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Chest pass automatic board for evaluating basic chest pass skills using vibration sensor
Tablero automático de pase de pecho para evaluar las habilidades básicas de pase de pecho usando un sensor de vibración

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Abstract. The purpose of the study is to develop an electronic basketball chest pass measuring tool that reduces human error while assessing basketball chest pass technique. The research and development approach was used in this study. A total of 31 students were used as research participants on large-scale test. Data analysis in this study is a validity test using an external validity test by correlating the results of the chess pass using the Chest Pass Automatic Board with the results of the conventional chess pass, and the reliability test using Spearman Brown. The results of data analysis obtained a product validity value of 0.9985 and a product reliability value of 0.999. The Chest Pass Automatic Board prototype is valid and reliable for measuring basketball chest pass technique.
Keywords: Basketball; Chest pass test; Instrument; vibration sensor.

Resumen. El propósito del estudio es desarrollar una herramienta electrónica de medición de pases de pecho en baloncesto que reduzca el error humano al evaluar la capacidad de pases de pecho en baloncesto. En este estudio se utilizó el enfoque de investigación y desarrollo. Un total de 31 estudiantes fueron utilizados como participantes de investigación en pruebas a gran escala. El análisis de datos en este estudio es una prueba de validez usando una prueba de validez externa al correlacionar los resultados del pase de ajedrez usando el Tablero Automático Chest Pass con los resultados del pase de ajedrez convencional y la prueba de confiabilidad usando Spearman Brown. Los resultados del análisis de datos obtuvieron un valor de validez del producto de 0,9985 y un valor de confiabilidad del producto de 0,999. El prototipo de Tablero Automático de Pase de Pecho es válido y confiable para medir las habilidades de pase de pecho en baloncesto.
Palabras clave: Baloncesto; Test de pase de pecho; Instrumento; Sensor de vibraciones.

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Introduction

The results of previous studies revealed that the chest pass was the most widely used type of pass during basketball games (Quílez-Maimón et al., 2020). The "ball Werfe
n und-Fangen test" was used in previous research to assess pupils' chest pass skills (Putra, 2020). The test is done by throwing and catching the ball against the wall. Another study measuring passing ability began with participants wearing the Inertial Measurement Units (IMUs), adopting a triple-threat position (which allows the player to dribble, pass the ball, or shoot the ball) holding the ball, standing behind a line 2.43 meters from a wall, and facing five targets 0.61 m × 0.61 m located on the walls at different heights and 0.61 m apart from each other (Quílez-Maimón et al., 2021). This shows that the type of pass chest pass has a major contribution in the game of basketball. Conceptually, the basketball chest pass ability test is done by throwing the ball at the wall, counting the number of ball bounces with a time of 60 seconds.

The progress of the times and today's technology allows the development of test technology and sports measurement that is better than before. Several studies have carried out the development of exercise test and measurement technology. Previous studies developed a hexagonal obstacle test agility measurement technology with the help of infrared sensors (Firdausi & Simbolon, 2021). Another study developed a leg power measuring device with an infrared sensor and a load cell called the Jump Power Meter (JPM) (Haryono & Pribadi, 2012). A study produced a prototype measuring instrument for Body Mass Index (BMI) using infrared sensors and load cells (Simbolon & Firdausi, 2019). Wireless technology, fitness trackers, and body sensors in sports have a significant impact on life efficiency and health system reliability today (Li et al., 2020). Infrared sensors had been also utilized in the development of a body flexibility testing tool in previous investigations (Firdausi & Simbolon, 2020). Another study combined multiple sensors for precise timing, position detection, and motion measurement enabling the acquisition of previously inaccessible kinematic and spatiotemporal variables (Hribernik et al., 2021).

Today's advancements in science and technology allow for the creation of tools that aid in the growth of sports. The way of determining the ability of a traditional basketball chest pass, as described above, allows for the use of contemporary technologies. Especially when it comes to reducing human error when evaluating a basketball chest pass's technique. When a task is closed in nature, it is simpler to determine the best movement technique since the athlete's exogenous elements (or external factors) are less significant in the modeling equation (Glazier & Mehdizadeh, 2019). Therefore, the main objective of this research was to develop an electronic basketball chest pass measuring tool that reduces human error while assessing basketball chest pass technique.

Methods

Research Design

This study uses the Research and Development (R&D) method to develop a product in the form of a basketball chest pass measurement instrument. R&D approaches can be used to create new tools, products, or procedures (Paterson, 2016). A study conducted in the context of product development is known as design research and development (Marius, 2014). Problem identification, literature review, product design and development, product performance testing, analyzing product testing findings, and communicating product testing results are research processes in the R&D method (Gomez et al., 2019).

