JURNAL UPI

Jurnal

Guru Komputer

Journal homepage: https://ejournal.upi.edu/index.php/JGrKom

JURNAL GURU KOMPUTER

Designing a Sound Programming Kit for Elementary School Students

Taufiq Pratama Putra, Enjun Junaeti, Heri Sutarno*

Universitas Pendidikan Indonesia, Indonesia
*Correspondence: E-mail: taufiqpratamaputra@student.upi.edu

ABSTRACT

The development of technology and knowledge is currently being updated. The generation born and accustomed to the digital world in his life is known as "digital natives". Elementary school age children are classified as "digital natives" and they should be directed to have technological expertise. One way to make these "digital natives" productive is to introduce the basic concepts of programming and electronics from an early age by using a sound programming kit. The design of this sound programming kit pays attention to the characteristics of elementary school students. This kit uses Arduino as a platform to run this kit because Arduino devices are easy to obtain, cost-effective, thus Arduino is recommended to introduce algorithms and programming for elementary school students. This study uses the ADDIE research method with the participants of teachers Miftahul Iman Elementary School Bandung. From this study the results obtained are 1) the sound programming kit that had been developed through several stages, namely analysis, design, development, implementation, and evaluation is rated “Very Good” by media experts with an average percentage of eligibility of 88.95%, 2) The teacher who did the test obtained an average Pretest score of 38.3 and an average Post-test score of 83.3, therefore gaining an increased value by 45. 3) The sound programming can be an alternative learning medium for teachers because it is interesting to be done by students and very flexible because it can be done outside of school.

ARTICLE INFO

Article History:
Submitted/Received 15 Sep 2020
First Revised 22 Jun 2022
Accepted 27 Aug 2022
First Available Online 28 Aug 2022
Publication Date 01 Sep 2022

Keyword:
ADDIE,
Algorithms and Programming,
Arduino,
Elementary Schools,
Sound programming kit.

1. INTRODUCTION

The development of technology and knowledge is growing rapidly and this is one of the challenges for the Indonesian today. In the era of the industrial revolution 4.0, Indonesian are brought to a technological mindset which covered various aspects of life. Today's technology is no longer a new thing for people whose lives cannot be separated from the proliferation of technological facilities such as: computers, gadgets, and the internet. The current era has reached the era of the industrial revolution 5.0 which processes and presents everything in a form of data and information, so information search is greatly supported and facilitated by various technology-based devices and system applications (Firmansyah *et al*., 2020).

Based on the results of KOMINFO and UNICEF's research on the behavior of children and adolescents in Indonesia in using the internet, they concluded: 1) 98% of children and adolescents know about the internet and 79.5% of them are internet users; 2) The rise of access to and use of the internet among children and adolescents is due to the increase in smartphone users who previously tended to use personal computers in internet cafes and school laboratories as well as laptops at home; 3) The main motivation of children and adolescents to access the internet is to seek information, to connect with old and new friends, and for entertainment; and 4) Parents and teachers are increasingly aware of the use of gadgets and the internet as a means of supporting children's education and learning.

Generations that are born and accustomed to the digital world in their lives are known as digital natives. Digital Natives are the children who were born in the last decades of the 20th century or children who are grow up with use of technology. According to Prensky (2001) there is a gap between Digital Natives students and educators who use old methods to teach their students. Technology has changed the way students think and process information, making it difficult for students to excel academically using old teaching methods.

Digital natives develop along with technological developments, teachers and the world of education are faced with serious challenges regarding abilities, methods, and teaching techniques in the classroom. For Prensky, teachers are "digital immigrants" who have a different "language". Digital immigrants treat the internet, for example, as a second source, while digital natives use the internet as their first source. In many ways, the current generation is a very different generation in relation to information technology and in how they relate to information sources.

With the existing challenges, "digital natives" are supposed to be directed to have technological prowess. In addition, students will have the ability to design or produce a product using existing technology. With that in mind, the benefits of "digital natives" should be directed so that students don't become consumptive towards technology.

