PERSPECTIVES OF SCIENCE AND EDUCATION
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SCIENTIFIC ARTICLE |

Development of scratch-based learning media on data analysis material in Phase C of elementary school

Z. H. PUTRA, F. P. SYAHMI, GUSLINDA, A. ALJARRAH

ABSTRACT

Introduction. The integration of digital technology in education is essential in the current digital era. Scratch is one of the digital technologies based on a visual programming language that can be used by children as a learning tool to study computational thinking skills, coding, and other mathematics domains. However, the use of scratch in mathematics instruction, particularly data analysis, remains limited, especially in elementary schools. Therefore, the present *study aims* to develop scratch-based learning media on data analysis material in phase C (grade 5 and 6) of elementary school.

Research method. The study employed a research and development (R&D) approach using the ADDIE (Analyze, Design, Development, Implementation, and Evaluation) development model. The process consists of curriculum analysis, student characteristics, and iterative design adjustments based on validation feedback from media, material, and language experts. Then, the scratch-based learning media was tested one-on-one (5 students) and in small groups (15 students) to assess the practicality of the media.

Results. The findings of this study indicate that the scratch-based learning media has fulfilled valid criteria from the expert judgments with an Aiken V score of 0.90 (very high). The media also received a high score of practicality from students with a score of 92%. These results confirmed that the scratch-based learning media is appropriate for the implementation of learning data analysis in phase C of elementary schools.

Conclusion. The scratch-based learning media for data analysis has proven to be both practical and feasible for classroom use, effectively enhancing student engagement and understanding in line with independent curriculum standards. This media supports computational thinking and offers a model for incorporating coding into elementary education.

KEYWORDS

ADDIE model, elementary education, data analysis, scratch-based learning media

For Citation: Putra, Z. H., Syahmi, F. P., Guslinda, & Aljarrah, A. (2025). Development of scratch-based learning media on data analysis material in Phase C of elementary school. *Perspektivy nauki i obrazovania = Perspectives of Science and Education*, (4), 505–523. https://doi.org/10.32744/pse.2025.4.33

Received: 26 February 2025 | Approved: 21 April 2025 | Published: 31 August 2025

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INTRODUCTION

Education for Sustainable Development (ESD) is gaining international recognition as an essential component of excellent education and a crucial facilitator of sustainable development [1]. Education in the 21st century faces various challenges, especially related to the new paradigm of learning that utilizes digital technology and artificial intelligence. These transformations have the possibility of helping us realize a better future and fulfill national and international development goals, yet they are frequently viewed as distinct, if not incompatible [2]. Several countries, including Indonesia, are dealing with similar issues.

The implementation of education in Indonesia is regulated based on a national curriculum that continues to be refined following science and technology development [3]. Indonesian Law No. 20 of 2003 concerning the national education system explains that each curriculum must include a learning plan that includes objectives, content, teaching materials, and methods used in the teaching and learning process [4]. The government through the Ministry of Education, Culture, Research, and Technology implemented the Merdeka curriculum with the hope of giving teachers the freedom to create interactive and relevant learning experiences for students [5]. This shows that teachers have an important role in designing dynamic learning activities and using innovative learning media.

The use of learning media is expected to be able to increase student interest and focus, especially technology-based learning media [6]. The utilization of applications or websites as learning management systems has the potential to establish a connection between students and the material that has been studied [7]. These systems offer the advantage of constant accessibility, enabling students to utilize their leisure time to reinforce lesson material and reduce the use of gadgets for social media. It not only attracts attention but also facilitates the transfer of knowledge from teachers to students [8]. According to Magunje and Chigona [9], the use of technology-based learning media can create a more interactive learning atmosphere and encourage student motivation, making learning more interesting and relevant to the needs of digitalization in the current era. The implementation of technology-based learning media in the Merdeka curriculum has been carried out at the elementary school level [10], middle school [11], and higher education [12] which generally has a positive impact on students' knowledge and skills. This is in line with the study of Loderer et al. [13] who state that technology-based learning media that is applied appropriately can have a positive impact on the development of students' skills in critical and logical thinking and help students to better understand the material presented.

The use of technology-based learning media has experienced rapid development and brought a new focus on the use of coding [14]. Students can use digital technology in all contexts of learning and instructional design of coding, which not only focuses on students' academic skills but also their self-management and social skills [15]. Several international studies on coding have been conducted, such as Barron et al. [16], which generally show that coding needs to be taught at various levels of education and become a competency that must be possessed by all including elementary school students. It also influenced Indonesia to implement coding through the competency strengthening and basic literacy implementation coaching program launched by the Ministry of Education and Culture [17]. The application of coding in learning can be utilized by teachers in creating learning materials such as the use of the Scratch web application.

Scratch is a coding application that can be used in designing projects, and integrating animation, sound, and simulators [18]. This application can be easily accessed via the Internet. Scratch is one of the visual coding applications designed by the Lifelong Kindergarten Research Group of the MIT Media Lab to introduce programming concepts simply to children [19]. Scratch allows students to create simple projects such as games, animations, and math applications, which are well suited to help elementary school-aged children understand basic logic and algorithm concepts in programming [20]. Some studies also show that Scratch learning can improve students' creativity and skills [21] and their computational thinking skills [22]. This is in line with the opinion of Fagerlund et al. [23] who state that Scratch is an ideal medium for introducing a computational mindset, which involves problem decomposition and algorithm-building skills.

Scratch has great potential, but its use in Indonesia is still very limited [24]. Initial observations in this study show that most teachers do not know Scratch and only utilize basic interactive media

such as PowerPoint. Thus, researchers are interested in conducting research and development on Scratch-based learning media by selecting mathematics subjects in phase C (fifth and sixth grade) of elementary schools [25]. One of the reasons for choosing math lessons is that elementary school students have entered the concrete operational stage that can formulate logic problems [26]. The resulting product is a learning media that contains an explanation of data analysis material in elementary school learning and gamification quizzes. Learning with gamification is characterized by the presence of internal rules or instructions for using the media, has a purpose, and is designed attractively [27]. Thus, this study was conducted to find answers to the following problem formulations:

1. How to produce a feasible Scratch-based learning media on data analysis material in phase C of elementary school?
2. How to produce practical Scratch-based learning media on data analysis material in phase C of elementary school?

