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DEVELOPING A MULTIFUNCTIONAL BALL FOR TEACHING PHYSICAL EDUCATION, SPORT AND HEALTH

Mugiyo Hartono[1] ✉ **Setya Rahayu**[2]

[1.] Faculty of Sports Sciences Universitas Negeri Semarang, Indonesia

[2.] Postgraduate Program Universitas Negeri Semarang, Indonesia

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Abstract

Students understand and develop movement skills through various sport games, but they have less enjoyable experience because of inappropriate and uncomfortable ball size. The existing standard balls often frighten the students because of their weight and may hurt them when the balls hit their body parts. This study is intended to design a multifunctional ball for basket ball, volley ball and football and to find out how it can improve the students' motivation in the teaching of Physical Education, Sport and Health in Primary and Junior High Schools in Semarang. This is a research and development study. The sample of 36 students were selected for the small-scale testing and 72 students for the large-scale testing. The results of the study show that the final product was a multifunctional ball with the size of 66 cm, made of soft, unslippery Poly Urhetane sponge, 270 gram in weight, air pressre of 0.250-0.3 bar and the bounce of 105-115. The ball was designed in light and interesting color. The final product has two functions for basket ball, volley ball and football, and does not cause pain because of their light in weight and reasonable size.

✉Correspondence:

Sekaran, Gn. Pati, Kota Semarang, Jawa Tengah 50229
FIK Universitas Negeri Semarang, Indonesia
E-mail: hartonofikunnes@gmail.com

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INTRODUCTION

It is widely known that there are at least three branches of sport games used as a medium of teaching movement in schools especially big ball games, including basket ball, volley ball, and football. Because the form and size of the balls as media are not appropriate for the students' ability, the teachers of Physical Education, Sport and Health (PESH) use average-size balls to play the games to teach movement in the teaching and learning process in schools. This condition has made many students, especially those in Primary School (PS) and Junior High Schools (JHS) scared to try to play with the balls because when they touch the balls for the first time, they feel some pain on their arms, head, and other parts of the body. This situation is really unsatisfactory to motivate the students to play basket ball, volley ball and football, consequently this leads to less conducive situation for the development of widely-national sports, especially to develop the students' sport potentials since their early age.

The idea to design and develop appropriate, convenient, multifunctional balls whicb do not cause any pain to the students, and can be used for basket ball, volley ball and football in the teaching and learning process of Physical education, Sport and Health especially in Primary and Junior High Schools, is based on a number of reasons. First, it is focused on the development of the teaching and learning process of Physical Education, Sport and Health in Primary and Junior High Schools because the students of this age are encouraged to develop their movement skills. In addition, these students have multilateral sports or learning to move as a whole, so during this period they need to have as many experience in movement as possible. Second, by using the convenient and painless multifunctional ball to play basket ball, volley ball and football, the teaching and learning process of Physical Education, Sport and Health in Primary and Junior High Schools will be fun for the students. Third, with enjoyable and fun teaching and learning process of Physical Education, Sport and Health, more students will be motivated to carry out movement and will be able to explore their movement skills, later they will have big opportunities to develop their potential sport talents during their golden age period. Fourth, so far the limited budget is used as an excuse for limited learning/media facilities including balls. In fact, the limited budget is used for providing three different types of balls for three different games, basket ball, volley ball and football. As a result, in one game there is only one or two balls available for 30 to 40 students. This condition is not encouraging for the students to explore their movement ability because they have a very limited opportunity to play and touch the ball during the teaching and learning process. Multifunction balls are developed to solve this condition because the balls can be used to play all three games. Lastly, multifunctional balls can be further developed and produced in large quantity given the market potentials are very big (in 2010 there were 174.922 PSs and 47.182 JHSs in Indonesia).

Based on the above background, it is important to design multifunctional balls for playing basket ball, volley ball and football. This study addreeses how the multifunctional balls are developed to play basket ball, volley ball and football and as a medium for the teaching and learning process of PESH in Primary Schools and Junior High Schools and how the multifunctional balls can improve the students' motivation to perform some movement and can make the teaching and learning process of PESH in PSs and JHSs more interesting.