By studying Algorithms and Programming and Robotics from an early age, it will train students to think logically while also hone their creativity. Coding can develop a complete set of interconnected abilities such as problem solving, teamwork, persistence, logical-mathematical thinking, abstraction, and creativity. Coding also trains children's persistence in dealing with problems. Perseverance is a difficult thing to teach, but it's an important skill to learn. Students can keep going when they encounter obstacles, and coding helps them do this, and of course, the ability to learn and code for children will train them to compete in a very competitive field of work in the future". Robotics education has great potential to improve teaching and learning by enabling students to apply their problem solving and critical thinking skills when building robots. Educational robotics is one of the best vehicles to provide concrete learning opportunities for students.

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN xxxx-xxxx e- ISSN 2774-7891

A study by Newley et al (2016) explain the use of an educational robot kit (Hummingbird Kit) with a programming device (Snap!) to elementary and junior high school students, proving that students are capable of successfully design, code, and build their own robots. Students can also explain how they perform certain actions with the help of programming language knowledge and explain the interactions between the Hummingbird kit (hardware) and Snap! programming language (software) when they present their robot to their audience (teachers and their parents). Several studies show the integration of robotics challenges improves students' critical thinking skills, math, and science content knowledge. Blanchard *et al* (2010) who examined the impact of robotic challenges on students' problem-solving abilities and critical thinking, they observed that most of the students used a trial-and-error problem solving strategy when they worked on the robot challenge.

On the other hand, some learning about algorithms and programming as well as robotics and electronics are still scarce and rarely applied in schools at the elementary level. In addition, teaching basic programming is not easy because computer programming competencies are considered difficult to comprehend (Pea, 1986). Students often face difficulties in understanding central concepts and in compiling programs that meet certain specifications (Fesakis, 2006). Apart from that, game tools suitable for elementary school students to teach programming or basic electronics and robotics are rarely found in Indonesia, most of them come from abroad, such as America, and are expensive.

Based on this background, this research has the main objective of designing and building learning media based on android devices as well as physical devices and cards packaged in a sound programming kit for elementary school students.

2. METHODS

This study uses research and development methods (Research and Development). The research method used in this study refers to the Research and Development (R&D) Model with the ADDIE model which consists of five stages, namely Analysis, Design, Development, Implementation and Evaluation which integrated according to the development research steps recommended by (Borg, 1984). In general, the research flow is described with a flowchart as shown in **Figure 1**.

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN xxxx-xxxx e- ISSN 2774-7891

