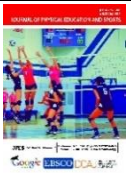
Journal of Physical Education and Sports

9 (3) (2020) : 269–281

https://journal.unnes.ac.id/sju/index.php/jpes



Arduino Uno Based Real Count Development as a Tool to Help Assessing Physical Exercise Results

Adyan Argadhia Hartono✉, Sulaiman Sulaiman, Setya Rahayu

Universitas Negeri Semarang, Indonesia

Article Info

History Articles
Received:
18 September 2020
Accepted:
20 October 2020
Published:
31 December 2020

Keywords:
Tools, Physical Condition Assessment, Exercises

Abstract

The development of previous tools used by researchers to assess physical exercise results only uses one variable. For example, the assistive tool is only for the variables of push-up, sit-up, speed, agility, or reaction. In its development, researchers have created a tool using four variables, named Real Count. This type of development research is used to produce specific products and test the effectiveness of the product, research design, product needs analysis, initial product drafts, expert validation, improvement of initial product drafts, product effectiveness trials and small-scale trials, first product revisions and field trials, and revision of the final product. The instruments used to collect data were interviews, observations, questionnaires, and documentation. Data analysis techniques use a Likert scale of 1-5. The product effectiveness test is in the "excellent" category at assessing physical exercise. In the media expert product trials, stage 1 is in the "good" category, and stage 2 is in the "excellent" category. Phase 1 of the sports expert's product trial is in the "fair" category. Phase 2, small-scale product trials, and large-scale product trials are in the "excellent" category. This study concludes that Real Count has been created as a tool for assessing exercise in physical condition. The Real Count is feasible and effective to be used as a physical training tool in Pemalang Regency.

✉ Correspondence address:
Kampus Pascasarjana UNNES Jl. Kelud Utara 3
Gajahmungkur Semarang
E-mail: rezafadh95@gmail.com

p-ISSN 2252-648X
e-ISSN 2502-4477

INTRODUCTION

Physical activity carries out various kinds of mobility skills tests based on the standard of physical education and sports competencies. Performance tests in physical education, sports, and health are intended to measure students' psychomotor abilities. These psychomotor abilities generally include physical fitness, agility, and coordination as the elements of movement skills. Performance tests can be carried out specifically to describe skills in physical education and sports. (Ministry of National Education 2007)

Technology is something that cannot be separated from daily life in modern times like today. No exception in the sports field. Technology has an important role to play in advancing achievements pursuits. The Minister of Youth and Sports, Roy Suryo (2013), stated that today's sports achievement scorers could be based on sports talent and be integrated with scientific technology (Permatasari et al., 2016). Countries that involve technology in the implementation of sports tend to have more advanced achievements. It is possible because high-tech tools have a higher level of accuracy than manual-tools. Unfortunately, technology involvement in sports has not yet been entirely accepted in all countries because of the expensive technologically sophisticated equipments (Permatasari et al., 2016).

So far, the devises to assess the results of physical exercise only consist of one variable, such as Push-Ups. (Irawan & Sandiyudha 2018; Muzakir 2016; Rahmat, et al., 2017), one variable of pace (Nisa, et al., 2014; Ihsan et al., 2018; Rahmat et al., 2016; Safrianti, 2010), one variable of agility (Hidayat & Hiron, 2017) and one variable of reaction (Wulandari, 2012).

Training methods have developed rapidly. At the first time, it was only in the form of natural explanations. These days, it has become such latest scientific knowledge that it is expected to follow sports changes, especially science and technology, to achieve maximum sports achievement (Hartono et al., 2017). In Indonesia, the improvement of testing tool and running measurement is still undeveloped. In fact, our country neither has had sufficiently sophisticated technology nor sports experts collaborate with technology experts. Therefore, there is no scientific solution to analyze various problems in sports (Rahmat et al., 2016). Physical conditions rarely evaluate the level of the physical condition of students who have been trained, so the trainer does not have data to make policies or draw conclusions in training. One of the reasons for this situation is the lack of test devices to support physical conditions, especially those based on digital as an assistive device for physical condition testing tool (Komaini et al., 2018). The physical condition component is a requirement to know if someone is fit. Some of these components are used for tests of physical skills in both academic and non-academic fields. The tests carried out vary depending on the needs and targets to be achieved. Strength, pace, agility, and accuracy are parts of the physical components used in performing the test. Several exercise techniques and physical condition programs were obtained from sports associations or other organizations related to improve students' performance (Burgess & Rappoport, 1993). Some of the tests carried out are push-ups, sit-ups, shuttle runs, and vertical jumps (Irawan & Sandiyudha, 2018).

