

Development of Training Model of Pencak Silat Dropping Technique in Match Category Based on Biomechanical Analysis for Youth Athletes

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ABSTRACT

1. **Introduction:** Pencak silat has a variety of techniques that must be mastered by fighters, especially fighters who will compete in the match category. The technique consists of three basic techniques, namely attack techniques (kicks, punches, elbows), defenses (defiance and avoidance), and falling/ dropping techniques (Widiyanto and Hariono, 2015, p.26). The techniques used in pencak silat matches have different point; among these techniques which have the highest point are falling techniques to knock down opponents with a catch, better known as dropping.
2. **Aim of the study:** This study is intended to develop a training model of pencak silat dropping technique for the adolescent match category.
3. **Material and methods:** This development research is based on the model carried out by Borg & Gall that was modified by Sugiyono into two stages, namely the pre-development and development stages. The instruments used in this research were interviews, questionnaires, observation, and Kinovea software.
4. **Result:** The small-scale trial participants consisted of 10 PPLP (Student Training Education Center) athletes from Yogyakarta. The large-scale trial participants were 15 teenage athletes joined the Yogyakarta Special Talented Athletes Development (PAB). The results showed 6 types of dropping techniques that have been concluded to be feasible and effective to use by experts based on bio-mechanical analysis.
5. **Conclusions:** The assessment results from material experts, trainers, and biomechanics on the training model developed through 2 (two) trials and carried out a semi-experimental effectiveness test, where experts gave an assessment of the model through a value scale of more than 80%. This means that the training model is worthy of being used and declared effective as a training model for pencak silat dropping techniques for youth athletes.

Key words: Training Model, Dropping Technique, Match Category, Biomechanics, Youth Athletes.

Introduction

The games of pencak silat are contested in four categories, namely Tunggal categories, Ganda categories, Regu categories, and Match categories (Persilat, 2012, p.1). The match category in pencak silat is a self-defense category featuring two combatants using various techniques to obtain reciprocal point in the specified target area. Therefore, fighters in the match category are required to have physical, technical, tactic, and mental well-being and are able to master various technical skills to support their performance in matches to reach the highest points and finally be able to obtain optimal achievement.

Pencak silat has a variety of techniques that must be mastered by fighters, especially fighters who will compete in the match category. The technique consists of three basic techniques, namely attack techniques (kicks, punches, elbows), defenses (defiance and avoidance), and falling/ dropping techniques (Widiyanto and Hariono, 2015, p.26). The techniques used in pencak silat matches have different point; among these techniques which have the highest point are falling techniques to knock down opponents with a catch, better known as dropping. According to Nugroho (2005, p.17), the dominant technique used in pencak silat matches is to obtain point, namely: (a) 44% kick technique, (b) 33% punch technique, (c) 14% drop technique through catching or kicking, (d) 5% falling technique, (e) 3% defense technique with feet, and (f) 1% defense technique with a punch. The technique of falling in pencak silat can be divided into two, namely: top down (slamming) and dropping down. The top down consists of two ways, namely through capture and direct falling (falling directly due to kicks or punches). (Hariono, 2004, p.69).

The dropping technique is still dominantly used as a technique that will produce the greatest score. Based on observations in several practice sites, currently the dropping technique training model still refers to the past experiences of senior athletes and they tend to focus more on the final results without regard to the correctness of the motion of the technique performed. The researchers found that in the 28 games of pencak silat youth competition, the dropping techniques that occurred amounted to 171, 122 dropping techniques failed to get scores or failed and 49 dropping techniques managed to produce scores, so that 71% of the dropping techniques carried out by Teenage athletes failed and 29% of dropping techniques produced score. But this is only seen from the success of the athlete dropping opponents, while in terms of truth the dropping technique is not so clear.

In sports journals examined by Hariono (2004, p.66) about the top-down technique, it is stated that the top-down form variations often used by fighters are more than three forms and by default they do not have names. However, the current fall is often referred to as dropping, but the standard name for each form of dropping technique has still not been formalized by PB IPSI. Therefore, to make it easier to name the form of dropping technique, naming will be sorted by Roman numerals.

