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Questions Based Computational Thinking for Primary School Students

[1]Lala Septem Riza, [2]Muhammad Hazmi Zuhdi, [3]Erna Piantari, [4]Wahyudin, [5]Khyrina Airin Fariza Abu Samah

[1]Department of Computer Science Education, Universitas Pendidikan Indonesia, lala.s.riza@upi.edu
[2]Department of Computer Science Education, Universitas Pendidikan Indonesia, hazmimiko8@student.upi.edu
[3]Department of Computer Science Education, Universitas Pendidikan Indonesia, erna.piantari@upi.edu
[4]Department of Computer Science Education, Universitas Pendidikan Indonesia, wahyudin_sanusi@upi.edu
[5]Universiti Teknologi Mara Cawangan Melaka Kampus Jasin Melaka, Malaysia, khyrina783@uitm.edu.my

Abstract

Nowadays, students not only need to have the ability to read, write and count, but also they should have the capability in computational thinking so that the brain will get used to thinking logically and structurally for understanding the technology that is around them faster. Therefore, this research is aimed to develop a learning media based on concepts of computational thinking. It provides some questions consisting of 4 categories and totaling 17 questions to train the ability in computational thinking. In developing the learning media, it used the model of ADDIE (Analyze, Design, Development, Implementation, and Evaluate) with a sample of same students from primary school in Subang, West Java, Indonesia. The results indicate that the developed instructional media has been evaluated and rated with the score "Very Good" by experts with the average percentage of feasibility around 96.19%. Computational Thinking skills possessed by students vary and have different abilities in each question category, and have different levels of difficulty according to the abilities possessed by each student. Assessment and student responses indicate a category that is "very good" towards learning media and get an average score of 87.11%. It indicates that the developed media is ready to be used in the primary school in general.

Keywords: Computational Thinking, Learning Media, Primary School Education, ADDIE.

1. INTRODUCTION

The advance of a country cannot be separated from the progress and improvement of development and technologies. The education process cannot be separated from them because it is closely related to the development of quality human resources. Education is a conscious effort to create an atmosphere of learning and the learning process so that students actively develop their potential to have religious-spiritual strength, self-control, personality, intelligence, noble character, and skills needed by themselves, society, and nation (Gaol and Sitepu, 2020; Pianta, Downer, and Hamre, 2016).

The challenges in the dynamic education curriculum encourage education in Indonesia to be more suitable to answer the 21st-century global competition, which is full of technological and information developments. To be able to answer the global competition of the 21st century, it is necessary to have tools, human resources/teachers who meet the standards to carry out good and quality education. Teachers have a very important role in education where teachers as the spearhead in

carrying out educational missions in the field are very important factors in realizing the quality and efficient education system (Bhattacharjee and Deb, 2016; Biesta, 2015). In this case, the teacher needs to have the ability to convey information to students and package it attractively in a teaching medium. The benefits of teaching media can increase and direct children's attention so that it can lead to motivation in learning (Couse and Chen, 2010; Troseth et al., 2016; Araiza-Alba et al., 2021).

The 21st-century global competition requires students to continue to be able to develop various skills related to science and technology (Malik, 2018). NSTA or the National Science Teaching Association is a teaching professional organization in America and Canada states that skills in the 21st century are developed in the world of education such as thinking skills and problem-solving skills. Thinking skills and problem-solving skills in the 21st century can be answered by implementing a Computational Thinking framework which is the basis for the development of learning methods for science, technology, engineering, arts, and math (STEAM) (Pear et al., 2019; Park and Green, 2019; Dolgopolovas and Dagienė, 2021; Li et al, 2020). The 21st-century skills make Computational Thinking a subject matter which is the main topic, because it is increasingly recognized as a fundamental or basic competency for today's computer world (Tenzin Doleck et al. 2017). Wing (2006) states that Computational Thinking (CT) is one of the basic skills that facilitate learning in computer science, but it does not mean thinking like computers, but CT is a skill that involves more about how humans think to solve problems, design systems, and understand human behavior. Having CT skills in today's century is a must for everyone because computational thinking can train the brain to get used to thinking logically, structurally, and creatively and make students smarter and make them understand the technology around them faster. CT is a problem-solving methodology that can be applied across subjects (Barr and Stephenson, 2011; Yadav et al., 2016). This forms a new perception that these basic skills are different and cannot be represented by other basic skills such as reading, writing, and arithmetic (Peckham, 2011). If learning about this ability is widely applied to students, it will form a discipline of new abilities for students to be able to conceptualize, analyze, and solve problems more innovatively, which can support every aspect of life in the 21st century (Wahyudin et al., 2021; Seehorn et al. 2011; Riza et al., 2019).

