

THE USE OF GLOBAL POSITIONING SYSTEM (GPS) POLARS TO DETERMINE MOTION INTENSITY

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Abstract

The objective of this study was to determine the motion intensity using a polar Global Positioning System (GPS) in physical education. As a model, we used 24 students (aged 12-13 years old), and their movements are tested using polar GPS equipped with polar heart rate sensor. Experimental results showed that the GPS can detect the position precisely, and its combination with heart rate can predict the energy used during the movement. The condition for this analysis showed that the movement of 0.23 km has a correlation to the heart rate of about 140 bpm, which is in a good agreement with the literature. The use of polar GPS in the learning process is highly recommended to measure the intensity of motion in physical education.

Keywords: Basketball, Learning activity, Motion intensity.

1. Introduction

Nowadays, the use of technology has developed rapidly and has become one of the important needs of human life. The Global Positioning System (GPS) is a continuously positioning system of three-dimensional speed and time information [1]. With the main use as a device to identify and develop a certain location for many purposes, GPS technology is highly potential to be applied in sports and health field [2]. The newest GPS technology is easily carried and used. It is often designed as daily accessories like a watch, key chain, and glasses. With this technology, various training such as running track and heart rate can be measured and controlled real time. It helps people to prevent over-training [3].

The use of GPS technology has been widely used in sports activities and sports training. GPS devices have been proven as a useful and needed device. GPS with a frequency of 1 Hz can be used to measure total distance, peak speeds during high-intensity, and intermittent exercise [4], whereas that with a frequency of 5 Hz can be used to determine distance and speed measures [5]. Several studies by MacLeod et al. [6] have evaluated the use of GPS devices in sports activities and have received a good level of validity and reliability. However, the number of studies examining the use of GPS technology in physical education learning is lacked.

From previous reports, GPS technology is often used to analyse player movement and motion intensity in various sports and games such as soccer [7-9]. Malik et al. [10] mentioned that in basketball games, GPS technology is used to determine the motion intensity of players based on their respective positions. GPS is utilized to examine the comparison of player movement and motion intensity based on the players' position in hockey [6, 11] and cricket [12]. It has been also applied in physical training such as circuits running [4].

GPS technology has been used to evaluate motion intensity in sports activities and sports training. However, there are only a few studies mentioning its use in physical education learning in schools. In fact, motion intensity is very important. By using GPS, a teacher can observe the students' motion intensity and then determine the appropriate learning method to make students an active role and increase their physical activity. Motion intensity is a qualitative component that refers to the amount of work or movement carried out in a given unit of time [10]. Mark and Janssen [13] proposed that the intensity of motion can be determined by measuring the heart rate, the type of exercise or learning, and the distance taken during the exercise or learning. Student's motion intensity consisted of average heart rate, maximal heart rate, and distance covered during the learning activity can be seen and analysed using a Polar GPS. The results can be used by the teacher as a consideration to make a better plan in learning activities in the future. Researches have only discussed the use of GPS to measure motion intensity in sports activities and sports training. Therefore, this study aims to determine the motion intensity of students in physical education learning by using polar GPS and see the students' and teacher's opinion about the use of this GPS technology.

2. Method

2.1. Participants

The participants in this study were junior high school students with a total of 24 students (12 males and 12 female) aged 12-13 years in Bandung, Indonesia. However,

only 8 students used GPS equipment in this study. Each student was given information about the design, requirements, benefits and risks of the study. According to Nandiyanto et al. [14], students aged 12-13 years were chosen because at that age students in the period of development and growth are identical to motion intensity and physical activity.

2.2. Instrument and test procedure

The instruments used in this study were Polar GPS RC3 and Polar Heart Rate Sensor H3. Polar GPS RC3 in the form of a watch was worn on students' hands to determine the position and movement of students during learning, while Polar Heart Rate Sensor H3 was put on the student body to find out the heart rate of the student by sending a pulse signal from the tool to the website. All measurement data are integrated with the Polarpersonaltrainer.com website. The measurement results about the distance, the maximum heart rate, and the average heart rate will be displayed on the website.

