# EDUHUMANIORA: Jurnal Pendidikan Dasar

# Development of Scracth-Based Game Media for Learning Science Materials of Changing the Form of Substance in Elementary School

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## ABSTRACT

Natural Science is a science that requires a scientific attitude, understanding of concepts and experimental skills. However, in its implementation in the field of education, there are still a lot of scores that do not reach the minimum criteria due to a lack of understanding of students' concepts and approaches that are still traditional. Therefore, in accordance with the capabilities of the 21st century, this study purposes to develop a game based media from Scratch that can be used by teachers and students in science learning material changes in the shape of objects. This research uses a method by applying Research and Development whose main purpose is to develop new products or improve existing products. The results of this study shows that the development of media based on the Scratch game can be developed by a teacher and can be used in learning with students. The results of testing the learning media that have been made on the display design aspect show a percentage of 93% which means it is very proper, the substance aspect of the material shows a percentage of 89% which means it is proper, and the respondent's response to the program shows a percentage of 83% which means it is proper.

## ARTICLE INFO

## 1. INTRODUCTION

High creativity is one of the things that is needed at the elementary school level to determine learning methods and media that suit the characteristics of elementary school children. Basic education is the level of education in Indonesia which is the foundation for students to develop their scientific foundations at a higher level, so that a strong scientific basis is needed. Likewise in science learning in elementary schools, which must be given the maturity of science concepts in elementary schools.

Digitizing education is a reform in the education industry 4.0 (Efendi, 2018). The era of the Industrial Revolution 4.0 has become an ideal position for educational institutions to build an ideal and superior workforce. learners can develop skills related to global skills related to the 21st century with qualification standards that prepare young people to start careers and the realities of life in the 21st century. Digital-based learning that leads to technology is also a support in 21st century learning.

This encourages the development of more individual learning methods and concepts, student independence and methods of acquiring personal knowledge are well implemented (Teknowijoyo and Marpelina, 2021). Additional Computational Thinking and Compassion competencies are needed to face the digital technology era. Developments to broaden the need for computing participation have brought a better educational paradigm (Kafai and Burke, 2015).

Natural Science is one of the sciences that examines both nature, objects, all symptoms and phenomena that exist (Syawaludin et al., 2019). Some of the content in science has abstract characteristics, so that not a few students have difficulty understanding the concepts (Cacik and Rinayanti, 2017). So in understanding the abstract science content, students need to be instilled with a scientific spirit, skills in scientific thinking and experimenting skills.

In its application which requires a high level of understanding, there are still many students who have not optimally studied science. As an example stated by Yuliati and Lestari, (2019) based on direct observations and interviews in grade 5 SDN Karamat I Palasah District in science learning students still do not meet good KKM or Minimum Completeness Criteria (75). As many as 15% of students managed to achieve a KKM score equivalent to 3 students. While the remaining 85% or the equivalent of 17 other students have not been able to achieve the KKM score.

The same thing happened to research conducted by Nuraini and Kristin (2017) which revealed that as many as 56% of students had not reached the KKM score. This is because the method used is still traditional, namely only lectures and relying on textbook media without providing real visualization. In addition, the teacher's low understanding of learning methods also supports this learning.

Things that can be done to overcome this problem are to increase students' understanding of science subject concepts, improve higher-order thinking skills, and apply 21st century soft skills, namely Critical Thinking, Communication, Creative Thinking, Collaboration, Computational Thinking (CT) and Compassion. Not only students, teachers as

educators also need to improve 21st century abilities and skills by creating digital media. One example is when learning activities use interesting media such as games, which are developed from the Scratch base. Fagerlund et al (2021) said that in his research is evidence for the implementation of the Scratch program development in elementary schools. The main objective is to apply Computational Thinking (CT) when developing Scratch-based media and integrate program development into Education curriculum materials. According to Jeanette Wing, computational thinking is a complement to the ability to read, write, and count (Maharani, 2020). Dengan kemampuan computational thingking memungkinkan siswa untuk dapat menyederhanakan permasalahan yang rumit dalam kehidupan sehingga dapat dipahami dengan lebih mudah.

