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Original Article

Development of a digital-based sit and reach box for measuring body flexibility

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ABSTRACT

Technology and education development are expected to make teachers easier to create and produce learning media used practically and efficiently. This study used the research development (R&D) method proposed by Borg and Gall, consisting of ten research steps. It aimed to develop a preliminary product design for a digital-based flexibility test measuring instrument. This research produces a body flexibility measurement tool for physical education subjects, particularly physical fitness. The participants of this study were Tanjung Lago 1 Public Middle School students validated, revised, and tested on small and large scales. Three experts validated this research through a questionnaire of various kinds of questions, i.e.1) an expert in sports tests and measurements, namely a lecturer at PGRI Palembang University (94% in the very compatible category), 2) an expert in electrical media from C.V. Cometronica Palembang (82% very appropriate category), and 3) the teacher of Physical education from SMPN 1 Tanjung Lago (97% very proper category). The three experts reveal that an average of 91% of the digital-based sit and reach box applied to measure flexibility tests is worthy. It is supported by the statistical results of small-scale trials with normality tests of 0.200, homogeneity tests of 0.785, and paired sample t-tests of 0.785, statistical results of large-scale trials with normality tests of 0.200, homogeneity tests of 0.64, and paired sample t-test of 0.299. This study indicates that the digital-based sit and reach box tool developed and tested for meeting validity and effectiveness can be implemented in teaching and learning activities.

***Key words**: development, flexibility, digital.*

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INTRODUCTION

Physical education is an educational process utilizing physical activity and planned systematically to improve individuals organically, neuromuscular,

perceptually, cognitively, socially, and emotionally (Bayu et al., 2022). Physical condition is one of the indispensable prerequisites to improve an athlete's performance and the basis for the starting point of an achievement sport (Zefiter & Irawan, 2018). According to Bangun (2016), sport is a physical training activity, namely physical activity to enrich and improve the ability and skills of basic movements and movement skills (sports). It means that everyone who does physical education through sports activities will have adequate physical fitness. Moreover, physical fitness can influence an athlete's achievement (Aprilianto & Fahrizqi. 2020). A person can have good physical fitness if the degree of good fitness is fulfilled for the parameters (Ciptadi, 2013). According to Darmawan (2017), physical fitness is a condition that everyone highly desires. With physical fitness, people will be able to appear more active and create work productivity. Physical fitness is a person's ability to carry out activities without experiencing significant fatigue. Physical fitness is a person's ability to carry out daily activities without experiencing significant fatigue and can still carry out further activities (Hartati et al., 2020). Determination is a stretching or stretching movement performed with maximum elasticity in joints and muscle tissue. Determination is one of the components of the condition that supports attaining optimal achievement (Purba, 2017).

The quality of movement ability increases if athletes have aspects of flexibility because flexibility is the range of distances from a joint or group of joints or the distance that can be achieved in a joint (Iyakrus, 2012). Each student has a level of physical fitness because of the learning process carried out in physical education subjects at school. The sit and reach test is a general measure of flexibility, specifically the flexibility of the lower back and hamstring muscles. Learning should be optimized in the aspect of technology because all forms of community activities often involve technology, especially in today's millennial generation (Prasetyo & Artikel, 2020). According to Pratama (2018), science and Technology is the study of technological developments based on science. In countries that are more developed than Indonesia, their sporting achievements are more advanced because they involve technological intervention. The phenomenon appears because modern technology's effectiveness, efficiency, and accuracy are

higher than manual ones. As science and technology develop, human activities will be easier.

Sport is also one that utilizes sports to date. In sports, science and technology can be used in managerial, data collection of athlete profiles, training processes and viewing matches in the digital world both online and offline (Rizal et al., 2018). According to Yoda (2020), technological advances also impact community involvement in conducting better sports activities in both educational, achievement and recreational sports. Each phase of the industrial revolution has a very broad impact in various fields. Moreover, there is no exception in sports, such as discovering all-digital test equipment measuring accurately, all-digital weight machines, and applications evaluating errors in performing movement techniques from various sports. These digital tools can predict and direct a person to choose the right sport and various technologies to produce high-achieving athletes. According to Perdana (2021), in its utilization, this computer/laptop/internet network facility is often not maximized; so far, many teachers still need to get advantage of the development of information and communication technology.