Students conduct physical education learning with basketball learning material for 2×40 minutes. Learning implementation is divided into 3 stages, namely, the introduction of learning, core learning, and closing learning. The introduction stages consist of warming up and learning purposes explanation. Core learning spent 50 minutes with students learn passing technique such as overhead pass, chest pass, and bounce pass. Core learning was closed with a modified basketball game. During 15 minutes closing stages, learning evaluation, students feedback collection, and cooling down session was conducted. Eight students used GPS equipment during core stage of learning. After the learning is complete, the teachers and students who using GPS equipment were interviewed to find out their opinions about the use of GPS in petrified physical education learning, especially to determine the students' motion intensity.

Calculation of heart rate and distance during the learning process was done to determine the level of physical activity and the motion intensity in students. The maximum heart rate that was considered safe for students was calculated by the formula $220 - \text{age}$ of students ($220 - \text{age}$) [13]. The mean heart rate for each student was calculated during the core learning process. The heart rate category was classified into four intensity levels, namely low category (<120 bpm), low to moderate (120-140 bpm), moderate to vigorous (140-160 bpm), and vigorous category (>160 bpm) [14].

2.3. Data collection

All data were taken from the Polarpersonaltrainer.com website, which had been synchronized with the Polar GPS RC3 and Polar Heart Rate Sensor H3 instruments. Heart rate data and distance data during the learning process were taken automatically by a sustainable system.

2.4. Data analysis

In this study, the data were analysed by using descriptive statistics. It is aimed to display means and standard deviations (\pm SD) that was in accordance with the purpose and number of samples in this study [7]. All calculations used the SPSS test statistic.

3. Results and Discussion

Table 1 shows the analyses of the average heart rate, maximum heart rate, and distance covered in physical education learning. From the 8 students using Polar GPS, it can be seen that the average heart rate means of students is at 138.94 ± 5.48 bpm. Meanwhile, the heart rate max is 191.75 ± 10.36 bpm, with an average distance of 0.23 ± 0.10 km.

Figure 1 shows that the results of the heart rate of female students are 205 bpm as the highest pulse rate and 179 bpm as the lowest, whereas in male students the highest heart rate was 206 bpm and the lowest was 186 bpm as shown in Fig. 2. In summary, Fig. 3 shows that the heart rate of female students is in the ‘low to moderate’ category of 25%, and the ‘moderate to vigorous’ category of 75%. In male students, the same number of achievements is 50% in the ‘low to moderate’ category and the ‘moderate to vigorous’ category. No student gets a low or vigorous category.

Table 1. Analysed data of heart rate and distance.

	Heart rate _{mean}	Heart rate _{max}	Distance (km)
Mean	138.94	191.75	0.23
SD	5.48	10.36	0.10
Min	127.66	179.00	0.10
Max	146.00	206.00	0.40

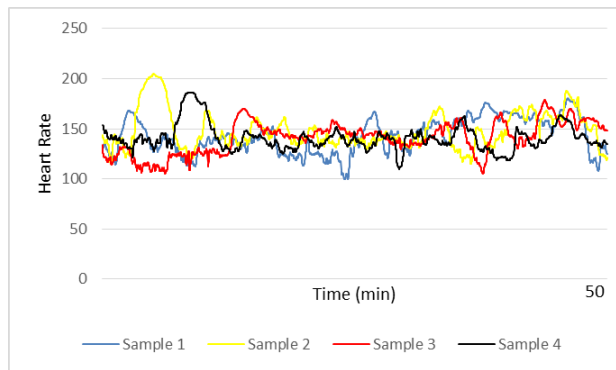


Fig. 1. Heart rate of female students.

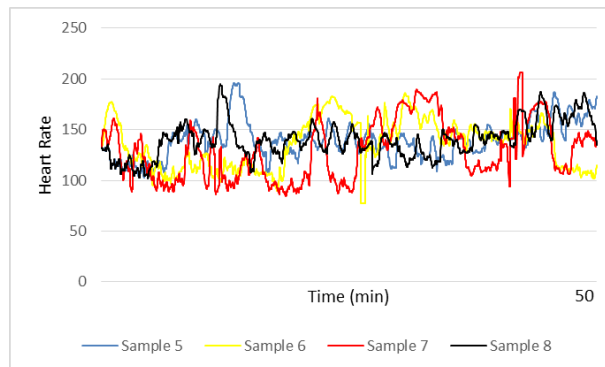


Fig. 2. Heart rate of male students.