Computational thinking skills enable students to simplify complex problems in life so they can be understood more easily. Similar research regarding the application of Scratch has also been carried out by Ideris et al. (2019) who tested the effectiveness of grade 6 students in using Scratch media in improving Higher Order Thinking Skills (HOTS). The results of the study showed that the students' positive response to the application of the media showed a high score. This shows that teachers are able to facilitate Scratch-based digital web game media at the elementary school level.

Scratch is a computer programming language for kids that can be executed in a simple way, ie. H. The user can simply drag and drop the graph. The ability to make computer programs is an important part of literacy in today's life. When we learn to code with Scratch, we learn important strategies for solving problems, planning work, and communicating ideas. Thus, this can support success in teaching computational reasoning skills to students from an early age (Wulandari et al., 2021).

Also learn from the media declared effective in increasing HOTS in elementary school students. This is because it is in progress. The development of the material elements of the learning environment is guided by the HOTS indicators, namely analyze, evaluate, and create. This HOTS indicator was developed as material in learning media (Saraswati and Agustika, 2020; Azam and Rokhimawan, 2020). With this, students can get used to using higher thinking skills studying these factors highlight the media about learning mathematics. Using a valid and efficient scratch application also adds valid HOTS students practical in use.

Another study was conducted by Lenggogeni and Ruqoyyah (2021) at a private elementary school in Bandung using Scratch-based media in the form of animated videos on animal life cycle materials that were applied using the Picture and Picture learning model. The research results obtained that the implementation went well and students gained meaningful experience and students were able to complete their assignments properly.

Another study was conducted by Nurhopipah et al., (2021)  using Scratch and found an increase in the ability to solve problems related to numbers, an increase in students' intelligence, an increase in students' understanding of the technology around them, and familiarize students with creative, logical and structured thinking. Many related studies have also been carried out (Wulandari et al. 2021; Kusumawati, 2022; Rani and Wintarti, 2022; Febrianto, 2017; and Sudihartinih et al. 2021).

Therefore, there is a need for innovative problem solving for value problems that are below the KKM standard. This study aims to improve students' understanding of concepts and learning outcomes in material changes in the material form of science subjects that are less than optimal by developing a Scratch-based game media program in elementary schools.

## 2. METHODS

The development of the instrument was carried out with the stages of compiling a theoretical framework, compiling the item indicators, compiling the instrument items, testing the validity of the media and Material Changes in the Shape of Things, and testing the reliability. Validity test is done by expert validity test technique. The data obtained from the results of expert assessments (experts) in the form of assessments according to indicators, and criticisms/responses related to deficiencies regarding the Transformation of Object Game product, are then described according to the data obtained. Assessments from experts are used as material to revise products so that they are better and more precise when implemented. The final stage of the expert validity test is carried out by quantitatively assessing each item of questions that has been compiled and corrected according to the advice of experts.

The validity test stage is carried out until the instrument is declared fit for use. The media assessment instrument and material for changes in the form of objects handled game products for changes in the form of objects after being declared valid, then a reliability test was carried out with elementary school test subjects in Bandung Regency by selecting by purposive sampling.

The research was carried out by implementing research and development (Research and Development) whose main objective was to create Scratch-based game media products. The research stages apply the 4D model or as described in **Figure 1.**
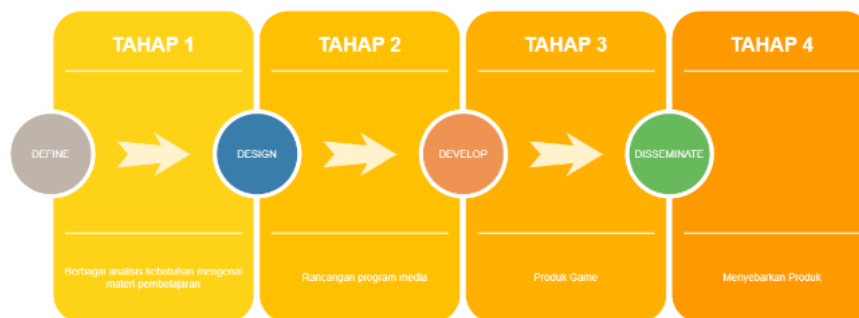


**Figure 1.** Research stages

### 2.1. Define Stage

The define stage produces various needs analysis regarding learning materials, the design stage produces a media game program design to be made, the development stage produces Scratch-based game products, and the disseminate stage is carried out to disseminate the product already made.