The reason why programming material is included in the primary school curriculum in 2014 is that it aims to make children/students get to know Computational Thinking from an early age (Sáez-López et al., 2019). By applying and introducing Computational Thinking since primary school students will get used to it when at the next level, namely junior high school in learning informatics lessons. There are several researches that have implemented software involving CT in teaching and learning. For example, Tak Yeon Lee (2014) has built the game application, called CTArcade. Moreover, we found other applications of CT in the following research: Utesch et al. (2020), Fagerlund et al. (2021), Lin et al., (2020), and Kazimoglu et al., (2012).

Therefore, this research will produce software in the form of the CT learning media for primary school students. This learning media applies the concepts and skills of question-based Computational Thinking. It involves four aspects, namely decomposition, pattern recognition, abstraction, and algorithms in primary school students. The developed learning media consists of different question categories. These categories are story, pictorial, color play, and mathematical questions, the four question categories have a Computational Thinking component.

2. Method and Materials

2.1. Research Design

The research design used in this study is the descriptive qualitative research design. The steps used in this study started from a literature study to do analysis of research results as illustrated in Figure 1. In this initial research, a

literature study related to the concept of Computational Thinking, examples of implementing Computational Thinking, and software for creating learning media such as Unity, was conducted. First, we collect data in the form of a theory that can help research.

We use a development model that is used with 5 stages of the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model (Almomen et al., 2016; Shelton & Saltsman, 2011). It was chosen because the purpose of this study was to produce a Computational Thinking learning media product for school students, another basic consideration is that this model is suitable for developing instructional/learning model products that are right on target, effective and dynamic, and are very helpful in developing learning for teachers. In the analysis phase, an analysis of the software and hardware requirements that will be used and needed to build learning media is carried out, based on the analysis of the results of literature studies and field studies which result in the development of question-based Computational Thinking, the questions are analyzed whether they contain Computational Thinking or not and identified how the application of these questions to the media. In the design stage, flowcharts and storyboards are made to facilitate the development process. At the development stage, it is the process of realizing what has been designed in the previous stage and starting product manufacturing activities in the form of learning media, activities that are carried out, starting from designing assets to be used in learning media and adjusting to what has been made at the design stage. Creating the required assets is done using the help of the CorelDraw application. This design is designed to become a complete learning medium using the Unity application. After the product is developed, the product is tested first with black-box testing before being implemented. The implementation stage in this study was carried out by directly trying out the media. The media is used at the same time in the validity test by 2 experts, namely one lecturer in Computer Science Education, University of Pendidikan Indonesia, and one ICT teacher who is also the principal of the school. The results of this trial are used as a basis for carrying out the evaluation phase. The evaluation stage in this study was carried out to determine the results of validation by the two experts whether the media product was suitable for use or not so that it needed to be improved.

After the development of instructional media is carried out, the next stage is to create experimental scenarios/research scenarios so that the research implementation can be more focused and clearer. Furthermore, research is carried out according to the scenario and applies the media created. Next, the learning media that will be used by the students are prepared, after preparing the learning media, students are given instructions on the steps that must be taken when using learning media. In the next stage, when students use learning media, we make observations to find out the Computational Thinking skills of these students and records them based on the observation sheets that have been made previously. After the students finished the observation, then the interview was conducted. Interviews were conducted directly with students after using learning media, then questionnaires were distributed through the WhatsApp group of the students' parents in the form of a link, but parents were only tasked with accompanying their children who were filling out the questionnaire. From the research conducted, the results will be analyzed and processed by qualitative methods and conclusions are drawn from the results that have been analyzed. Furthermore, the activity of making a draft regarding the research after all data is obtained. The draft is made as physical evidence that the research process has been carried out so that it can be read by everyone and as reference material for further research development.