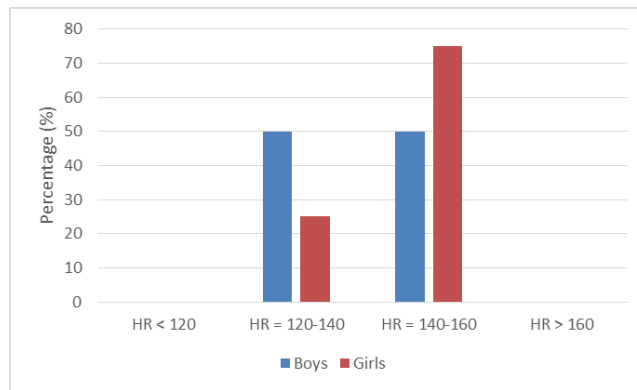


Fig. 3. Percentage heart rate category based on gender.

Figure 4 shows that the highest achievement is obtained by the S8 student with a score of 0.40 km while the lowest distance is obtained by the S4 student with a score of 0.10 km. The average students reach 0.23 km.

The classroom teachers were interviewed about their opinion about this device. Initially, they did not consider the motion intensity as urgent information. Even if they find difficulties in collecting the data, they did not take it as an urgent problem. They then realized that these results help them to make a better plan for the next learning activities based on students' condition and needs. The results indirectly remind the teacher about the purposes of physical education learning, in which, this is for strengthening students' capabilities and competencies in sports and physical health. Students who use GPS equipment reveal that this is a new experience in using GPS equipment while studying physical education. This GPS technology helps them to understand their activities while doing learning [14, 15].

Measuring heart rate is one of the most frequently used ways to determine the intensity of physical activity [13]. Mileage during learning can also be used to analyse students' movements about how far they run or do activities. Polar GPS is prospective to track and visualize the position, movement, heart rate, and playing area of students. It is also a promising method to determine the physical activity and motion intensity of students when learning at school [7, 16]. From the results of the research, the student's heart rate was at the average of the 'low to moderate' and 'medium to high' intensity categories. However, for the student's distance, it was only in the range of between 0.10 and 0.40 km. This means that the physical condition of the students can be expressed as 'poor'. The Poor physical condition of students will produce low physical activity and increase some diseases such as obesity. It can occur due to student inactivity [17-21]. In addition, a low category of heart rate indicates students low tenacity where they can easily have tired and sick because of sudden increasing physical activities [22].

Many researchers discussed the motion intensity of players in sports games and exercises that helped coaches to analyse the movement patterns of players. Thus, they could organize training programs and strategies in matches [7-12, 23, 24]. In this study, the results of motion intensity can be used as a teacher's reference in determining the appropriate method of learning for students. Interesting and pleasant methods according to student needs can encourage students to be active in physical education learning [25]. If the activity of students in the learning process

increases, it is expected that students' fitness and body performance will increase as much as the increase of their physical activities during physical education learning [16].

Based on studies by Pareta and Pareta [26], although GPS has been widely used in various applications, this was the first study who promotes the use of GPS Technology in physical education in junior high school. However, further studies are still needed with a greater number of meetings and movement activities as well as more adequate and wider field sizes to determine the effectiveness of using Polar GPS [26]. In addition, Polar GPS can also be used to measure calories burned-out during activities [27, 28], however, research on their application in physical education learning is still rare.

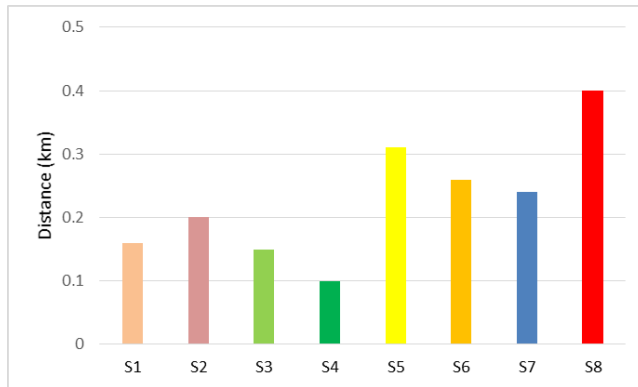


Fig. 4. Students' distance during physical education learning.

4. Conclusions

GPS can provide real-time and valid data of motion intensity. When it is applied in physical education, the teachers found that it helps them in learning activities. The data from this GPS technology is clear enough to be used as consideration for planning the next learning activities. Further research needs to be done to decide how far this device can be used as a tool in the school.

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