At the planning carried out by collecting descriptive data. Data collection was carried out by interviewing teachers at schools regarding learning needs that correlated with the production of products such as the visual needs of students, the state of student motivation

and the availability of tools to use the product at school. Data collection was conducted at elementary schools in Bandung district.

## 2.2. Design Stage

Analysis of curriculum material indicators, validation analysis from the expert team validator that will be made by GBPM and game storyboard flow.

## 2.3. Development Stage

While at the development stage it is carried out by testing the feasibility aspects of display design, material substance, and responses from respondents regarding the programs that have been made. The feasibility test was carried out by distributing questionnaires to respondents who had used learning media. There were 20 respondents in this study, consisting of teachers (4 people) and prospective teachers (16 people). In **Table 1** there are the qualifications and descriptions of the teachers and prospective teachers.

**Table 1.** Eligibility criteria

| Qualification | Keterangan |
|---|---|
| 90% ≤ x ≤ 100% | Very Eligible |
| 80% ≤ x ≤ 89% | Eligible |
| 70% ≤ x ≤ 79% | Decent Enough |
| 50% ≤ x ≤ 69% | Less Eligible |
| x ≤ 49% | Not Feasible |

## 2.4. Dissaminate Stage

This stage includes several stages, namely the results of the material test, the results of black box product testing, the response questionnaire from students and teachers. Formative evaluation is carried out periodically in every game creation in consultation with a team of experts in their field. A summative evaluation is carried out after taking data from a team of media and material experts to revise the product.

## 3. RESULTS AND DISCUSSION

Product testing involves participants participating in operating how the product can be run. Participants include students and teachers. The advantage of this research compared to previous research is that there is an update in product manufacturing, namely the existence of a virtual lab so that apart from the material and quizzes given to students, students can also use the virtual experiment lab feature. This can support students' visualization of how changes in the shape of objects can occur, increasing students' curiosity because it is packaged in digital which is specifically designed for grade 4 elementary school students.

**3.1. Defining Stage (Define)**

This stage has the goal of defining or analyzing the needs needed to develop learning media in the form of games. The analysis technique obtained by applying observation and interview techniques to teachers in elementary schools. The general characteristics of students come from West Java with different conditions and backgrounds for each student. From the results of observations and interviews it is known that students are less focused on natural science subjects, especially material for changes in the state of matter because students often look at the books in front of them, play with friends around them, chat, and pay attention to other things outside of learning. This makes students less concentrated during learning. In the observations and interviews, information was also obtained that the teacher applied learning media in the form of pictures contained in books and concrete media available at schools to make students interested, but still could not make students more focused, thorough, and interested in learning.

One of the efforts that can be applied to increase student learning concentration is to attract attention with interesting learning in the form of games. Game media can attract students' attention again and be fun for students because there is a combination of various visualizations and multimedia. The material developed is a change in the form of matter in science subjects. The states of matter consist of liquid, solid and gas. The change from liquid to solid is called freezing by releasing heat.

The change from solid to liquid is called melting by absorbing heat. The change from liquid to gas is called evaporation by absorbing heat. The change from gas to liquid is called condensation by releasing heat.

