

# Developing Ergonomic Balls

Eka Nugraha\*, Ricky Wibowo, Burhan Hambali

Physical Education Department, Faculty of Sport and Health Education  
Universitas Pendidikan Indonesia  
Bandung, Indonesia  
\*ekafok@upi.edu

**Abstract**—Modified sports equipment is such an important factor in having learning media in physical education. This study aimed to design a physical education learning medium with ergonomic in accordance with the anthropometric mapping of Indonesian students. This study used a mixed method with design basic research (DBR) employing various instruments to collect data including document study, survey, interview, and direct observation. The population in this study was all junior high school students all over Indonesia and 1018 out of them were selected to be the sample. Based on the data analysis, it is found that 95% of physical education teachers used formal sports equipment without considering the anthropometric aspects of their students. Thus, it is concluded that it is necessary to create a learning medium with good ergonomic in accordance with the anthropometric mapping of students and in line with the development of literature in physical education.

**Keywords**—physical education learning media; ergonomic balls; modified sports equipment

## I. INTRODUCTION

Learning media is an inseparable factor in the success of teaching and learning, including in physical education. In physical education, modified equipment of such sport as volleyball, basketball, and other types gives more chances of skill improvement [1-3] and other various equipment and facilities in accordance with improvement of effective teaching and learning of physical education [4]. However, the fact shows that most physical education teachers do not understand this so that they use the real equipment used in sport without any modification based on the needs of learning outcome. In the industry, this type of modification is called ergonomic.

According to Stockbridge, ergonomics related to humans are knowledge on bodies; their abilities, limitations, and characteristics relevant with a certain design [5]. Moreover, Santosa G points out that ergonomic is about adjusting the anatomic and physiological conditions of children for the sake of their safety [6]. In the context of pediatric ergonomics, it has to be clearly understood that children are not the miniature of adults. Thus, there needs to be learning media relevant to the development of children's growth, either physical or psychological growth [7,8]. In physical education, some students are reluctant to actively participate since they fear or do not have confidence to play using the real equipment of a certain sport, a standardized ball for instance. In fact, the ball is not relevant to the anthropometric aspects of students.

As a matter of fact, learning is a process of behavioral changing. Some of the indicators of learning are 1) learning is influenced by training and experiences; 2) learning processes cannot be directly evaluated; however, the results are reflected from skill improvement; and 3) individual change of skills are permanent [9]. In learning, media are an important component significantly influencing learning outcomes. There are four main components of lesson planning including aims, content, method, and assessment/ evaluation as shown in Figure 1 [10].

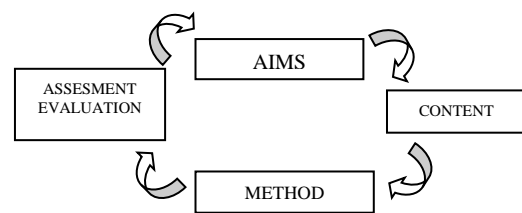


Fig. 1. Cycle of lesson planning [10].

Since learning media are a supporting aid of learning, the implementation should be carefully planned by teachers. Selection of media should consider the following criteria 1) learning objectives; 2) theoretical framework; 3) students' characteristics; 4) students' learning styles; and 5) facilities available [11]. This idea is also supported by another study stating that the selection and the use of equipment in learning are an important aspect in a well-organized lesson [12].

In physical education, the equipment is divided into small and large equipment. Small equipment is such things as balls, batting tee, cones, etc. [13]. Several studies related to the use of equipment of learning media in teaching and learning processes have been conducted. A study by Nugraha and Hasanah proved that there is a significant influence of modified equipment towards learning outcomes in elementary schools [14]. Moreover, a study by Wijoyo revealed that the use of a modified ball is more effective compared to the use of a formal ball [14]. A study by Rasip finds out that the modified balls are effective to use in learning [15]. In short, the use of modified balls offered the students more fun so that they were getting more enthusiastic in the teaching and learning process. In addition, the use of modified balls also gave more opportunities for students to develop their cognitive, affective, and psychomotoric domains. Figure 2 shows an example of a modified basketball made out of petroleum waste (PU = Polu Urethane) based on a natural rubber (NBR = Nylo Butan Rubber) or fruit waste, or a combination of all. This type of

ball is produced in overseas countries such as China, the Netherlands, USA, etc.