Assessment is an activity of collecting and processing information by using numbers or data from sports training results so it becomes a benchmark for the branches of sports. By having an assessment, it gave a priority or challenge that hinders sports training activities and provided an increase in sports training (Rebeck Asarta, 2011). All these times, the results of a sports student's training are based on the coach's observation and the important thing is to perfom well in a match. However, the exercise also affects the duration of the match and the dominant physical condition, especially arm muscle strength, abdominal muscle strength, agility,

pace, and reaction. There are no technologies in the training period, so the sports students' training results are not monitored in real-time at each training session. Some trainers argued that there were no tools that could help them practice by providing the results with valid data to motivate sports students. If there was a technology that some coaches could utilize, the strengths and weaknesses of the sports students' physical conditions and some of the decline in student sports achievement in most schools could be improved. In addition, the lack of creative trainers in Pemalang who are still using manual methods in the training process hindered the maximum results.

Researchers have used the development of previous tools to assess the results of physical exercise using only one variable; for example, the assistive device is only for the variables of push-ups, sit-ups, speed, agility, or reactions. Nevertheless, in its development, the researcher can create devices in assessing the sports students' physical condition results. The researcher had the idea to make a product to evaluate the physical exercise at school during training to improve their physical condition. The product is called Real Count.

METHOD

Thee researcher used a descriptive development method as the steps to create a product. The researcher surveyed physical condition training assessments in several extracurricular activities in some schools in Pemalang Regency. Subsequently, the researcher provided several problems to assess physical condition exercises and to develop innovative physical conditioning exercise assessment tools that facilitate the training process.

The next step was the preparation of the initial product for the physical condition training assessment. A team made this product with respective tasks, including drawing design, assembling electronic components, and adjusting sensor devices.

Initial product drafts needed to be validated by experts in their fields before being tested in small-scale trials. Researchers appointed three experts to validate the final product. They are Ahmad Sholeh, S.Pd., M.Kom Owner Trainerku (Education Trainer), Producer of Vocational Education Teaching Aids (SMK) as the electronics, Aripin, A.Md (Consultant for Building/Home Electrical Planning) as the electrician, Muhammad Arif Budiman, ST (Expert Technician in PT Multitech Infomedia) as the robotics, and Sobirin, S.Pd. (Head of Youth and Sports, Youth and Sports Service, Pemalang Regency sports).

After getting corrections from the experts, an initial revision was made. Initial product revisions were received from media experts and material experts' suggestions to fix the weaknesses found in this research. Afterwards, the revised products could be used for field trials.

Field trials and small-scale trials were conducted to extracurricular students of Senior High School 1 (SMAN 1) Ulujami, SMAN 1 Bodeh, and SMAN 1 Comal. Ten people were involved in this observation. A large-scale analysis determines its feasibility and effectiveness after it has been improved and revised in the previous small-scale trials. One to two students had large-scale tests at SMKN 1 Ampelgading in Pemalang Regency, such as SMAN 1 Ulujami, SMAN 1 Bodeh, SMAN 1 Comal, SMKN 1 Ampelgading, SMAN 1 Petarukan, SMAN 2 Pemalang, and SMAN 1 Pemalang. The total sample used for large-scale trials was 30 people.

After conducting large-scale trials, the product was improved and revised to enhance and review its physical exercise assessment products and determine its weaknesses and strengths.

The final product is a physical xercise assessment device called Real Count. This device was made attractive, safe, and practical to support the success of assessing the physical condition exercise of extracurricular students in Pemalang Regency.

The researcher used qualitative and quantitative data. Qualitative data were obtained from interviews and questionnaires in the form of criticism and suggestions from experts either orally or in writing as input for product revision material. On the other hand, quantitative data were obtained from observations of athletes.

The data analysis technique to test the product's feasibility is a questionnaire with a Likert scale of 1-5, with the categories of very poor, poor, fair, good, and excellent.