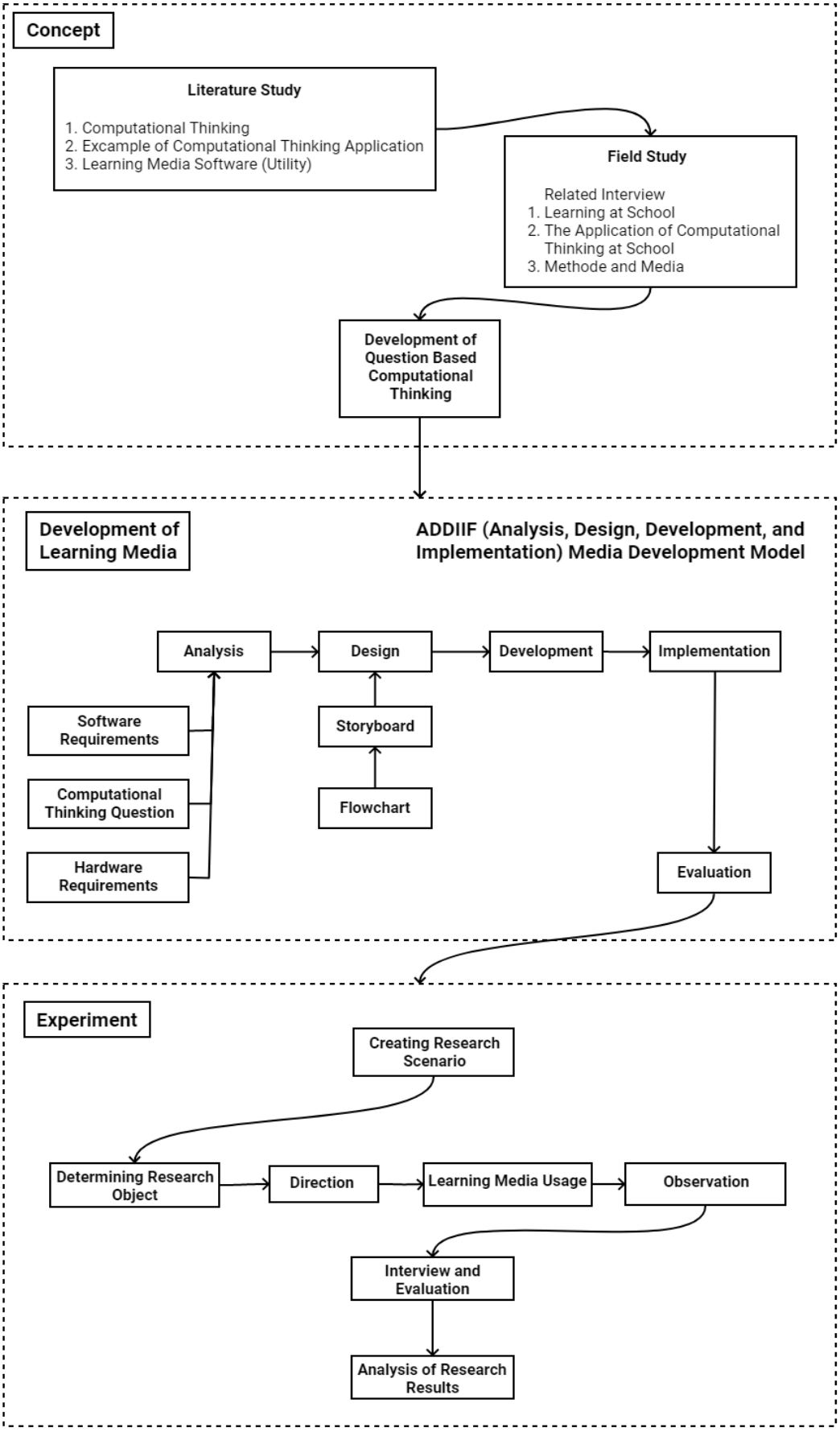

Fig. 1 *Research Procedure Flowchart*

2.2. Population and Sample

In this study, the population was sixth-grade students in the Primary School in Subang, West Java, Indonesia. What is used as the object of research is of course not the whole population, but some of the characteristics that exist in the population, hereinafter referred to as the sample. To determine the sample to be used, this study uses a purposive sampling technique, where the sample selection is based on certain considerations. The six students were selected based on the results of the 5th grade Final Semester Assessment and suggestions from the teacher. Since the research was performed in the Covid-19 pandemic and the numbers of samples are low, this study conducts qualitative methods for data analysis.

