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Assistive Technology for Communication: ESP32 Microcontroller Based 12-Button Board for Disability Students in *SMP Kristen Permata Hati Manado*

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Abstract

Education is the right of every citizen, including students with special needs, such as physical, emotional, mental, intellectual, and social disabilities. To facilitate proper education for students with special needs, a team consisting of permanent lecturers from the Electrical Engineering Study Program at Unika De La Salle Manado cared for and committed to supporting students with special needs at SMP Kristen Permata Hati Manado. The team tried to apply a 12-button board based on an ESP32 microcontroller for students with special needs or students with disabilities at SMP Kristen Permata Hati Manado to make it easier for them to communicate and interact with teachers while in class, especially when examinations are in progress or learning activities is in progress. The input on the 12-button board was processed into sound (speech) which was then sent to the receiver wirelessly so that what was conveyed by students with disabilities in the classroom could be understood by the teacher through the speakers. The results of implementation in school received a good response from the teachers and the students. Teachers were also very helpful in providing students with an understanding of the use of assistive technology.

Keywords: *12-button board, assistive technology, ESP32 microcontroller, student with disabilities*

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Introduction

A child's learning process during the developmental period is very important because at that time a child will slowly and independently begin to form his thinking process naturally and creatively through learning media or the visual things he hears and sees. Unfortunately, not all children are born with perfect hearing and vision abilities because there are certain factors that cause some children to be born disabled and imperfect, experiencing blindness, deafness, and even nervous disorders which ultimately prevent the child concerned from learning knowledge and skills in learning, while it is necessary they receive education like a normal child.

Encouraged by the above matter, the Electrical Engineering Study Program, through its lecturers, cared for and committed to implementing assistive technology for students with disabilities at *SMP Kristen Permata Hati Manado* to make it easier for them to communicate and interact while studying in class. From the results of a survey conducted on teachers, it was discovered that the school had deaf students and autistic students.

The technology utilized was an embedded system consisting of an ESP32 microcontroller as an input-to-output data processor, where the input data from the 12-button board was processed into sound (speech) which then came out via the speaker wirelessly (WiFi technology) so that what was conveyed by the disabled students in the classroom can be understood by the teacher (Singgeta & Manembu, 2018, Kurniawati et al., 2020, Prasetyo & Susetyo, 2020, Singgeta et al., 2023).

It is expected that the designed device can operate properly and be utilized by students with disabilities at *SMP Kristen Permata Hati Manado* for communication purposes and the learning process in the classroom.

Methods

The methods applied for this community service program contained several procedures, i.e. conducting oral surveys and observation, designing and researching the assistive technology, testing, and implementation at school (Luter et al., 2015, Abdullah et al, 2018, Rahmah, 2018, Susanto et al., 2019, Damastuti, 2021, Heriyadi et al., 2022)

The data and results for the community activities were acquired from interviews and observation reports made with one of the parents and also the principal and the teachers, including doctors. This community service was organized by a team of electrical engineering lecturers and students from May until December 2023. This activity can be planned for development in the future, conducted by educators who pay special attention to students with disabilities. The concept and technology of assistive technology can always be improved to support the government's educational programs and also the needs of the students. This community service helps extend lecturers' and students' soft skills and hard skills.

Results and Discussions

Results

The community service team contacted the school principal, Ms. Heity Jeine Wowor, and sent an official letter. After being approved, the team started their first program in May 2023 with surveys and observation. At first, the focus was only on the deaf student, but later on, based on the guidance we received from the reviewer, the team should implement the assistive technology also for autism students. The team came back again to school to conduct related interviews and then consulted with a specialist doctor. The documentation about the consultation with the doctor is shown in Figure 1.

Fig. 1. Consultation being made with the doctor by community service team

Based on the surveys and interviews with parents, teachers, doctors, and suggestions from technical guidance, it could be concluded that the team needed to design an assistive technology with the following benefits and priorities:

1. The assistive technology must be able to do an image-to-speech process and can be listened to through the speaker or headset by the teacher.
2. The technology must be able to do an image-to-text process and can be seen through the LCD screen.
3. The 12-button board, besides images, also needs to have texts so they can be read by the disabled students.
4. The designed technology must be comfortable to be used (efficient and portable).