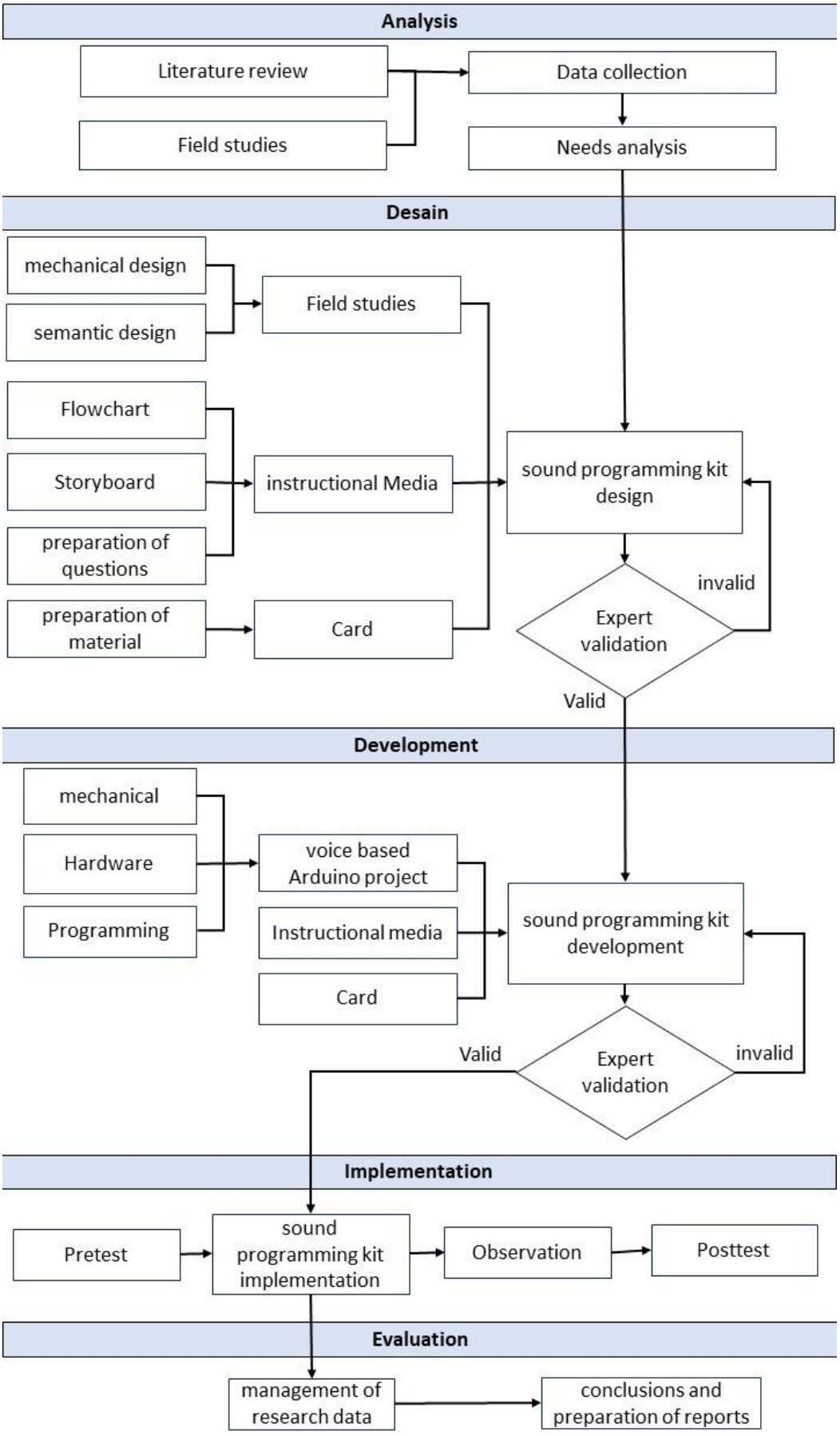

Figure 1. Flowchart of Research Procedures.

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN xxxx-xxxx e- ISSN 2774-7891

2.1. Research procedure

2.1.1. Analyze

In the analysis phase, the researcher conducted a needs assessment, identified problems and conducted a task analysis for the purposes of developing a Sound programming kit from the results of field studies and literature studies.

2.2.2. Design

At this stage the researcher designs the Sound programming kit that will be used in learning activity. At this stage the project design consists of mechanical design and circuit design. The design of learning media consists of flowcharts and storyboards. The researcher also creates a set of questions to measure teacher and student knowledge, and preparing teaching material to be implemented in the media.

2.2.3. Development

At this stage the researcher uses the design that was made at the design stage for the manufacture of the sound programming kit media, then at this stage validation is carried out by media expert to determine the feasibility of the sound programming kit media that has been made. With the aim of getting suggestions and improvements so that the kit made is suitable for use.

2.2.4. Implementation

At this stage testing the units that have been developed in the process and the prototypes that are ready. After the learning media is declared feasible by the expert, the learning media will be tested in the field. The trial process will be carried out on elementary school teachers before being tested on students. The teacher will be given an interview and initial test (pretest) and the result is used to measure the extent of the difficulty of the questions and the teacher's initial knowledge. After the teacher completes the pretest, they are directed to study the material on learning media and try to assemble a sound-based Arduino project that refers to the material in the learning media. After that the teacher does the Final Test (post-test).