2.3. Research Instrument

The instrument used in this study was a field study instrument, namely unstructured interviews conducted by teachers. Then, analysis of data obtained from the results of field studies and student responses can be described immediately because they are the results of interviews. The data analysis obtained from the observation sheet instrument is also described based on the direct activities carried out. Furthermore, the level of validation of learning media by experts and assessment of learning media by students in this study are classified into four categories using a scale as shown in Figure 2.

Fig. 2 *Interval category results of expert validation and student assessment*

3. Results and Discussion

3.1 Question-Based Computational Thinking Development

This study is to teach Computational Thinking to primary school students using questions that contain the computational-thinking components, namely decomposition, pattern recognition, abstraction, and algorithms. There are 17 questions in learning media that can be divided into 4 categories: a matter of story, picture, color, and mathematics as follows:

1. It is categorized as a story problem, which is dominated by stories related to questions that must be solved. In the story category, 4 questions must be solved by drag and drop all of them;

2. The picture category contains 5 questions with 1 question about the stuffing command and 4 other questions in the form of drag and drop;

3. In the color-based-question category there are 4 questions and all of them are with the drag and drop command;

4. In the mathematical category, there are 4 questions consisting of 1 question with the fill command and 3 questions with the drag and drop command.

An example of the questions included in the mathematical category questions can be found in Figure 3. For example, students are asked to calculate 6 x 3 + 2: 2. This question might contain several components of computational thinking: decomposition and algorithms. Firstly, we need to decompose the question because it must be divided into small parts and solved one by one. In the arithmetic operation rule, what is done first must be multiplication and division then the results of both are added up. Then, the algorithm is that in this problem students are required to be able to arrange the available choices and place them in the answer box according to the sequence number from start to finish who can solve the problem.