Physical Education, Sport and Health (PESH) is one of the subjects in the primary, secondary, and even tertiary education level. According to Board of National Edicational Standards (2006: 702), PESH is an integrated part of education to develop the students' physical fitness, movement skills, critical thiking skills, social skills, logics, emotional stability, moral actions, healthy life and introduction of clean environment through physical, sport, and health activities carried out systematically to achieve the national educational goals.

The quality of the teaching and learning process can be improved by modifying the games, facilities and infrastructures of PESH. The less effective teaching and learning process is caused by the followings: 1) the available facilities and infrastructures for the teaching and learning process is not appropriate for the students' ability and development. For example, PS and JHS students have to use average balls, so they have difficulties to move because the ball is too heavy, its size is not appropriate for the students' condition, the materials are too hard, etc; 2) facilities and infrastructures provided by the school are limited so the number of balls are not proportional to the number of the students.

According to Ateng (1992), the modification can be completed by (1) reducing the number of players in a team; (2) reducing or narrowing the field size; (3) shortening the game duration; (4) lowering the net and basket ball rings or widening the goal bars; (5) facilitating the goal shooting by widening the goal bars or with no goal keepers or by other mehtods; (6) using lighter balls for beach volley balls for playing regular volley ball or by using junior balls for playing football and basket ball; (7) changing the game rules.

Similarly, Asep Suharta (2007:47-48) suggests that the game for PESH is modified to meet the following characteristics: (1) appropriate for the the children's ability (age, physical fitness, health status, competency level, and previous experience); (2) safe to be played; (3) having alternative aspects including size, weight and appearace, game field, playing time, rules, number of players, player rotation or position; 4) developing players and relevant sport skill for further sport development.

It can be concluded that to make the teaching and learning process of movement effective, it is important to modify game facilities that will enable the students to easily move and will ensourage them to comtinuously move as many as possible. Therefore, it is fundamental to develop multifunctional balls more convenient than previous existing ones to play basket ball, volley ball and football for the teaching and learning process of movement in PESH.

Generally infrastructures are defined as things that support the implementation of a process. In sports, infrastructures are those used to make the completion of tasks easier. Sport facilities must have measurement standards including sport fields, indoor hall, and outdoor fields (Supartono, 2000:5).

Sport facilities are things that are used to implement the sport activities and they consist of apparatus and devices. Apparatus are things to be used, for example, crate jumps, single beam, parallel bars, rings, and easel. Devices are things to complement the infrastructures, for example net, sign flags, border lines, and anythings that can be played or manipulated by hand and foot, for example: ball, racket, and bat (Supartono, 2000:6).

It is *pedagolistically* assumed that movement is the best medium for general personal exploration, communication and development. The function of exploration refers to the fact that children especially have contact with their world, explore amd widen their world through movement and move themselves and manipulate their environment. The function of communication refers to the fact that human beings communicate and learn social roles through movement and playing (Depdiknas, 2003: 105-106).

Basket ball, volley ball and football are sports characterized by complex movement and open. Their complexity can be seen from their diversity in their movement techniques, including kicking, dribbling, controlling, grabbing, passing over, heading, and smashing. Furthermore, if we look at the body movement needed to perform the above movement techniques, a number of movement including running, throwing, catching, pushing, swinging, jumping, and holding. Additionally, to perform those movement properly, the support of adequate physical ability including speed, endurance, stremgth, explosive power, flexibility, reaction, balance, accuracy, and agility.

Basket ball, volley ball and football are taught to students in Primary School and Junior High School. These three games have different

characteristics frpm other games. Big ball games have high complexity of basic movement and require the support of good physical ability. In addition, these games require special balls with different specification for different movement techniques, for example, size, weight, air pressure, material, reflection, ball elasticity.