Learning Media

Learning media can be defined as a communication process between teachers and students that aims to achieve competence or learning objectives [28]. Learning media has an important role in improving the learning process at school. Teachers utilize learning media as an intermediary to present material so that it is easily understood by students [29]. Some studies that have been conducted, for example in the study of de Roock et al. [30], generally show that effective learning media can improve student learning outcomes and improve teacher professionalism in teaching. Therefore, learning media needs to be designed creatively and interactively, involving students in the activities in the media so that students are more motivated and focused in understanding the material presented.

The development of technology brings changes in learning media into two types, namely traditional media such as books, blackboards, and pictures and media based on video technology, interactive applications, and digital multimedia [31]. However, along with the development of technology, learning media are increasingly based on applications or digital media that present information in an attractive visual and auditive manner and display real-world situations in virtual form. Digital learning media can be adapted to the student's learning environment, thus realizing a more active and dynamic learning experience [32].

Scratch

Scratch is a visual-based programming with the concept of drag-and-drop puzzles that aims to facilitate users who want to learn through fun animations [33]. Scratch is a derivative of Logo, developed at the MIT Media Lab. Scratch continues to grow in the world of education as an effort to introduce computer science to majors other than computer science, which is also very popular as a medium for introducing computer science at an early age. The use of Scratch can be used offline and is free of charge. The use of Scratch can be an aid in practicing computational thinking skills [19]. Scratch consists of communication and interpretation of coding that creates patterns of interaction between humans and computers [34]. Several studies on the use of scratch have been conducted, for example, helping teachers stimulate students' interest in learning, supporting students in planning, monitoring, and evaluating the learning process [35], stimulating student engagement and teacher academic performance [36], and developing student creativity [37].

Scratch still has weaknesses as a programming language, one of which is that it does not support procedures, so Scratch cannot be used to convey the phenomenon of recursion, which is one of the central ideas of computer science [36]. The concept of Scratch is programming without writing syntax and programming codes in the form of blocks that are dragged and dropped on its interface [37]. Scratch also lacks support for data structures. However, this weakness does not appear to be intentional on the part of Scratch's designers, as they avoid things that are too advanced for children to learn [38]. It is incumbent upon educators to meticulously examine the technical intricacies inherent in its utilization to subsequently furnish students with the appropriate instructional guidance, given that students within a classroom environment may possess a disparate array of skill sets [39].

Data Analysis Materials in Elementary School

Data is a set of information in the form of numbers or certain categories that have more meaning than just abstract representations [40]. At the primary education level, particularly in grade five, students are introduced to the basic concepts of statistics including data collection, processing, and analysis. This material aims for students to understand how to organize data and derive meaning from it, equipping them with analytical skills that are useful in everyday life [25].

In learning simple statistics in elementary school, students are taught to collect, organize, present, and read data through daily problem-based exercises, such as counting the number of students who like certain types of food [41]. These activities help students identify and present data in tables or graphs, as well as draw conclusions, which is important for developing their analytical skills [7]. Data analysis at this level also includes the introduction of simple sample measures such as averages and percentages, which introduce simple statistical concepts [42]. By understanding statistics early on, students can interpret information from surveys or graphs and recognize how data describe phenomena in their environment [43]. In Merdeka Curriculum, students in phase C (grades 5-6) are expected to sort, compare, present, analyze, and interpret data in various visual forms [7]. This data analysis learning is essential for building numeracy and data literacy skills, as well as preparing students to face a data-driven world and make rational decisions in the future.

METHODS

The type of research used is research and development (R&D) using the ADDIE model (Analyze, Design, Development, Implementation, and Evaluation) [44]. This research method produces development products that are tested feasible and practical to provide effective benefits. The following stages of the ADDIE model are listed in Figure 1.

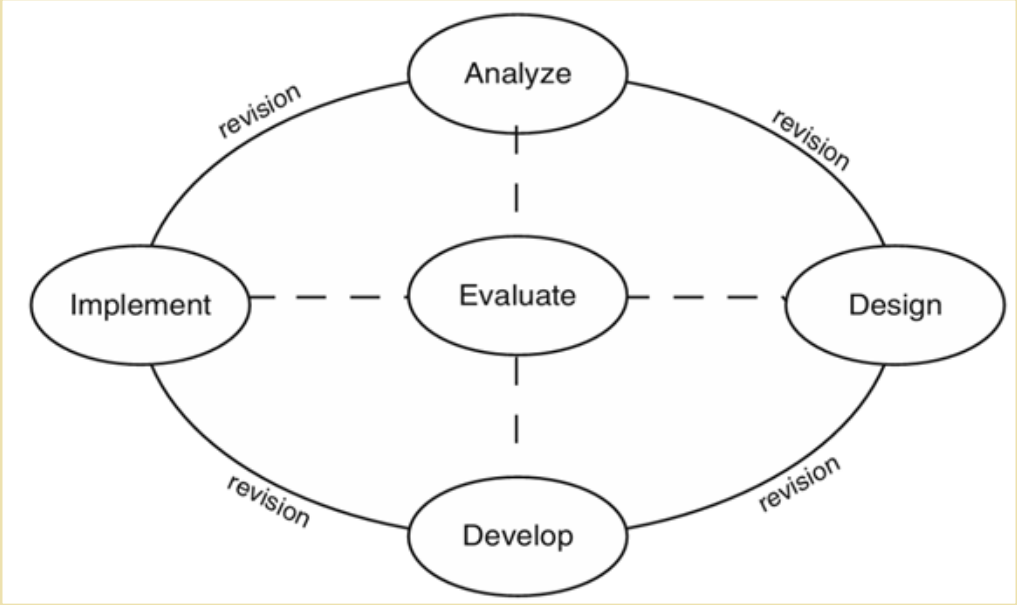

Figure 1 Stages of the ADDIE Model [44]

First, researchers analyzed the curriculum applied by the school to find information related to the learning outcomes and objectives of the material contained in the Scratch media. Furthermore, researchers analyzed the characteristics of students in terms of their thinking ability from the age level according to Piaget's theory [45]. Researchers also observed students' attitudes in understanding material in mathematics lessons according to Bruner's theory which explains students' views in building their knowledge obtained from experiences or new findings of students while learning [46]. In addition, researchers also observed students' attitudes in solving problems and collected information related to students' ability to operate technology. The goal is that researchers

can design learning media that are relevant to students' learning styles. Finally, researchers analyzed the material from the learning resources used by teachers and fifth-grade students. Researchers identified material that was still difficult for students to understand in math lessons. Thus, the author can determine the concept of Scratch media design that is relevant to the learning needs of fifth-grade teachers and students.