The change from gas to solid is called crystallization by releasing heat. The change from solid to gas is called sublimation by absorbing heat. These changes are shown in **Figure 2** below.
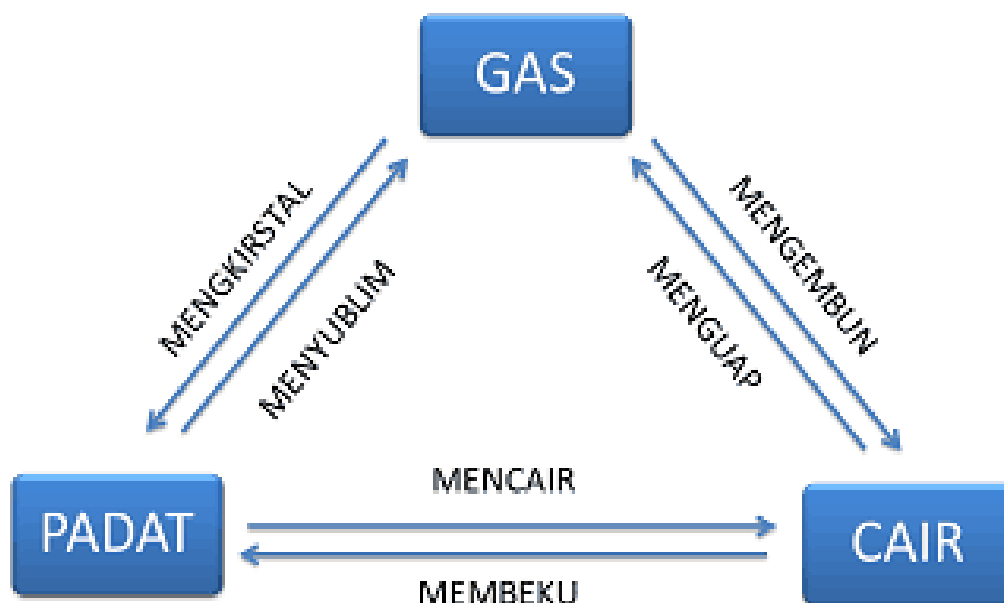


**Figure 2**. Substance changes

**3.2. The Design Stage**

This stage has a goal and is carried out to design a learning media program in the form of a Scratch-based game with learning material for changes in the state of matter in science subjects. The concepts in the scratch application are shown in **Table 2** below.

**Table 2**. Concept Application

| No | Indicator | Description |
|----|-----------|-------------|
| 1 | Title | Learning Science Material Changes in the Form of Substances in Elementary School |
| 2 | User | Elementary student |
| 3 | Picture | All images used are in .jpeg and .png format |
| 4 | Music | The entire music used is the result of independent sound recordings and some of it uses music that is not copyrighted |

The program is created by first designing an algorithm and implementing it using the program blocks available in Scratch. The basics of program blocks that will be used are in accordance with the needs of the program to be executed. The designed program flow is shown in **Table 3**.

**Table 3**. Program Flow Plan

| Scenario | Description |
|----------|-------------|
| 1 | Directed to the main page in which there are three menu options, and choose one of these options as desired |
| 2 | The user selects the help menu, is directed to the help page and is provided with the option to return to the main menu |
| 3 | The user selects the lab menu, is directed to the material page, in which there are three forms of matter that can be selected as learning materials, the user selects two of the three forms of the substance, after selecting the two forms of the substance the user will get a description of the results of a combination of the two forms of the substance. After the description is displayed, the user will be displayed again with three choices of initial substance forms and can select the desired two pairs of new substance forms again, or return to the main menu. |
| 4 | The user selects the quiz menu, is directed to the quiz page, which contains a learning evaluation. On this page the user will get a score from the evaluation activities that the user has carried out, after completion the user can re-evaluate or return to the main menu |

