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Physical Distance Tracking Jacket for Students with Special Needs

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Abstract: The COVID-19 pandemic has affected all types and levels of learning including the education of students with special needs. Schools nationwide have taken the initiative to protect the safety and health of students by implementing home teaching and learning method, that can assist to reduce the transmission of virus by physical distancing. Therefore, a study was conducted aiming to develop a product that would assist students with special needs to attend school whilst prevent the transmission of COVID-19 virus. The main objective of this product development is to design a physical distance detector jacket for student with special needs based on the engineering design process (EDP) development model which involves four phases namely problem identification phase and problem research, making and selecting possible solutions, prototype development phase and product evaluation phase. This product uses an ultrasonic sensor to detect physical distance of less than one meter and gives a warning in three different ways to the students with special needs such as micro: bit display warning sign, buzzer sound, vibration from the back of the body by using vibration motor. The physical distance tracking jacket is suitable for vision impaired students, hearing impaired students and learning impaired students. The product would assist teachers to ensure that students with special needs would abide and comply to the physical distancing SOP during the teaching and learning process in school.

Keywords: Physical Distance Tracking Jacket, Ultrasonic Sensors, Micro: Bit, Buzzer Sound, Vibration Motor, Engineering Design Process (EDP).

1. Introduction

In this era, education systems across countries are experiencing drastic changes due to a highly contagious and potentially deadly epidemic known as coronavirus disease 2019 (COVID-19). The COVID-19 outbreak has affected the entire world in early April with positive cases reaching one million people and rising death rates due to coronavirus infecting the respiratory tract (Daily News Online, 2020). On January 7, 2020, the first case of COVID-19 was detected in Wuhan, Hubei, China and the outbreak was detected outside China on January 13, 2020, in Thailand, Nepal, South Korea, Sri Lanka,

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United States, Singapore, Malaysia, France, Cambodia, Vietnam, Germany and Canada (Daily News Online, 2020). As a result, mass gatherings were prohibited, learning in schools and universities were also put to a halt to prevent the spread of COVID-19 disease (World Health Organization, 2020).

The COVID-19 pandemic has affected all types and levels of learning including the education of students with special needs. Schools have taken necessary precautions in protecting the safety and health of students by implementing home teaching and learning (PdPR) methods. Electronic learning systems and digital devices are used in the approach to this method and has become the new norm in countries worldwide to delivery teaching and learning, world widely.

Electronic learning system (e-Learning) is a new approach in the world of education worldwide which is a learning system based on the help of electronic resources in formal teaching (Mishra & Koehler, 2007). PdPR is a good solution, however it is not an easy option for students with special needs as they require clear attention and understanding during teaching and learning. Students with special needs are those with physical, intellectual, or mental disabilities and there are various barriers while interacting (Raja & Aizan, 2018). This group also deserves the same opportunities as a normal student (Mohd Amin & Mohd Yasin, 2016). Students with special needs have to be given full attention in the aspect of learning especially during this pandemic.

The challenge faced by students with special needs is that special learning will continue during the period of the Movement Control Order (MCO) (Che Lah, 2020). However, there are difficulties and obstacles because not all students with special needs are proficient in online learning. The announcement of schools reopening on 1 March 2020 has caused parents worrying about the safety and health of their children especially parents with disabled children in terms of sight, hearing and learning as they lack understanding about physical distancing rules while attending school. Physical distancing before and during the implementation of teaching and learning needs to be strictly controlled by teachers as a large number of students with special needs will have difficulties to comply with physical distancing. Therefore, it needs to be emphasized that in special education learning, a device or technology can assist special needs students maintain physical distance to prevent the transmission of COVID-19 inside or outside the school.

2. Background Problem

The transmission of COVID-19 virus can occur in various ways (Bohning et al., 2020). Among the factors that can cause the spread of this virus is that there is no physical imprisonment in public. Therefore, precautions need to be taken to curb the congestion and close proximity. The spread of COVID-19 can be limited by maintaining physical distance and following the basic principles of prophylaxis (Manesh et. al., 2018). Physical distance is a method of minimizing frontal interactions of others and is able to prevent the spread of epidemics in groups of people (Nizam Zain, 2021). The increased transmission of COVID-19 has impacted the society especially in the field of education. Following the announcement of the reopening of schools, all educational institutions under the Ministry of Education Malaysia in the Klang Valley and Melaka began to reopen after moving to Phase 3, National Rehabilitation Plan (Nizam Zain, 2021). The special needs students regardless disabilities including hyperactivity and autism are among the major challenges faced by special education teachers when the country is still facing a COVID-19 virus pandemic (Bali & Othman, 2017).