Second, the design stage is where researchers collect information related to the material discussed in the media from student textbooks and other relevant references. Furthermore, researchers designed validation instruments and the practicality of the media. Then, the researcher made a media concept outline according to the data analysis material references and student characteristics. Then, researchers began designing Scratch-based learning media with animation and sound features available in the application.

Third, the development stage is that researchers conduct validation tests on Scratch media through questionnaires assessed by media, material, and language validators. Then, the data in the validation questionnaire was processed using the Aiken V formula and the total score was adjusted to the expert test validity criteria in Table 1.

Table 1

Product Validity Criteria

Correlation Coefficient	Validity Interpretation
V>0,8	Very Valid
0,6≤V<0,8	Valid
0,4≤V<0,6	Fairly Valid
0≤V<0,4	Invalid

The validated instrument can be a reference for improving Scratch-based learning media. Then, researchers conducted the first trial which was attended by 5 students to find out the students' assessment of Scratch media through observation during learning and conducting interview sessions.

Fourth, the implementation stage was conducted for teachers and students in phase C or fifth-grade elementary school. Researchers introduced Scratch media to fifth-grade teachers, gave teachers a response questionnaire, and conducted interview sessions to assess the practicality of using Scratch-based learning media. Furthermore, researchers conducted a small group trial which was attended by 15 students and divided into 3 groups to practice students' cooperation attitude in solving challenges on Scratch media. After conducting the trial, students were also given a response questionnaire and interviewed to assess the practicality of Scratch-based learning media. Then, the data in the response questionnaire was processed using the percentage formula and the total score was adjusted to the media practicality category in Table 2.

Table 2

Media Practicality Criteria

Score in Percent (%)	Practicality Category
100-81%	Very Practical
80-61%	Practical
60-41%	Practical enough
< 40%	Not Practical

Fifth, evaluation is carried out in each stage of the ADDIE development model. This study uses formative evaluation to obtain feedback or assessment results that are used in revising learning media that are being tested or after being tested [47].

RESULTS

The following is a description of the results of Scratch-based learning media development research on data analysis material in phase C of elementary school according to the ADDIE model stage.

Analyze

At this stage, researchers analyze the needs of learning media development, such as curriculum, student characteristics, and materials used [48]. The description of the analysis stage that researchers do can be seen as follows.

Curriculum Analysis

The curriculum has become a guide for teachers and students in the learning process by going through various stages of revision according to the times and technology [49]. From the results of the researcher's observations, class V at the primary school where the research was conducted using the independent curriculum. The application of the independent curriculum in learning requires teachers to think creatively and innovatively in preparing teaching tools. The independent curriculum frees students to be able to solve problems through the discovery of information obtained but still directed according to the concept of the material being studied. So, the importance of the teacher's role as an educational facilitator who facilitates students with various information from the material being taught. Therefore, Scratch-based learning media was developed to assist teachers in providing information related to data analysis material that is difficult for students to understand and achieve the success of learning objectives in an independent curriculum. The following mathematics learning outcomes on data analysis material are listed in Table 3.

Table 3

Learning Outcomes for Data Analysis Materials

Learning Elements	Learning Outcomes	Learning Objectives
Data Analysis	Students can sort, compare, present, and analyze data on the number of objects or measurement results in visual frequency tables, graphs, bar charts, pie charts, and pictograms to obtain information.	1. Students can find measurement data in certain activities. 2. Students can sort the data set obtained. 3. Students can compare measurement data sets. 4. Students can present data in the form of frequency tables, line graphs, bar charts, pie charts, and picture charts.

Analysis of Student Characteristics

Researchers analyzed the characteristics of grade V students based on Piaget's theory and obtained the results that grade V students at the primary school where the research was conducted were on average 11 years old and included in the concrete operational cognitive development stage towards formal operations [50]. Some students who are at the concrete operational stage can solve math problems rationally but have difficulty solving them abstractly. Some other students who are already at the formal operational stage, can solve problems abstractly and think creatively by finding other solutions without relying on a concrete mindset.

Furthermore, researchers also analyze student characteristics based on Bruner's theory which states that students can solve a problem by building their knowledge from previous learning experiences. With the mindset of processing information found previously and then combining it with the latest information being studied, students can make decisions as a solution to the problems they face [46]. This theory is also in line with the data analysis material and behavior of grade V students, where the material has been previously studied by students when they were in grade IV. However, at that time students only learned the type of data processing in the form of frequency tables. Then, when students were in grade V, students began to learn other types of data processing such as graphs or diagrams. From students' learning experiences related to data analysis material, students still remember how to process data in tabular form and their knowledge increases with the existence of types of data processing in the form of line graphs, bar charts, pie charts, and pictograms.

However, students still need additional learning resources other than printed math books from the Ministry of Education and Culture and Worksheet to strengthen their understanding of the material.

For this reason, students need learning media that is in accordance with their ability to think at their age and visualize problems from everyday life in processing data. Also adjusting to the independent curriculum, integrating technology and learning media can improve students' ability to think computationally, namely being able to operate computer devices, and being able to solve problems logically and structurally [51]. From the observation, the researcher found that all students have gadgets and are proficient in using them. However, in the learning process, the teacher uses one-way media such as PowerPoint which only contains material and animated videos. The proper use of learning media is the occurrence of two-way learning interactions. So, researchers developed Scratch-based learning media by utilizing simple coding applications and involving students in accessing them.

