) Training equipment, 2) Camera, 3) Draft Model developed, 4) Draft model evaluation, and 5) Draft badminton smash skill evaluation instrument.

c. Initial Product Development

After planning the product, the researcher began to develop the product. The product developed in the form of a badminton smash skill training model which is arranged according to the stages of motion training, as well as a description of the characteristics of each model activity performed. The

development of this training model needs to pay attention to several aspects, such as the equipment used, the devices used and the place to do it. The model activities developed are arranged systematically and in detail, starting from the name of the activity, the purpose, the tools used, and a description of the movements or steps of the exercise. Based on the results of the needs analysis and planning stages that have been carried out in the product design design, 34 items of badminton smash skill training model for students are formed.

After developing the initial product based on needs analysis and product design planning, the next step is to conduct expert testing or expert validation (expert judgment) of the product model developed. This is done so that the product developed is more ready and feasible to be tested in the field.

The following is the data from the validation results of the three experts related to the motion activities carried out, 32 are feasible to implement, and there are 2 that are feasible to revise. This is because basically the activity is feasible, but there are revisions in several things, such as the use of media and the distance between targets and the direction of the shot. Therefore, the results of validation from the three badminton experts left 34 forms of activities that are suitable for use, but with some input and improvements.

Based on the table above, in summary of some of the validation results in the form of suggestions and input from experts, the following conclusions were obtained:

a) All activities are in accordance with the stages of learning motion, because there are several activities for the attitude of smash motion formation.

b) The objectives of each activity should be more specific according to the stages of the movement, namely the initial attitude, the impact, the final attitude and the coordination movement.

c) Each activity should be given a description or divided by the characteristics of the movement, starting from easy, moderate to difficult activities, so that the stages of each activity given are clearer.

d) The media used for each type of activity is more optimized for each element of motion in badminton smash movements such as jumping elements, forward / backward motion, right / left side.

e) The images in each activity need to be made more attractive, such as being made clearer so that students are more interested and understand to see and study them.

f) The model developed must be able to illustrate the purpose of the exercise as a whole, namely to foster the development of cognitive, affective and psychomotor aspects.

d. Product Revision from Expert

Based on the evaluation results, suggestions and input from several experts, the researchers revised the model products that had been developed. The revisions made at this stage are as follows:

- The images and characters on each motion activity are made more interesting clear, thus increasing student interest and understanding.
- Movement ability, training interval, difficulty factor, power and speed of the stroke are the basis for seeing the quality in execution.
- There are several strike directions and target distances to be adjusted, so that it is easier to understand and clearer the instructions and objectives when performing the movement activity.
- The objectives in each movement activity are made more specific and reflect each stage of the badminton smash movement, such as initial attitude, execution attitude, final attitude and coordination movement.
- The characteristics of each movement activity are made of easy movement activities, moderate movement activities and difficult movement activities.

The following is a revised draft of the model design and motion activity task display of the developed model.

e. Small Group Trial

In this trial, researchers involved 30 students at Yogyakarta State University as respondents. The implementation of this small group trial was carried out at the badminton building of Yogyakarta State University and involved one of the badminton teaching team. During the implementation of this trial, the researcher together with the team made direct observations of the implementation of this smash training model and provided evaluation sheets to respondents to obtain information related to the training model activities that had been obtained.

Based on the results of observations and evaluations from respondents, here researchers get some notes about the smash training model that has been given. As for some notes during this small group trial, including the following:

1. Overall, this training model is very good and is appropriate for students, because the objectives of each activity are clear, the division of each activity is also in accordance with the level of difficulty so that students know each activity systematically. The division of training formations that provide more knowledge to participants, so that this badminton smash can be learned by who and how many people in each activity performed.
2. The scope of smash movement activities makes this training activity more focused and able to foster the creativity of participants to make variations of movements in each activity.
3. There are some activities that still seem unclear to do, so it is necessary to revise the form of the activity so that participants can do it more optimally.

f. Revision of Small Group Trial Results

After the small group trial was conducted and obtained some notes and input from respondents and teaching lecturers, the next step was to revise the developed model. The following is a summary of the revised small group trial results based on field notes, input and suggestions from related parties.

