KnE Social Sciences

ICESRE
5th International Conference on Education and Social Science Research (ICESRE)
Volume 2022

Knowledge E
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Conference Paper

Development of Electric Cube Assistive Technology to Facilitate Physical Fitness Trainings of Children With Special Needs

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Abstract.
Assistive technology has opened many doors of education for special needs students. Assistive technology can be an equalizer for individuals with special needs to be able to participate in the school and community environment. This study aimed to research and develop assistive technology that can facilitate special needs children to be able to do physical activities like physical fitness exercises. The final product of this study is a smart cube equipped with a timer and a special fitness training program that is integrated into the smartphone. The research method used in this study was research and development adopted from Borg and Gall, divided into three stages. The design stage, the development stage, and the implementation stage. The research subjects consisted of experts in adaptive physical education, physical activity instructors for students with disabilities, and students with disabilities. Data was collected using the test method (physical fitness movement literacy) and non-test methods (survey, test, observation, interview and documentation). The results of the small group and large group try out stated that the product can be implemented well, and by looking at the results of the research, it can be concluded that the product is suitable to use by children with special needs, especially children with mild mental disabilities.

Keywords: Assistive device, Electric cube, Physical fitness, Special needs children

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Published 21 December 2022

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICESRE Conference Committee.

1. Introduction

Children with special needs are different from other normal children. They cannot perform physical activities perfectly, especially children with mental disabilities. Special needs children really need help. Negative things are often experienced by children with disabilities such as ostracism which can disconnect them from health services, education and so on. These negative things usually last a long time. Supportive services and technologies can enable children with special needs to improve physical fitness,

basic movements, and help them to be more active. After all, if the children move more actively, their bodies become healthier, fitter and free from disease (1,2).

Assistive technology can improve their quality of life (5,6). Assistive technology includes related products and services that improve the function of persons with disabilities(3,4). In this case, we developed a device in the form of a Smart Cube equipped with various commands to do some activities such as push, pull, jump, lift, run and balance. This can be a tool for children to make them become more active, as well as able to participate in various aspects of life.

For children with disabilities, technological aids are very important for them. In this study, we wanted to provide research results about the benefits of smart cube assistive technology for special needs children. It offers strategies and collaborations to increase the development and participation of children with disabilities through smart cube assistive technology. Mental disabilities children have limitations in two main things: The first is limited intellectual function, and the second is limitations in adaptability, such as difficulty communicating effectively, taking care of oneself, and interacting. The smart cube device is expected to make it easier for the special needs students to learn physical activities (5–8).

Assistive Technology can help mentally disabilities children to engage in normal life activities, become more sociable and independent (8,9). Even Arab countries are giving important efforts to facilitate their lives and encourage their involvement in normal social life. (10,11). Historically, assistive technology has been associated with individuals who have moderate or severe physical and sensory impairments and needs. The key to successful use of assistive technology is by creating a good compatibility between the variety of available devices and the various physical, cognitive, and sensory challenges faced by children with special needs. Thus, children with disabilities can use computer-based or smartphone-based instructional assistive technology to facilitate physical fitness training. Therefore, that researchers will develop an electric smart cube to facilitate physical fitness training for children with special needs.

2. Method

2.1. Research Design

The design of this study used a research and development approach which is adopted from Borg & Gall. The research procedures include these following steps: conducting needs and environment analysis, product design, individual testing, expert validation,

field testing, product revision, implementation of developed product, and dissemination.The research subjects in the survey research consisted of teachers, children with disabilities expert, information technology expert, and students with disabilities. Based on the data to be disclosed, research variables consist of four main variables, namely assistive technology, physical fitness, physical literacy, and instruments.

2.2. Data Collection

The data were collected using two methods: test and non-test. The test method was conducted to obtain data on the physical literacy status and fitness of children with disabilities which were collected by using physical literacy instruments. While the non-test method was carried out to collect data on needs analysis, environment analysis, expert validation, and product testing by using a questionnaire, interview guide, observation guide, documentation and literature review. After data collection was completed, the data were analyzed using percentages descriptive quantitative analysis.