Utilizing the development of information and communication technology, the potential to develop technology in the field of sports owned by Indonesia is not inferior to other developed countries because it has many sports scientists whose abilities are no doubt, so this potential must continue to be explored as deeply as possible for the advancement of sports and to improve the quality of physical education learning in schools as well as sports achievements that can make the nation and state proud. With respect to the observations of this field, many problems making teachers and coaches complain when measuring the flexibility test using non-digital tools are discovered. It makes teachers and trainers tired and cause a loss of concentration because the implementation of tests using manual tools takes a long time, causing teachers and trainers to make mistakes in recording the results of the determination test.

The next problem appears from the observation results, particularly the needs analysis presented in the questionnaire distributed by researchers to 57 respondents. Many physical education teachers and trainers still need help measuring the flexibility test. The questionnaire results show that 94.7% of respondents have done

physical fitness tests, of which 50.9% have done the flexibility test. Meanwhile, for those who have done the test, 47.4% of them need help in doing the test due to invalid tools, human error due to fatigue, to recording the wrong results due to using tools that are still manual. So far, during the learning process of measuring flexibility, it is still conducted manually using a sewing meter or ruler, owning many disadvantages. Determination measurements with non-standard tools obtain less accurate, valid, and maximum results. The abovementioned problem should be overcome by developing a sit-and-reach tool to measure digital-based body flexibility. Along with the advancement of technology in this digital era, the development of sports equipment should be developed according to time. In this digital era, manual tools of sport should be replaced immediately to make them more practical and effective, efficient, and accurate. This development research produces digital-based sit and reaches box products owning the advantage of speed and validity in taking test results. This product is equipped with an ultrasonic sensor as a distance meter and an Arduino Uno to create a program to control various other electronic components to visualise the results on the LCD.

Test officers no longer need to use stationery to create test participants' data and results because this tool has been equipped with an Android-based application downloaded via the user's smartphone. The product is also embedded with a Bluetooth module connected to the user's smartphone, so the test results are directly stored on the user's smartphone even without an internet network. The test result data is stored in an Excel file, easily opened via smartphone or Excel. Moreover, the data are written with the participant's name and clear test results. Thus, this product can simplify the calculation of the determination test automatically and facilitate the performance of the trainer/teacher in conducting the body's determination test. It is expected that the tool can be developed continuously to improve the quality of physical education learning at school. Moreover, the production of this tool is expanded to foster and modernize sports equipment using technology. In addition, it is developed more advanced and better in the future, so sports science and technology can develop rapidly by referring to its function.

METHODS

This research applied research and development methods (R & D). According to Sugiyono (2013), the research and development method (Research and Development) is implemented to validate and develop a product. Validating a product means a product that already exists, so researchers only test the effectiveness of the product. Developing a product means improving a pre-existing product, making it more practical, effective, and efficient, or creating a new product. In this study, the procedure of the research and development method or R&D proposed by Borg and Gall (1983; cited in Sugiyono, 2013) was applied to develop a sit and reach tool for measuring digital-based flexibility. The procedure of the research and development method covering 10 steps (Borg & Gall, 1983; cited in Sugiyono, 2013) is elaborated below:

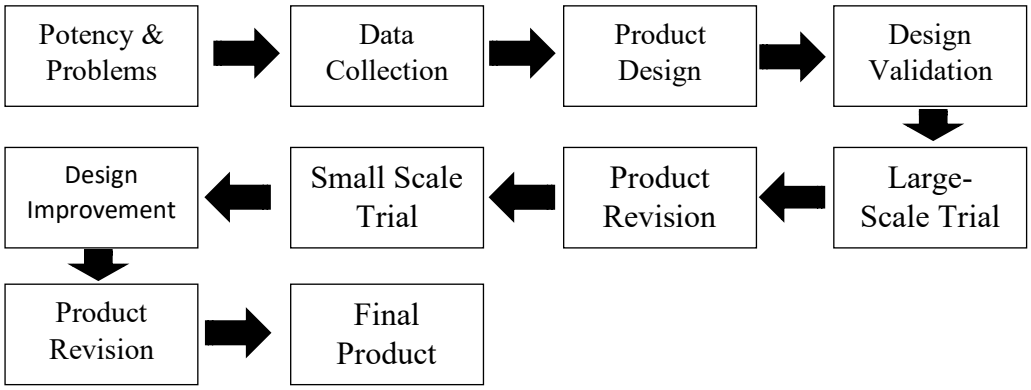

Figure 1 (Research & Development Procedure)