The final results of the questionnaire test analysis are stated by:

$$P\ (\%) = \frac{f}{N} \times 100\%$$

P = the result will be obtained percentagewise
f = the number of scores
N = Criteria score obtained from the maximum score of the questionnaire

The feasibility criteria for questions can be seen in the table as follows:

Table 1. The Score Interpretation

Percentage	Category
0% - 20%	Very Poor
21% - 40%	Poor
41% - 60%	Fair
61% - 80%	Good
81% - 100%	Excellent

(Source: Marhadini et al., 2017)

RESULTS AND DISCUSSION

Arduino Uno-based Real Count is designed as an assisstive device to assess the results of physical training of sports students.

The developed product is an Arduino Uno based device called Real Count. This device was utilized to assess the strength training results of the arm muscles and abdominal muscles through push-ups and sit-ups, speed training by 10 to 50 meters runs, agility training by shuttle runs, zig-zag runs, and agility runs. Reaction training was done by moving hand on the light or sticking both right and left hands sticking with the student's sensor.

The components built up for Real Count have their respective functions.

Iron was used to make a frame to support all the components that set up the Real Count.

Figure 1. The Iron Pipe (1 Inch)
(Source: Researcher)

This iron pipe was used as the stake on Real Count so it is easier to be used. This tube

helps to make the device easy to place in the field while the athletes are training.

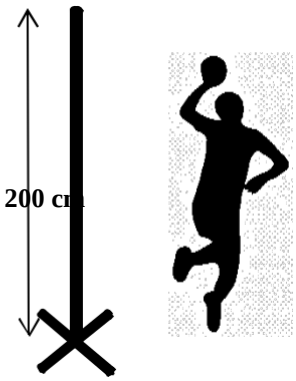


Figure 2. The Stake Pole
(Source: Researcher)

There are four electrical tool boxes on which each pole used for the sensor's container, Arduino Uno, Microcontroller, Wireless.

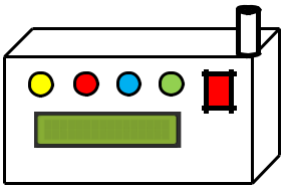


Figure 3. The Tool Box
(Source: Researcher)

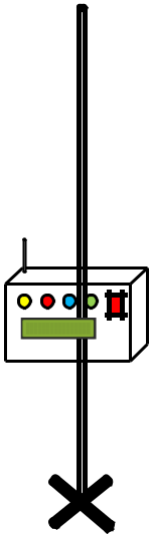


Figure 4. The Real Count Placement Illustration
(Source: Researcher)

Sensors are used for external input. A sensor is a device to detect tendencies or signals of energy changes, such as electrical energy, physical energy, chemical energy, biological energy, and mechanical energy (Sharon et al., 1982). The sensors used in this tool are ultrasonic sensors, infrared sensors and motion sensors.

Figure 5. The Sensors
(Source: Researcher)

Arduino Uno is a board that utilizes the ATmega328 microcontroller. It has 14 digital pins (6 pins can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power supply connector, an ICSP header, and a reset button. Arduino Uno contains everything needed to support a microcontroller. It will work if it is connected to a computer via USB or given DC voltage from a battery or AC to DC adapter can make it work. Arduino Uno uses the ATmega16U2 programmed as a USB to serial converter for serial communication to a computer via a USB port (https://www.arduino.cc/en/Products/Counterfeit, 2016).

The technical data for Arduino Uno R3 board is as follows:

Microcontroller: ATmega328

- Operating Voltage: 5V
- Input voltage (recommended): 7-12 V
- Input voltage (limit): 6-20 V

Digital I/O pins: 14 (6 of them are PWM pins)

- Analog pin input: 6
- DC per I/O pin: 50 MA
- DC for 3.3 V pin: 150 mA
- Flash Memory: 32 KB with 0.5 KB used for the bootloader − EEPROM: 1 KB
- Time Speed: 16 Mhz

Figure 6. Arduino Uno
(Source: Researcher)

There is 1 Microcontroller, each of which is used as the main process. A microcontroller is a computer system which all or most of the elements are packaged in one IC (Integrated Circuit) chip, often called as a single-chip microcomputer. This microcontroller is also a computer system with

specific tasks which differs from a PC with various functions. Another difference is the substantial RAM and ROM ratio between a microcontroller and a computer. In a microcontroller, ROM is much larger than RAM, while in a computer or PC, RAM is much larger than ROM. Microcontrollers can process data as well as can be used as a control unit. We can control a device by using a chip as a microcontroller. Microcontrollers have distinctions from microprocessors and microcomputers. A microprocessor is a part of a CPU without memory and I/O support from a computer, whereas a microcontroller generally consists of a CPU, memory, specific I/O, and other supporting units (Andrianto, 2013).