Fig. 2. A modified basketball.

Based on the aforementioned reasons, this study aimed to design physical education learning media in a form of modified balls, test the ball in a laboratory, and test their use in selected junior high schools.

### II. RESEARCH METHOD

The method used in this study was a mixed method using design bases research [16] consisting of repetitive design, development, and revision [17,18] as shown by Figure 3.

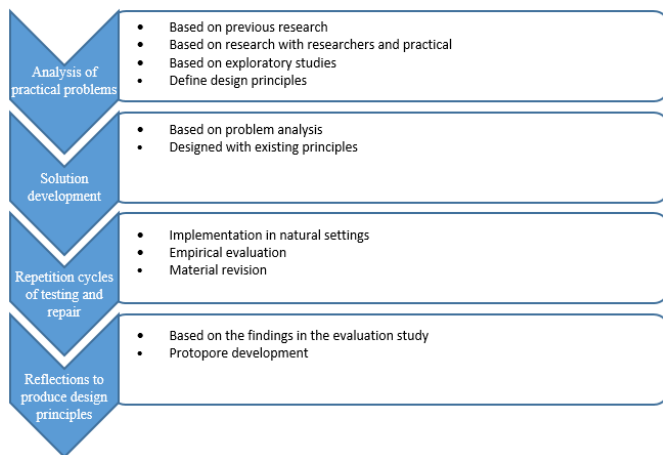


Fig. 3. Design of basic research by Reeves [17].

### III. RESULTS AND DISCUSSION

Based on the interview with physical education teachers, it has been found that 95% of the teachers in West Java used a formal sport equipment for learning. Thus, it is strongly recommended that schools start considering the ergonomic aspects of the equipment used in their physical education [19] to promote learning with constructivism approach by Piaget [20]. It is believed that planning learning media should be planned futuristically [21].

Based on the studied literature and anthropometric mapping of seventh graders in Indonesia, an ergonomic ball is designed as explained in Table 1.

TABLE I. DESIGNING AN ERGONOMIC BALL

Type of Test	Unit	Requirement	Remark
The ball condition The ball is still round after bouncing The ball surface follow the students hands' contoure	-	The ball surface is not sticky and there is no printing waste. The ball surface is coated with two layers with high density yet not stiff.	The ball surface is not sticky and sliperry and is back immediately to the previous state after modification.
Surface area of the ball  b, the ball roundness	cm	68.00 – 73.00  ≤ 1.5	The surface area of the ball is according to the range of an open arm. Average: 14.07, Average of the head circumference :49,04 and the average of body mass index =2.0
c.the weight of a basketball no.5	gram	between 350-410	The ideal weight which is the safest towards the impact of bounces is searched with the average at 49.04
Bouncing ability	cm	Between 120-140, For physical education between 80-110	When the ball is bounced at the height of 180 cm, the bounce will be between 80-110 cm, with the height average at 150.28 and that of the limb length at 75.42
The width of the hem/ the border line among panels	cm	≤ 0.60	The line is black
The abrasion strength		≤ 50. The performance is not changed after normal use	The ball is saved cleanly in a dry room with a certain humidity and temperature.

Theoretically, designing a prototype learning equipment or media needs a long time for repetitive trials, revisions, and adjustment to the needs [22-24]. It is important to have modified equipment so that physical education runs smoothly [25].

### IV. CONCLUSION

Physical education equipment is closely related to its users so that designing a modified equipment needs certain criteria. Some of the important criteria are their functions, performance, safety, and easy modification for the development of physiology, sociology, and psychology of the users.

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