2.2.5. Evaluation

At this evaluation stage, the researcher processed the data according to the data obtained, such as the results of interviews, pretest, post-test, ability observation sheets, media assessment sheets. The result is used to determine the advantages and disadvantages of the sound programming kit and what needs to be improved for further research.

2.2. Research Participants and Locations

To carry out this research and obtain data, research activities require participants who have certain criteria. Participants consisted of 3 Miftahul Iman Elementary School teachers. This research was conducted at Miftahul Iman Elementary School, Bandung, which is located on Jl. Dr. Setiabudhi No 179/171 A Isola Village, Sukasari District, Bandung City, West Java 40154.

2.3. Research Instruments

The instruments used in this study were: Field study instruments, namely semi-structured interviews conducted with class teachers; The pretest and post-test instruments are in the

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN xxxx-xxxx e- ISSN 2774-7891

form of a collection of multiple choice questions; The media validation instrument is using Multimedia Mania 2004 – Judge's Rubric North Carolina State University; The ability observation instrument is in the form of an observation sheet containing aspects of ability and the teacher's response instrument is unstructured interviews conducted with teachers after using learning media.

2.4. Data analysis

Data analysis of the pretest and posttest instruments was taken from the results of testing by the teacher using descriptive statistics with more basic conclusions on the average value (mean). Data analysis of expert validation instruments used Multimedia Mania 2004 – North Carolina State University Judge's Rubric (Shepherd & Mullane, 2010) using a Rating-Scale measurement scale. The score which determined the result can be seen in **Figure 2**.

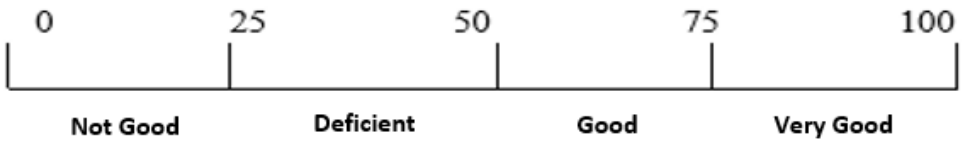

Figure 2. Category interval of expert validation responses.

Data analysis of the ability observation instrument uses the Rating-Scale measurement scale in Figure 2 and calculation classification in **Table 1**.

Table 1. Classification of Validation Value Calculations by Experts.

Percentage Score (%)	Criteria
0 – 20	Very less
21 – 40	Not enough
41 – 60	Enough
61 – 80	Good
81 – 100	Very good

3. RESULTS AND DISCUSSION

3.1. Analysis Stage

In the early stages of designing and building a sound programming kit, researchers made initial observations which included field studies and literature studies. The field study that the researchers conducted was to carry out the interview process with the class teacher at SD Mithaful Iman Bandung. From the results of staff interviews with the class teacher are:

(i) In the assessment, current learning activity had already implement the use media such as Quizzes, Google Form, Edmodo, and others. The devices such as laptops and projectors are used in conveying material in class.

(ii) Students are allowed to bring smartphones or gadgets when learning and are usually scheduled by the teacher.

(iii) Electrical or electronic circuit material is only available in Grade 6 to grade 5 without in-depth study of information literacy and media literacy.

(iv) Difficulties during the learning process are usually a lack of stimulation at home which makes it difficult for students to be directed and do not understand the purpose of learning the material.

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN xxxx-xxxx e- ISSN 2774-7891

(v) The teacher has implemented media in the learning process such as YouTube, power point, word, pdf, Prezi, and others.

(vi) Students are generally enthusiastic when using the media, but some feel they don't learn because they only feel they are watching.

