



# Development of Educational Game "Jagocah" using Scratch on Fraction Material in 4 Grade Primary School

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## Abstract

The lesson of unit fraction and common denominator fraction on grade 4 of elementary school is still difficult to understand by the students. According to the observation done in SDN 3 Sumbersari Malang, only 30% of the students could grasp the concept of unit fraction and common denominator fraction proficiently. The lack of understanding of the lesson could be contributed to the lack of learning media that could be used practically during the learning process. The objective of this research is to create a web-based educational game as a learning medium for students and to evaluate its validity and practicality. The research findings educational game that has been validated and tested with the validity score of 96% by the content expert, 80% by the media expert and 91% valid by the teacher as well as the practicality percentage of 94% from the data obtained by the students as the user of the media.

**Keywords:** keyword 1; keyword 2; keyword 3

## 1. Introduction

Mathematics at the 4th grade elementary school level has several materials taught, one of which is fractions. Fractions are the basis of many advanced materials in mathematics such as percentages, ratios, and algebra, students' lack of understanding of fractions can cause difficulties in solving more complex problems (Rohmah, 2019). Fraction material at the 4th grade elementary school level is a significant first step in introducing students to the world of fractions. At this level, students will learn the basics of fractions, such as introduction to fractions, reading fractions, basic operations with fractions, and Application of Fractions in Real Contexts. In particular, fraction material in 4th grade elementary school includes an introduction to simple fractions, adding and subtracting fractions that have the same denominator, as well as the application of fractions in real situations. The goal of this lesson is to give students a strong foundation in understanding and using fractions. In its implementation, there are various problems in the learning process in grade 4 elementary school fraction material. Based on the results of the author's observations while participating in Teaching Assistance activities from February to June 2023 and supported by interviews with the 4th grade homeroom teacher at Sumbersari 3 Elementary School Malang, it was found that the understanding of 4th grade students at Sumbersari 3 Elementary School Malang was still relatively low in fractions, one of the reasons low understanding of fraction material among students, namely the limited media that is able to increase students' interest and understanding of the fraction material being taught. Problems with the ability of 4th grade elementary school students in fraction material are not only experienced by Sumbersari 3 Elementary School Malang, but this problem also appears in other elementary schools, in research conducted by Rahmah, G. et al (2023) at SDN Perumnas 1 Tangerang City, It was found that some students

still experienced difficulties in learning mathematics, especially fractions. so more intensive discussions need to be carried out to resolve it. Research conducted by Sari, W. N. et al., (2022) also found something similar, at SD Negeri 95 Palembang there were only 4% of students who had a very good understanding category, while 66% of other students had an understanding in the very poor category. In an effort to solve this problem, it is necessary to create a learning support media so that it can attract students' interest in learning. Interactive learning media has a positive impact on mathematics learning and significantly improves student learning outcomes. Apart from that, students show a positive attitude towards learning mathematics that utilizes interactive media. (Hakim & WIndayana, 2016). One type of interactive learning media is game-based media, especially educational games. This educational game can significantly increase students' understanding of mathematical concepts and learning motivation compared to conventional learning methods. (Paulina, C. et al., 2023). A study conducted by Amirulloh et al (2019) shows that game-based mathematics learning media developed using the ADDIE method obtained very good feasibility test results, namely 90.5%. The same results were also shown by Indrawati and Suadirman (2013) who showed that the game-based learning media they developed succeeded in getting a feasibility score in the good category. In an effort to provide more interesting and effective learning methods. Interactive multimedia learning media has many advantages compared to other media, such as greater flexibility and the ability to learn independently. or can be studied according to students' abilities, interactively, and individually (Lia, L. 2015). The use of video games as a mathematics learning medium offers a more interactive approach, providing opportunities for students to be directly involved in their learning process. Students show great interest in the use of educational games in learning mathematics because they are actively involved in the learning process. (Handican, et al., 2023). Fraction material, which is part of the Mathematics subject in grade 4 of elementary school, has an important role in students' daily lives as well as in further education. Good mastery of fraction material will help students face problems, be independent and creative in solving existing problems, both in the academic scope and in real life. Therefore, if the fraction material is not presented well and students do not understand it, they will experience difficulties when continuing to the next level or phase. Based on the explanation above, the author is interested in submitting a thesis with the title "Development of the Scratch-Assisted Educational Game "Jagocah" on Fraction Material in Grade 4 Elementary Schools"