The procedure of research and development conducted in this research are as follows:

1. Potency and problems: The data on potency and problems were gained through observations. Exploring the potency and the problems facilitated the researchers to find out the solutions to the problems. The needs analysis results indicate that about 77.2% of respondents have done the flexibility test using conventional methods, particularly a ruler or meter measuring instrument. However, about 47.4% of respondents need help with the flexibility test due to fatigue factors, especially since it takes a long time and there are often errors in recording results. Meanwhile, about 96.5% of respondents stated that there is a need for developing the determination test using technology, and 3.5% of

other respondents stated that more development is not needed. Therefore, improving a digital-based determination test tool that is useful as a practical, effective, and valid determination test measuring tool is significant to conduct.

2. Data Collection: The results of the needs analysis show that 77.2% of respondents have done the determination test using conventional methods using a ruler or meter measuring instrument, but 47.4% of respondents get trouble in conducting the determination test due to fatigue factors, especially there are often errors in recording the results, and it takes a long time. Moreover, 96.5% of respondents stated that the development of the determination test using technology is crucial, and 3.5% of other respondents stated that it is not needed more improvement in the determination test.
3. Product design: The design of a sit and reach box tool for measuring body flexibility combining ultrasonic sensor components and Arduino Uno with battery power, was created. Then, a tool was designed to process the results of the determination test data collection displayed on the LCD, and this data can be saved on a smartphone via the B-Flext application.
4. Design validation: It is the process of assessing a product. Validation of the product was carried out by involving three experts owning capabilities in sports tests and measurements, i.e., a) a test and measurement expert, b) a media expert, and c) material experts (a physical education teacher / a coach). In this stage, the sports test and measurement experts tested the product of a sit-and-reach box tool for measuring body flexibility.
5. Design improvement: Having validated the product, the experts illustrated the shortcomings and strengths of the product. Thus, the design of the product was improved.
6. Small scale trial: The revised product was tested using a small-scale group consisting of 27 students. The test examined whether the revised product was more effective and efficient. The data obtained from the results of the small-scale trial was analysed for improvement of the product.
7. Product revision: The result of the product testing on a small scale was applied to examine the product's shortcomings. Thus, the need for product revision was carried out to improve the quality of the product.

8. Large-scale trial: Next, the revised product was tested on a larger scale by involving 51 students. Therefore, the result of the product test was discovered.
9. Product revision: The product revision is carried out if there are deficiencies and weaknesses in real use. The need for product evaluation was conducted to improve the quality of the sit and reach box tool for measuring digital-based body flexibility.
10. Final product: Having revised the quality of the product, the sit and reach box tool for measuring digital-based body flexibility is applied as a tool in measuring the accurate, effective, and efficient determination tests.

The participants of this study were students studying at SMP Negeri 1 Tanjung Lago, Banyuasin Regency. This research was conducted in two stages, i.e., a) small group trials and b) large group trials. In the small-scale trial, the sample was 27 students; in the large-scale trial, the sample was 51 students. Data reduction was carried out continuously, from the beginning of data collection until completion. Having conducting the data reduction, the next data analysis activity was presenting the data and making conclusions. This study applied quantitative descriptive statistical analysis to analyse the statistical data, so the conclusions were attained. Data analysis techniques employed the paired t-test (dependent sample t-test) using SPSS 21 for Windows. The data from the SPSS 21 application was presented in the form of qualitative data illustrating the feasibility of the product. The prerequisites met before the t-test includes the normality test (Kolmogrov-Smirnof). The obtained data is categorised as normally distributed with a probability value greater than 0.05.

RESULT AND DISCUSSION

Result

The developed tool is a prototype design for developing a digital-based flexibility test tool. This tool is named "B-Flext" (Bowo Flexibility Test). This tool uses ultrasonic sensors or distance sensors and Arduino as an essential part of the development of this test tool. Moreover, this tool is embedded with a Bluetooth module to connect to an Android-based smartphone as a test control. It is illustrated in Figure 2.