Based on the development model used in this study. Several methods were used in the chest pass automatic board development procedure as follows. The researcher determines the possible causes of the performance gap of traditional chest pass measurement tools during the analysis stage. The researcher confirmed that the performance gap was caused by the tester's aid in traditional chest pass measurements. The researcher then outlines the study teaching goal, which is to create a chest pass technique measuring apparatus that functions autonomously and requires minimal tester aid to perform its measurements. Researchers also looked at the gaps in existing sports and health technology development. A study of the need for sports and health technologies, particularly in Indonesia, was also conducted. The disparity was also validated by the researcher with the target audience. The researcher also evaluates the required resources, creates a project management plan, and decides on a possible delivery mechanism at this point (including cost estimates).

The design stage, In this stage the researcher confirms the expected results and the relevant product testing procedures. In this stage, the researcher takes an inventory of tasks, sets performance goals, produces test strategies. At the developing stage, the researcher chooses and develops the materials that will be used to create the product. Items are generated based on predetermined designs. The product is subsequently put to the test. Preparing items for field testing during the implementation stage. This method is used to test the product in order to create a legitimate and dependable system. The system's performance is also evaluated in order to account for the outcomes. The equivalency test method was used to conduct product trials. When data is collected from a single sample group using two instruments. Researchers evaluate the quality of products and testing methods before and after implementation at the evaluation stage.

System design

In the design of the chest pass automatic board, the vibration sensor model SW-420 was used. A potentiometer on this module can be changed for sensitivity thresholds. In prior study, a vibration sensor was used to create a system that could identify the elderly in the event that they fell (Fauziah et al., 2019). This sensor was also utilized in other studies to measure dynamic vibrations and force (Yupapin & Pornsuwancharoen, 2019). this sensor is also used in a low-cost wireless vibration monitoring system that may be utilized at any time to monitor machine vibration (Bhuiyan et al., 2021). The block diagram of our proposed system can be seen in figure 1.

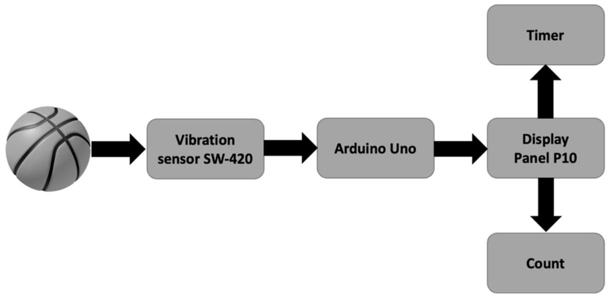

Figure 1. The block diagram of chest pass automatic board system

The chest pass automatic board consists of a target area (1) and LED display timer (2) and counter (3) as can be seen in figure 2. A vibration sensor is installed on the target plane to detect the ball's reflection and send a signal to the microcontroller located on the LED display box. Furthermore, the ball bounce count results are automatically displayed on the LED display. Timmer can be changed, and the countdown can be set to 60 seconds or one minute to measure the ability of the chest pass. Milliseconds, seconds, and minutes are displayed on the display.

Figure 2. The chest pass automatic board realization

Figure 3. The chest pass automatic board testing

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The only time the user needs to intervene is when the timer has to be reset. When the initial ball bounce lands in the target region, the timer begins counting down automatically. When one minute has passed, the counter automatically locks the outcome of the one-minute chest pass ability. When testers reset the device, the timer will reset to one minute and the counter will reset to zero. The chest pass automatic board testing as figure 3.

Participants

In October 2021, this study was carried out at the Universitas Muhammadiyah Bangka Belitung sports laboratory. Students in the physical education, health, and recreation program served as research subjects. A total of 31 students were used as research participants.