(vii) The introduction of algorithms and programming to elementary school students may be a difficult. However, if the material is really made concretely, using language that is easy to understand, and is taught slowly and pleasantly, it is possible to do it.

From the analysis above, an introduction to algorithms and basic programming or basic electronics can be done for elementary school students, but several factors that affect students must be considered. Innovation is also needed to help the learning process that can be used by students.

3.2. Design Stage

The results of this stage are in the form of material and questions that have been adapted to the learning objectives which are then validated and design series, flowcharts and media storyboards that have been adapted to the needs of the analysis stage.

3.3. Development Stage

The results of this stage are sound programming kit learning media and the creation of sound-based Arduino projects along with their components. After the media has been developed, testing is then carried out using black box testing techniques to ensure that the product is free from errors by researchers, then validation is carried out to see the feasibility of the learning media being developed. After the learning media is considered feasible, it will be continued at the implementation stage. The following is a learning media interface that refers to the storyboard and flowchart that has been made:

3.1.1. Starting Page

On this page the user can select three menus, namely “Start” (Mulai) to go to the main menu, “Instructions” (Petunjuk) to display instructions for using the application, and an “About” (Tentang) to display an information about creator of the application, and an “X” button to exit the application as shown in **Figure 3**.

Figure 3. Starting Page Interface.

3.1.2. Pretest Page

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN xxxx-xxxx e- ISSN 2774-7891

On this page the user can work on the pretest questions and display the score. If the student answer correctly, 5 points will be added for each question. The interface of the pretest can be seen in **Figure 4**.

Figure 4. Pretest Page Interface.

3.1.3. Main Menu Page

On this page the user can choose three menus, namely “Material” (materi), “Project” (Proyek) and “Final Test” (Tes akhir) or posttest. The student are guided by the researcher to pick the menu in sequence, starting with Material, Project and finally, Final Task.

Figure 5. Main Menu Page Interface.

3.1.4. Components Page

After the student click on “Material” menu, they will be sent to “Component” page. On this page the student can start the study by selecting the available component menu. The interface can be seen in **Figure 6**.

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN xxxx-xxxx e- ISSN 2774-7891

Figure 6. Component Page Interface.

3.1.5. Arduino Page (Components)

On this page the user can learn material about the selected component. Material about the meaning, function, structure, and structure of the code. The interface can be seen in **Figure 7**.

Figure 7. Arduino Page Interface (Components).

3.1.6. Structure Page (Basic Programming)

On this page the user can choose the basic programming code they want to learn. The interface can be seen in **Figure 8**.

Figure 8. Interface Page Structure (Basic Programming).

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN xxxx-xxxx e- ISSN 2774-7891

3.1.7. Void setup page (Basic Programming)

On this page users can read the explanation of the programming code they selected earlier. The material included the definition and an example on how use of the code. The interface can be seen in **Figure 9**.

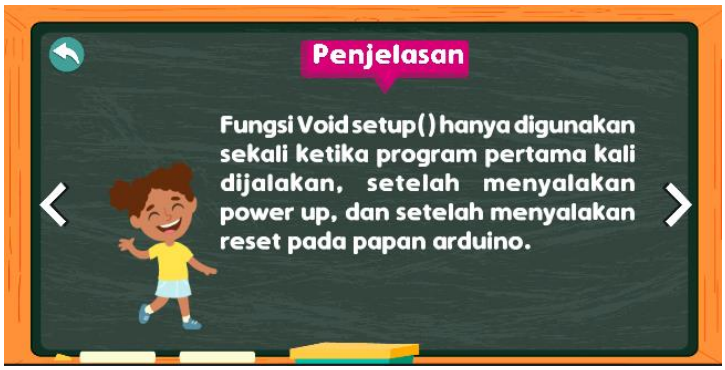

Figure 9. The void setup Page Interface (Basic Programming).