Based on this analysis, the use of Scratch application on data analysis material is considered appropriate for student characters. Scratch-based learning media can be accessed by students themselves and presents data analysis material with interesting animations, harmonious sound, and gamification quizzes as challenges that can strengthen students' understanding of the concept of data analysis material. Learning in class feels more fun for students and teachers also get a variety of new applications that can be used as learning media. Therefore, learning that suits the needs of students and teachers can build prosperity for both with positive interactions [52].

Material Analysis

Researchers obtained information that students' learning resources on data analysis material used Mathematics books for grade V of elementary school from the Ministry of Education, Culture, Research, and Technology in Chapter 8 on Data [53]. The math book explains data collection, presenting data in the form of tables, pictograms, and bar charts. Then, the school also provides a math worksheet book for students to complement the material that is not explained in the math book, namely presenting data in the form of line graphs and pie charts. The discussion of separate materials and the display of images on the worksheet that are less clear, make students understand the data analysis material well. Therefore, researchers chose data analysis material because previously students already had learning experience in data processing in the form of tables, so in grade V students began to continue learning data processing material in the form of graphs, diagrams, and pictograms. Data analysis material also helps students to think logically and structurally. Researchers combine both subject matter from learning resources used by teachers and students through Scratch-based learning media. By utilizing technology, Scratch media can present moving animations as a visual display of data processing concepts, so that students have a new learning experience, are more motivated, and focus on learning.

Scratch media can realize mathematics learning following Piaget's theory, namely fifth-grade students who are 11 years old can solve problems concretely and formally [50]. Furthermore, Bruner's theory consists of three aspects, namely enactive, iconic, and symbolic. In the enactive aspect, the presentation of examples of data processing problems on Scratch media raises problems from the experience of the environment around students, for example, math exam score data. Next, students process the data iconically by changing the data in the form of a frequency table or adjusting the problem instructions. Then students interpret the data symbolically in the form of explanations related to the results obtained by students, for example determining the highest, lowest, or highest score they get on the math exam score. Data analysis material also improves students' computational thinking skills in the element of decomposition, where students can arrange data that is still random to be simpler, and in the algorithm element, where students process data according to systematic steps [51]. Analyzing data analysis material from student learning resources and expert theories helped researchers develop Scratch media relevant to the material studied by grade V students.

Design

Researchers began designing research instruments and Scratch-based learning media which can be seen in the following explanation.

Instrument Design

The research instrument was designed to test the feasibility and practicality of Scratch-based learning media on data analysis material in grade V SD. The research instrument to test the feasibility of the media was assessed by three experts, namely media/design experts there are 5 indicators with 5 statements, material experts there are 5 indicators with 5 statements, and linguists there are 5 indicators with 5 statements. Furthermore, the research instrument to test the practicality of media use and visualization was assessed by teachers with 10 statements and students with 10 statements. The researcher also designed an interview instrument that would be carried out after the Scratch-based learning media trial phase with the resource person of the fifth-grade teacher with 5 questions and the fifth-grade students with 4 questions.

Product Design

The initial stage that researchers did was to compile data analysis material tailored to student learning needs. Furthermore, researchers grouped each type of data presentation with a varied animation and background display using the features contained in the Scratch application. The use of Scratch application as learning media that researchers develop consists of 35 varied backgrounds and 190 sprites.

The design concept of Scratch-based learning media begins with a title that contains an invitation for students to learn data analysis material, namely "Learn Data Analysis Let's Go!". The menu display contains 8 categories, namely understanding which discusses the concept and application of data. Furthermore, the types of data processing are tables, graphs, bar charts, pie charts, and picture diagrams. Where, each type of data processing discusses the definition and parts of statistics, how to process data, examples of data presentation that must be completed first by students, and the last slide as a correction of student answers. Furthermore, the challenge section contains the concept of true or false games accompanied by a storyline and presents various data processing missions that must be completed by students. If the student answers correctly, the animation switches to the next mission. If the student answers incorrectly, the animation displays the word wrong and the student must try again until it is correct. Finally, the author's biography contains a brief biography of the researcher.

Development

Researchers have developed and improved Scratch-based learning media as a development product validated by media, material, and language experts. The following is the appearance of the parts of the Scratch-based learning media and the results of validation by experts.

Scratch-based Learning Media Display and Explanation

Scratch-based learning media presents 8 main menus that discuss the concept of data analysis material (Figure 2). There are three menus on the right side and five on the left side. Before students click the menus, they can see some explanation from the teacher's character in the center of the screen.

All parts of the data analysis material explain concepts with visuals and language that are easily understood by students. For instance, when students click the table menu, they will get some information explaining this topic (Figure 3). They will learn the definition of a table and its components.

Figure 4 presents some information on how to create or present data with key points. It provides some information on how to present vertical or horizontal bar charts. Besides, there are some steps that students need to follow to create a bar chart.

The Scratch-based learning media presented examples of problems that must be solved by students. The goal is to find out students' understanding of processing data. Figure 5 presents an example of a task that the students need to analyze and then present on a line chart.

The next step in this activity is that students can try to present the data in a line chart. Their answers will be corrected together according to the explanation and display of the correct data presentation (Figure 6).