The learning process of motion techniques in sport certainly requires disciplines that examine the motion mechanically. It is expected that the motion techniques carried out are in accordance with the rules of good motion. In sports achievements, the biomechanics of sports has a big role to improve the performance of athletes by forming the right technique so that athletes are able to do the technique effectively and efficiently. Dropping techniques are one of the techniques in pencak silat that have relatively high difficulties, therefore a study of sport biomechanics is needed to analyze the motion of dropping techniques so that they can be carried out effectively and efficiently. A dropping technique is given after the fighter has mastered several techniques such as punch and kick techniques, while in the process of training a technique that has high difficulty, a clear picture is needed when doing the technique so that athletes better understand the stages of motion that must be done.

A fighter who will carry out technical movements requires an explanation in advance of the implementation or sequence of motion that will be carried out. So he/she will not be confused or get wrong perceptions when doing techniques. Keep in mind that in the execution of the dropping technique, there are two fighters who demonstrate the motion sequence. One fighter who performs dropping techniques and one fighter who will be slammed or dropped (opponent). If the opponent does an attack in the form of a kick then the catch will be carried out (kick using a crescent kick technique with the right foot). These kinds of things must be conveyed first before the implementation of technical training begins, so the athletes will not get wrong perceptions.

Referring to the mastery of the dropping technique, it is necessary to do the training process by applying a dropping technique training model based on sports biomechanics analysis which will be packaged in a simple manner to facilitate the fighter and trainer to understand and apply the motion skills. The dropping technique training model compiled through biomechanical analysis has the privilege of making the sequence of motion performed, how the movement is carried out, and which body parts must be dominant in making movements so that dropping techniques can be carried out efficiently. In addition, trainers and fighters will better understand the concept of dropping technique that will be carried out to improve mastery of the technique. So when they are fighting, the dropping technique can be done automatically and effectively. The description of direct observation in the field makes researchers assume that the above problems can be overcome by the existence of a clear and simple development of a dropping training model that is easily understood by fighters and coaches in their efforts to improve mastery of dropping techniques, besides being supported by sports biomechanical analysis dropping techniques that are carried out efficiently, especially when performed by youth fighters in the match category.

Method

This study used research and development methods which is a research to produce certain products based on needs in the field. This development research was conducted to produce a training model for pencak silat dropping techniques in youth athletes based on biomechanical analysis. The analysis emphasized in the motion patterns of dropping techniques so that the movements carried out can have a good level of security which can also be effective and efficient.

This research was conducted on youth athletes who have gone through the selection stage, such as teenage athletes who have joined the PPLP DIY, DIY Popwil Team and PAB DIY. The research was conducted for 4 months (June-September 2018).

In this study, development procedures were started from the pre-development stage, including: (1) literature review, (2) relevant research, (3) preliminary study and determination

of the form of dropping using the Delphi method. The development phase includes: (1) preparation of the initial product, (2) expert validation, (3) small scale model trials, (4) large-scale model trials and effectiveness tests, and (5) operational products.

The data in this study were qualitative and quantitative data. Qualitative data was obtained from interviews with coaches and athletes during preliminary studies, suggestions and input from experts or experts on the training model. While quantitative data was obtained from expert or expert assessment of product drafts and observations on small and large scales.

The data sources of this research were the participants in which the data were obtained. The data sources in this study were grouped into two groups, namely the initial data source and data sources in the feasibility trial of the product of the developed pencak silat dropping training model. These data sources included pencak silat trainers, pencak silat material experts, media experts and biomechanics experts.

The instrument of data collection is a measuring instrument used to obtain data from a study (Ali, 2010). The instruments used in this study were as follows: (a) interviews; (b) value scale questionnaire; (c) observation; (d) questionnaire; (e) cameras and camcorders; and (f) kinovea software.

Value scales questionnaire was used to collect data in the form of suggestions and assessments from experts or experts on the training model of the dropping technique developed and subsequently used as revised material for research products and used to determine eligibility for use in small and large scale trials as data collection in the field. The use of value scale questionnaire in this study used the Likert rating scale, while the Likert scale is used to measure attitudes, opinions and perceptions of a person or group of people about a phenomenon (Sugiyono, 2016). The value scale used was a questionnaire of grades 1-4, with details as follows: (a) score 1 for very inappropriate assessment, (b) score 2 for inappropriate assessment, (c) score 3 for appropriate assessment, (d) score 4 for very appropriate assessment.