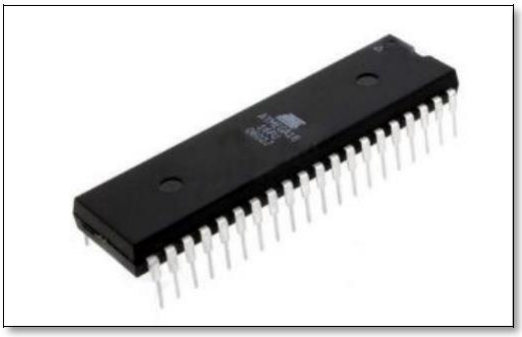


Figure 7. The Microcontroller chip
(Source: Researcher)

There are 4 LCDs used on each pole to display the sensor input results. LCD (Liquid Crystal Display) is a type of display media that uses liquid crystals as the primary display (Andrianto, 2013).

The features presented in this LCD:

- Consisted of 16 characters and two lines.
- Had 192 stored characters.
- Equipped with a character generator programmed.
- Addressable in 4-bit and 8-bit modes.
- Equipped with backlight.

The initializing process Arduino pins connected to the LCD pins RS, Enable, D4, D5, D6, and D7 was carried out in the Liquid Crystalline (2, 3, 4, 5, 6, 7), where the LCD is the variable used every time the instruction related to LCD is utilized. The definition of 16x2 LCD pins that can be seen in table 1 is an LCD device. In this final project, LCD can show its character using a library called Liquid Crystal.

Table 2. 16x2 LCD Specifications

Pin	Description
1	Ground
2	Vcc
3	Contras Setting
4	Register Select
5	Read/Write LCD Register
6	Enable
7-14	Data I / O Pins
15	VCC + LED
16	Groud - LED

(Source: Researcher)

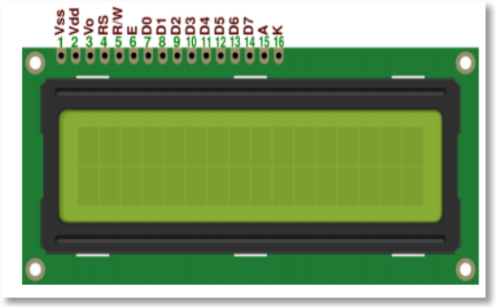


Figure 8. The 16x2 LCD (Liquid Crystal Display)
(Source: Researcher)

There are four wireless antennas attached to each pole, which are used to send the recording results of sports students' training process. This antenna helps to amplify the signal sent to the recording device. Antenna is a wireless transmission media device that uses air or free space as a medium of conduct. It is also defined as one or a group of conductor used to emit, transmit or capture electromagnetic waves from free space.

From the definitions of antenna, it can be seen that it has two functions:

1. To emit electromagnetic wave signals (Transmitter).

2. To receive the electromagnetic wave signal (Receiver).

Figure 9. The Wireless Antenna (Source: Researcher)

Table 3. The Design of Initial Product and Final Product of Real Count

Component	Initial Product Design	Product End Result
Tool Box	Using iron plate material	Using plastic plate material
Tool Pole	Using PVC pipe.	Using iron pipes.
Sensor	Using Ultrasonic Sensor, PIR Sensor and Infrared sensor	Using Infrared Sensor.
Arduino Uno	Using R3	Using Mega 2560
Microcontroller	Using Atmega 328P	Using Atmega 2560
Lcd Display	Using 16x2 with green backlight	Using 16x2 with blue backlight.
Wireless Antenna	Using TP-Link 81FA Type	Using Type TP-LINK WR840N

The advice given by media (tools) experts was:

1. In "Strength" there was a menu of "push-ups, sit-ups, and pull-ups".
2. In "Speed" there was a menu of “10 meters, 50 meters, and 100 meters run.
3. In "Agility", there was a menu of "shuttle run, agility run, and zig-zag run".
4. The cable was not long enough and easily broken. It was advisable to use "Rispeberry".
5. The saving process for "Strength" was too long, and the sensor for "Strength" only detected skin. If the sensor stimulation was exposed to hair when the athlete did push-ups or sit-ups, it could not be detected.
6. The box frame material was easily damaged.
7. The name on the main LCD toolbox could not be read, and the toolbox had too many cables.