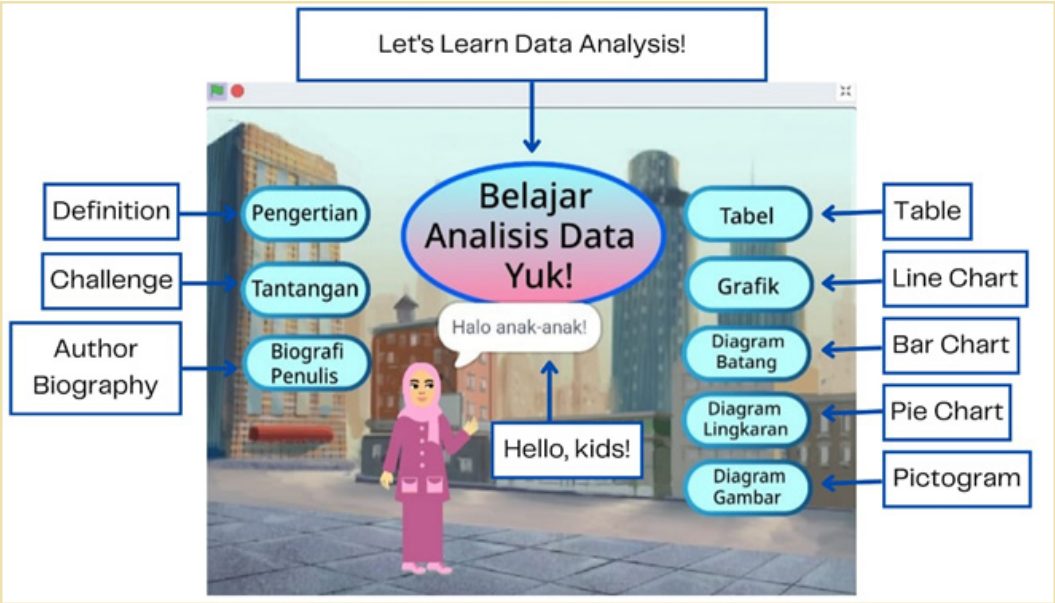

Figure 2 Scratch-based Learning Media Menu Display

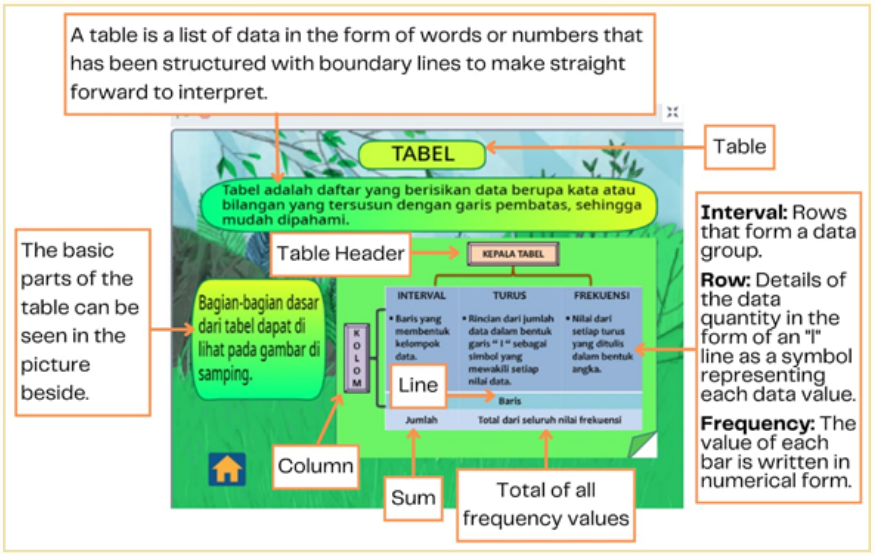

Figure 3 Explanation of Scratch-based Learning Media Materials

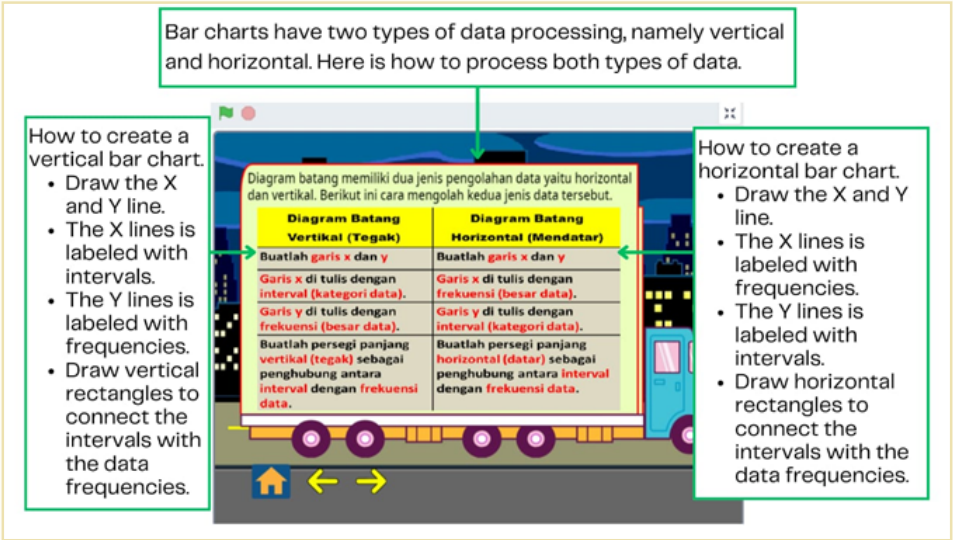

Figure 4 Explanation of Data Presentation Tips

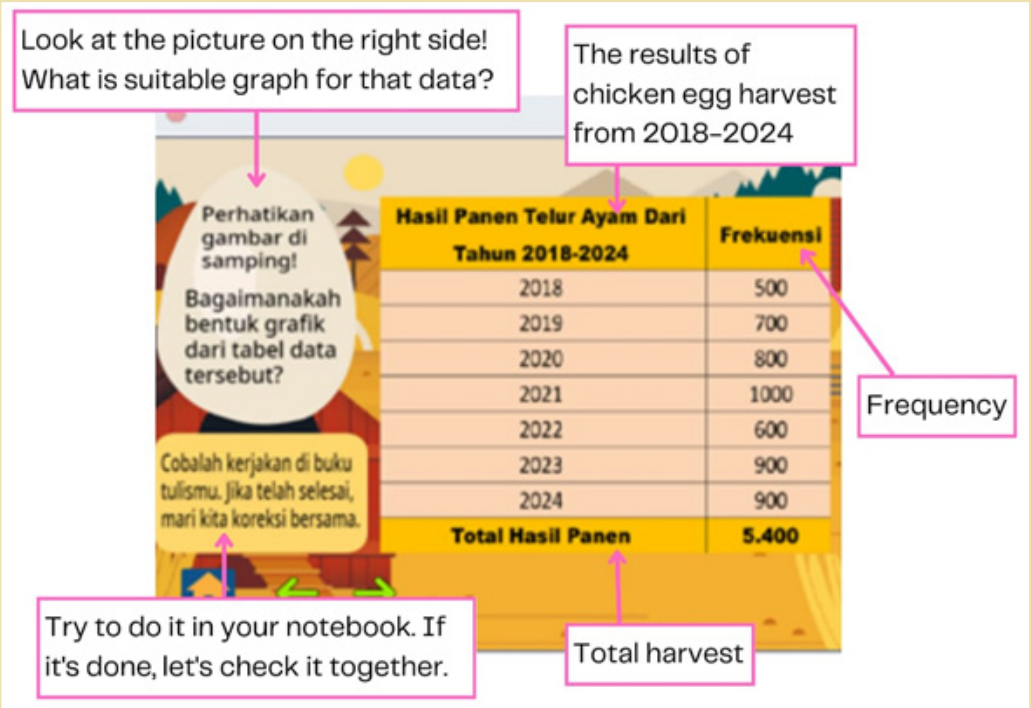

Figure 5 An Example of Problems

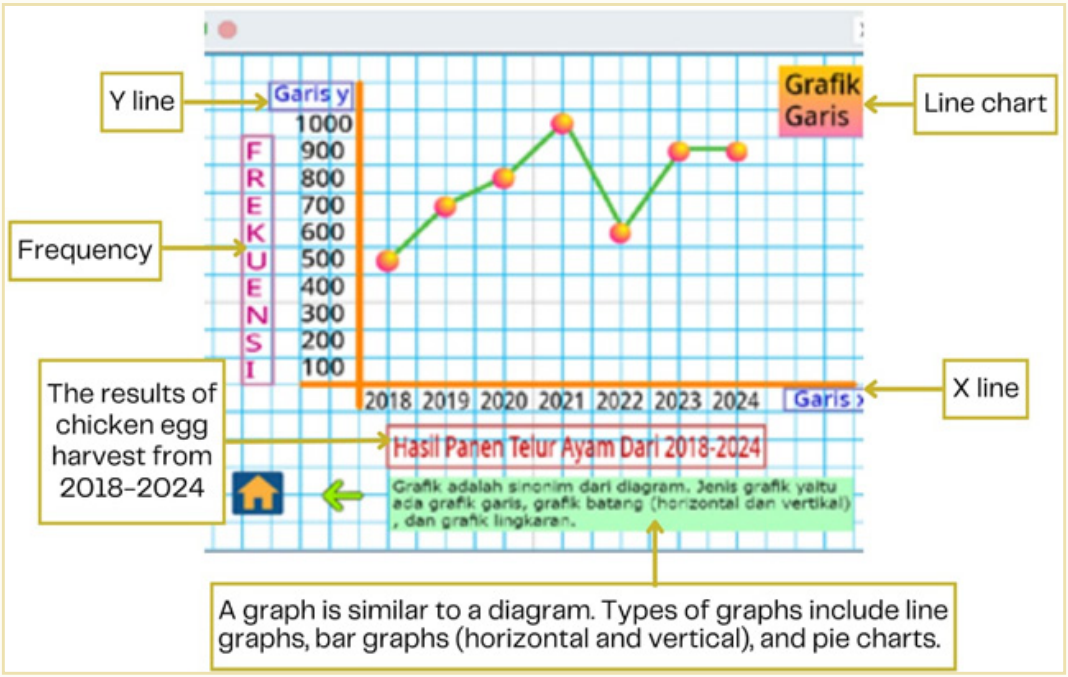

Figure 6 An Example of Solution for a Problem

Next, the challenge contains a data processing mission with the results of student answers based on correct or incorrect information with harmonized animation and audio. Figure 7 presents the display of the challenging activities starting with students collecting some objects on the screen. The following display is shown in Figure 7.

Scratch-based Learning Media Validation Results

Scratch media has been developed following suggestions from media, material, and language expert validators, and has passed the feasibility test stage through a validation questionnaire. The following Scratch-based learning media validation test results are listed in Table 4.