The camera was used to take pictures of pencak silat dropping techniques as material for guidebook material. The camera used in this development research is a DSLR type camera (Digital Single Lens Reflex) because it has clear image sharpness. In addition, the handycame used was aimed at taking motion videos of pencak silat dropping techniques. This video then was used as a material for movement analysis with biomechanics based. In this study, the researchers used two handycames which will be placed in two positions, namely the right and left positions of the fighter who did the dropping technique. After the video was taken, a biomechanical analysis would be carried out to analyze the motion of dropping techniques using simple tools or motion analysis applications. In this research, Kinovea software was used to help researchers ascertain the motion patterns of dropping techniques by using slow motion menus and formed angles on certain movements.

In this study, questionnaires of grades 1-4 were used. After the raw score was changed to a percentage value, then it was converted by using the assessment norm that refers to the benchmark reference assessment (PAP) with the following percentage ranges:

Table 1. Conversion of Benchmark Reference Assessments.

No	Score Value	Description
1	80% - 100%	Very Good
2	70% - 79%	Good
3	60% - 69%	Good enough
4	45% - 59%	Poor
5	< 44%	Very Poor

Results and discussion

A dropping technique is a series of continuous movements that are preceded by a catch process and then proceed with an effort to eliminate the opponent's balance so that it can be dropped in the field of competition during the competition. From that understanding, the success of doing dropping techniques is seen from the initial process of catching up to the position of the fallen opponent (the body part of the opponent touches the matras) and the dropping fighter does not fall with the opponent.

The use of techniques in pencak silat matches aims to obtain point by means of carrying out attacks, defenses, or falling down. The techniques used in pencak silat matches have different scores, among those techniques which have the greatest scores are top-down techniques to knock down opponents with a catch, better known as dropping, with a score of 1 + 3.

The forms of variation in dropping techniques through catches are very diverse in a pencak silat match, according to Hariono (2004, p.66), there are approximately seven types of falling techniques that are dominantly used during the competition. Because the dropping technique is a relatively difficult technique, then during the practice in that technique given to the fighter must go through the right stages, meaning that the trained technical movements must start from the initial stage, the implementation stage, the final stage which certainly does not endanger the two fighters.

In the execution of the dropping technique, there are two fighters who demonstrate the motion sequence. One fighter who performs dropping techniques and one fighter who will be dropped (opponent), if the opponent does an attack in the form of a kick then the catch will be carried out. The types of kicks in pencak silat are very diverse, according to Hariono (2017, p. 12) kick techniques in the study of sports biomechanics there are 4 (four) types of kicks that are dominantly used in pencak silat match categories, namely front kicks, crescent kicks, side-kick (T), and back kick. Therefore, in the implementation of dropping techniques it is necessary to determine the type of kick technique that will be carried out according to the characteristics of the teenager's fighter. According to the results of research that has been done, it shows that the crescent kick technique is a technique that is widely used in a youth martial arts competition. The operational understanding of sickle kicks is an attack of the limbs whose trajectory resembles a semicircle with an inward direction (Hariono, 2017, p.15). In addition, sickle kick techniques are easier to do and have a greater advantage when used in pencak silat matches because the sound is produced harder when the impact occurs.

The practice of learning dropping techniques is very important for trainers and trainees because the motion of kickback techniques requires a high level of coordination so that it is very vulnerable to get injury if it is not done with appropriate motion patterns. Efforts can be made to produce learning outcomes effective and efficient dropping techniques, namely by providing assistance, guidance and correction of errors made, after which the trainer can provide examples of correct movements in certain ways. The virtue of mastering the technique well is that the child trainer will be able to do technical movements effectively and efficiently. In addition, the trainee will be able to use the technique repeatedly over a long period of time without significant fatigue.

Based on observations in the competition, the fighter when doing dropping techniques actually fell together with his opponent. There were even a number of events in the youth martial arts match when a fighter would slam and there was an imbalance due to differences in weight during the process of dropping opponents. The opponent fell right on his feet the fighter who was going to slam so that a fighter who will slam suffered from an injury. In addition, physical factors such as strength, speed, balance, and flexibility in the process of dropping are also very influential, meaning that not only in terms of mastery of the technique itself but also influenced by physical factors that support the implementation of dropping techniques to achieve success. Based on direct observations it was known that the difficulties experienced in performing dropping techniques included: difficulty in determining the time of catch, difficulty in determining the form of dropping technique that will be carried out, difficulty in dropping opponents because the opponent has a higher body or has more weight, and too late to move your opponent's weight so it's easy to slam.