Product Revisions, Initial Products

Figure 10. The Initial Products (Source: Researcher)

The initial product got several revisions from the experts, including lost contact and unsaved data. The researcher was advised to create an application, cables for data lines and to use Wi-Fi so that the data

could be controlled through cellphones. The following are the results of the initial product revision.

Figure 11. The Real Count Initial Revision (Source: Researcher)

The initially revised product was tried out on a tool effectiveness scale trial. In the final product revision, the one used in small-scale trials had been revised by replacing five sensors into one sensor on the device.

Figure 12. The Real Count Final Revision (Source: Researcher)

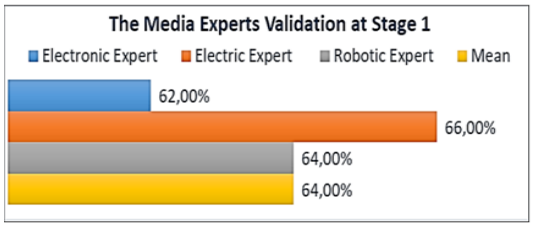
The final product was created after two revisions. Furthermore, the final product was used for large-scale trials.

Figure 13. The Final Real Count (Source: Researcher)

The development of Real Count was designed and produced to be the initial product as a shooting training device. The process was carried out through research and development procedures, such as planning, production, and evaluation.

The validation of the media experts in this study was conducted in two stages. The electronics expert validator at stage 1 with code A1 gave an average score of 3.1 or 62% included in the "good" category. The electrical expert validator with code A2 gave an average score of 3.3 or 66% included in the "good" category. The electrical expert validator code A3 gave an average score of 3.2 or 64% in the "good" category. Media expert validators A1, A2 & A3 at stage 1 gave an average score of 3.2 or 64% included in the "good" category.

Figure 14. The Graph of Media Experts Validation at Stage 1
(Source: Researcher)



The media and electronics expert validator at stage 2 with code A1 gave an average score of 4.4 or 88% included in the "excellent" category. The electrical expert validator with code A2 gave an average score of 4.6 or 92%, included in the "excellent" category. The electrician expert validator with code A3 gave an average score of 4.5 or 90% included in the "excellent" category. Media expert validators A1, A2 & A3 at stage 2 gave an average score of 4.5 or 90%, which was included in the "excellent" category.

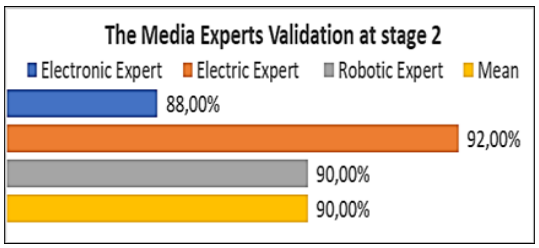


Figure 15. The Graph of Media Experts Validation at Stage 2
(Source: Researcher)

The validation of sports experts in this study was carried out in two stages. The sports expert validator at stage 1 with code B1 gave an average score of 3.1 or 62.00% included in the "good" category.

The result graph of the sports expert validation at stage 1 is as follows:

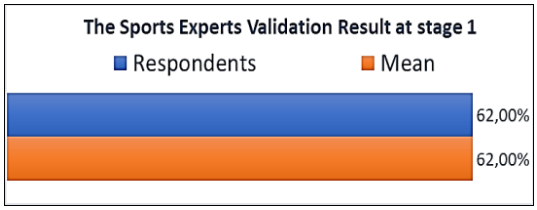


Figure 16. The Graph of The Sports Experts Validation Result at Stage 1
(Source: Researcher)

The sports expert validators at stage 2 with code B1 gave an average score of 4.3 or 86.00% included in the "excellent" category. The sports experts validator with code B1 at stage 2 gave an average score of 4.3 or 86.00% in the "excellent" category.