## **2. Method**

### **2.1. Type of research**

Based on the problem formulation that has been explained, this research uses a development research approach with the aim of creating learning media products. Apart from this type of research, it is also used to validate educational products (Assyauqi, 2020). Based on this understanding, this research aims to produce learning media in the form of the educational game "JagoCah" on fractions with one numerator and the same denominator. In its development, there is a procedure used, namely using the ADDIE development model which consists of five stages, namely analysis, design, development, implementation and evaluation. (Sugiyono, 2015). Each stage has its own sequence of implementation. This research carried out on May 27, 2024 and May 29, 2024. In this research, there were four test subjects, namely media experts, material experts, teachers and students. The trial was carried out at SDN Summersari 3 in class IV. For data collection techniques using interviews and questionnaires.

## 2.2. Instrumen

The measuring instruments used in this research include validation sheets. for materialexperts, media and teachers, as well as questionnaires for students. Interviews wereconducted to collect information from teachers at the pre-research stage, whilequestionnaires were used for material experts, media and teachers to obtain validationresults, as well as for students to assess the practicality of the media.The instrument grid for media experts, material experts, teachers and users can beseen in the table below:

**Table 1** Grid of material expert instruments

No	Assessment Aspects	Indicator	Number of Items
1	Learning	Suitability of material to Learning Outcomes	2
		The material is presented in a systematic way.	2
		Appropriate sentence structure and use of language that is easy to understand.	2
2	Material	The material is as formulated	2
		The material is appropriate to the student's ability level	2
		Clarity of description of fractional material	2
		The material coverage is related to the subthemes discussed	2
		Material is clear and specific	2
		The images used are appropriate to the material	2
		The examples given are appropriate to the material	2
Amount			20

source: Putri, (2019)

**Table 2** Grid of media expert instruments

No	Assessment Aspects	Indicator	Number of Items
1	Visual	The text can be read clearly	2
		Background image selection	2
		Font size and type	2
		Colors and graphic elements	2
		Additional images	2
		Animated display	2
		Graphic display	2
		Additional sounds are clearly audible	2
		Clarity of explanation of material	2
		Clarity of instructions	2
2	material	Location and function of buttons	2

Ease of operating the media	2
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source: Putri, (2019)

**Table 3 Grid of teacher instruments**

No	Assessment Aspects	Indicator	Number of Items
1.	Material	Suitability of material to Learning Outcomes	2
		The material is presented systematically	2
		Sentences and language that are easy to understand	2
		The images used are relevant to the material	2
		The examples presented are appropriate to the material	2
		The text can be read clearly	2
		The material is appropriate to the student's ability level	2
		Additional images	2
2	Display and Programs	Animated display	2
		The sound is clear	2
		Clarity of instructions	2
		Location and function of buttons	2

source: Putri, (2019)

**Table 4 Grid of students instruments**

No	Assessment Aspects	Indicator	Number of Items
1	Planning learning	The material is easier to understand by using learning media.	2
		Practice questions in the media according to the material presented.	2
		Students learn independently with the help of media.	2
		Learning becomes more interesting with the help of media.	2
2	Operational	Starting to use media becomes easier	2
		The navigation provided is easy to use.	2
		Availability and clarity of instructions for using the media.	2
3	Visual communication	Media front page	2
		The type of font used in the media is easy to read	2
		Suitability of shape, color and image resolution on the media	2
		The language used in the media is easy to understand.	2

source: Dewi, (2020)

### 2.3. Data analysis

Data analysis techniques to calculate the average score of all assessment indicators for learning media using the formula:

$$\bar{X} = \frac{\Sigma X}{N}$$

Information:

$\bar{X}$  = Average score of indicators

$\Sigma X$  = The total score of indicators

N = Number of indicators

### 3. Results and Discussion

#### 3.1 Result

The educational game "JagoCah" was developed using Scratch for fraction material in 4th grade elementary school by applying the ADDIE research model. In media development, several stages must be passed as follows:

**3.1.1. Analysis** At this stage, the researcher carried out an analysis by conducting interviews with the class IV homeroom teacher at SDN Summersari 3, Malang City. Based on the results of direct interviews with fourth grade teachers at the school, students experienced difficulty in understanding fraction material which was considered difficult and difficult to understand. The difficulties most often experienced by students include the absence of learning media that can be used when learning material on fractions with one numerator and fractions with the same denominator in class, material on fractions with one numerator and with the same denominator is generally done using the method of conveying information verbally or lectures and other media. Lack of availability, lack of students' understanding of fraction material and students already know and can operate digital devices such as smartphones and laptops. The four points that have been mentioned are the basis and strong reasons for researchers to conduct this research. Mrs. Isna as the class IV teacher also stated that there were around 60% of the 27 students who had difficulty with fractions. This indicates that more than half of class IV students do not understand fractions. The next stage carried out was curriculum analysis. The curriculum applied in class IV of SDN Summersari 3 is the Independent Curriculum, therefore in curriculum analysis, Learning Achievements are used as the basic indicators of learning achievement that students must have, the Learning Achievements used are as follows.

**Table 5 Learning Outcomes Used in JagoCah Media**

Learning Outcomes B Fase	Learning Outcomes Per Year
Students can compare and order fractions.	Students can compare and order fractions with one numerator and fractions with the same denominator.

Source: Elementary/MI Class 4 Mathematics Teacher's Guidebook

#### 3.1.2. Design

In this phase, planning is carried out to create the learning game media "JagoCah" based on needs analysis. The first stage is the design of the application logo, consisting of two text elements and one line element representing a fractional line, with the font "Press 2P to start," according to JagoCah's gamification theme. The logo, created using Adobe Illustrator, serves as both an asset and an icon. The second stage is level design and gameplay, including four levels: level 1 introduces the concept of one-numerator fractions through interactive conversations and mini-quiz; level 2 tests understanding of one-numerator fraction material; level 3 introduces the concept of like-denominator fractions; and level 4 is a quiz regarding fractions with the same denominator. Students can continue or repeat levels at the end of each level. The third stage is interface design, including the placement of navigation buttons and selecting appropriate colors, including the main menu page, level select page, and finished level page, created with Figma software.

### 3.1.3. Development

This development phase was filled with the development of the educational gamemedia "JagoCah" which was based on storyboards and designs that had been previously designed. The development stage starts from creating image assets that will be implemented in the game. Assets that need to be prepared include backgrounds, buttons, characters, and objects used to help explain. To produce the required assets, Figma and Aseprite software were used.

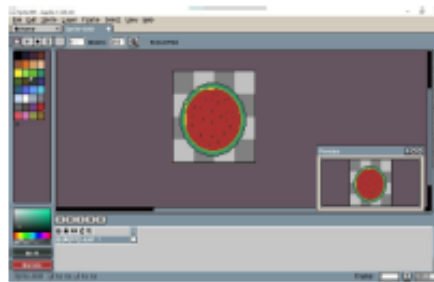


Figure 1. Figma Software

Once the required assets are ready, the next step is to enter the assets that have been created into Scratch to be used as components that will compose the "JagoCah" learning media according to the design on the storyboard.

Game components that have been placed according to the design are then given commands in the form of code tailored to the desired results.

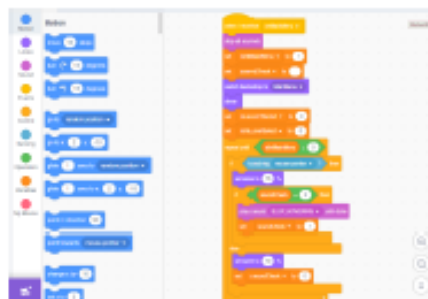






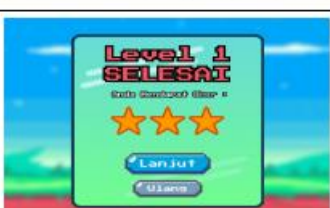


Figure 2. Scratch Appearance

From the development that has been carried out, products are produced as follows :

Image	Description
	<p>The home page of the JagoCah game</p>
	<p>Level select page</p>
	<p>First Level, an explanation of the fraction of the numerator one</p>
	<p>Second level, practice questions related to one-numerator fractions</p>
	<p>The third level, explanation regarding fractions with the same denominator</p>
	<p>Level four, practice fractions with the same denominator</p>
	<p>The final display of the level, shows the score obtained by the student</p>

### **3.1.4. Implementation**

After the media has undergone a validation test process, the next stage is the implementation stage. Here, the validated media will be tested on class IV students at SDN Sumbersari 3, Malang City. The media will be tested on class IV students who are divided into two groups, namely small groups and large groups. Small group trials were carried out on 6 class IV students. The large group trial involved 27 grade IV students. The field trials were measured by student questionnaires which showed that the JagoCah learning media had a relatively high feasibility score, with an average score of 94%.