There are several stages in doing dropping techniques, namely: (1) ready position, (2) catching stage, (3) dropping process (eliminating opponent's balance), and (4) continued motion. Of the four stages, mistakes often occur when performing a ready position such as the direction of view that tends to look towards the opponent's feet with a view towards the bottom. It unconsciously makes both arms position not parallel with the chest. This will be detrimental when doing catches because the space to make catches becomes smaller. Besides with a downward view, it will be followed by a stance that is not erect. This will also harm the trainee because the position of the body will affect the balance during the catching process. The following explanation will be presented in the implementation stages of dropping technique.

Technique I

Dropping technique I is done by capturing the opponent's attack with both hands, then bringing the opponent closer by pulling the opponent's feet closer to the body. After that, the fighter changes the direction of the opponent movement so that the opponent cannot defend. The dropping technique I utilizes the initial pull speed after capture, therefore this technique can be carried out by a fighter who has a difference in body height during the match. The following is the implementation of the dropping I motion pattern:

- a. Ready position: Attitude with right foot in front position.
- b. Catch Stage:
 - 1) The right hand holds the opponent's ankle and the left hand holds the upper side of the opponent's foot (Dorsum Pedis).
 - 2) The right and left legs are maintained constantly to resist pressure from the opponent's kick.
- c. Dropping Process:

- 1)The opponent's attacking leg is pulled forward towards the bottom (to stabilize the opponent's position), by pulling the right foot towards the back so that the right foot is aligned with the left foot.
 - 2)If the opponent's drawn leg is 30-40 cm from the mat, it is immediately rotated to the right (from the position of the fighter) quickly.
 - 3)The left foot then moves quickly to the right (following the right foot) to accelerate the rotation.
- d. Continued Motion
- 1) When doing the rotation to the right, the left foot moves quickly to the right to increase the speed of rotation and ends with the stance.
 - 2) The strike is upright and the final position is back to the opponent's fall.

Technique II

Dropping technique II is done by capturing the opponent's attack with both hands, the right hand is under the opponent's leg (lower thigh) while the left hand catches the opponent's leg on the tibia. The catch movement is carried out in conjunction with the initial motion of the kick made by the opponent or by picking up the opponent's attack, the position of the right foot moves closer to the foot of the opponent. Then the fighter turns the hip to create a circular motion towards the back with the help of the left foot movement to the left. The dropping technique II utilizes the speed of hip rotation to eliminate the opponent's balance, and the direction of this hip rotation follows the direction of the kicks made by the opponent so that dropping the opponent will be easier. The advantage of doing dropping II technique is more simple so that a fighter can easily apply it in the learning process. The following is the implementation of the dropping technique II motion pattern:

- a. Ready position: Attitude with left foot in front position.
- b. Catch Stage:
 - 1)The back leg (right) steps forward along with the opponent kicking. The position of the right foot is between the foot of the opponent to hold the foot of the foot.
 - 2)The right arm is on the opponent's lower thigh. The left arm holds the opponent's ankle at the top (tibia).
 - 3)Stepping foot movements and arm movements catching the feet together.
- c. Dropping Process:
 - 1) The hip is rotated to the left. The right foot is maintained to hold the opponent's foot so it doesn't move.
 - 2) The left and right arms are maintained to lock the opponent's attack foot.
- d. Continued Motion
 - 1)When making a turn to the left, the left foot moves quickly towards the back of the position of the fighter to increase the speed of the turn and end with the stance. The arms are in front and are opened about shoulder-width apart.

Technique III

Dropping technique III is done by capturing the opponent's attack with one hand, the right hand is on the opponent's right shoulder while the left hand catches the opponent's leg. The catch movement is carried out simultaneously with the initial motion of the kick carried out by the opponent or by picking up the opponent's attack. Both feet move forward to approach the opponent's body, the right foot is next to the opponent's foot support. Furthermore, the fighter presses down on the opponent's right shoulder with his right hand,

and lifts it towards the opponent's attack foot with his left hand, while the right foot brings up the opponent's foot. The movement is carried out simultaneously to create a directional movement on the opponent's body so that the opponent loses his balance and is easy to drop. The dropping technique III has motion complexity during the process of eliminating the opponent's balance because in the pencak silat competition is limited by a range of 5 kg of weight then there can be a difference in weight when doing a kickback technique in a match. When you bring your feet to one another, you need a lot of strength, therefore, fighters who have shorter bodies and lower body weight than their opponents are not recommended to do this kick during the competition because it will require more muscle performance to do dropping III. Following is the implementation of motion kick III technique:

- a. Ready position: Attitude with right foot in front.
- b. Catch Stage:
 - 1)The right foot steps forward followed by the left foot when the opponent kicks. Fighter's right leg is next to the opponent's left foot (left).
 - 2)The right arm is on the upper right shoulder of the opponent. The left arm catches the opponent's attack foot (the bottom of the knee).
- c. Dropping Process:
 - 1)Right foot performs a sweep of the opponent's (left) foothold together with the movements of both arms. Introduction of sweeping in the lower posterior cruris region or lower tibia.
 - 2)The right arm presses the right shoulder down. The left arm lifts up against the opponent's attack foot. The movement of both arms is to stabilize the opponent and is carried out together with sweeping feet so that the opponent's body is lifted up.
- d. Continued Motion:
 - 1)After moving the upper kick, pushing the shoulders down, and lifting the opponent's attack foot simultaneously, the position of the fighter ends with the stance.
 - 2)The arms are in front of the chest and opened about shoulder width apart.
 - 3)Upright strike and final position facing towards the opponent's fall. A straight forward view.

Technique IV

Dropping IV is done by capturing the opponent's attack with one hand, the right hand is on the opponent's right shoulder while the left hand catches the opponent's leg. The catch movement is carried out simultaneously with the initial motion of the kick carried out by the opponent or by picking up the opponent's attack. The right foot moves forward to approach the opponent's foot, the right foot is in front of the opponent's foot. Furthermore, the fighter leans the fulcated leg of the opponent with his right foot, namely the target of the Achilles tendon, while the right hand pushes the shoulder of the opponent towards the front of the body of the fighter to help the process of eliminating the opponent's balance.

This technique has a movement complexity when the process of eliminating the opponent's balance because in pencak silat competition is limited by a range of weight as much as 5 kg, there can be differences in weight when doing kickback techniques in a match. When you bring your legs to your feet against a fighter, you need a good strength factor, therefore a fighter who has a shorter body and a lower body weight than your opponent is not recommended to do this kick during the competition because it will require more muscle performance to do dropping IV . Following is the implementation of IV kickback technique:

- a. Ready position: Attitude with left foot in front.
- b. Catch Stage:

- 1)The left foot moves outward with the position of the foot turned to the left. The right foot is stepped forward, and the position is facing the opponent's foot.
 - 2)The right arm holds the opponent's chest. The left arm catches the opponent's attack foot, with the catch under the knee joint.
- c. Dropping Process:
- 1)The right foot performs the flexion in the posterior cruris region or the Achilles tendon.
 - 2)The right arm accelerates the movement by making a forward push on the opponent's chest.
 - 3)The left arm maintains the catch against the opponent's attack foot.
- d. Continued Motion:
- 1) After making a leash and the opponent's body falls down, the body's position to do the horses to maintain the body so as not to fall.
 - 2) Position your arms in front of your chest and open about shoulder width apart.
 - 3) Upright strike and final position facing towards the opponent's fall.

Technique V

Technique V is done by capturing the opponent's attack with one hand, the right hand is on the shoulder of the opponent's right while the left hand catches the opponent's leg. The catch movement is carried out simultaneously with the initial motion of the kick carried out by the opponent or by picking up the opponent's attack. The right foot moves forward to approach the opponent's foot, the right foot is in front of the opponent's foot. Furthermore, the fighter kicked his opponent's foot with his right foot, the target of the kick on the ankle. To eliminate the balance, the fighter turns the hip to the right along with the kicking of the foot and the push of the right hand.