The sports expert validation results graph at stage 2 is as follows:

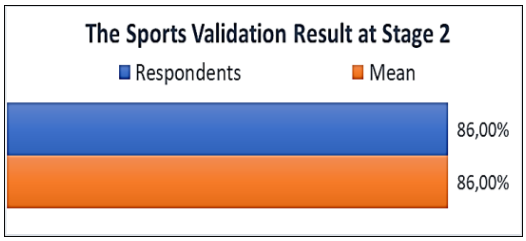


Figure 17. The Graph of The Sports Experts Validation Result at Stage 2
(Source: Researcher)

The product validated by media and sports experts has been tested on extracurricular students to determine the product's effectiveness. The total value of push-up was 27 or 54%, sit-up was 25 or 50%, 10 meters run was 28 or 56%, 50 meters run was 27 or 54%, shuttle run was 27 or 54%, agility run was 26 or 52%, the right-hand reaction was 33 or 66% and the left-hand reaction was 32 or 64%. Before using this tool, the average was 2.8 or 56.25%. The total value of push-up was 41 or 82%, sit-up was 40 or 80%, 10 meters run was 41 or 82%, 50 meters run was 40 or 80%, shuttle run was 40 or 80%, agility run was 40 or 80%, the right-hand reaction was 41 or 82%, and the left-hand reaction was 41 or 82%. At the post-training stage using this device, the mean was 41 or 81%. Therefore, the researcher concluded that after training using the device, the score increased in push-up was 14 or 28%, sit-up was 15 or 30%, 10 meters run was 13 or 26%, 50 meters run was 13 or 26%, shuttle run was 13 or 26%, agility run was 14 or 28%, the right-hand reaction was 8 or 16%, and the left-hand was 9 or 18%. Thus, the target number after training using the device was 1.3 or 24.75%.

Table 4. The Result of Exercises before Implementing Real Count

Student's name	∑	Average	%
Dimas	23	2,875	57.50%
Panji	23	2,875	57.50%
Arifin	20	2.5	50.00%
Abdul	21	2,625	52.50%
Agung	27	3,375	67.50%
Yoga	21	2,625	52.50%
Novian	22	2.75	55.00%
Fandi	23	2,875	57.50%
Dika	23	2,875	57.50%
Madhon	22	2.75	55.00%
∑	225	28.1	562.50%
Average	6.5	2.8	56.25%

(Source: Researcher)

Table 5. The Result of Exercises before Implementing Real Count

Student's name	∑	Mean	%
Dimas	31	3,875	77.50%
Panji	35	4,375	87.50%
Arifin	32	4	80.00%
Abdul	30	3.75	75.00%
Agung	35	4,375	87.50%
Yoga	30	3.75	75.00%
Novian	33	4,125	82.50%
Fandi	31	3,875	77.50%
Dika	33	4,125	82.50%
Madhon	34	4.25	85.00%
∑	324	40.5	810.00%
Mean	32.4	4,1	81.00%

(Source: Researcher)

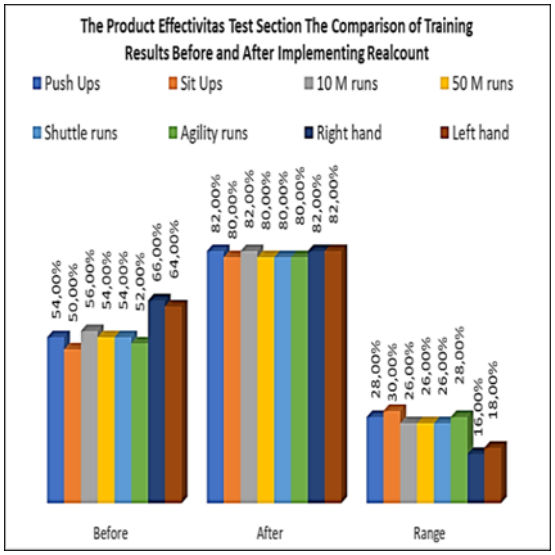


Figure 18. The Comparison of Training Results Before and After Implementing Real Count
(Source: Researcher)

Small-scale product trial was carried out to ten extracurricular student-athletes in SMAN 1 Bodeh and SMAN 1 Comal in Pemalang Regency. Small-scale product trial result got an average score of 4.49 or 89.80% included in the "excellent" category.

Small scale product trial chart:

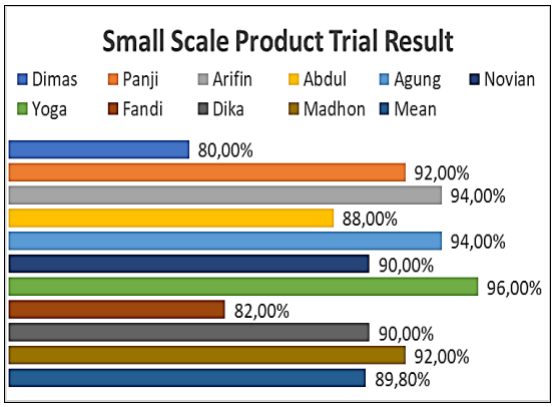


Figure 19. The Graph of Small Scale Product Trial Result
(Source: Researcher)

Large-scale product trial was conducted for extracurricular students at SMKN 1 Ampelgading. The total sample used for large-scale trials was 30 people in Pemalang Regency from the seven clubs. The results of large-scale product trials got an average score of 4.37 or 87.40% included in the "excellent" category.