Based on the results of the small group trial and the results of the review at this revision stage, it can be concluded that almost all activities/motion tasks in the badminton smash skill training model can be carried out, but there are several activities/motion tasks that must be revised to make them clearer so that participants as a whole can better understand the purpose of the activities they are doing.

After revisions at this stage was made, the next step is for researchers to test this badminton smash skill training model to a larger group, meaning that it will involve more respondents.

g. Large Group Trial

This large group test involved 50 students of the State University of Jakarta as participants. In this large group test stage, researchers also involved several lecturers teaching badminton games.

Based on the results of the large group trial, several notes and feedback were obtained from the respondents and the teachers involved. Some of the notes and feedback obtained when conducting this large group test are as follows:

1. Overall, the activities/motion tasks in the badminton smash training model can be applied by all subjects.
2. There are some activities/movement tasks that require adjustments to the direction and speed of the player's stroke, and the distance between the person and the target.
3. The use of media equipment/tools to be used should be prepared in advance and slightly multiplied.
4. The draft activities/movement tasks given during the training process should be organized based on the level of movement characteristics, ranging from easy-medium difficult.

The results of field notes in the large group test will later become the basis for making final stage revisions to the development of this badminton smash training model.

h. Revision of Large Group Trial Results

The stage II revision of the Exercise model is useful as a basis for evaluation material in improving the product that will be applied to effectiveness testing at a later stage. Based on the field notes obtained during the large group test and the revisions made, it can be concluded that this badminton smash training model can be used on a wider scale and can also be applied. Furthermore, it will be tested again to determine the extent of the effectiveness of the smash skill training model product for these students. Testing will use an instrument that will be used to collect data on the results of the initial test that will be given to respondents, so that it can be seen whether the model developed is effective or not. The instrument used in this study is an assessment of the quality of movement and quantity of badminton smash skills. This instrument was first reviewed by an expert for the suitability of the test used.

Table 1. Badminton *Smash* Model Activity Design

No.	Activity Name	Score
1.	*Smash* in place in front of the right	
2.	*Smash* in place in front of the center	
3.	*Smash* in place in front of the left	
4.	*Smash* in the right center	
5.	*Smash* in the center	
6.	*Smash* in the left center	
7.	*Smash* on the right back	
8.	*Smash* in place behind the center	
9.	*Smash* on the left back	
10.	*Smash* is placed in front of the right starting from the center.	
11.	*Smash* is placed in front of the center starting from the center.	
12.	*Smash* is placed in front of the left starting from the center.	
13.	*Smash* in the right center starting from the center.	
14.	*Smash* on the left center starting from the center.	
15.	*Smash* is placed on the right back starting from the center.	
16.	*Smash* is placed behind the center starting from the center.	
17.	*Smash* is placed on the left back starting from the center.	
18.	Right-front jumping *smash*	
19.	Jumping *smash* in front of the center	
20.	Jumping *smash* in front of the left	
21.	Right-center jump *smash*	
22.	*Smash* jump in the middle	
23.	Left-center jump *smash*	
24.	Right back jumping *smash*	

25.	Jumping *smash* behind the center	
26.	Jumping *smash* behind the left	
27.	The right-front jump *smash* starts from the center.	
28.	Jumping *smash* in front of the center starts from the center.	
29.	The left-front jump *smash* starts from the center.	
30.	The right-center jump *smash* begins by moving from the center.	
31.	The left-center jump *smash* starts from the center.	
32.	The right-back jump *smash* starts from the center.	
33.	Jumping *smash* behind the center starts from the center.	
34.	The left-back jump *smash* starts from the center.	

i. Model Effectiveness Test

In this effectiveness test, researchers used a research design using a pretest-posttest control group design, meaning that there were two groups involved in this study, namely the experimental group and the control group, where all groups in this effectiveness test used Jakarta State University students as participants. The experimental group with a total number of participants of 31 students, and the control group of other students with a total number of participants of 31 students. Each group was given different treatment, where the experimental group was given training using the smash skill training model developed, namely the training process carried out based on the given motion task, which was then given the task of studying more deeply and making variations of movements according to the instructions listed on the draft model and then demonstrating to their friends at the next meeting. While the control group used the usual or conventional training model, where in the control group the researcher completely left the training process to the badminton teaching lecturer in the group.