3. Result and Discussion

3.1. Results

3.1.1. Needs Analysis Results

As the first step of research and development study, researchers need to collect various information and factual data that underlies this current study. The information and data were obtained by researchers through needs analysis activities by using questionnaires, interviews, and observations of the learning implementation, as well as conducting a literature review as a basis for designing appropriate device.

Needs analysis of product development for children with special needs was carried out by distributing questionnaires and simple interviews to special school teachers, observing the implementation of movement learning and reviewing relevant literature to the model/tool developed for this study. Needs analysis was used to determine the need for development through the responses felt by children with special needs, the current learning conditions, and the readiness of teachers.

Based on the results of observations, it was found that teachers needed tools that facilitated teaching and learning in special school because it has not run smoothly. Then, the researchers interviewed the teachers, and the results showed that the teachers

did realize that this cube shaped tool were indeed needed. Teachers feel the need to develop tools for special schools that are more varied, and equipped with clear motion visualizations, so that they can be understood and implemented correctly without miscommunication. Therefore, the results of this preliminary study, researchers have found the fact that there is a need of assistive device to facilitate special needs students' learning.

This section contains answers to the questions "what have you found". Therefore, only representative results from the research are presented. What is meant by "representative results" are results that represent the research findings, which lead to the discussion. Generally, research results are presented in figures or tables, but can also be in the form of descriptions for certain cases.

Although, good figures and tables are interesting and easy to understand, but the most important thing is that the results / data presented in the figure or table are honest. If an image can only be understood with the support of research data which may require half or a full page of paper, then the data should be included as an appendix. Do not hide important data that raises reader questions or leads to mistrust of the reader.

The results section is written following the chronological order as presented in the method section. The important thing in presenting results is that the author must not include references in this section. This section is the "findings" of the author himself. However, if the results of the study are presented in a figure or table that directly compares with the findings of another person, the part of the figure or table must include the findings of that other person, without the need to discuss it in this section.

3.1.2. Product Design & Material Design

Electric smart cube (PA CUBE TOYS) is composed from two components, namely, system and case. The system consists of Board, Push button, Sound, and Light. While the case in in the form of acrylic hardcase and stickers. Figure 1 shows the product design of the Electric cube prototype.

3.1.3. Program Design

Two types of programs are being developed in this study: the mobile application and system/microcontroller program.