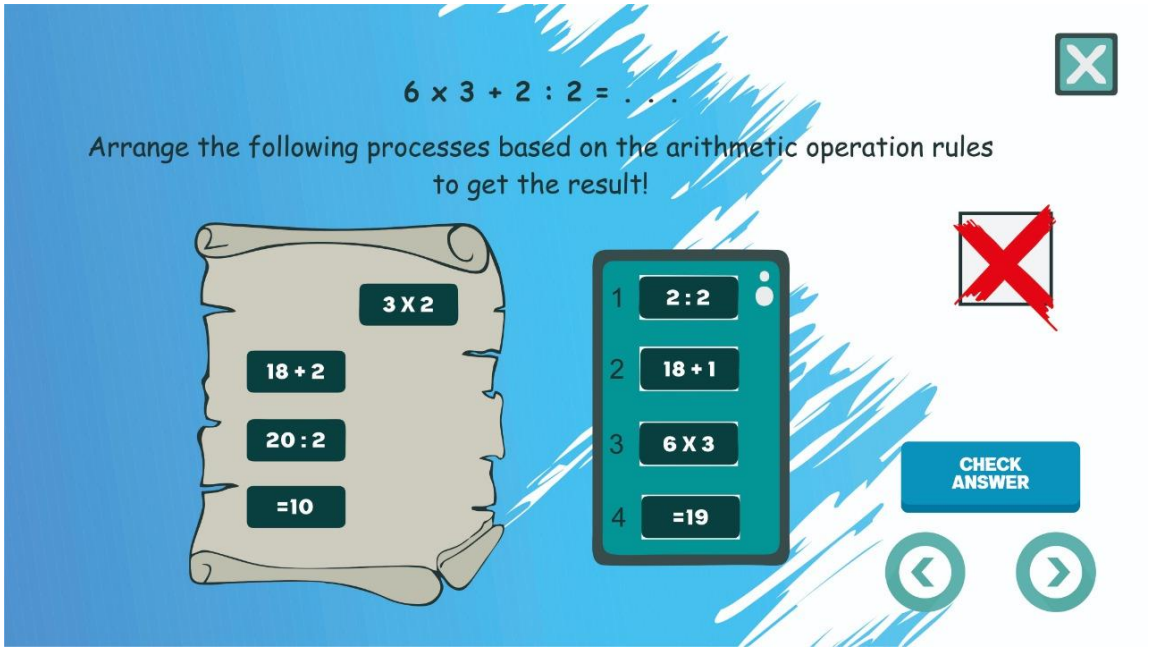

Fig. 3. *An example of questions included in mathematics*

Then on the questions of the story category, for example (see Figure 4), in which there is a daily story of someone named Danu, besides there are stories in this question there are also 5 image icons, namely sound image icons, temperature, light, buttons, and screens. The available image icons are related to Danu's daily stories. In this question, students are asked to find the words contained in the story, then they are linked with the existing image icons, and the word is written in the box provided. Decomposition and abstraction techniques, decomposition because students indirectly have to find the right words and connect them with the existing image icons, from a complete story they are asked to divide the story into words and linked with picture icons. Abstraction because it has ignored the words from the story that are not following the applicable rules, namely words that are not appropriate or not related to the image icon.

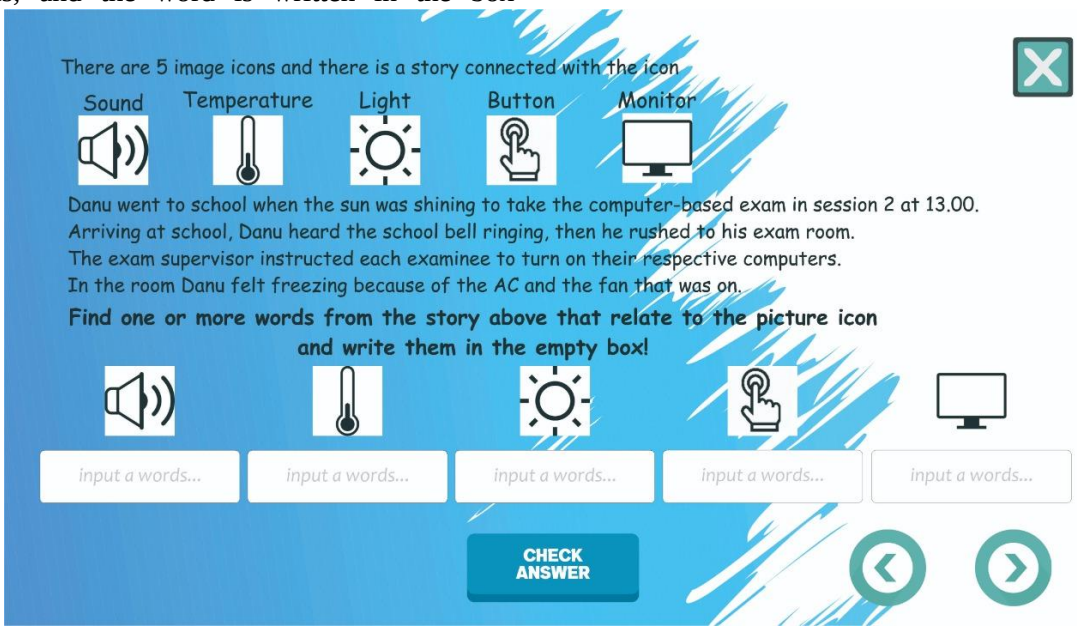

Fig. 4. *An example of questions included in questions based on story problem.*

3.2 Expert Validation Results

This expert validation refers to Multimedia Mania 2003 - Judges Rubric North Carolina State University (Neo, 2010). This stage serves to assess the feasibility of the learning media that has been made. The results of media testing by media experts are described in Table I. After the learning media is successfully created, then validation is carried out by experts and the average aspect of the learning media assessment gets a value of 96.19%, and this figure represents that the media made is included in the "very good" category as shown in table I. Table I shows that the assessment by experts includes five aspects, 98.75% mechanism aspects in other words technically, navigation, spelling, grammar, and completion of learning media can be categorized as very good. Aspects of Multimedia Elements 91.75% in other words, interface design, content, images, video, audio, and other enhancements to learning media are used effectively. Aspects of Information Structure 96.87% in other words a series of logical and intuitive information and media containing several clear flows of choices and can be categorized as very good. 94.37% documentation aspect, in other words, all sources are cited correctly and there is permission to use all assets and copyright for the use of assets listed on the learning media, and 96.15% aspects of Content Quality, in other words, the media shows significant evidence in the authenticity of its development and all content on the media supports the expected learning objectives and has been listed following the objectives of the learning media.