Dropping technique V is done by changing direction after making a catch, that is, the fighter must immediately rotate the hip to the right to create a spin on the opponent, along with the right foot doing the kick and the right hand pushing on the opponent's shoulder. Movement to eliminate the opponent's balance is done with together, meaning the fighter in doing the type of dropping V must have good motion coordination in order to be able to bring down the opponent. The advantage of doing a V kick is that it can be done by a fighter who has a different height, because dropping V utilizes the hip swivel motion to change direction and does not require large energy to lift the opponent's body. The following is the implementation of the kickback technique V:

- a. Ready position: Attitude with left foot in front.
- b. Catch Stage:
 - 1)The right foot steps forward when the opponent attacks.
 - 2)The position of the right foot is between the foothold (left) of the opponent.
 - 3)The left arm catches the attack foot under the knee joint. The right arm is on the opponent's right shoulder. The right arm puts pressure on the opponent's right shoulder.
 - 4)The head is held upright. Front view.
- c. Dropping Process:
 - 1)Hips and shoulders are rotated to the right quickly.
 - 2)Right foot performs kicking on the fulcrum (left) of the opponent simultaneously when the hips and shoulders rotate to the right. The left leg is rotated to the right following the movements carried out by the hips and shoulders simultaneously.

- 3)The left arm lifts the opponent's leg upward during the hip rotation process. The right arm pulls the opponent's right shoulder downward following the shoulder rotation. This movement is carried out in conjunction with hip rotation and changes in motion of both legs.
- d. Continued Motion:
 - 1)After making a leash and the opponent's body falls down, the body's position to do the horses to maintain the body so as not to fall.
 - 2)Position your arms in front of your chest and open about shoulder width apart.
 - 3)Upright strike and final position facing towards the opponent's fall.
 - 4)A straight forward view.

Technique VI

Technique VI is done by capturing the opponent's attack with both hands, the right hand is in the achilles tendon area of the opponent while the left hand is in the opponent's foot, then the fighter draws the opponent's body so it is easier to slam the opponent's attack foot with his right hand and leg right moves back so that it is parallel to the left foot, while the left hand is on the opponent's chest. After the opponent's body is brought closer, the next step is to eliminate the balance of the opponent by kicking the opponent's foot with the left foot to the right and the left hand push to the left, while the right hand tries to lift the opponent's attacking leg so that the opponent's area is narrowed. The movement is done together so that the hip rotates to the left of the fighter, and the opponent will fall towards the back.

Technique VI has a complex movement during the process of eliminating the opponent's balance because in the pencak silat competition is limited by a range of 5 kg of weight then there can be a difference in weight when doing kickback techniques in a match. If the fighter has a weight in the range below then when kicking the foot fulcrum and lifting the attacking opponent's foot up requires great strength, therefore the fighter who has a shorter body and lower body weight than the opponent is not recommended to do this kickback competition because it will require more muscle performance to be able to do dropping VI. The following is the implementation of the VI kickback motion pattern:

- a. Ready position: Attitude with right foot in front.
- b. Catch Stage:
 - 1)Both feet are maintained in the same position as the tide.
 - 2)The right arm catches the attack foot with the palm of the opponent's lower leg (posterior cruris region). The left arm holds the upper side of the opponent's foot (dorsum pedis) with the palm.
- c. Dropping Process:
 - 1)The right leg is pulled towards the back about half a step.
 - 2)The left arm pushes the opponent's chest. The palm of the right hand draws the opponent's attack foot (right) towards the right side of the body along with the right foot's backward motion.
 - 3)The hip is rotated towards the left to create a rotation of the opponent's body.
 - 4)Left foot performs kicking on the fulcated leg (left) of the opponent in the gastrocnemius section. Looking forward.
- d. Continued Motion:
 - 1) After making a leash and the opponent's body falls down, the body's position to do the horses to maintain the body so as not to fall.
 - 2) Position your arms in front of your chest and open about shoulder width apart.
 - 3) Upright strike and final position facing towards the opponent's fall.

- 4) A straight forward view.

The Role of Biomechanics in Dropping Techniques

Pencak silat sports have a variety of techniques that must be mastered, so that during the competition the athlete will be able to obtain the value of the implementation of the technique. Although the pencak silat technique is very diverse, in the pencak silat competition there are only a few dominant techniques are used to obtain scores, such as punch, kick, and drop (slamming), of the three techniques the highest value is the kickback technique with the acquisition of 1+ 3 (Hariono, 2016, p.179). Dropping techniques in pencak silat have a variety of forms, while the forms of dropping have different levels of complexity, so that it requires high body coordination to be able to bring down opponents. According to Crespo et al (2002) the coach must pay attention to the fact that the athlete's development and age growth can vary, so the trainer needs to observe his athlete biomechanically. Because in this book takes the age group of adolescents, not all forms of dropping will be applied to adolescent athletes, but will take a dropping technique that is in accordance with the characteristics of adolescents so that it will not be dangerous when doing so.