1. **System / microcontroller program**

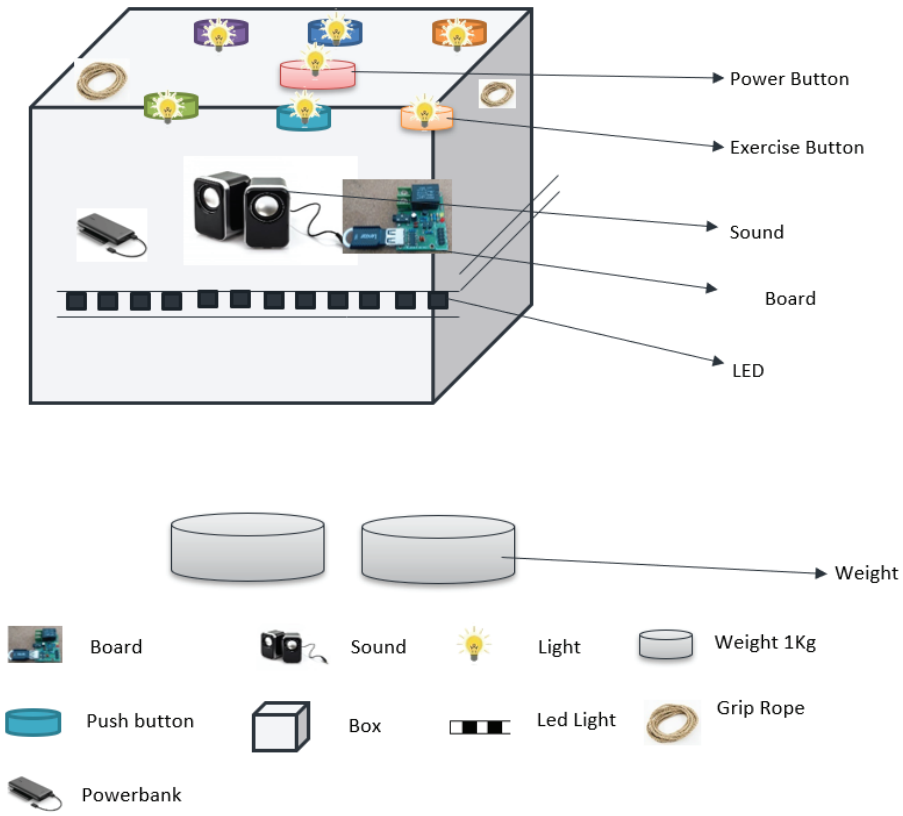

Figure 1: Electric cube prototype.

Figure 2 shows the workflow of the system developed:

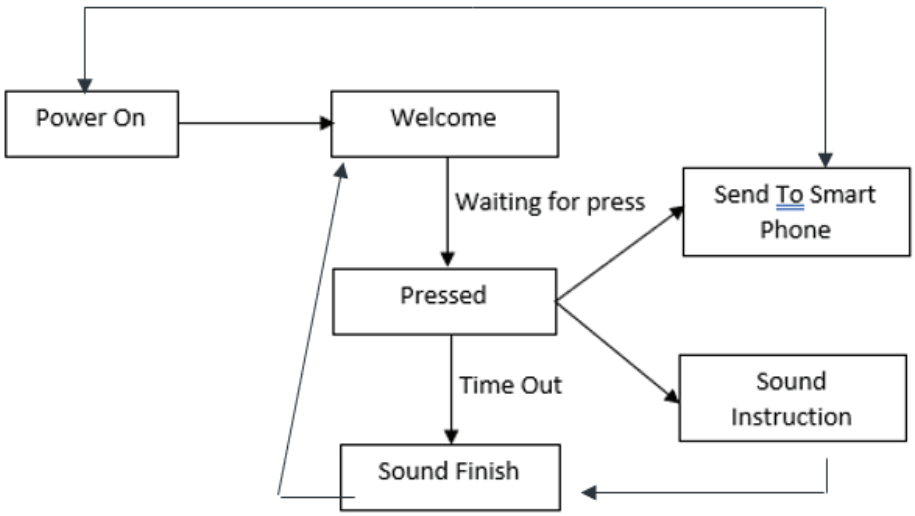

Figure 2: Electric Cube Workflow System.

Turn the cube on by pressing the power button. The cube is in the default settings, but the users can set it in a smartphone application through a Bluetooth network connection. When the power is turned on, all the exercise command indicator lights on the push

button will light up, indicating welcome to the users. After that, the teacher or student can press a practice button. When one of the training buttons is pressed, the cube will emit an exercise sound that has been set in the smartphone related to the duration and amount of the exercise. Applications and boxes will return to the first welcome state when the exercise is finished.