### **3.1.5. Evaluation**

In this phase, the validation results of media experts, materials, teachers, and student responses to the "JagoCah" media are analyzed to determine whether the media is suitable for use in learning fractions with one numerator and the same denominator. From the results of the questionnaire given to teachers and students, it was revealed that no revisions were needed for the JagoCah educational game learning media.

## **3.2 Discussion**

### **3.2.1 Research and Development Procedures**

Research and development of JagoCah educational games uses the ADDIE development model, containing the phases of needs analysis, design, development, implementation and evaluation. According to Sugiyono (2015), Research and development (R&D) has the aim of producing certain products. The analysis stage at SDN Sumbersari 3 Malang shows that there is no adequate learning media for fraction material, so that many students have difficulty understanding the concept of fractions with one numerator and the same denominator. The development stage begins with analysis to identify problems and formulate solutions. Interviews with grade 4 homeroom teachers raised concerns such as the number of students who found it difficult to process the concepts of one-numerator fractions and same-denominator fractions. Research conducted by Sari et al (2022) also found a similar thing where only 4% of students had a very good understanding category, while 66% of students had a very poor understanding of fraction material. The lack of students' understanding of the material on fractions with one numerator and the same denominator can be directed at the lack of learning media that can help students understand the material. In line with a study conducted by Hakim (2016) which found a relationship between interactive learning media and increased student learning outcomes. Research conducted by Shoimah et al (2021) also shows that the use of interactive game learning media can improve learning activities and understanding of the concept of fractions in Mathematics for grade 3 students at MI Ma'arif Nu Sukodadi, which is explained by the use of learning media that can improve fraction abilities from the previous 75 % of students did not pass the KKM, to only 7% of students who did not pass. The development process continues with media design in the form of storyboards. After the design is complete, it continues with the Development stage, the development stage is carried out using Scratch in making JagoCah media. Development is carried out by creating a program and filling in content on the home page, the select level page and the first to fourth levels. The concept of assets and level design used in the game is also matched to the students' personalities, which is in accordance with Indriani's

(2018) statement which states that grade 4 students are experiencing the concrete-operational phase, namely the stage where children's activities are centered on real objects or various experiences. what he has experienced. So that the content developed is adjusted, such as the background, objects used as examples, are real and concrete objects that are commonly understood.

This media includes programs and content for several levels of learning. After being developed, the media is tested for validity by material experts, media, teachers, and feasibility aspects are tested by students who fill out a questionnaire. Evaluation is carried out to identify shortcomings and successes, with corrections from experts and users used to improve the content of material and media aspects.

### 3.2.2 Validation of Media, Material and Teacher Experts

We can examine the level of validity of the JagoCah educational game from the results of validation carried out by three validators, namely material experts, media experts and teachers. The validation results from the three validators are presented in the table below.

**Table 6 Expert Validation Results**

No	Validator	Validation Results	Category
1.	Material Experts	96%	Very Valid
2.	Media Experts	80%	Very Valid
3.	Teacher	91%	Very Valid

Based on these results, we can draw the conclusion that learning media in the form of the educational game "JagoCah" has a very valid level of validity category. The following is an explanation of the expert validation results:

#### A. Material Expert Validation

In developing the JagoCah Game media, the material is structured based on Learning Achievements (CP) and translated into game levels. Referring to Akbar (Indahsari, 2019), media for learning must meet eight criteria, namely in harmony with learning objectives, student character, educational references, efficiency, safety, ability to develop activeness, creativity, pleasant atmosphere, and media quality. Material expert validation used 10 indicators with 20 statements, resulting in 16 statements with a score of 5 and 4 statements with a score of 4. Media expert validation showed 96% which was classified as very valid, provided that the media was worthy of being tested in the field.

#### B. Media Expert Validation

The development of the JagoCah educational game for grade 4 elementary school students pays attention to student characteristics and then translates them into images, colors, vocabulary and cognitive functions. According to David & Glore (2010), visual design influences user motivation to interact in learning, so validation by media experts is needed to assess the suitability of media displays. Validation using 12 indicators and 24 statements shows 2 statements with a score of 5, 20 statements with a score of 4, and 2 statements with a score of 3, resulting in a percentage of 80% which is in the very valid category. However, revisions are needed before the media is tested, including adding the identity of the developer, supervisor, Malang State University logo, and instructions for use.