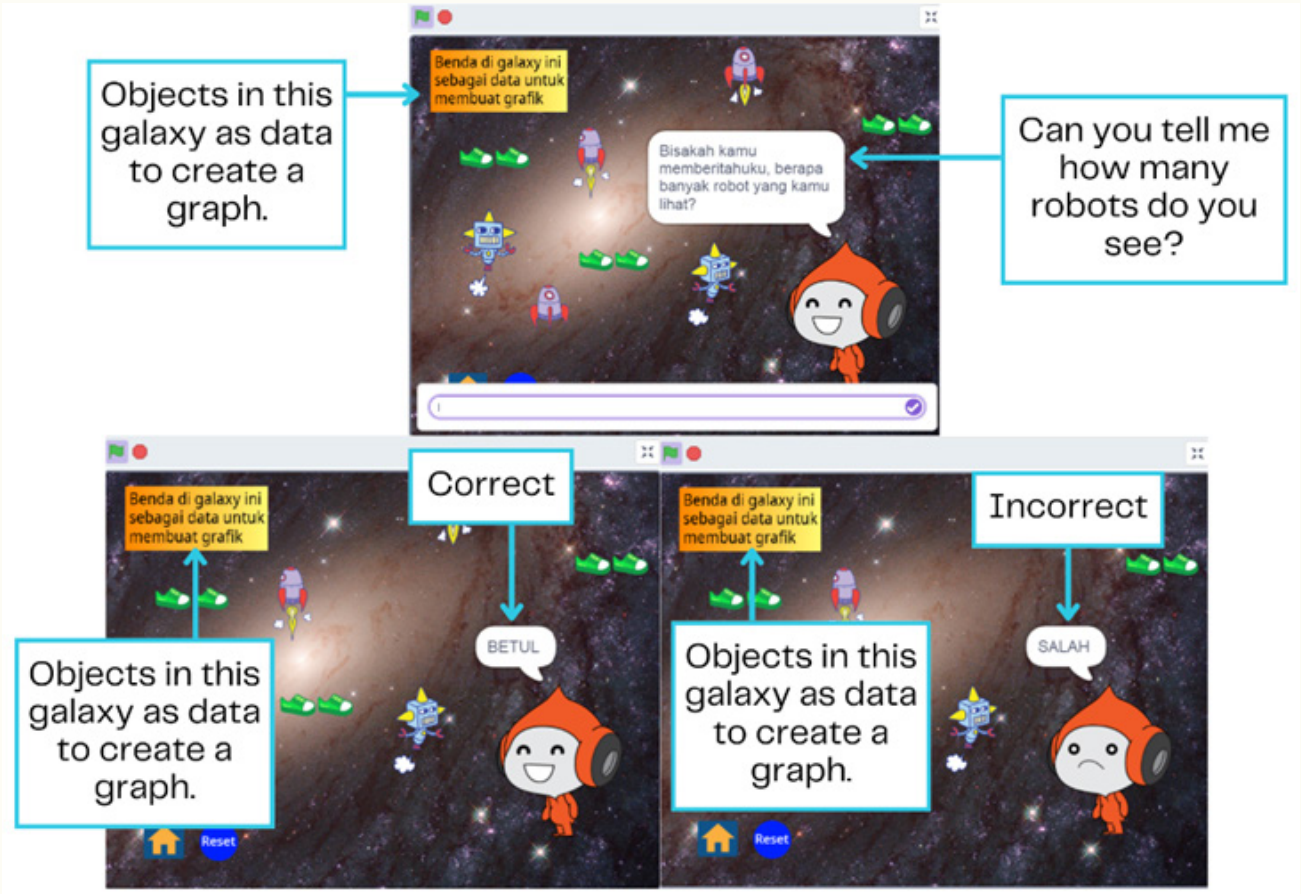

Figure 7 Activities in the Menu of Challenge

Table 4

Validation Test Results

Aspects	Score	Validity
Design	0.91	Very Valid
Material	0.91	Very Valid
Language	0.89	Very Valid
Average	0.90	Very Valid

Scratch-based learning media is declared very valid with an average score for all aspects reaching 0.90. Scratch-based learning media has been declared feasible to enter the trial stage to grade V students and can be accessed using Google Chrome and the internet network with the link https://scratch.mit.edu/projects/1010472176. The QR Code version can be seen in Figure 8.

Figure 8 QR Code for Scratch-based Learning Media

Then, the researcher introduced Scratch-based learning media to 5 fifth-grade students and worked on sample problems individually. Researchers have asked permission from the VA, VB, and VC class teachers to choose 1 or 2 student representatives to try Scratch media. So the representatives of class VA were 1 student, class VB was 2 students, and class VC was 2 students. The goal is to see the feasibility and initial practicality of using Scratch media on data analysis material before later entering the small group trial stage. The following is the one-to-one test activity in Figure 9.

Figure 9 One to One Trial

Students are shown the display in Scratch media in the form of coding or programming language used and Scratch media gets a positive response because the application of media with coding is new to students. The researcher asked students trigger questions to build students' memories of the previous data analysis material. Then, the researcher summarized the students' answers and related them to the types of data processing. Furthermore, students began to try Scratch media by following the narration delivered by the animation.

It begins with students clicking on the "understanding" menu then students read and understand the definition of data, the concept of data processing, and the application of data analysis in everyday life. All students who have understood the meaning of data can proceed to the second menu, namely the data processing "table". For each menu in Scratch media, students are allowed to ask questions about things they do not understand. On the "table" menu, students understand the definition of a table, the concept of rows and columns in a table, and the placement of intervals and frequencies. Moving on to the next slide, students understand the steps in filling in the table. Then, students are asked to work on sample problems regarding the presentation of random data which is then processed into a table. All students' answers were corrected and discussed together by clicking the arrow on the last slide. It was found that all students could answer the questions well. However, in the graph section, students still experience a slight misconception in placing the frequency value on the y-line. Where students sorted the frequency based on the smallest number of frequencies in the question instead of starting from the number after 0. Meanwhile, the position of the interval class, the placement of the connecting point between the interval and frequency, and the pull of the connecting line were answered correctly by the students. Therefore, researchers provide explanations to students regarding the determination of the frequency position on the x-line in data processing in the form of graphs. So in the example of a bar chart problem, students can answer correctly because they understand how to determine the position of the frequency on the x-line.

All discussion menus in processing data have the same stages, starting from understanding definitions, data processing concepts, steps in processing and placing data, example problems, and forms of solution. Finally, students click on the "challenge" menu which is accompanied by a storyline. In the first mission, students collect initial data for the table by clicking on the fruits

floating in the rocket. Next, students match the blocks containing the fruit data into the rows and columns of the table appropriately. If the answer is correct, students can continue the mission for further data processing. But, if the answer is wrong, students can retry the answer until it is correct and the scoring applies to the entire mission in the challenge. In graph data processing, students are asked to collect objects floating in outer space by typing the number of objects seen, then students arrange the blocks containing the data of these objects in x and y lines accordingly in making a graph. In bar charts and picture diagrams, students are asked to observe the data and then select the right data according to the problem. In the pie chart, students are asked to find the angle and percentage of the initial data presented by the animation according to the formula listed on the screen. Students can type their answers in the column provided. After students have completed all the challenges, the researcher and students summarize the learning that has been done.

Based on the results of the one-to-one trial, it was found that Scratch-based learning media on data analysis material received good responses from students. In addition to being proficient in using laptops, students' motivation and learning activeness also increased, although there were a few misconceptions experienced by students, students had a high interest in correcting mistakes and focusing on learning. Therefore, Scratch media can be continued at the small group trial stage.

Implementation

Researchers first asked for teacher responses regarding Scratch media assessed through response questionnaires and interviews. Scratch media received a positive response from the teacher, then the researcher asked permission from the teacher to select 15 students to take part in the small group trial stage. Students who took part in this trial were differentiated from students who had participated in the previous one-to-one trial so that other students had the opportunity to use Scratch media. It began with the division of students into 3 groups, where each group consisted of 5 students. The goal is to improve students' cooperation attitude in solving challenges later. The following small group trial implementation process is shown in Figure 10.