3. Methodology

The development of the physical distance detector jacket for special needs students will use the Engineering Design Process (EDP) Model. In the methodology there are four parts that will be discussed namely project design, project operational framework, program flow chart and summary. There are four sections that described product design according to the work steps of model engineering design process (EDP) which is used as a guide, namely the phase of problem identification and problem research, the second phase of making and selecting possible solutions, the third phase of

prototype development and the fourth phase of product testing and evaluation. EDP model was chosen because it is a suitable model to be used in product development. The EDP model is a method that identifies problems and finds solutions based on several systematic and orderly steps in various ways (National Academy of Engineering, 2020). EDP is a process and a powerful and flexible approach to problem solving and can be used in almost any situation. Figure 1 shows six work steps that need to be done to develop a physical distance detector jacket.

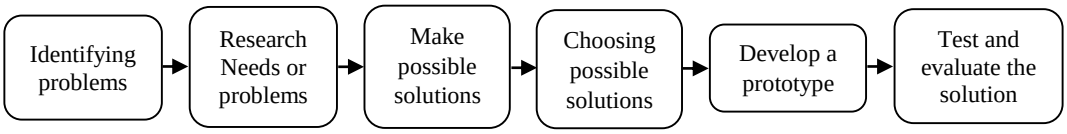


Figure 1: EDP model

1. Phase 1: Problem identification and problem research

The phase of identifying the problem is the initial phase of research studies conducted to identify the problems encountered and the purpose of the product to be developed. In this phase, the objectives and purpose of product design are based on the problems encountered to ensure that the development process carried out continues in accordance with the objectives to be achieved.

2. Phase 2: Create and select possible solutions

This phase helps make possible solutions in implementing product design where information is obtained through journal reading and review of existing products. The collection of this information leads to the path of appropriate solutions and methods to be applied. Accordingly, several suggestions of solutions capable of overcoming the problem arise. The best solution is selected from several methods to overcome the problem or issue studied. There are three features on the physical distance detector jacket product to be developed which are buzzer vibration and warning sign display on micro: bit for students with hearing difficulties, alarm sound and buzzer vibration to help students with vision difficulties as well as warning sign display on micro bit. Meanwhile, alarm sound and buzzer vibrations for students with learning difficulties.

3. Phase 3: Prototype Development

Product development is divided into two main parts namely hardware and software. The research and selection of materials carried out to develop a physical distance detector jacket for students with special needs is very important so that the materials used can be functional and suitable for the product. The product developed is characterized by self-management among students with special needs that is with the use of tools or devices such as ultrasonic sensors to help students with who are visually impaired, students with hearing difficulties and students with learning difficulties always be aware of the distance either inside or outside of school. In this product development phase, the selection of appropriate materials and components is an important aspect of obtaining the best design by considering all available factors. Hence, the prototype development of physical distance detector jacket was produced in block diagram shown as Figure 2.

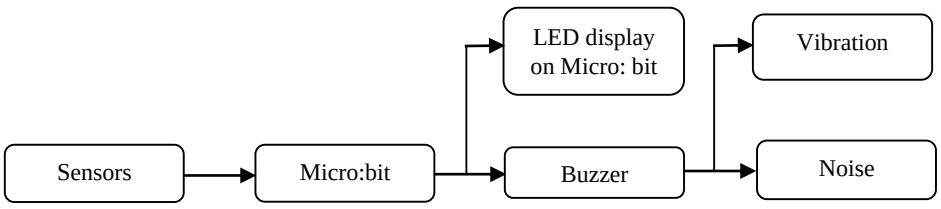


Figure 2: Block diagram of physical distance tracking jacket for students with special needs

The ultrasonic sensor detects a confinement of less than 1 meter, using three different warnings systems namely vibration and sound through the buzzer as well as the display of warning signs on the micro: bit will be generated by the physical distance detector jacket. This product has the ability to produce different warnings to help students with vision difficulties, students with hearing difficulties and students with learning difficulties. Figure 3 shows the flow chart of the development of physical distance tracking jacket for special needs students.