However, before the treatment is carried out both in the experimental group and in the control group, the researcher first conducts an initial test to all respondents using a test instrument that has been made based on the results of the expert test. After that, provide treatment for eight meetings in accordance with the training program that has been made and based on the scope of the material provided. After providing treatment, at the end of the meeting, the researcher conducted a final test to all groups, both experimental and control groups with the same test instrument as in the initial test. The following are the results of the pretest and posttest in each group can be seen in the following table:

Table 2. Data on Pretest and Posttest Results of Experimental and Control Groups

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest Kontrol	31	48	67	59.81	4.135
Posttest Kontrol	31	58	82	70.68	7.204
Pretest Eksperimen	31	49	69	57.10	6.101
Posttest Eksperimen	31	71	95	85.94	6.475
Valid N (listwise)	31				

Based on the data in table 2, it can be described that the total number of respondents is 62 people, divided into two groups, namely 31 experimental groups and 31 control groups. The minimum score of the experimental group on the pretest was 49 and the control group was 48, while the maximum score of the experimental group was 69 and the control group on the pretest was 67. Then it can also be seen that the minimum score of the experimental group on the posttest was 71 and the control group was 58, while the maximum score for the experimental group was 95 and the control group

was 82. Furthermore, if you look at the average scores of the two groups in both the pretest and posttest sessions, there are differences, namely in the experimental group the average score in the pretest session was 57.10 with a standard deviation of 6.101, while in the control group it was 59.81 with a standard deviation of 4.135. And in the posttest session the score in the experimental group increased to 85.94 with a standard deviation of 6.475, while in the control group it was 70.69 with a standard deviation of 7.204. Although there is a direct increase in the average score, to determine the effectiveness of the model developed there are several stages of analytical testing, such as testing the analysis requirements (normality and homogeneity tests) and significance tests.

Normality Test

This test is carried out to determine the state of a data in the normal distribution or not produced. If the data produced is normally distributed, then data testing can proceed to the next stage, if the data is not normally distributed, then testing must be done with non-parametric tests. Based on the results of data processing and analysis that has been carried out using the help of the SPSS version 26 program with the One-Sample Kolmogorov-Smirnov Test analysis technique, the following results are obtained:

Table 3. Data on Normality Test Results of Badminton Smash Skill Test Experiment Group

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest Kontrol	.105	31	.200*	.956	31	.233
Posttest Kontrol	.100	31	.200*	.951	31	.165
Pretest Eksperimen	.103	31	.200*	.937	31	.069
Posttest Eksperimen	.114	31	.200*	.943	31	.097

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on the results of normality testing using Shapiro-Wilk in table 4.9, it can be seen that the Asymp. Sig. (2-tailed) in the Experiment pretest and posttest sessions of 0.069 and 0.097 > = 0.05. This means that the skill test data in the experimental group in the initial and final test sessions are normally distributed. Meanwhile, based on the results of normality testing using Shapiro-Wilk Control, it can be seen that the value of Asymp. Sig. (2-tailed) in the initial and final test sessions is 0.233 and 0.165> = 0.05. This means that the control group smash test data in the pretest and posttest sessions are normally distributed.

Homogeneity Test

This homogeneity test was carried out with the help of the SPSS version 16 program as well as the analysis technique using the test of homogeneity of variances with the Levine statistic. Homogeneity testing was carried out on both groups, namely the experimental group and the control group. The following are the results of the homogeneity test of two variances which can be seen in the following table:

Table 4.10. Data Experimental Group Homogeneity Test Results

Based on the analysis results shown in table 4.10, the significance value of the smash skill test is 0.386> = 0.05. This means that the smash skill test data in the experimental group has the same or homogeneous variance.