### C. Teacher Validation

Before developing JagoCah learning media, researchers conducted interviews with the fourth grade homeroom teacher to understand learning needs. Based on this interview, JagoCah learning media was developed in accordance with the views of Mukaromah & Andriana (2022) who stated that learning media makes it easier for teachers to teach and increases student activity. Teachers, as the main users, need to validate the media. Validation by the teacher using 12 indicators and 24 statements showed 14 statements with a score of 5 and 10 statements with a score of 4, resulting in a percentage of 91.66% which shows that the media falls within the criteria of being very valid or valid so it is worth testing on grade 4 students at Summersari Elementary School 3 Malang.

#### 3.2.3. Analysis of Student Responses

The level of suitability of the JagoCah learning media can be determined from the results of filling out the response questionnaire for class 4 students at SDN Summersari 3, Malang City. The following are the average results of the JagoCah learning media practicality questionnaire

**Table 7 Results of media practicality questionnaire**

No	Subject	Validation Results	Category
1.	Small Scale Trials	97.2%	Very Valid
2.	Large Scale Trials	94%	Very Valid

JagoCah learning media products have a practicality value of 94% so they are able to be included in the very feasible category. From the test results, it was found that the statement "Learning media is easy to use" received the highest feasibility score, in the sense that the JagoCah game is easy to use. This is in line with Lestari & Sugianto (2017) who argue that games that are easy to use tend to be more accepted by students. Other statements such as "The one-numerator fraction material in the game is easy to understand" and "The same-denominator fraction material in the game is easy to understand" also received high scores, namely 115 and 111 respectively. This is in line with the results of Hasanah et al.'s study (2021) who said that learning media in the form of games can help students to master the topic of mathematical fractions. These two statements show that the results of the development of the educational game "JagoCah" are in accordance with the initial development objectives which were intended to develop learning media that is suitable for application on the topic of one-numerator fractions and same-denominator fractions. Positive responses were also shown in statements related to the visuals and appearance of the game being developed, such as the choice of writing, colors, images and language used which had a high feasibility score. In general, the JagoCah Educational Game received a feasibility score of 94%, which is classified as very suitable for application in the learning process of one-numerator fractions and same-denominator fractions in grade 4 of elementary school.

#### 3.2.4. Strength and Weakness of "JagoCah" Learning Media

The JagoCah educational game developed contains a number of advantages and deficiencies. The following is a description of the advantages and disadvantages of JagoCah learning media

### A. The Strength of jagocah learning media

This educational game is in the form of a website so it can be accessed from various devices, allowing users to learn independently anytime and anywhere. In it there is an explanation accompanied by interactive examples for the material, this is in accordance with the opinion of Marhaeni (2023), regarding the advantages of web-based educational game media in learning is that this media is interesting, not monotonous, creative, and able to increase students' interest in learning. The "JagoCah" game also has an interactive quiz which is equipped with easy-to-use scoring. Additionally, there are relevant sound effects for each action performed by students, enhancing their learning experience. Developed using Scratch software, the results can be converted into various forms other than the web if needed in further development. This game also includes interactive conversations that can make it easier for students to understand and understand fractions material better.

### B. Weakness of JagoCah learning media

The JagoCah Educational Game also has shortcomings, namely the application size is quite large, around 90 MB, this is in accordance with Yulianti's opinion (2020). The weakness of web-based games is that this game cannot function on systems with RAM memory below 512 MB. This is because the application requires around two hundred MB to four hundred MB of RAM when operating the game, which can cause the application to force close. Lastly, the drawback of the JagoCah educational game is that it is web-based so it can only be accessed with an internet connection.

## 4. Conclusion

The process of developing the educational game media "JagoCah" produced several significant conclusions. First, the evaluation of the validity of the material shows very high content validity with a score of 96%, as well as the suitability of the media reaching a score of 80%, indicating that this media is very suitable to be applied in class IV. Second, this media has been tested on students and teachers to ensure its practicality with evaluation results according to students reaching a score of 94%, indicating that this media is very practical for them. Finally, the evaluation of the practicality of the media according to the teacher resulted in a score of 91%, indicating that this media is very practical in its application. Thus, the overall evaluation results confirm that the learning game media "JagoCah" is a learning tool that is very feasible and suitable for application in learning activities regarding fractions in grade 4 elementary school.

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