This research's product is not much different from the products produced by previous researchers. There are several similarities in some specifications. The following table shows the differences of product specifications with similar products made by previous researchers:

Table 6. The Differences of Real Count and other products

Arduino Uno Based Real Count Development Tool for Assessing Exercise Results	➢ Can be used to assess exercise results by measuring Push-Ups, Sit-ups, and Pull-Ups. ➢ Can be used to measure agility. ➢ Can be used to measure speed. ➢ Can measure the running speed. ➢ Can be logged/resulted in Android phones, laptops, and computers. ➢ Using two sources of power, from PLN (State Electricity Enterprise) electricity and batteries. ➢ Using Ultrasonic sensor, infrared sensor, Light Dependent Resistor (LDR) sensor, sound sensor, and laser. ➢ Using Arduino Uno, Mikrocontroller, LCD, Transistor, Capacitor, and Signal Wireless ➢ Can be used indoors or outdoors.
(Irawan and Sandiyudha 2018) Development Push-Up Counting Tool	➢ It can only be used for push-ups. ➢ Only digital numeric results appear on the device. ➢ Using batteries. ➢ Only using ultrasonic sensor. ➢ Using Arduino Uno,

	Mikrocontroller, and LCD. ➢ Can be used indoors.
(Hidayat and Hiron 2017) Agility Measurement Using Wireless Sensor Network (WSN) Technology	➢ Only measure agility. ➢ Can be logged on to Android phones. ➢ Using PLN electricity source. ➢ Using the kinect sensor. ➢ Using a Microcontroller and LCD. ➢ Can be used indoors.
(Safrianti and P 2010) Measuring the speed of motion of objects using sensors Phototrasnsistor Atmega 8535 Microcontroller Based	➢ Only measure the speed. ➢ Can be logged/resulted in a computer. ➢ Using batteries. ➢ Using a phototransistor and two infrared pieces. ➢ Using Arduino Uno, Microcontroller, and LCD. ➢ Can be used outdoors.
(R. Rahmat, Rusdiana, and Supriyatna 2016) Development of a Microcontroller-Based Running Speed Measurement Tool with Interfacing Persona	➢ Only measure running speed. ➢ Can be logged/resulted to a computer. ➢ Using PLN electricity source ➢ Using Phototransistor and Laser. ➢ Using Arduino Uno, Microcontroller, LCD and Mini CPU ➢ Can be used indoors.
(Wulandari 2012) Making Human Response Speed Measurement Tool Based on AT Microcontroller	➢ Only measure response speed. ➢ Can be logged/results to computer. ➢ Using PLN electricity source. ➢ Using Light Emitting Diode. ➢ Using Arduino Uno, Mikrocontroller, LCD, Transistor, and Capacitor ➢ Can be used indoors.

(Source: Researcher)

Real Count is a device created to assess physical condition. The advantages of this product are as follows: (1). Easy to operate. (2). Help coaches to train the training process for the conditions of school sports students. (3). It can be used for practicing arm muscle strength and abdominal muscle strength. (4) It can be used to train speed. (5). It can be used to train agility and reaction. (6). It can assess training results in real-time and be used in a variety of exercise physical conditions. (7). Safe to be used. Besides of those advantages, Real Count also has disadvantages. They are: The product is made of iron. Therefore it is quite heavy. (2). It uses electricity with dry batteries, so it needs to be charged when used for training. If the power goes out or not fully charged, this product cannot be operated. (3). While sending data wirelessly, data can be lost due to signal constraints.

CONCLUSION

Based on the results of research and discussion of the Real Count development, these findings were obtained: A physical condition training assessment product, called Real Count, has been created. Real Count is suitable as a tool for assessing physical training of extracurricular students in Pemalang Regency. It is effectively used as a tool to evaluate physical training.

REFERENCE

Departemen Pendidikan Nasional. (2007). Panduan Penilaian Kelompok Mata Pelajaran Jasmani Olahraga Dan Kesehatan.Anduan Penilaian Kelompok Mata Pelajaran Jasmani Olahraga Dan Kesehatan.