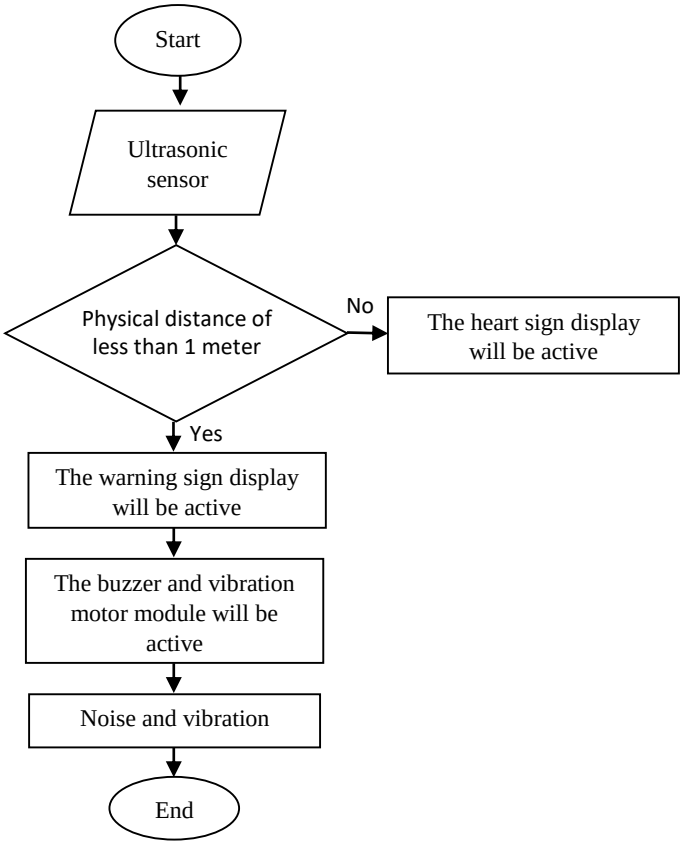


Figure 3: Flow chart of physical distance tracking jacket for special needs students

1. Phase 4: Product Testing and evaluation

The testing and evaluation process is a very important phase and will be done after the product construction phase. This test is conducted to find out if the product can work well or vice versa. This testing involves an electronic circuit developed in which testing the suitability of the components used in the circuit. This phase explains the function of the product to detect the imprisonment received by the sensor, then the sensor will be processed in the Micro: bit program where information will be sent to the buzzer to emit vibrations and sounds, display warning signs on micro: bits and buzzers.

4. Testing and Evaluation of Product

Engineering analysis is an important element and must be present in writing to document a project accurately and in detail. This analysis is also conducted according to various methods and instruments appropriate to the developed product. Three analysis is conducted by the researcher namely circuit design analysis, design analysis and functionality analysis. This analysis is also a very important thing in determining the success of a product produced and ensure the implementation objectives are achieved.

1. Circuit Design Testing

In this circuit design, there are several components used on the physical distance detector jacket product for students with special needs to complete a functional electronic circuit. Among the components that have been used are micro:bits, ultrasonic sensors, buzzers, vibration motor, and batteries. The 3V power supply serves as a power supply to the micro: bit controller while an external power supply of 5V is used for the ultrasonic sensor to function properly. Different supply values are used because the ultrasonic sensor cannot function properly if the existing 3V supply is on the micro:bit. Figure 4 shows the circuit connection of physical distance tracking jacket.

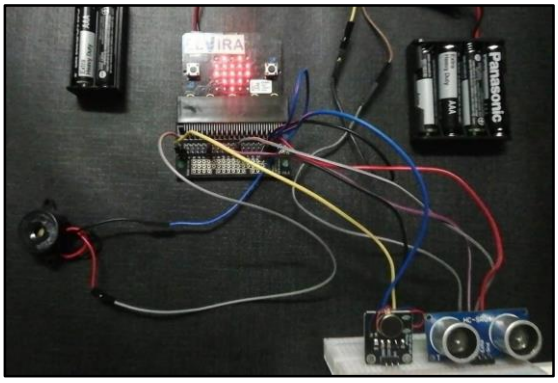


Figure 4: The circuit connection of physical distance tracking jacket for students with special needs