On Tuesday, October 3, 2023, the Electrical Engineering Study Program Team consisting of 6 students and 4 lecturers visited the *SMP Kristen Permata Hati Manado* to carry out assistive technology information sharing activities for teachers and students with disabilities and directly carried out equipment testing in the classroom. Previously, the team had first contacted the principal to be permitted to carry out a community service program at the school.

When the team came to school, the first thing to be performed was meeting with the teachers and sharing information about the usage of the assistive technology, the communication device that have been created. With the help of the students, the team demonstrated how to use the device and then asked for opinions and input from the teachers. Input for the development of the device became a note for the team to later refine the technology so that it could later be handed over to the school for use.

After completing information sharing with the teachers, the device was then taken to the classroom to be informed to students with disabilities (2 deaf students and 1 autistic student). How to use the device was explained by the principal and the Mandarin Language teacher who happened to be teaching at that time. When testing was performed, in general, the three students were able to use it well and utilized the existing buttons to communicate. The team also received feedback for further device development.

After receiving advice and important notes from the implementation at school, the team conducted a meeting for making video and writing a manual (Figure 2), and did some

modifications to the device together with testing with the help of a telecommunications expert (Figure 3). The result of the testing performed with a spectrum analyzer in the Electrical Engineering Telecommunications Laboratory suggested that WiFi communication is better than Bluetooth communication.

Fig. 2. Meeting for making video and writing a manual book

Fig. 3. Transmitter signal testing in the telecommunications laboratory

On November 14th, 2023, the team invited teacher representatives to come to the campus of the Catholic University of De La Salle Manado for evaluation and testing of the assistive technology that had been improved (with speakers and text displays). The assistive technology product is shown in Figure 4. With this technology, students could send a message to the teacher using the 12 (twelve) input buttons which had already given images and texts (shown in Figure 4). The push button would send a voice message through the speaker/headset/earphone, so the teacher would be able to understand what the student wants to ask or request while the learning process or exam is in progress. The panel box was printed using a 3D printer.

The speaker/headset/earphone output was adjusted in a small volume that is capable enough not to disturb the classroom atmosphere and can only be heard by the teacher. Based on the reviewer's suggestion, we also made an output in the form of text displayed by the LCD screen. When the student pushed a button, a beep sound rang and the teacher could read the message sent by the disabled student.

The device uses 2 (two) alternatives of power supply, i.e. AC adapter and charged battery. It uses WiFi communication for continuous signal transmission reliability. It is also flexible for implementation and the voice message can be modified according to specific needs. The documentation of the information sharing, implementation, and evaluation at school are shown in Figure 5 until Figure 8.