Hartono, Mugiyo, Akhiruyanto, A., & Fathoni, K. (2017). Pengembangan Akselerometer Running Monitor Berbasis Android Untuk Mengetahui Karakteristik Lari Jarak Pendek. Sainteknol, 15(2), 193– 208.

Hidayat, Cucu, & Hiron, N. (2017). Kajian Dan Perancangan Teknologi Sistem Pengukuran Agility Dengan Teknologi Wireless Sensor Network (WSN). Siliwangi, 3(1), 161–66.

Hidayat, R., Sulaiman, & Hidayah, T. (2016). Faktor Anthropometri, Biomotor Penentu Keterampilan Sepak Takraw Atlet Putra Pon Jawa Tengah. Journal of Physical Education and Sports, 5 (2), 83–89.

Ihsan, Nurul, Yulkifli, & Yohandri Yohandri. (2018). Instrumen Kecepatan Tendangan Pencak Silat Berbasis Teknologi. Jurnal Sosioteknologi, 17(1), 124–31.

Irawan, Awang, F., & Sandiyudha, T. B. (2018). Pengembangan Alat Bantu Push-Up (Push-Up Counting) Sebagai Alternatif Perangkat Kebugaran Jasmani. Media Ilmu Keolahragaan Indonesia, 8(1), 26–30.

Komaini, Anton, Sahri, J., & Tohidin, D. (2018). Pengembangan Instrumen Tes Kelentukan Statis Berbasis Teknologi Sensor. Jurnal Sosioteknologi, 17(3), 343–49.

Nisa, C., Widya P, N., Santosa, A., & Rahmawati, E. (2014). Perancangan Instrumentasi Pengukur Waktu Dan Kecepatan Mengunakan Dt-Sense Infrared Proximity Detector Untuk Pembelajaran Gerak Lurus Beraturan. Jurnal Penelitian Fisika Dan Aplikasinya (JPFA), 4(1), 36.

Maryono, Rahayu, S., & Rustiana, E. R. (2017). Metode Latihan Kelincahan Dan Fleksibilitas Pergelangan Kaki Terhadap Keterampilan Menggiring Bola. Journal of Physical Education and Sports, 6 (1), 66–71

Muzakir, A. (2016). Rancang Bangun Aplikasi Push up Detector Untuk Mendeteksi Kesalahan Gerakan Push Up. 2(1), 93–96.

Permatasari, Nita, N. K., Rusdiana, A., & Ruhayati, Y. (2016). Pengembangan Alat Ukur Waktu Reaksi Berbasis Microcontroller. Jurnal Terapan Ilmu Keolahragaan, 1(2), 13.

Rahmat, Egih, Rusdiana, A., & Ruhayati, Y. (2017). Pengembangan Teknologi Tes Chin Up Berbasis Arduino Uno Dan Sensor Laser. Jurnal Terapan Ilmu Keolahragaan 2017.

Rahmat, Redi, Rusdiana, A., & Supriyatna, A. (2016). Pengembangan Alat Ukur Kecepatan Lari Berbasis Microkontroler dengan Interfacing Personal Computer. Jurnal Terapan Ilmu Keolahragaan, 1(01), 34–39.

Rebeck, Ken, & Asarta, C. (2011). Methods of Assessment in the College Economics Course. In International Handbook on Teaching and Learning Economics, Edward Elgar Publishing Ltd., 177–87.

Safrianti, Ery, & Alvian, E. 2010. Sensor Phototransistor Berbasis Mikrokontroler Atmega 8535. Seminar Nasional Teknik UR.

Sudrajat, Anang, Nasuka, & Irawan, F. A. (2019). Development of ANS PONG as a Tool for Block Training and Smash in Table Tennis Games. Journal of Physical Education and Sport Science, 8(1), 19– 25.

Titting, Fellyson, Hidayah, Taufik, Pramono, & Harry. (2016). Pengembangan Multimedia Pembelajaran Senam Lantai Berbasis Android Pada Pendidikan Jasmani Olahraga Dan Kesehatan di SMA. Journal of Physical Education and

Sports, 5(2), 120–26.

Wulandari, & Puspita, I. (2012). Pembuatan Alat Ukur Kecepatan Respon Manusia Berbasis Mikrokontroller at 89S8252. Jurnal Neutrino, 1(2), 208–19.