Tabel 4. Test Of Homogeneity of variance

Effectiveness Test

1. Paired Sample T-Test Experimental Group

After testing the requirements of the analysis by carrying out normality and homogeneity tests, the next step is to test the significance with a t-test approach assisted by using the SPSS version 16

program using paired sample t-test analysis. This is intended to determine whether there are differences in the results of the badminton smash skill test at the pretest and posttest. The basis for decision making is as follows:

If the p-value or Sig. (2-tailed) <0.05, then there is a difference that • significant between the results of badminton smash skills on pretest and posttest data.

If the p-value or Sig. (2-tailed) > 0.05, then there is no significant difference between the results of badminton smash skills on pretest and posttest data.

Table 4. Paired sample test

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pretest Kontrol - Posttest Kontrol	-10.871	5.258	.944	-12.800	-8.942	-11.511	30	.000
Pair 2	Pretest Eksperimen - Posttest Eksperimen	-28.839	4.140	.744	-30.357	-27.320	-38.784	30	.000

Based on the analysis results shown in table 4, it can be seen that there is a difference in the mean value between the pretest and posttest scores of -28.839 with a t-count score = -38.784 with df = 30 and a p-value or sig. (2-tailed) = 0.000 < 0.05. This means that there is a difference in the smash skill test results in the pretest and posttest sessions in the experimental group after being given treatment in the form of a smash skill training model.

2. Paired Sample T-Test Control Group

After testing the significance of the experimental group, the next step is to test the significance

of the control group as well. The decision-making basis is the same as in the previous experimental group, which is as follows:

- If the p-value or Sig. (2-tailed) <0.05, then there is a significant difference between the results of the badminton smash skill test in the pretest and post-test
- sessions.
- If the p-value or Sig. (2-tailed) > 0.05, then there is no significant difference

between the results of the badminton smash skill test in the pretest and post-test sessions.

Based on the analysis results shown in table 4.11, it can be seen that there is a difference in the mean value between the pretest and post-test scores of -10.871 with a t-count score = 11.511 with df = 30 and a p-value or sig. (2-tailed) = 0.000 <0.05. This means that there is a difference in the smash skill test results in the pretest and post-test sessions in the control group after being given conventional training treatment.

Independent Sample T-Test of Experimental and Control Groups

After conducting paired sample t-test tests on both groups, the next step is to conduct independent sample t-test testing for both test results in the experimental group and also the control group. This aims to determine whether there are differences in badminton smash skill test results between the experimental group and the control group. Testing is carried out on the post-test value in each test in each group. The basis for decision making is as follows:

- If the p-value or Sig. (2-tailed) <0.05, then there is a significant difference between the results of the badminton smash skill test in the experimental group and the control group.
- If the p-value or Sig. (2-tailed) > 0.05, then there is no significant difference between the results of the badminton smash skill test in the experimental group and the control group.

Based on the results of the independent sample t-test analysis shown in table 5, it can be seen that the F value = 0.761 with a p-value score or Sig. = 0.386> 0.05 which means it has the same variance or homogeneous. Therefore, significance testing can be seen in the Equal variances assumed column and t-test for Equality of Means. Based on the results in the column, it can be seen that the t score = -8.771, df = 60 and the p-value score or sig. (2-tailed) = 0.000 <0.05. This means that there is a

difference in badminton smash skill test results between the experimental group and the control group, where the results of the badminton smash skill test in the experimental group are better than the control group with a Mean Difference score of 15,258.

Table 5. Data on Independent Sample T-Test Results of Experimental Group and Control Group

Levene's Test for Equality of Variances			t-test for Equality of Means							
z F		Sig.	T		df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Pair 1	Equal variances assumed	1.229	.272	3.832	60	.000	2.065	.539	.987	3.142
	Equal variances not assumed			3.832	57.175	.000	2.065	.539	.986	3.143

Based on the results of the N-gain score test calculation (table 6), it shows that the average value for the experimental group is 6828 or 61.05%, including in the moderately effective category. While for the control group is 2751 or 36.57% including in the ineffective category. It can be concluded that using the training model is effective enough to improve badminton improvement results for student athletes.