2. Design Testing

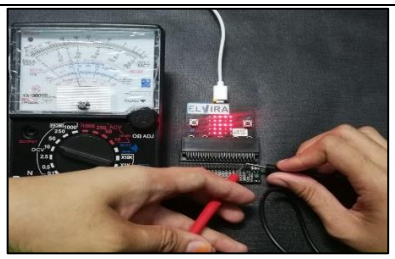
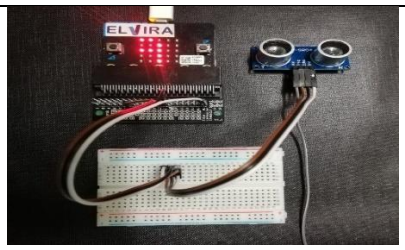
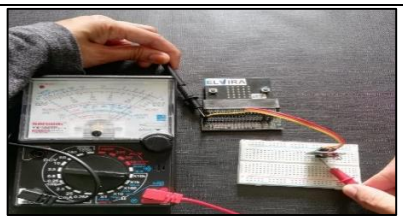
The design of the physical distance detector jacket for special needs students is equipped with several key components namely micro:bits, ultrasonic sensors, buzzers and vibration motor. The physical distance detector jacket for those students is built with a length of 25 cm and independent size as this product can be adjusted according to the body size of the user. The color of this design is orange and is symbolic for students with vision impairments, students with hearing impairments and students with learning disabilities. In this design, the special needs students' symbol was displayed on the jacket to facilitate the movement of those who are already restricted when in school or out of school. Each front and back side of this physical jacket detector has an ultrasonic sensor and buzzer. While on the back of the jacket has a vibration motor that fix inside the jacket.

Figure 5: Frontal view

3. Component Functionality Testing

The design of the physical distance detector for special needs students used several key components required to complete the entire operation effectively and efficiently. Testing the functionality of each of these major components can help researchers identify each component operate accordingly and in accordance with the desired operation. Table 1 shows the Functionality analysis of each of the components on the physical distance tracking jacket for special needs students.

Table 1: Functionality testing of each of the components on the physical distance tracking jacket for students with special needs

Operation	Description
	1. The developed circuit has the main component that controls the entire operation of this physical distance detector jacket is a micro: bit microcontroller. Testing is performed on the micro: bit by measuring the voltage value at the foot of the 3V power supply on the 3V micro: bit pin. This test is done using a multimeter by placing the positive foot on the 3V micro: bit pin and the negative foot on the earth foot which is the 0V pin on the micro: bit.
	1. The researcher tested the functionality of the physical distance detector i.e. the ultrasonic sensor by observing the LED display on the micro board: the bit is either lit or otherwise. 2. If the micro: bit board and heart -shaped LED are lit, it means no physical imprisonment of less than 1 meter occurs around it. At the same time, the alarm sounds and the micro:bit displays "ALERT".
	1. The vibration motor module is used as a warning sign to visually impaired students and hearing-impaired students. Before the vibration module functionality test is performed, the vibration motor module leg connection test is first tested using a multimeter to ensure no damage to the wires and to avoid the occurrence of connection errors on the desired pin legs.

4. Programming of physical distance tracking jacket for students with special needs

The Makecode micro:bit website is very important as it helps the researcher to analyze as well as identify the programming that is implemented to function accordingly on the circuit for the development of the physical distance detector jacket product for this students with special needs. This Makecode facilitates the researcher to connect the micro:bit controller with other components used. This programming used blocks that have been programmed by the researcher to the microcontroller. Figure 6 and 7 shows the testing of programming functionality for this physical distance detector jacket by downloading a hex file to micro:bits.

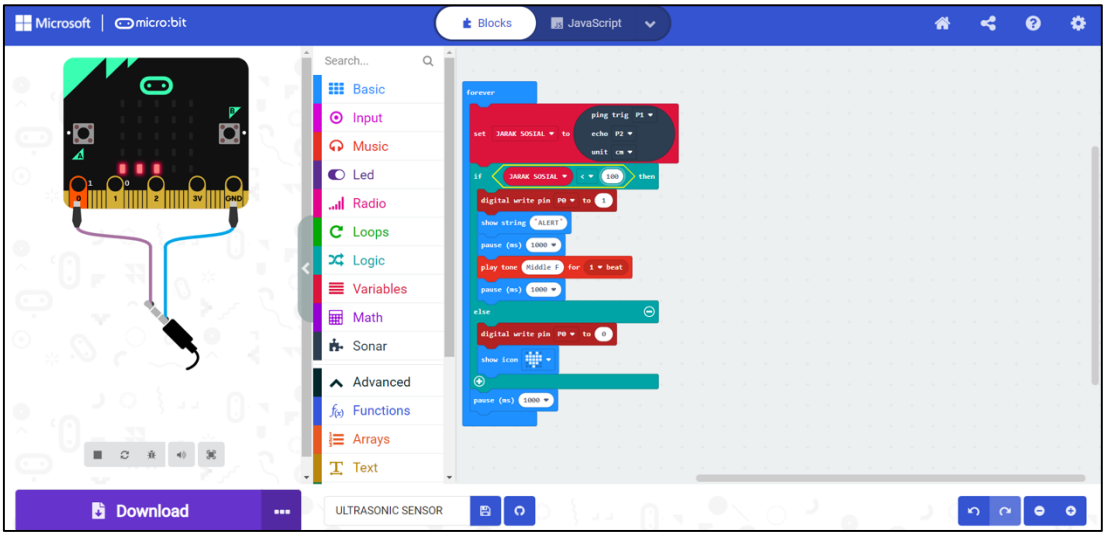


Figure 6: Downloading the programming for the physical distance detector on the front view to micro:bit.