A number of basic techniques directly related to or touching the ball for basket ball include basic dribbling, passing over, catching, and shooting the ball to the ring. Dribbling is performed by bouncing the ball with some pressure and force to the ground, passing over and shooting the ball by pushing the ball to the front, catching the ball by holding it from any pressure. All the movement involves the direct touching to the ball and this will cause the difference in weight, lightness, pain or other feeling the children experience. Similarly, with the volley ball, the techniques include low passing, high passing, service, and smash and this techniques involves the direct touching between the ball and hand and the pressure is harder than that in the basket ball. For football, there is a big difference as compared to the basket and volley ball. In the football, almost all body parts are involved in the direct contact with the ball. For example, kicking, dribbling, and controlling the ball involves a number of body parts (head, chest, stomach, thigh, and foot), heading the ball with the head, catching the ball for the keeper, throsing the ball in, etc., so for the football, the contact between the body parts and the ball is more complicated as compared to the basket ball and volley ball.

RESEARCH METHODOLOGY

Accoring to Borg and Gall (2007:589), research and development (R&D) is an industry-based research model intended to design new procedures or products, then systematically tested in the field, evaluated, and revised to meet certain criteria in terms of effectiveness, quality or standards. Further, Borg and Gall (2007: 590) suggest that R&D has the following characteristics: (1) conducting a preliminary study or research to search for research findings related to the product under development; (2) developing a product based on the research findings; (3) field testing in a real setting or situation for which the product will be used; and (4) revision of the product to solve the weaknesses obtained during the field testing. So, R&D is a systematic use of scientific knowledge to produce materials, devices, systems, methods, models, and their prototype design.

The research is conducted in ten steps: (1) research and information collecting, (2) planning, (3) developing a preliminary form of product, (4) preliminary field testing, (5) main product revision, (6) main field testing (small-scale), (7) operational product revision after small-scale field testing, (8) operational field testing (large-scale), (9) final product revision, (10) dissemination and implementation.

In the need analysis stage, the specification and characteristics of the existing balls for three different games (basket, volley, and football), including their types and brands were analysed. This involves the following stages: 1) analyzing the ball materials, structure, and frame; 2) measuring the ball pressure, circumference, and weight from various sizes available for use in many schools; 3) analyzing the ball bounce from various ground condition, different material types and size. The technical strength and weakness of the ball according to the movement characteristics of the three games, basket ball, volley ball and football. The steps taken include: 1) analyzing the ball movement from different variety of pushing power given to the ball; 2) analyzing the level of pain or inconvenience as a result of hitting part of the body (foot, hand, head, and other body parts); 3) analyzing the difficulty level (weight, size, material) of the use of the ball.

In the preliminary product design and development, a number of phases were involved including: 1) designing and setting up the specification of multifunctional balls; 2) designing and determining the deviation range of multifunctional balls; 3) designing and classify the result of the design of the multifunctional balls; 4) determining the height of the ball bounce in accordance with the characteristics of

the students of Primary School and Junior High School by measuring the children's anthropometry (the height of knee, waist, amd shoulder) to find out the ideal average size; 5) designing the form and color of the multifunctional balls by an art designer; 6) consulting the results of the three steps to the experts in ball specification technology, in sport game, in physical education, sport and health; 7) consulting to the ball producers about technical aspects and mechanism of ball production.

The stage of development of the preliminary product of multifunctional balls begins with the design of the multifunctional balls. The design was then reviewed further by consulting with the producer to find out whether the specification of multifunctional balls could be produced, by considering all technical aspects of the production, including the production mechanism, material availability, the diffocuilty level of the design, production time, and other procedural stages on the company.

In the validation stage, a special field-testing was conducted and at the same time expert validation was made. To validate the product, the researcher involved a number of experts, uncluding: 1) experts in ball specification; 2) experts in sport games (basket ball, volley ball, football); 3) experts in PESH, and 4) experts in mechanical engineering to measure the stregth of the ball materials. Based on the field-testing and expert judgement, the product was revised to obtain the expected.

The small-scale field testing was conducted to find out the feasibility of the preliminary product, by using a descriptive analysis, involving the testing of movement techniques appropriate with the characteristics of basket ball, volley ball and football. In this try-out, 36 children (18 students from State Primary School Ngijo 01 Gunungpati Semarang and 18 students from State Junior High School 34 of Semarang) were involved. Experts in PESH, in techniques, in ball specification, and laboratory officers were involved. The results of the small-scale field testing and suggestions from the experts' evaluation were used to revise the product.