Data Analysis

Product validity analysis was carried out by correlating the data from the chest pass measurement with the product and conventional. This validity is also known as external validity. The external validity of the instrument is tested by comparing it to find similarities (Rusdiana et al., 2021). The equivalency test method was used to evaluate product reliability. The data was obtained by combining the traditional chest past measuring method with chest pass measurements taken with the researcher's product. The data obtained from the two instruments were analyzed by product-moment correlation (Cahanin et al., 2021). Furthermore, the product reliability coefficient was analyzed using the Spearman-Brown formula. Reliability refers to the degree to which an instrument in a measure actually measures the same phenomenon (Jones & Gratton, 2004). To determine the value of the validity and reliability of the chest pass automatic board product, it is calculated using the product-moment formula (1). Furthermore, reliability is followed by the Spearman-Brown formula (2). The level of statistical significance of the test was set at the 0.05 level.

$$r_{xy} = \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{\{N\sum x^2 - (\sum x)^2\}}\sqrt{\{N\sum y^2 - (\sum y)^2\}}}$$

(1)

$$r_i = \frac{2r_b}{1 + r_b}$$

(2)

Results

A twenty-person sample was used in a small experiment. Small-scale product testing provides a wealth of information for this product's development. There is a counting jump or jumping as we call it. Jumping occurs when the signal given by the vibration sensor is counted twice even though the ball is only reflected once to the target area, resulting in double-counting. Based on table 1, it is known that mean ± SD of the conventional test data (36.3 ± 3.38), and the mean ± SD of the automatic board test data (35.15 ± 3.84), is based on the results of a small-scale product trial with 20 samples. There is a one-point discrepancy between the minimum (30) and maximum (42) conventional test scores and the minimum (29) and maximum (41) test scores utilizing the automatic board.

Table 1.
Small-scale test data description

	Chest Pass	
	Conventional	Chest Pass Automatic Board
n	20	20
Mean	36.3	35.15
Median	37	36
Standard Deviation	3.38	3.84
Range	12	12
Minimum	30	29
Maximum	42	41
Sum	726	703

One person scored 30 based on a study of the frequency distribution of data from small-scale traditional testing. Four participants received a score of 33, 36, or >39. The highest frequency is 39, which corresponds to 7 persons. In the meantime, two people scored 29 on the chest pass test utilizing the automatic board. Three persons received a perfect score of 32. Five people got 35, 38, and >38, which was the highest frequency. Figure 4 depicts the comparison of these data.

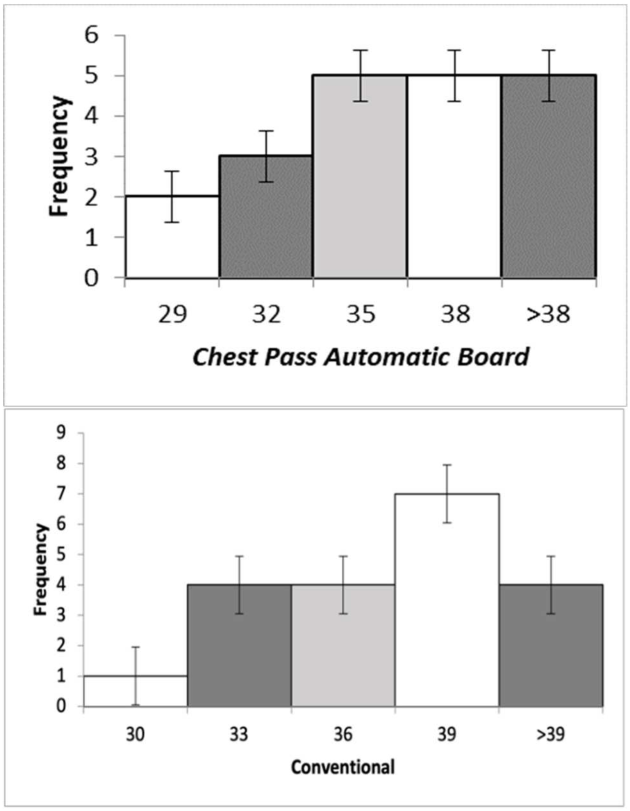

Figure 4. The small-scale test results histogram

A large-scale test with a sample of 31 people was conducted after a small-scale test and enhancements to the chest pass automatic board product. Overcome jumping

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trouble encountered in small-scale tests. Sensor readings ranging from 250 milliseconds to 500 milliseconds are used to set the settings. The minimum value of Analog to Digital Converter (ADC) vibration has also been reduced from 1000 to 500. Table 2 shows the results of the chest pass ability exam utilizing the traditional chest pass test against the automatic board chest pass test.