3.1.8. Project Component Pages: Unmute the Your Speakers

On this page the user is shown what components are needed to complete a project. Additionally, component images can be tapped and navigated to the component material for hints. The interface can be seen in **Figure 10.**

Figure 10. Raise Your Speakers Project Components Page.

3.1.9. Project Summary Page: Turn on the Speakers

On this page use a series of drawings to guide the student to assemble the project. The interface can be seen in **Figure 11**.

Figure 11. Series of Loudspeaker Projects.

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN xxxx-xxxx e- ISSN 2774-7891

3.1.10. Video Pages of the Loudspeaker Project Series

On this page, users can click on a video on how to assemble a project, which will be directed to YouTube. The purpose of this page is to give the student a better understanding on how to do the project. The interface can be seen in **Figure 12**.

Figure 12. Video of the Raise Your Speaker Project Series.

3.1.11. Project Code Page: Raise Your Speakers

On this page the user displays a code that must be typed on the laptop to then be uploaded. The interface can be seen in **Figure 13**.

Figure 13. Unmute Your Speaker Project Code.

3.1.12. Raise Your Speakers Project Challenge page

On this page users are shown challenges that can be tried by users. The interface can be seen in **Figure 14**.

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN xxxx-xxxx e- ISSN 2774-7891

Figure 14. Raise Your Speakers Project Challenge.

3.1.13. Post-test page

On this page, users can work on post test questions (final test) and display the score if correct, 5 points will be added for each question. The interface can be seen in **Figure 15**.

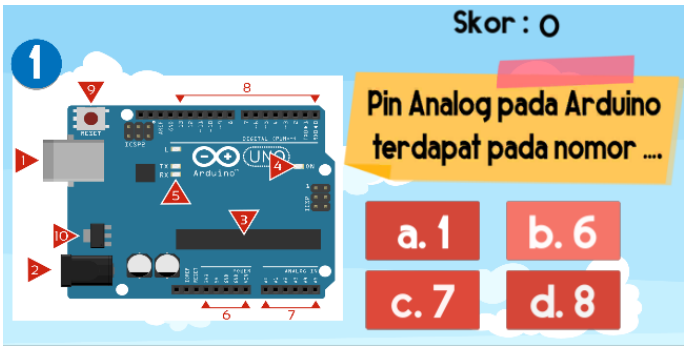

Figure 15. Post-test page.

3.2. Expert Validation Test Results

At this stage the Sound Programming Kit learning media is validated by expert, in this case lecturers and teachers, who have conducted previous trials. The goal is to determine the feasibility of the Sound Programming Kit learning media from the teacher's point of view. This validation refers to Multimedia Mania 2004. The results of the media validation by the lecturer can be seen in **Table 2**.

Tabel 2. Results of media validation by the expert (lecturers)

Name	Aspect										Percentage Total
	Mechanism		Multimedia Elements		Information Structure		Documentation		Content Quality		
	N/A	P (%)	N/A	P (%)	N/A	P (%)	N/A	P (%)	N/A	P (%)	
1	14.80	92.50	7.50	93.75	14.80	92.50	3.60	90.00	36.90	92.25	92.20
2	16.00	100	8.00	100	16.00	100	4.00	100	40.00	100	100
Total	30.80	96.25	15.50	96.875	30.80	96.25	7.60	95.00	76.90	96.125	96.10

Based on **Table 2**, the value obtained from the validation results by expert lecturers from the Department of Computer Science Education obtained a value of 96.25% from the mechanism aspect, the multimedia element aspect was 96.875%, the information structure aspect was 96.25%, the documentation aspect was 95%, and content quality aspect of 96.125% with a total value of 96.1%. This data has different result compared to expert validation evaluation by the teacher, which result can be seen in **Table 3**.