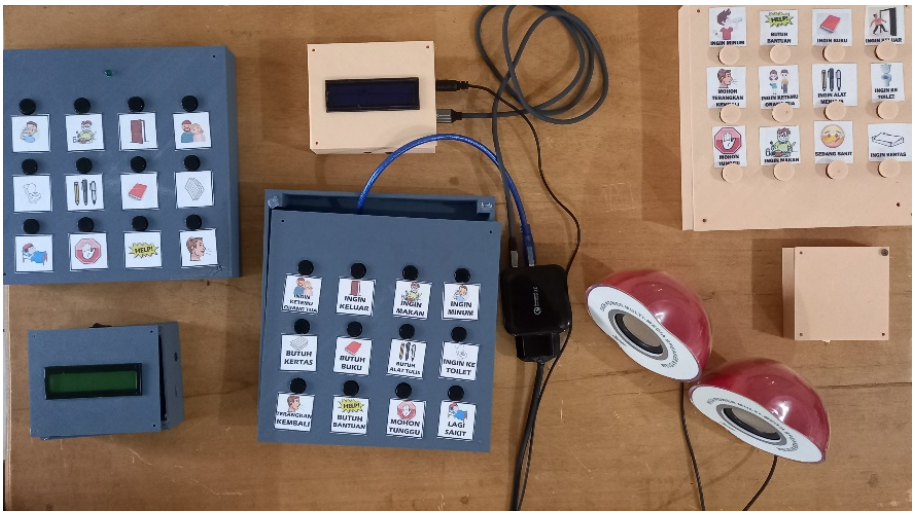

Fig. 4. The prototype of the assistive technology for communication

Fig. 5. Demonstration of the use of assistive technology to the teachers

Fig. 6. One teacher was answering the survey form made by the team

Fig. 7. Information sharing of the assistive technology for communication for disable students at *SMP Kristen Permata Hati Manado*

Fig. 8. Forum group discussion for evaluation

The community service program of the Electrical Engineering Study Program Team at *SMP Kristen Permata Hati Manado* had been carried out well. The outcomes are technology products, learning videos, a manual book, and a final report. From the team's observations and surveys, and also comments obtained from the school's principal, teachers, and parents, although needed a little bit of hard work to explain to the students with disabilities, about the assistive technology and how to use it, the students did understand and could use the technology well enough during the lesson in classroom.

The students and also the teachers gave positive comments during implementation at school. The results are described in detail in Table 1 and the tools being used were forms derived from Forum Group Discussion and classroom observations as can be seen in Figure 9.

Table 1. Feedback from community service activities

No	Respondent	Comment/What was Observed
1	Principal	a. The assistive technology was very helpful b. Keep designing and innovating
2	Teacher	a. The assistive technology was good b. It was a good assistive for communication
3	Parent	a. Felt happy for the support b. Children could access valuable knowledge
4	Students	a. Helped me to communicate b. This tool can help me c. Thanks for the school for being nice preparing the technology, however, I will very happy if the teacher and my classmate still help me and guide me

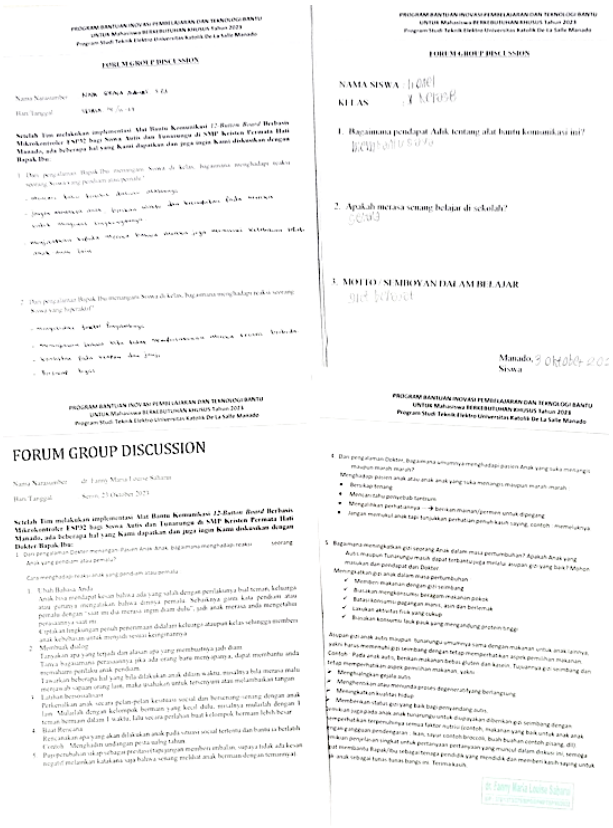

Fig. 9. Evaluation tools for the community service activities

Conclusion

The community service activity being conducted by Electrical Engineering lecturers and students was found to be very useful for disability students at *SMP Kristen Permata Hati Manado* in order to help them communicate using assistive technology. The other important benefit was to improve the hard and soft skills of Electrical Engineering lecturers and students learning more about the Electrical Engineering courses and could practically implement what they had learned. The concept and technology of assistive technology can always be improved

to support the government's educational programs and the students with disabilities' development in learning.

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