Table 2.
Large-scale test data description

	Chest Pass	
	Conventional	*Chest Pass Automatic Board*
n	31	31
Mean	38.54	38.48
Median	38	38
Standard Deviation	4.31	4.24
Range	18	18
Minimum	30	30
Maximum	48	48
Sum	1195	1193

The mean ± SD of the conventional test data (38.54 ± 4.31), and the mean ± SD of the automatic board test data (38.48 ± 4.24), are known based on a descriptive statistical analysis of data from large-scale trials. It is known that there is no difference in the minimum (30) and maximum score (30) between the traditional chest pass exam and the automatic board based on the score (48). It is known that there is no difference in the frequency distribution of the data from the large-scale trial between the traditional chest pass test and the automatic board chest pass test, based on the study of the frequency distribution of the data from the large-scale trial. At point 37.2, each has the highest frequency, with as many as 12 people. At 40.8, nine persons are present. Five people have a 44.4 rating. Three people have a score of >44.4. In addition, two people have a value of 30. Figure 5 depicts the comparison of these data.

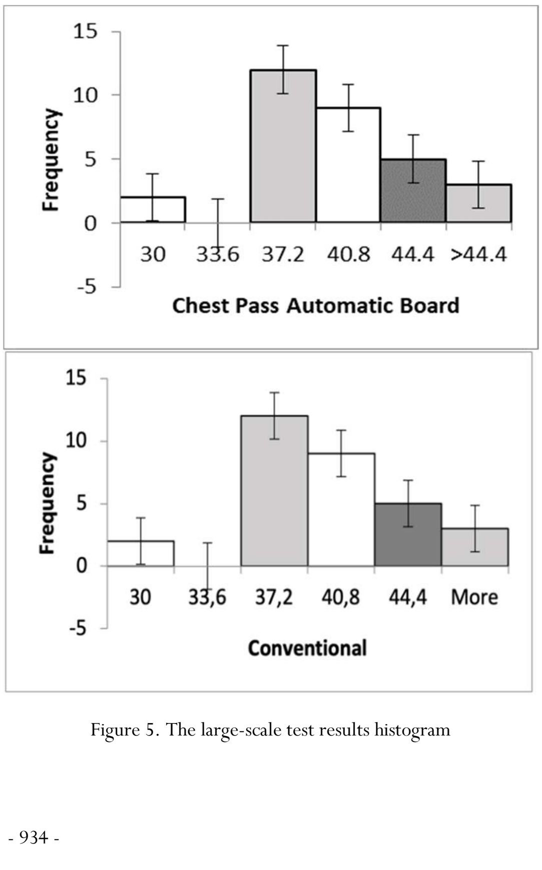

Figure 5. The large-scale test results histogram

To assess the value of validity, the data from the two instruments were evaluated using product-moment correlation. The validity value was 0.998 based on the data analysis results. Furthermore, the Spearman-Brown method was used to examine the product reliability coefficient, obtaining a reliability value of 0.999.

Discussion

Basically, passing the ball to someone's chest target in basketball necessitated strength and accuracy (Juniardi & Wibowo, 2019). For the management of technical gestures, specifically in basketball, motor coordination is essential (Mejia & Perez, 2021). According to the findings of the mentioned research, the developed product has seen a trouble in small-scale testing. Overcome jumping trouble encountered in small-scale tests. This is most likely related to the participant's throwing force during the test. Sensor readings ranging from 250 milliseconds to 500 milliseconds are used to set the settings. The minimum value of ADC vibration has also been reduced from 1000 to 500. The jumping problem can be handled when those adjustments are made. After the jumping problem was fixed, the test results on a large scale revealed that the device was valid and reliable for use in measuring basic chest pass skills. If the validity value of an instrument is more than 0.78, it is considered excellent (Zainuddin et al., 2020).

In a recent study, researchers discovered a useful technique for evaluating developmental changes in basketball passing skills in outdoor situations (Quílez-Maimón et al., 2021). However, in lab circumstances, the technology described in this work is simpler and more practical. Different studies reveal that players use techniques that fall short of theoretical recommendations, are not regulated, and do not meet the criteria that allow successful free throws in field tests (Díaz-Aroca & Arias-Estero, 2022). Despite the differences in laboratory conditions and actual game, athletes should have appropriate theoretical knowledge and technical skills that can be tested in a laboratory setting. However, most previous research has only looked at accuracy as a single component in basketball passing performance, which appears to be insufficient for identifying expert players (Seifert et al., 2012). This device has the potential to be improved. This device could be upgraded in the future to include a strength meter. Coaches and researchers in team sports will benefit from this research in terms of improving talent assessment.

Conclusions

With a validity score of 0.998, the chest pass automatic board product developed by this study is valid for measuring the ability of a basketball chest pass. According to the findings of large-scale reliability testing, the chest pass automated board product has a positive and substantial correlation, with $r_{count} > r_{table} = 0.999 > 0.355$, indicating that the chest pass automatic board product is dependable for measuring the ability of basketball chest passes.

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