Table 3. Results of Media Validation by the expert (teacher)

Name	Aspect										Percentage Total
	Mechanism		Multimedia Elements		Information Structure		Documentation		Content Quality		
	N/A	P (%)	N/A	P (%)	N/A	P (%)	N/A	P (%)	N/A	P (%)	
1	15.00	93.75	6.50	81.25	12	75.00	4.00	100	31.00	77.50	85.50
2	14.50	90.63	4.50	56.25	13	81.25	2.50	62.50	25.00	62.50	70.63

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN xxxx-xxxx e- ISSN 2774-7891

3	14.00	87.50	7.50	93.75	13	81.25	4.00	100	33.50	83.75	89.25
Total	43.50	90.63	18.50	77.09	38	79.17	10.50	87.50	89.50	74.58	81.80

Based on **Table 3**, the value obtained from the validation results by the expert teachers of SD Mithaful Iman Bandung obtained a value of 90.625% from the mechanism aspect, the multimedia element aspect was 77.083%, the information structure aspect was 79.17%, the documentation aspect was 97.5%, and content quality aspect of 74.58% with a total value of 81.8%.

The researcher then compared the result and made the average calculation of it. Based on the results in **Table 4**, the total average of media experts and teachers is 88.95%, so that the Sound Programming Kit learning media can be categorized as "Very Good".

Table 4. Results Average total media validation by media experts and teachers.

Media expert validation average	Average teacher validation	Total average
96.10 %	81.10 %	88.95 %

If interpreted in Figure, it will look like in **Figure 16**.

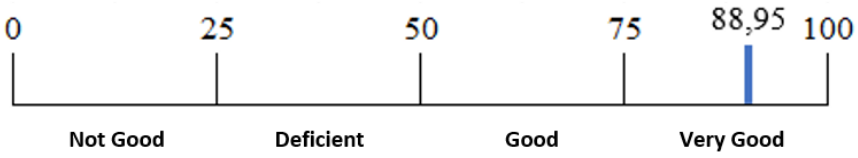

Figure 16. Interpretation of the Assessment Kit by Experts.

3.3. Pretest and post-test results

The researcher also conducted an initial test (pretest) and posttest conducted by 3 teachers using the initial test (pretest) and posttest with 20 questions each. The purpose of this pretest is to find out the teacher's initial knowledge about components and programming in general, whether the level of difficulty of the questions is suitable for elementary school students, and how long the teacher works on these questions which will be a reference if the test were to be given to the elementary school students. After studying the material then do a final test (posttest) to see the progress. The results of the pretest and posttest are shown in **Table 3**.

Table 3. Pretest and post-test results.

No	Teacher	Pretest Score	Posttest Score	Average Working Time
1	Teacher 1	55.00	85.00	15 – 30 minutes
2	Teacher 2	35.00	85.00	15 – 30 minutes
3	Teacher 3	25.00	80.00	15 – 30 minutes
Average		**38.30**	**83.30**	

Based on the results in table 4.9, the average result for the initial test (pretest) is 38.3 and for the final test (post-test) it is 83.3. So that there has been an increase in the knowledge of teachers after using the Sound Programming Kit learning media. In addition, the average execution of each pretest and posttest ranges from 15 to 30 minutes.

3.4. Observation Results

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN xxxx-xxxx e- ISSN 2774-7891

The results of observations at this stage are based on the observer's observations of the teacher in assembling the projects contained in the Sound Programming Kit using the ability observation sheet.

The observation ratings obtained is 73.5%. According to the interval, the teachers are categorized as "Good" in conducting sequences and carrying out challenges on each project in the Sound Programming Kit. If interpreted in Figure, it will look like in **Figure 17**.

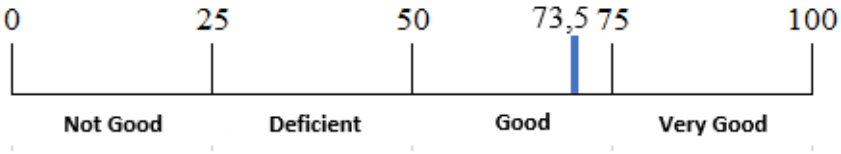

Figure 17. Interpretation of ability observation results.