Based on the small-scale field testing and suggestions from experts, analysis and field observation, the resision was made on the product with the consultation with technical experts from the producer that will produce the multifunctional ball. The revision and improvement was conducted to obtain multifunctional balls with specification appropriate for the students of Primary School and Junior High School to play basket ball, volley ball and football.

After the revision of the product, the large-scale field testing was conducted with the subjects of 36 Grade IV and V students of State Primary School Ngijo 01 and 02 Gunungpati Semarang and 36 Grade VII and VIII students of State Junior High School 34 Semarang. The testing was indented to evaluate the technical aspects of the ball for the game, and to determine the most appropriate ball for the children to play three games: basket ball, volley ball and football.

After the revision of the product was made and the production was conducted, the final product was the multifunctional ball to play basket ball, volley ball and football for the students of Primary School and Junior High School and can be used for the teaching and learning process of PESH. To show that the product is based on research, the academic report was written for publication and the society can use the product.

The field-testing was conducted in two phases, small-scale field testing and large-scale field testing. The latter was conducted by using a descriptive analysis involving three factors, the ball size of 64, 66, and 68 cm with 2 different materials, PU (Poly Urhetane) and PVC (Polyvinel Chloride), so 6 different variables of ball were tried out for different movement to play basket ball, volley ball and football. In addition, to obtain the most appropriate multifunctional ball design for the students of Primary and Junior High Schools. The students in each cell were given the same treatments. In this field testing, a repeated measurement with a number of various treatments and sample size for each cell was used.

Table 1. The Design of the Sample for the Small-Scale Field Testing of Multifunctional Balls

	Movement for Basket ball (throw, catch, drible, shoot)			Movement for Volley Ball (pass, serve, smash)			Movement for Football (kick, control, dribble, head)		
Circumference of the Material	64Cm	66 Cm	68Cm	64Cm	66Cm	68Cm	64Cm	66Cm	68Cm
PU Sponge Material	36	36	36	36	36	36	36	36	36
PVC Sponge Material	36	36	36	36	36	36	36	36	36
Total	*36*			*36*			*36*		

Note : For each game movement block, the same sample of 36 students, consisting of 18 PS students (Grade V) and 18 JHS students (Grade VII)

Table 2 The Design of the Sample for the Large-Scale Field Testing of Multifunctional Ball

	Movement for Basket ball (throw, catch, drible, shoot)			Movement for Volley Ball (pass, serve, smash)			Movement for Football (kick, control, dribble, head)		
Circumference of the Material	64 Cm	66 Cm	68 Cm	64 Cm	66 Cm	68 Cm	64 Cm	66 Cm	68 Cm
PU Sponge Material	72	72	72	72	72	72	72	72	72
PVC Sponge Material	72	72	72	72	72	72	72	72	72
Total	*72*			*72*			*72*		

Note : For each game movement block, the same sample of 72 students, consisting of 36 PS students (Grade V and V) and 36 JHS students (Grade VII and VIII)

The subjects of the field testing consisted of male and female Grade V and V PS students, and male and female Grade VII and VIII JHS students. They performed a variety of movement to play basket ball, volley ball and football by using multifunctional balls from different product sample with different size and material. Two different materials were used to make multifunctional balls, PU (Poly Urhetane) and PVC (Polyvinel Chloride). The strength of the materials were tested in the laboratory of Mechanical Engineering Department of Semarang State University. In the testing, an experimental method by using Gotech U60 engine was used to test the imitated leather. The testing was meant to compare the pulling force of the two materials so the strength and weaknesses of the materials were identified.

The data were collected from the primary data of labotayoty tests and the secondary data of field testing in Primary School and Junior High School. The qualitative data were collected from the observation of balls used in basket ball, volley ball and football by the practitionaers of PESH and sprot game experts. The quantitative data were collected from the evaluation by the users including students dan esperts and PESH teachers on the product under investigation. The instruments were observation guides, questionnaires and tests.