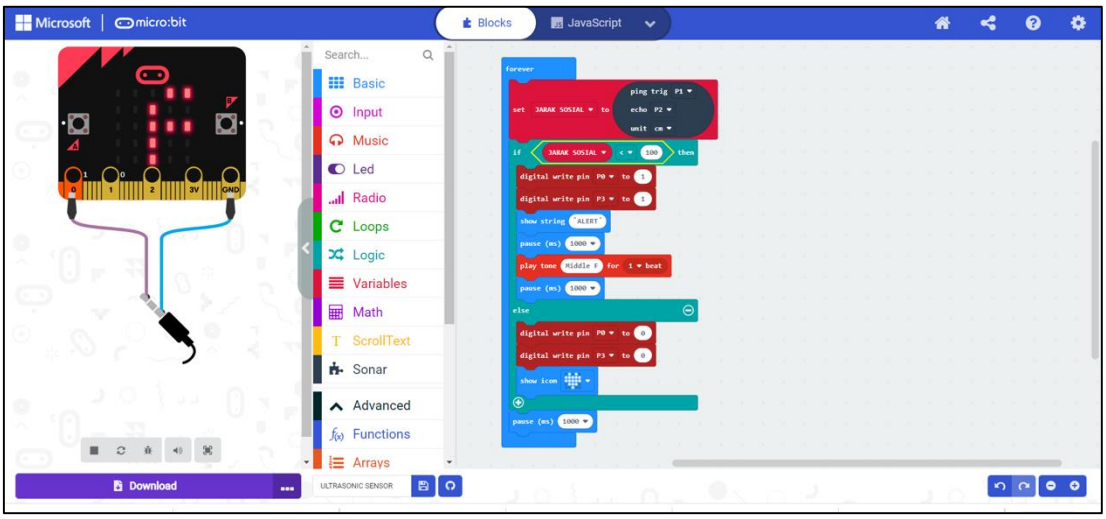


Figure 7: Downloading the programming for the physical distance detector on the rear view to micro:bits

4. Experts' reviews analysis

On the review section, all the experts involved agreed on the functionality of the physical distance detector jacket for students with special needs and meeting the set objectives. An expert has suggested that the physical distance detector jacket for the students with special needs can be improved by ensuring that the buzzer sound is placed in an accurate position that can be heard by the students with special needs. Table 2 shows the suggestions and comments from experts.

Table 2: Suggestions and comments from experts

Operation	Description
Expert 1 (Lecturer, Faculty of Technical and Vocational Education, Universiti Tun Hussien Onn Malaysia)	The product is well developed and has commercial value in the future.

Expert 2 Special Education Teacher (Learning Disabilities)	It is more recommended if this product can be produced using only one switch, only for two front and rear devices at once to facilitate it to be used by target users such as MBK. The rationale is because MBK is a person who finds it difficult to remember something and needs someone's help if there are two switches to turn on in addition to avoid the risk of one part of the battery running out of power source first without MBK being aware of it. Thus, the effectiveness of the functionality of this product may not achieve its proper objective if one of the front or rear devices does not work at the same time.
Expert 3 (Health Pharmacist Officer, Kinabatangan Area Health Office)	The product works well and fits.