Figure 3. shows commands that are embedded in the button (press button) include the following:

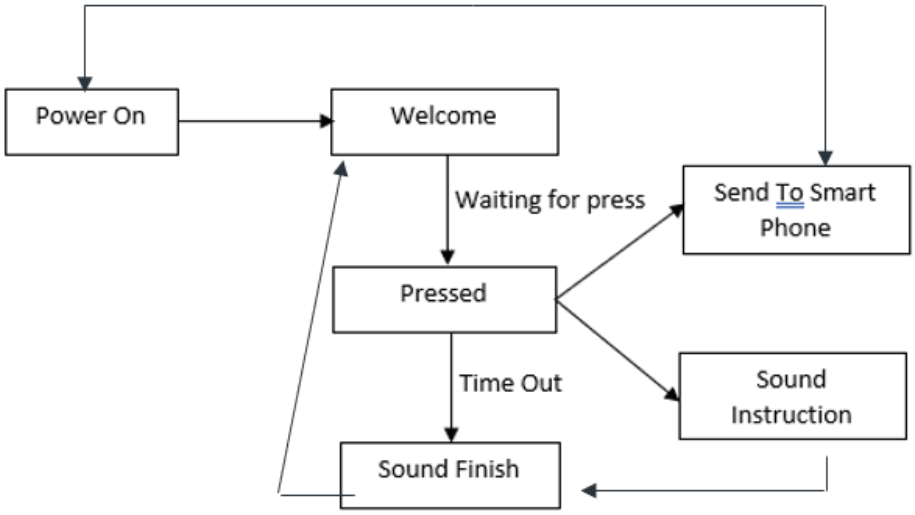

Figure 3: Diagram of commands on each press button.

1. **Smartphone Application**

The smartphone application is used to set the electric cube in terms of the volume and intensity of each exercise. The smartphone application uses an Android-based programming language. The application connects to the electric cube with a Bluetooth network. The application has six main menus according to the type of exercise: push, pull, jump, lift, run and balance. Each menu determines the exercise amount and duration starting from 30 seconds, 60 seconds, and so on.

3.1.4. Product Validation

This smart cube prototype aims to facilitate educators and students as a guidance for students with mild mental disabilities' physical activities. This cube adds light and sound features to attract students' attention. Before the smart cube prototype was tested on

participants, it was validated by three experts: information technology expert, physical education for special needs children learning expert, and lecturer in Adaptive Physical Education course. Table 1 shows expert validation results:

TABLE 1: Experts Validation Results.

Indicator	Score			
	Adaptive Physical Education Expert	Adaptive Physical Education Lecturer	Information technology experts	Description
Smart cube runs smoothly, receives, and displays instructed results.	3	3	3	Good/Feasible to use
Push button sensor can send information to the sound according to the command and send the results to the smartphone application.	3	4	3	Good/Feasible to use
Push Button Size.	4	4	3	Very Good
Electric cube push button settings	4	4	4	Very Good
Command and push buttons suitability	4	4	4	Very Good
Ease of use of the electric cube	3	3	3	Good/Feasible to use
Cube hardware design	3	3	3	Good/Feasible to use
Score	**24**	**25**	**23**	
Maximum Score	**28**	**28**	**28**	
Percentage	**85,71**	**89,29**	**82,14**	**Very Good**
Average	**3,43**	**3,57**	**3,29**	**Good**

The experts tried this electric cube, in addition, the expert also saw how this cube was used by the students. Physical education experts gave an assessment with a percentage of 85.71%, which means that the product is very good and worth to test, while according to the lecturer in Adaptive Physical Education course, the smart electric cube gets a score of 89.29%, which means it is very good and feasible to use. According to information technology expert, this smart electric cube got a score of 82.14 which means it is good and worth trying out in an actual class.

3.1.5. Results of product try out

The product try out were carried out in three stages, the first stage is a limited try out, the second stage is the initial try out and the third stage is the main/field try out. Limited try out were carried out by researchers together with developers independently, with trial and error during product development. Researchers involved 12 students with mild

mental disabilities in the initial tryout. Meanwhile, the field try out involved 20 students with mild mental disabilities. The students were 13 years old.