The quantitative data were analuzed by a simple descriptive analysis (mean, percentage) and the narrative descorition of the data from observation. The deep analysis by using a qualitative analysis was used to analyze the qualitative data from ibservation, other information and feedback.

The following is an example of the quantitative data analysis (percentage):

$$P = \left(\frac{s}{---} \right) \times 100$$

Where:
p = the obtained value
s = scores obtained by the students
n = maximum scores

RESEARCH FINDINGS

After following the stages of research and development, from the need analysis as the basis for designing the product to developing the preliminary product of the ball, then expert validation was conducted to examine the feasibility of the preliminary product of the ball. After the validation, the revision was made before the small-scale field testing was conducted to 36 children of Kalisegoro PS of Gunungpati Semarang and State JHS 34 of Semarang. The second revision was made after the small-scale field testing. Then, the large-scale field testing was conducted to 72 children of the same Primary and Junior High Schools, but different samples.

Based on the series of the above stages, the final product of multifunctional balls appropriate for the students of Primary and Junior High Schools to play basket ball, volley ball and football is described below:

Figure 1. The Final Product of Multifunctional Balls viewed from Different Sides

The multifunctional balls as the final product as illustrated above, have the following characteristics:

1. Figure A: the multifunctional ball on the triangular part with curve lines with the text "BALL" in the centre, circled with the text on top 'Multifunctional ball' and the text at the bottom Basket ball, Volley ball, Football.
2. Figure B: As in Figure A, but on other side, there an air hole on the triangle with curve lines and the text on top of it BAVOS (short for **Basket ball**, **Vo**lley, **Football**).
3. Figure C: focusing on the panel specifically for football with black and white five angle illustration.
4. Figure D: for the panel panel specifically for basket ball characterized by curve lines and light brown color.
5. Figure E: illustrating the part of the ball specifically for volley ball, the panel is

rectangular with connected yellow and blue color.

6. Figure F The part of the panel for symbol or logo when needed.

Table 3. The Specification of the Final Product of the Multifunctional balls

Ball Size cm	Material	Design/Color	Pressure bar-kg/cm^2	Weight gram	Bounce cm	Structure
66	Soft material and not slippery made of PU (Poly urhetane) Sponge	Divided into 4 circular panels triangle, each with picture and has specific color for basket ball ball, volley ball, football , and logo. Other part of the panel is a connected triangle and rectangle.	Between 0,250 – 0,3	270	105 – 115 (from the height of 200)	Outer Part is soft panels mechanically sewn. Inner part consists of inner ball made of thin rubber covered with soft yarn encircling all the rubber surface. Completed with air hole.

Based on the research findings, one type of the multifunctional ball is appropriate for the three games (basket ball, volley ball and football), has the size of 66 cm, made of PU (Poly Urhetane) Sponge. This 66 cm multifunctional ball is 1 cm bigger than the standard ball for volley ball or football for children (size 63 – 65 cm), but is 3 cm smaller than the standard ball for football for adult (size 69 cm).

Based on the evaluation form experts in PESH, especially with respect to the need for movement that requires the support of big balls as compared to the ball for volley ball and football, the size of the multifunctional ball will be more appropriate if it can accommodate the characteristics of basket ball even though the students and experts choose the ball far under the normal size of basket ball.

The multifunctional ball is made of PU (Poly Urhetane) Sponge which is light, elastic, smooth and not slippery, with the thickness of 2 cm of soft sponge so this provides comfort for various movement to play basket ball, volley ball and football. With such comfort, the students will not experience problems in performing movement activities, so that the excuse for movement problem because of the existing ball characteristics inappropriate for the children is addressed by provising the alternative solution of the multifunctional balls. In this way, the lighter and more comfortable multifunctional ball as compared to the existing ball will be the alternatives for children to play basket ball, volley ball and football and and suitable for the teaching and learning process of PESH in schools. This is demonstrated by the fact that the children do not feel scared or hesitant, even they

have the courage to play and touch the ball. Additionally, the children are highly excouraged and excited to use the multifunctional ball, so this become additional motivation if the multifunctional ball is used in the teaching and learning process of Physical Education and Sport in schools .