3.5. Teacher Response Results

The researcher also conducted interview stages to find out the responses and suggestions given by the teachers to the Sound Programming Kit media and the results obtained:

(i) Well-developed media can be an alternative in teaching teacher electric circuits to students as well as in extracurricular development at school. Because so far, we still use simple components.

(ii) The need for adjustment of learning steps that are in accordance with the way of thinking of children at their age. The tools are not familiar, so it takes time to introduce them to teachers and elementary school students. The components used are up to the standards but according to the teacher, they are too small so there is a little difficulty in the assembly.

(iii) The Media Sound Programming Kit that is being developed is interesting and can be introduced to elementary school students because it is fun and also fosters curiosity. The teacher believed it can also train students' persistence to use technology in a more positive direction.

4. CONCLUSION

This Sound Programming Kit for elementary school students has been completed and developed using the five stages of the ADDIE research method. The media was validated and rated "Very Good" by experts from lecturers and teachers with a score percentage of 88.95% which means it is feasible to use.

The results of understanding the teacher's knowledge before and after using the Sound Programming Kit increased, obtained an average pretest score of 38.3 and an average post-test score of 83.3. There is an increase in value that occurred by 45. As well as the average ability to arrange teachers reaching 73.5% or can be categorized as “Good”.

The response from the teacher was very positive. The teacher is enthusiastic about the introduction of algorithms and programming as well as basic electronics because it is something new for the teacher. This kit can also be an alternative to learning methods at school.

Based on the results of the research that has been done, there are several suggestions that can be given:

(i) Sound Programming Kit can be implemented as an alternative to teaching material in thematic subjects and can be a part of extracurricular robotics.

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN xxxx-xxxx e- ISSN 2774-7891

(ii) Programming is better using block programming so that it is more understandable by students and teachers. Multiply various features and audio-visual content in learning media for students because they can attract elementary school students' interest.

(iii) Applications can be developed to be more interactive which includes features that can assemble virtual circuits such as simulations or can also be in the form of Augmented Reality or Virtual Reality.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

6. REFERENCES

Blanchard, S., Freiman, V., and Lirrete-Pitre, N. (2010). Strategies used by elementary school children solving robotics-based complex tasks: Innovative potential of technology. *Procedia-Social and Behavioral Sciences, 2*(2), 2851-2857.

Borg, W. R., and Gall, M. D. (1984). Educational research: An introduction. *British Journal of Educational Studies, 32*(3), 274.

Fesakis, A. D. (2006). Review of educational environments for programming: Technological and Pedagogical Dimensions. *THEMES in Education, 7*(3), 279-304.

Firmansyah, B., Nur, A. P., Angelia, F., Cahya, W., and Akbar, A. S. (2020). Pengenalan coding bagi usia sekolah menggunakan aplikasi SHINIBIK (Shinhan University dan IBI Kosgoro 1957) bagi murid Sekolah Dasar Negeri 11 Lenteng Agung Jakarta Selatan. *Jurnal Pengabdian Teratai, 1*(1), 35-51.

Newley, A., Deniz, H., Erdogan, K. A. Y. A., and Yesilyurt, E. (2016). Engaging elementary and middle school students in robotics through hummingbird kit with Snap! visual programming language. *Journal of Learning and Teaching in Digital Age, 1*(2), 20-26.

Pea, R. (1986). Language-independent conceptual 'bugs' in novice programming. *Journal of Educational Computing Research, 2*(1), 25-26.

Prensky, M. (2001). Digital natives, digital immigrants part 2: Do they really think differently?. *On the Horizon, 9*(6), 1-6.

Shepherd, C., and Mullane, A. M. (2010). Managing multimedia mania: Taming the technology beast. *Journal of College Teaching and Learning (TLC), 7*(1), 59-70.

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN xxxx-xxxx e- ISSN 2774-7891