Initial try out and field try out were carried out in one place at different times, initial try out was carried out first and field try out was carried out later after making revisions based on the results of the initial try out. The implementation systematics of these two try outs were the same. The electronic cube was introduced to the teacher first, the teacher received training on how to use the smart cube, and then the teacher used the cube in teaching learning activities according to the prior training. Experts and observers who are adaptive physical education teachers are invited to observe how the smart cube is used in the real classroom. During the observation, the experts and observers evaluated the product during the try out. Table 2 shows Initial try out results data:

TABLE 2: Initial try out results data.

Indicator	Score						Description
	Expert 1	Expert 2	Expert 3	Observer 1	Observer 2	Observer 3	
Smart cube runs smoothly, receives, and displays instructed results.	2	3	3	3	2	2	Good
Push button sensor can send information to the sound according to the command and send the results to the smartphone application.	3	3	2	3	3	3	Good
Push Button Size.	3	4	3	3	3	3	Very Good
Electric cube push button settings	3	3	4	3	4	3	Very Good
Command and push buttons suitability	3	3	2	3	2	3	Good
Ease of use of the electric cube	3	2	3	3	2	3	Good
Cube hardware design	3	3	3	3	4	3	Good
Score	20	21	20	21	20	20	
Maximum Score	28	28	28	28	28	28	
Percentage	71,43	75,00	71,43	75,00	71,43	71,43	Good
Average	2,86	3,00	2,86	3,00	2,86	2,86	Good
Percentage Average						72,62	Good

The results of the initial try out showed that the average percentage from the experts and observers was 72.62%, which means the product is in a good category. The product can be used well, but there were some notes for revision from both experts and observers. Some things that need to be fixed were the cube settings via cellphone which took too long and sometimes didn't connect. During cube usage, some buttons didn't show the intended commands, and it was necessary to add a sticker on the button to show the relevant command on the button.

After making improvements, the cube is then tested in the main field trials with more subjects. Table 3 shows the field trial results:

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TABLE 3: Field Trial Results.

Indicator	Score						Description
	Expert 1	Expert 2	Expert 3	Observer 1	Observer 2	Observer 3	
Smart cube runs smoothly, receives, and displays instructed results.	3	3	3	3	3	3	Good
Push button sensor can send information to the sound according to the command and send the results to the smartphone application.	3	3	4	3	3	4	Very Good
Push Button Size.	3	4	3	3	3	3	Very Good
Electric cube push button settings	3	3	4	3	4	3	Very Good
Command and push buttons suitability	4	3	4	3	4	4	Very Good
Ease of use of the electric cube	4	4	3	3	4	3	Very Good
Cube hardware design	3	3	3	3	4	3	Very Good
Score	23	23	24	21	25	23	
Maximum Score	28	28	28	28	28	28	
Percentage	82,14	82,14	85,71	75,00	89,29	82,14	Very Good
Average	3,29	3,29	3,43	3,00	3,57	3,29	Very Good
Percentage Average						82,74	Very Good

The results of the main/field try out showed that the average percentage from the experts and observers is 82.74%, which means that the product is in the very good category. The product can be used properly without any significant problems.

4. Discussions

Sports and physical activities for mental disabilities children must be based on science and technology (9,11,12). The presence of technology can make teaching and learning activities become more efficient and increase the success rates in teaching.(9) It should also be mentioned that, technology-based technologies have some characteristics such as: portability, low cost, and ease of use.(8)

However, this electric cube device has some limitations. In addition, our research did not reach the mass production stage because it requires companies as business partners, and requires considerable costs. Therefore, we emphasize that this device can help to facilitate children with special needs in physical exercises, namely push, pull, jump, lift, run and balance movements.

5. Conclusion

After performing all of the research stages from need assessment to large group try out, a good response was obtained from the testing of the smart cube device. Not only is the cube practical and efficient to use, but its appearance is also attractive because of its good packaging. It means that children with special needs feel more comfortable when they use this device and the learning process becomes more interactive.

Acknowledgements

The author would like to thank the Institute for Research and Community Service, Universitas Negeri Malang which has provided research funds, as well as to children with special needs in the city of Malang, Indonesia.

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