The multifunctional ball is 66 cm in size, and has the weight of 270 gram. Even though within the range of the specification of the preliminary prototype of the multifunctional ball, that is the weight range of 248 - 270 gram, it is still at the highest level of the range of tolerance of the maximum weight of the ball. Based on the consultation with the ball technical expert in Production Section of PESPEX, to make the ball lighter within the middle range of the torelance of 255-260 gram, the rubber part of the ball should be thinner, and the yarn layer of the ball should be very thin. If the above specification should be forcibly used, this will reduce the power of the ball because the very thin material is fragile (fragile when given the air pressure of 0.250-0.3 bar), and when used to play basket ball, volley ball and football that requires various movement and relatively high bump. Therefore, the specification of the final multifunctional ball is within the standard minimum bsed on the consideration of power and comfort of the ball. However, the espected weight can be realized if the material has better quality than PU but the material is difficult to find inside the country.

The frame and structure of the ball consisting of outer layer and inner part covered with nylon yarn, are a minimum standard of the ball to be feasible strength and characteristics. Additionally, the multifunctional ball is made for children of Primary and Junior High Schools with limited level of ability. Theoretically, there are two ways of making the ball, sewing and lamination. The sewing method can be conducted manually or handsewing, and machinesewing. The lamination method is conducted by sticking the panels with glue, and pressing strongly with special devices. In this method, a pattern device should be specially prepared in accordance with the size of the ball to be produced. Technical experts suggest that to make the ball by using the lamination method, it begins with the preliminary process of sewing method, because to obtain the accurate size, the panel sections and other characteristics should undego feasibity try-out through trial and error, so the lamination method can be conducted if the sewing method can be completed without any technical problem. The weakness of the sewing method is that there is some holes in the sewing parts so the air can go through the ball so the ball will be heavier.

In the small-scale field testing, the researcher experimented the ball when the field was wet, and it was found that the ball was heavier at the average of 18 gram or around 6-7%. The additional weight affects the children when the ball hit them. In the lamination method, there is no holes in the ball panels. According to the production section, the laminated ball has only 1-2% of absorption so it is much better than those made by sewing methods.

CONCLUSION AND SUGGESTION

The most feasible multifunctional ball that can be used to play basket ball, volley ball and football for the students of Primary and Junior High Schools has the size of 66 cm made of PU (Poly Urhetane) Sponge, soft and not slippery, has the weight specification of 270 gram, the bounce of 105-115 (dropped from the height of 200 cm) with the air pressure between 0,250-0,3 bar. The ball also has panels divided into 4 circular triangular panels, each illustrated and colored as the sign of basket ball, volley ball, football, and logo, other parts of the panel is interconnected triangle and rectangle. The ball has a variety of light color and illustrated desain giving the spedific sign of basket ball with light brown, volley ball with blue and yellow and football with back and white.

When used to play basket ball, volley ball and football by the students of Primary and Junior High Schools, the multifunctional ball does not cause any pain because it is relatively light, so the students do not hesitate to touch and

play the ball. The students are happy and enthusiastic to play with the multifunctional ball in various movement both in playing basket ball, volley ball and football. The multifunctional ball highly motivates the students so it will give a positive impact to the teaching and learning process for Physical education and Sport in schools.

Based on the conclusion, it is recommended that (1) even though the weight of the multifunctional ball of 270 gram is within the range of weight tolerance as required, it is at the maximum limit, so it is ruggested that the weight is reduced to the range of 255-265 gram; (2) the ball produced by the sewing method has high water absorption so when it is used in the wet field, the ball is getting heavier. Therefore, it is suggested that a lamination method is used even though it takes higher cost and longer time; (3) even though further development of the multifunctional ball is needed, it has feasible standard for the students of Primary and Junior High Schools to use it to play basket ball, volley ball and football, and (4) teachers of Physical Education and Sport can use the multifunctional ball as an alternative to play basket ball, volley ball, and football and can motivate the students in the teaching and learning process of Physical Education and Sport.

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