Table 6. Data from the N-Gain Score Test Calculation of Experimental Group and Control Group

No.	Class	N-Gain Score Test	N-Gain Test Percent	Interpretation
1	Experiment	.6828	68,28%	Effective Enough
2	Control	.2751	27,51%	Ineffective

j. Final Product Revision/Finishing

After testing the effectiveness of the model and obtaining results or findings empirically that the badminton smash skill training model product developed is effective in improving the results of badminton smash skills. Therefore, it can be concluded that this skill training model product can and should be applied and used in lectures and badminton sports training.

k. Dissemination and Implementation

This badminton smash skill training model as the final product has been disseminated both offline and online. Offline this model will be made into a printed book and also an electronic book (e-book) with the title "Development of Badminton Smash Training Models for Student Athletes".

While online this model product will be made an android-based application version as an effort to facilitate the dissemination and ease of access to the material or model applied. In addition, the results of this research have also been disseminated through international seminars or conferences with the title: "Development of a Badminton Smash Training Model For Students" 2023 at the State University of Jakarta.

4. DISCUSSION AND CONCLUSION.

This research is included in the type of development research or research and development (R&D)

with the model used is Borg and Gall, where there are ten stages that must be carried out by researchers during the research process (Gall et al., 2003). The product produced in this study is a badminton smash skill training model. The process is based on the results of theoretical and empirical studies through analyzing the needs of students, especially in sports majors who want renewal in learning badminton smash based on the motion tasks given so that they better understand each stage of motion in the smash movement in badminton games.

This skill training model has the advantage of providing direct feedback, so that students can get feedback in the form of corrections and suggestions directly from the lecturer on each motion task given.

The developed model is made to meet the movement needs of smash training in badminton games, which until now has been felt that the process of providing training activities is just that. This is certainly an innovation in training formation based on improving the knowledge, attitudes and also the movement skills of participants through a systematic and structured system of physiological body work, biomechanics, motor skills (Bilici & Selçuk, 2018; Rezk, 2017; Vernadakis et al., 2010).

The badminton smash skill training model developed has gone through validation results from experts in the badminton field, and has also been tested on a small's scale scope and on a large scale in several universities. There are at least 24 activity items or motion tasks to learn badminton smash that can be done. All activities have also been divided based on movement characteristics, ranging from easy, moderate, to difficult levels. Validation tests and trials have been carried out. Overall, based on scientific principles, this badminton smash skill training model is suitable for use.

Hands-on learning can provide important insights in systematically analyzing and solving problems in practice, as the instructor co-guides and plays a direct role in teaching (Yu et al., 2021), while the most effective type of feedback is when it is given as soon as possible or very close to the time of task execution (Rossiter, 2020).

Based on the description of the discussion and coupled with some literature results from various relevant studies that have been reviewed, there are several novelty of this research, including the following:

1) The skill training model that is compiled is designed based on the formation of motion tasks or activities carried out with the smash position in place and smash that begins with moving first. so that it is more in line with the characteristics of the real game.

2) Each activity or movement task is organized by level of difficulty, so it will be easy for learners to adjust.

3) The blows made are not only focused on accuracy, but by calculating the speed of the blows made when the smash is performed.

4) The interval when doing one smash to the next smash is given enough time so that when doing smash students are more visible in quality.

5) Feedback is more thorough due to more time in observation.

6) The presentation of the movement activity procedure (in the draft book) is made as clear as possible, equipped with the name of the activity, the characteristics of the activity, the media used, the objectives, and the learning steps of each task given.

7) The display of illustrations of motion tasks made clearer, more interesting, and colorful, so that it attracts the interest of students to see and learn about it.

Based on this, of course, this badminton smash skill training model can be used as a learning media and learning resource, thus enabling active, creative and flexible interaction (Barzuoka et al., 2007).

Limitations in this study, including the number of movements and the number of participants. Recommendations for other researchers who want to conduct research on the same topic, are expected to develop a wider number of subjects, and include or add several variations of movements in each activity. Collaboration between multi-disciplinary academics and practitioners can certainly produce a product that is more innovative and in accordance with the needs in the era of industrial

revolution 4.0.

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