In the application there are 3 main layout options that will be displayed inside the initial menu as shown in **Figure 3**.
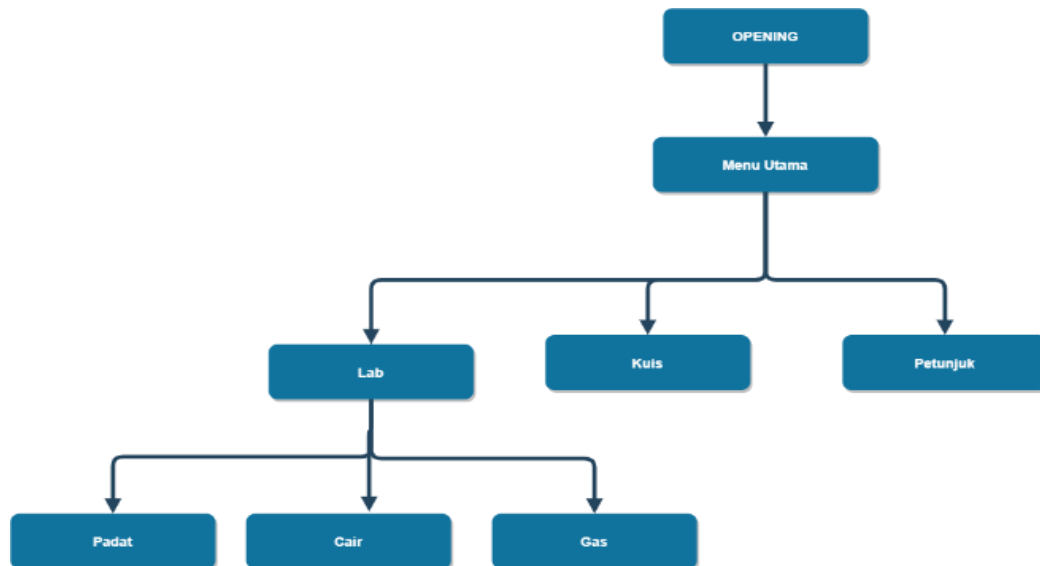
**Figure 3.** Program Structure

The menu structure details are as follows

a. Home Menu

The initial menu display consists of the "Lab", "Quiz", and "Hint" menus. The title of this preview is "The Lab Kids".

b. Instructions

The display of instructions is used to provide directions to the user so they are not confused in running the program. This view only contains descriptions of the instructions needed in the game.

c. Lab

This display shows the declaration of the state of matter, namely Liquid, Gas, and Solid. Users can match one form of substance with another independent. After the declarations of the two states of matter meet, a change in the state of matter will appear and a description of the results will be displayed. For example, when Liquid is paired with Solid, the words "Frozen" will appear and an explanatory description of the frozen state changes. The following is a description of the "Lab".

1) Liquid → Solid

Called: Freezing.

Freezing is an event releasing heat when a liquid substance becomes a solid substance.

2) Solid → Liquid

Called: Melting.

Melting is an event of absorbing heat when a solid becomes a liquid.

3) Liquid → Gas

Called: Yawning.

Evaporation is an event of absorbing heat when a liquid substance becomes a gaseous substance.

4) Gas → Liquid

Called: Condensing.

Condensing is an event releasing heat when a gas substance becomes a liquid substance.

5)   Solid → Gas

Called: Sublimation.

Sublimation is an event of absorbing heat when a solid substance becomes a gaseous substance.

6) Gas → Solid

Called: Crystallized.

Crystallizing is an event releasing heat when a gas substance becomes a solid substance.

d. Quiz

This display is the display after the "Lab" menu which is used to measure the extent to which the user's understanding of matter changes the state of matter. The quiz shown is a multiple choice quiz. Users can touch the answer that corresponds to the question shown on the screen. There is a scoring in this menu, so that the user can see whether the answer he chooses is right or wrong.

1.  Development Stage

This stage has a development goal to be able to produce Scratch-based game products in accordance with the designs that have been prepared. At this stage testing is also carried out by distributing it to respondents to determine the feasibility, effectiveness and success of the program that has been made. The results of the program created through Scratch are shown in **Figure 4** below.



**Figure 4.** Initial Menu Display

The initial menu display has the options "Lab", "Quiz" and "Instructions". If user pressing one of the options, another display will appear from the selected option, for example in **Figure 5**.

**Figure 5.** Display of the Lab

Menu This view will appear when the user presses the "Lab" option on the start menu. Look at **Figure 6** which is a quiz display.



**Figure 6.** Display of the Quiz

Menu The image shown above is one of the quizzes that contains questions regarding material changes in the state of matter. After creating the program, testing of game learning media was carried out to determine the feasibility, effectiveness, and success of the program that has been made.

a. Display Design Aspects

The display design aspect is carried out with the aim of assessing the feasibility of the display design in the program. This aspect focuses on the existing display, such as the color selection used, the font chosen, the layout arranged, the navigation icons on the screen display, and the representation of the program being made. The following will show the results of the assessment that was carried out by giving a questionnaire to the respondents. The following is the result of the assessment of the display design aspect.