According to Hay (1993), the function of biomechanics can be used by trainers and athletes to learn the movements of techniques, evaluate techniques, reduce the risk of injury, and develop new techniques so that the performance of athletes can be increased. Complex technical movements are very susceptible to injury, because if it is not done simultaneously, the body part that is supposed to do the movement will be in an unprepared condition. Therefore, a coach must understand the stages in practicing high-tech techniques, especially in this case kickback techniques so that athletes can master the technique more easily. With the understanding of biomechanics in the sport, a coach or teacher will be able to identify the training model or the type of exercise that will be applied to improve mastery of the motion technique so the fighter can perform the technique efficiently both in practice and in matches.

Principles of Dropping Technique from Sport Biomechanics

In the match category of pencak silat, dropping techniques that succeed in dropped your opponent will produce the highest score. A dropping technique is a technique that is preceded by a catch process and then proceeded with ways to bring down opponents with movements that are arranged simultaneously. To form a kickback technique for martial arts athletes, a training model that can be done in stages in accordance with the sequence of kickback techniques that will be performed is needed. The stages for carrying out dropping techniques, namely: (a) preparedness, (b) catching stage, (c) dropping process (eliminating opponent's balance), (d) continued motion. Based on the series of steps, the movement of the technique carried out by the athlete involves a force that will cause the movement to occur. The movement of the athlete's body is influenced by the principles of mechanics in carrying out the motion of the technique, along with the mechanical principles that affect the kickback technique:

1. Acceleration

Acceleration is a change in speed (McGinnis, 2013, p.60). McGinnis further stated that "when objects speed up, slows down, starts, stops, or changes direction, it is accelerating". The acceleration that occurs when performing kicking techniques is in the whole set of kickback techniques from starting to make catches to kicks, when the hand from a standstill then catches the kick quickly, slams like pulling the opponent's lower leg to eliminate the opponent's balance quickly, and stop the body from anticipating not falling together.

2. Force

The force (Hall, 2012, p.63) is the product of mass and acceleration, where the formula for finding a force is $F = ma$ (F: force, m: mass, and a: acceleration), can also be said with push (push) or pull (pull). A force in moving something has a direction therefore the force is a vector quantity. In the implementation of the kickback technique, if the fighter has a large body mass then when moving it will produce a great style too. In addition, if the fighter has a high speed when doing dropping techniques, it will affect the style needed. In the kickback technique, the application of greater force is produced during the implementation and advanced stages, because the fighter will try to bring down the opponent, while in the youth martial arts sport is arranged with classes based on weight with a difference of 5 (five) kilograms. Therefore, fighters who have weight on the lower average will need a greater style by adding speed during the process of dropping to knock down the opponent with the weight that is in the upper average.

3. Angular Motion

Angular motion according to McGinnis (2013, p.167) is related to rotational or rotational motion. This happens when the body or moving object rotates or part of the rotation on an axis. Angular motion can occur on an axis that is outside the body or inside the body. In motion the angular motion kick technique always occurs both in the joints of the body and the axis on the foot of the opponent. In this study, we will take a number of forms of kickback, assuming that the technique is a simple and harmless kickback technique to be carried out by teenage fighter. Examples of angular motion that occur in the form of kicking as in the catch movement are the arm will move semicircle to catch the kick, then after being caught the position of the foot in front is drawn parallel to the right foot and throw the captured leg assisted by rotation of the body so that the opponent's body will lost balance and finally fell.

4. Center for gravity and balance

According to Blazevich (2007, p.61) "The point at which the body is evenly distributed in all directions is the center of mass". So according to Balzevich the center of gravity and the center of mass have almost the same term, except that the center of gravity is only used when the body is in a vertical direction, so the lower the center of gravity the body will be more balanced. Apart from that balance, according to Hall (2012, p.64) the other important thing is a person's ability to control equilibrium.

On the implementation of the body's center gravity, style kicking technique will change according to body movements and body position. The success of the kickback technique happens when a fighter succeeds in knocking out an opponent without falling together or falling after making an effort to slam. This means that the fighter must perform a series of swift and simultaneous kickback techniques so that the opponent does not have time to anticipate during the kickback process. The fast and simultaneous movements are started from the catching process, the process to eliminate the opponent's balance, until the final process is to keep the body from falling along with the opponent.