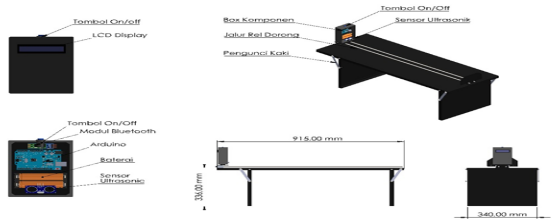

Figure 2. The Product Circuit

This research produces a digital flexibility test as the measuring instrument possessing a very good validity value. The results of expert validation indicate that a percentage assessment attains 91%. It means that the sit and reach box tool for measuring digital-based body flexibility has a very good category.

The results of the normality test, homogeneity test, and paired sample test on small-scale and large-scale trials present the tool effectiveness test. The effectiveness test results obtained from the normality test are 0.200 in the small-scale trial and 0.200 in the large-scale trial. The results of homogeneity tests are 0.785 in the small-scale trial and 0.64 in the large-scale trial. Moreover, the paired sample test obtained a sig value of 0.458 in the small-scale trial and a sig value of 0.299 in the large-scale trial.

Table 1. Testing the effectiveness of the small-scale trial

The Results of Small-Scale Trial		
Normality Test	Homogeneity Test	Paired Sample Test
0,200	0,785	*Sig. (2- tailed)* 0,458

Table 1 indicated that the obtained Sig. (2- tailed) value, it is 0.458> 0.05 is assumed that there is no significant difference between the results of the determination test using a digital-based sit and reach test measuring instrument with a manual sit and reach test measuring instrument. Thus, the digital-based sit and reach box tool is effectively applied in small-scale trials.

Table 2. Testing the effectiveness of large-scale trials

The Results of Large-Scale Trial		
Normality Test	Homogeneity Test	Paired Sample Test
0,200	0,640	*Sig. (2- tailed)* 0,299

Table 2 shows that the obtained Sig. (2- tailed) value is 0.299> 0.05. It means there is no significant difference between the results of the determination test using a digital-based sit-and-reach test measuring instrument and a manual sit-and-reach test measuring instrument. Therefore, the digital-based sit and reach box tool is effectively employed in large-scale trials.

Discussions

Research investigating sit and reach box tools to measure digital-based body flexibility is very effective in being applied as a tool to measure flexibility tests in sports and education. According to Najib et al. (2021), considering the importance of validity in the tests carried out, it is necessary to use supporting applications in the test process. The utilization of technology in supporting the achievement of sports should be developed.

The results of this study are in line with research conducted by Putra (2019) examining the advantages and advantages of this tool, the measurement accuracy, and the effective time required when measuring flexibility. Moreover, the results of this development research are relevant to research carried out by Sahri et al. (2018) investigating the creation of a sensor-based determination test instrument with a high level of validity and reliability.

This research is closely related to the role of technology in this modern era. The study conducted by Nugraha & Rusdiana (2017) discovers that technology can develop sports in various fields, including sports achievement. Moreover, technology can estimate the volume of training programs, the intensity of training programs, and the rest in implementing training programs so that planning can be more effective in accordance with the results obtained. Furthermore, research carried out by Kanca (2018) comes across in the 21st-century era, teachers should be able to utilize digital technology to design creative and innovative learning. In a similar vein, Safei et al. (2018) proposes applying advanced technology with sports science disciplines functioning as an analytical tool for a particular sport to improve sports performance.

CONCLUSIONS

The resulting product of this study is a sit-and-reach box tool for measuring digital-based body flexibility. The tool is created by referring to the input and suggestions from test and measurement experts, media experts, and material experts. The product development of this determination measuring instrument has been tested on a small scale involving 27 samples and on a large-scale trial comprising 51 samples. The samples were the students studying at SMP Negeri 1 Tanjung Lago. Moreover, the tool has met the validity, practicality, and effectiveness tests. The sit and reach box tool for measuring digital-based body flexibility is very effective in being applied as a tool for measuring flexibility tests in sports and education.

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