5. Discussion

In the production of a product, it requires systematic and careful planning so that the product development process can be handled smoothly and accordingly. Based on this discussion, the researchers find out that this product has achieved the objectives that have been listed.

i. Designing physical distance detector jacket for students with special needs

The process for designing this product is an initial step before the product is fully developed (Mahesh et al., 2018). Before the implementation of the product design was developed, the researcher had identified the problems faced by the visually impaired students with special needs, the hearing impaired MBK and the learning impaired students with special needs. Next, past research information on products available in the market is collected by the researcher. The engineering design model EDP was selected as a guide. Through this design guide, the first step that needs to be done is to identify the needs or problems that occur. The problem of existing products is that they are less compatible with students with special needs. After identifying the problem, the researcher examines the need for the problem. The concept of the EDP model is used to develop a project design that helps solve problems until it achieves the desired objectives. The EDP model is a systematic process in solving problems encountered (National Academy of Engineering, 2020). In the EDP model there are four design phases that need to be implemented by the researcher. The four phases in the EDP model are the problem identification and problem research phase, the creating and selecting possible solution phase, the prototype development phase and the product testing phase. In order to achieve the project objectives, the phase that has been set in the EDP model, namely the phase of problem identification and problem research is done. In this phase, information through existing studies is collected to identify the problems and create solutions in respect to the existing physical incarceration detectors. Therefore, a detector should be developed to detect a physical distance of less than 1 meter to reduce the transmission of COVID-19 virus. Then, a selected solution is capable of detecting the physical distance for the MBK with various warning signs such as displaying a warning sign on a micro: bit display, using a buzzer to emit sound and vibration that will be generated using a vibration motor module. In the prototype development phase, the suitability of the components to achieve the project objectives is identified.

ii. Developed a physical distance detector jacket for students with special needs

The implementation of the second objective is to develop a physical distance detector jacket for students with special needs. To ensure that the objective is achieved, the appropriate components are selected to achieve the desired objective. The selection of materials and components is critical to developing products for physical distance detection. An ultrasonic sensor that has been set to the

desired distance i.e. the component will detect less than 1 meter has been used in the physical distance detector jacket for students with special needs. In addition, the Micro: bit display is used to display the heart shape which signifies safe i.e. no physical imprisonment of less than 1 meter. When the ultrasonic sensor detects a physical imprisonment of less than 1 meter then the micro: bit display will display "ALERT" as a warning sign. Various components are used as warning signs to keep the physical imprisonment of visually impaired students with special needs, hearing impaired students with special needs and learning impaired students with special needs during teaching and learning is carried out like a buzzer to emit sound and vibration motor to produce vibration. To ensure that this product functions accordingly, the functional instructions have been done using the Makecode website. This software allows the determination of the workflow for the developed system. While developing this product, there were several problems faced by the researchers i.e. problems in terms of detection. The problem when testing the distance detection using ultrasonic sensors is that the sensor detects nearby and stationary objects. Therefore, the ON/OFF push button is used to solve this problem. The ON/OFF push button is used to stop the operation of the physical distance detector when the MBK is close to a stationary object. In the early stages, researchers intend to use PIR sensors because they can detect heat emitted by humans and the distance to be detected is wide compared to ultrasonic sensors however, PIR sensors are less suitable to be carried anywhere because the sensors detect movement produced by users. Overall, the product as per planned sketches was successfully developed. However, there are some problems in the product development, whereby the researcher needs to protect the components in the jacket by using the type of fabric that is safe to be worn by students with special needs and comfortable. Therefore, components are sewn on the fabric as a protector in the jacket.

iii. Testing the functionality of the physical distance detector jacket for MBK

In the early stages, testing is done on circuits built on electronic circuits. The connection of these pins must be correct to allow the product to work properly and smoothly. The first test performed was to test the functionality of Micro: bits. Testing is performed on the micro: bit by measuring the voltage value at the foot of the 3V power supply on the 3V micro: bit pin. This test is done using a multimeter by placing the positive leg on the 3V micro: bit pin and the negative leg on the earth leg which is the 0V pin on the micro: bit. The value reading for micro: bits using a multimeter is 3V. Next, the researchers tested the functionality of the physical distance detector i.e. the ultrasonic sensor by observing the LED display on the micro board: the bits are either lit or otherwise. Testing the connection of the vibration motor module legs will be tested first using a multimeter to ensure that there is no damage to the wires and to avoid the occurrence of connection errors on the desired pin legs. By performing this analysis, the researcher was able to identify the functionality of the physical distance detector jacket whether it is in good condition for use. Therefore, the results of this analysis can help researchers develop an improved product in the future. Overall, the development of the physical distance detector jacket for MBK was able to function and successfully achieve the objectives planned by the researcher.

6. Conclusion

The objectives of the study have been successfully achieved after the researcher undertook the process of designing, developing and testing the development of a physical distance detector jacket for MBK. The main goal of this product development is to design, develop and test the functionality of the product where the product is able to detect physical distances of less than 1 meter. Having this physical distance detector jacket allows MBK to be alert in the pandemic situation to help prevent the transmission of COVID-19 virus during teaching and learning process.

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