**Table 4.** Result of Appearance Design Aspect Assesment

| N | Statement | Criteria |
|---|-----------|----------|
| 1 | Typography | Very Worth it |
| 2 | Layout | Very Worth it |
| 3 | Navigation icon | Worth it |
| 4 | Representative | Very Worth it |
| 5 | Color selection | Worth it |
| | **Average** | Very Worth it |

Based on the results in table 2, it can be concluded that the design aspects of the application are very feasible for use in elementary level education starting from the selection of colors, typography, layout, navigation and representative icons.

b. Aspects of Material Substance

Aspects of material substance focus on assessing the correctness of the material in terms of the material displayed, the suitability of the topic of the material with what is being discussed, the accuracy of words and terms, and the contextualization of the material shown. The following is the result of the assessment of the substance aspect of the material.

**Table 5**: Results of Assessment of Material Substance Aspects

| No | Statement | Criteria |
|----|-----------|----------|
| 1 | Material depth | Worth it |
| 2 | Topic suitability | Very Worth it |
| 3 | Material truth | Very Worth it |
| 4 | Accuracy of word and terms | Worth it |
| 5 | Material contextuality | Worth it |
| | **Average** | Worth it |

Based on the results in table 3 above, it can be concluded that the substance of the material from the application is feasible for use in the world of elementary level education starting from the depth of the material, the difficulty of the topic, the correctness of the material, the accuracy of words and terms and the contextual material.

c. Respondents' Responses to the Program

The following table is included which is the result of responses from respondents to the programs that have been developed.

**Table 6**: Results of Assessment of Material Substance Aspects

| No. | Statement | Kriteria |
|-----|-----------|----------|
| 1. | Text is easy to read | Very Wort it |
| 2. | Caption and picture are clearly | Worth it |
| 3. | Information delivered | Worth it |
| 4. | Easy to use | Very worth it Layak |
| 5. | Providesdecent comfort | Decent enough |
| 6. | Attract attention | Worth it |
| | **Average** | Worth it |

Based on these results, the assessment of the substance aspect of the material is said to be feasible from the criteria of easy-to-read text, clear descriptions of images, conveyed information, easy to use, provides comfort, and attracts attention.

d. Aspects of Functional Testing

Aspects of functionality testing focuses on examining the feasibility of the media that is made. Is the media made can be said to be feasible or not. Apart from that, another reason is to find out whether there is a failure or malfunction of each menu that is made. Therefore, testing is done one by one on all the menus that are made.

Tests carried out using the black box method refer to the plan program flow in **Table 3.** Access that was tested using the black box method successfully included access to the Main Menu, Instructions Menu, Main Menu (in the instructions menu), Lab Menu Selecting a solid state in the Lab learning Menu, Selecting a liquid form in the Lab learning Menu, Selecting a gaseous state in the Lab learning Menu, Displays the proper description in the Lab learning Menu, Displays the proper description in the Lab learning Menu, Displays the proper description in the Lab learning Menu, Displays the proper description in the Lab learning Menu, Displays the proper description in the Lab learning Menu, Displays the description that should be in the Lab learning Menu, Access the Main Menu (In the lab menu), Access the Quiz Menu, Displays other evaluation questions in the quiz, Displays answer choices in quiz evaluation questions, Selects the correct answer in evaluation questions in the quiz menu, choosing the wrong answer in the evaluation questions in the quiz menu, re-evaluating on the quiz page, access the main menu (in the quiz menu).

## 4. CONCLUSION

This web game-based media from Scratch can be developed by teachers and used in learning by students wherever and whenever they are. This media can be used as an effort to solve the problem of low minimum student criterion scores and can grow and develop motivation in student learning because it presents attractive visualizations for elementary school-age children. Steps taken in developing this media through the stages of defining, designing, and developing. The results show that the Scratch-based game media program is feasible to be used to help learning natural science materials on changes in the state of matter in elementary schools.

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