Table I *Expert Validation Results*

No	Valuation Aspect	Number of Testers	Number of Points	Ideal Score	Score Gained	Percentage (%)
1.	Mechanism	2	4	32	31,6	98,75%
2.	Multimedia Element	2	2	16	14,7	91,75%
3.	Information Structure	2	2	32	31	96,87%
4.	Documentation	2	2	16	15,1	94,37%
5.	Content Quality	2	3	72	68,4	96,15%
		2	2	32	31,6	
TOTAL						**96,19%**
CATEGORY						**Very Good**

3.3 Student Assessment Results and Responses

In Table II, assessment and student responses are carried out to find out the weaknesses and strengths of the learning media made so that they can be an adjustment and an illustration if further development is carried out. Testing was carried out by students in the form of student responses using Multimedia Mania - Student Checklist and using interviews.

As for the results of student's responses to learning media based on interviews, students are enthusiastic when they know that they will be researched because they use learning media in the form of applications that they have not previously tried. Well-developed learning media can sharpen the brain and make the brain think long, even though there are problems that are difficult and make think, but the students are happy when learning to use learning media, they can learn new things, namely Computational Thinking, there are difficulties when using the media because there are some questions that are not understood, students have problems in the mathematical category because they do not like it, and in the playing part of the color, it makes a headache.

Table II. *Student assessment results and responses*

No	Evaluation Aspect	Average of Ideal Score	Average of Score Gained	Percentage (%)
1.	Mechanism	24	21	87,5%
2.	Multimedia Element	12	11	91,66%
3.	Information Structure	24	20	83,33%
4.	Documentation	12	10	83,33%

5.	Content Quality	54 24	48 22	89,74%
TOTAL				**87,11%**
CATEGORY				**Very Good**

Assessment and student responses indicate a category that is "very good" towards learning media and get an average score of 87.11% as shown in table II. The assessment by these students includes five aspects of assessment, namely mechanisms, multimedia elements, information structures, documentation, and quality content. The mechanism aspect has 87.5%, which indicates that the use of navigation, spelling, grammar, and completion of learning media can be categorized as very good. Aspects of Multimedia Elements are 91.66% which means that in the media interface design, content, images, videos, audio, and other enhancements in learning media are used effectively. Aspects of Information Structure 83.33%, which means that a series of logical and intuitive information and media contains several clear flow options and can be categorized as very good. 83.33% documentation aspect means that in the media all sources are cited correctly and there is permission to use all assets and copyright for the use of assets listed on the learning media, and aspects of Content Quality 89.74% which means that the media shows significant evidence of the authenticity of its development and all content on the media supports the expected learning objectives and has been listed following the objectives of the learning media.

Another response of students to learning media when being interviewed after using the learning media is that students feel happy because they can learn to use new things and students feel that when learning to use learning media like this, learning becomes fun because so far they still use learning with the lecture method by the teacher. Also, students gave suggestions on learning media that had been made so that the letters on the media were enlarged again so that they were clearer, and the pictures on the media used more interesting images.

4. Conclusions

The Computational Thinking learning media for primary school students has been designed so that it produces question-based Computational Thinking learning media consisting of 4 different question categories. After the learning media is successfully developed, then the media is assessed and validated by experts to find out whether the learning media has been completed or needs improvement. The learning media has been tested for feasibility by 2 experts with a percentage value of 96.19% that means it is suitable for use and is included in the very good category.

The response from students to learning media is considered very positive. This is based on the results of the analysis of the student response instruments to learning media with an average percentage value of 87.11% and is included in the "Very Good" category. The responses of other students were obtained from the results of interviews, namely, students felt happy because they could learn new things and students rated good about the learning media that had been made besides those students did not feel bored after using learning media.

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