The response of the movement when capturing the opponent's kick is very influential on the implementation of kickback technique. The accurate time of reaction will facilitate the fighter to do the kickback technique. For this reason, the attitude of the arm or palm determines the speed to catch the kick.

5. Momentum

Momentum is the magnitude of the thrust of an object, it can also be said that momentum is a force of motion (Sudarmada and Wijaya, 2015). Momentum kicking techniques can occur when both fighters do catch movements, when both fighters have

almost the same weight then the type of catch can be done in conjunction with the kicking process. However when the fighter will slam with a catch that tends to wait for the opponent's kick, the fighter must pay close attention to the amount of weight with your opponent.

CONCLUSION

The assessment results from material experts, trainers, and biomechanics on the training model developed through 2 (two) trials and carried out a semi-experimental effectiveness test, where experts gave an assessment of the model through a value scale of more than 80%. This means that the training model is worthy of being used and declared effective as a training model for pencak silat dropping techniques for youth athletes.

The research products are a DVD and a guidebook for the implementation of a dropping exercise model of 6 (six) forms of dropping techniques for teenagers. The names of the dropping techniques are adjusted to the Roman numerals of dropping technique I to VI dropping techniques.

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REFERENCE

1. Blazevich, Anthony. 2007. *Sport Biomechanics-The Basic: Optimizing Human Performance*. London: A&C Black Publisher Ltd.
2. Crespo, et al. 2002. *Developing Young Tennis Players*. Roehampton. London: ITF.
3. Hall, Susan J. 2012. *Basic Biomechanics (6th Ed.)*. New York: McGraw-Hill.
4. Hamill, J. Knutzen, M, Kathleen. Derrick, Timothy. 2015. *Biomechanical Basic of Human Movement (4th Ed.)*. Baltimore: Wolters Kluwer Busines.
5. Hariono, Awan. 2017. *Standardization Urgency Martial Art Kicking Technique Beginner Fighter Match Category*. Semarang: UNNES.
6. Hariono, Awan. 2004. Falling techniques on Pencak Silat. Vol. 3, number 2, p. 62-71. National Journal of Physical Education and Sports Science. Directorate General of Sports, Ministry of National Education.
7. Hariono, Awan. 2016. The Role of Biomenkanika on Motion Performance of Kick Techniques in the Pencak Silat Match Category. pp. 176-186. National Sports Journal. UNNES, Semarang.
8. Hay, G James. 1982. Biomechanics of sport—exploring or explaining (Part I). *International Society of Biomechanics Newsletter*.
9. Hay, G James. 1993. *The Biomechanics of Sport Techniques*. Englewood Cliffs, New Jersey: Prentice-Hall.
10. Knudson, Duane. 2007. *Fundamentals of Biomechanics*. New York: Springer.
11. McGinnis, Peter. 2013. *Biomechanics of Sport and Exercise (3rd Ed.)*. Champaign: Human Kinetics.
12. Nazir, Moh. 2013. *Research Methods*. Bogor: Ghalia Indonesia.
13. Nugroho, Agung. 2005. Research Report Identification of Pencak Silat Technique Achievement Scores in the Match Category. Yogyakarta: FIK UNY.
14. Persilat, 2012. *Pencak Silat Competition Rules*. Jakarta: PERSILAT.
15. Sudarmada, I Nyoman and Wijaya, I Made Kusuma. 2015. *Biomechanics in Sports*. Yogyakarta: Grha of Science.
16. Sudjiono, Anas. 2013. *Introduction to Educational Evaluation*. Jakarta: Rajawali Press.

17. Sugiyono, 2016. *Research and Development Methods: Research and Development*. Bandung: CV. Alfabeta.
18. Sugiyono. 2012. *Quantitative, Qualitative, and R & D Research Methods*. Bandung: CV. Alfabeta.
19. Widiyanto. Hariono, Cloud. 2015. *Analysis of Motion Technique of Front Kick Pencak Silat Athlete PPLM DIY (A Sport Biomechanics Study)*, p. 26-44. in Sukadiyanto and Suharjana (edt.). Yogyakarta State University, Yogyakarta.