Figure 10 Group of students using Scratch media

The implementation of this trial began with the introduction and explanation of Scratch-based learning media by researchers. Then, students were allowed to see the display in coding on Scratch so that students could find out how Scratch media was designed. Then, the researcher explained a little about the data analysis material so that students recalled the material they had learned. Furthermore, students try the media and understand the explanation of data analysis material starting from the definition menu, tables, graphs, bar charts, pie charts, and picture diagrams. In each menu, there are examples of data presentation that must be completed first by students individually, then go to the next slide for answer correction. The results of students' answers to each

example problem are discussed together as a reflection of students completing data presentations appropriately and systematically. Students' answers that are still wrong can be corrected by understanding the material on the previous slide again. After students have successfully understood the material and completed the presentation of the problem well, students can move on to the challenge section. In the challenge menu, each group works together to complete it quickly. The first group to complete the challenge is the winner.

The three groups began to complete the challenge with enthusiasm. The researcher formed groups of 5 students, adjusting the type of data processing, namely tables, graphs, bar charts, pie charts, and picture charts. So that students can take turns using the laptop to complete the challenge. At the end of the challenge, group 2 from class VB won, followed by Group 3 from class VC, and finally group 1 from class VA. Then, researchers together with students summarized the material that had been learned and researchers also asked about students' responses to Scratch media. The following is an excerpt of the researcher's interview with one of the students.

Researcher : How do you respond to Scratch-based learning media on data analysis material?

Student : It's more fun because you can get that knowledge.

Researcher: Can you understand the explanation of data analysis material contained in Scratch media?

Student : I can, because the explanation is complete.

Researcher: In your opinion, which way of learning is fun and easy to understand? Is it using learning media or not?

Student : Use learning media because it's more exciting and fun to use a laptop.

Researcher : The Scratch app can be used by children to create a variety of simple works, such as games, picture stories, and so on. Are you interested in trying it out?

Student : Really interested because it's fun to play games too.

Data analysis material is included in mathematics learning which is quite complex with problem solving based on logic and will continue to be studied at the next level of education. Thus, teachers need to instill the concept of data analysis material by using innovative learning media combined with effective learning tools for students.

Evaluation

A formative evaluation was conducted to improve the Scratch-based learning media. Through the validation test, researchers improved the media according to the suggestions and input from the three validators to produce a feasible learning media. The results of the Scratch media trial for teachers and fifth-grade students are useful for measuring the practicality of using Scratch-based learning media. The following is a recap of the results of the validation test and the practicality test of Scratch-based learning media listed in Table 5.

Table 5

Recap of Validation Test and Practicality Test Results

Assessment Stage	Percentage	Category
Validation	90%	Very Valid
Grade V Teacher Response	96%	Very Practical
Small Group Trial	92%	Very Practical

Thus, Scratch-based learning media on data analysis material in phase C elementary schools are feasible and practical to use in classroom learning. All elementary school levels can access this learning media through the Scratch application using only the internet and website. Scratch-based learning media has become one of the pioneers of the use of coding applications in learning.

DISCUSSION

Learning media is a teaching aid for teachers to support the student learning process [54]. Currently, learning media can be combined with technology and varied with various applications that support subject matter and student characters. Effective learning media is media that involves students in its use and builds good communication between teachers and students [55]. Therefore, this research fulfills the needs of teachers and students by developing Scratch-based learning media. The application of coding applications in elementary schools is still rarely used, so developing learning media using Scratch can create effective learning for grade V students [56]. The use of Scratch media for grade V students can hone their computational thinking skills, and increase their creativity to try new things that are positive towards technology [57].

Scratch-based learning media on data analysis material in phase C of elementary school was developed using the ADDIE development model [44]. Following the stages, researchers began to analyze related to the curriculum used by schools, the characteristics of grade V students, and the material contained in Scratch media. It was found that fifth-grade students at the elementary school apply an independent curriculum that directs students to be able to solve problems logically and systematically through the discovery of mathematics learning information. The learning outcomes of data analysis material in the independent curriculum can be linked to the use of programming applications such as Scratch that guide students to be more analytical in obtaining information from technology [58]. Furthermore, the results of the analysis of student characteristics with data analysis material are based on Piaget's theory, where the age of grade V students starting from 11 years is already at the formal operational cognitive development stage which can think abstractly to systematically or vice versa [50]. For this reason, Scratch media visualizes data analysis material with example problems that students can solve systematically. Then, the way students build their knowledge is based on Bruner's theory regarding learning experiences in finding information [46]. Where Scratch media displays a comprehensive discussion of data processing in elementary school. Thus, students can recall the types of data processing that have been studied in grade IV in the form of tables, then the latest information is obtained when students are in grade V for data processing in the form of graphs or diagrams. Finally, Scratch media on data analysis material involves students interacting with computer devices, and data processing done by students can improve the mindset of computational decomposition and algorithms [51].

The media development and implementation stage is important to determine the feasibility and practicality of using the media over a wide range and long period. The Scratch media that has been designed is then tested for validation by experts and the assessment results are adjusted to the Aiken V validity index [59]. Suggestions and input from experts are very important for researchers to improve Scratch-based learning media. The media that has been feasible can be tested on grade V students. Students are very enthusiastic, and active, and enjoy the learning process using Scratch media about data analysis material. Previously, students had difficulty understanding how to process data due to limited book discussions and less varied media. With Scratch media, students no longer consider math as a difficult and boring lesson. Thus, the Scratch media trial stage for teachers and grade V students received a positive assessment from the response questionnaire, and Scratch media was declared practical to be applied to learning in grade V at the research elementary school and other elementary schools [60]. The use of Scratch application can be utilized by teachers as a creative and interactive learning media for achieving learning success in the classroom [61]. Scratch media can also be used for students who are slow in learning because its unlimited access can help teachers retell the concept of data analysis material to these students [62]. In addition, support from schools in the form of adequate technology facilities also gives teachers a positive perception of slow-learning students, where teachers believe that these students can learn the material even though it takes time and repeated explanations [63]. Thus, Scratch-based learning media that utilizes technology can help slow learners understand data analysis material well and on par with other students with normal capacity [64].

CONCLUSIONS

Scratch-based learning media on data analysis material has been tested feasible and practical, so it can help teachers teach data analysis material that is effective and fun for students. Scratch-based

learning media is very appropriate for use in the independent curriculum and can also be used in the long term. The use of coding applications such as Scratch is following the progress of the times in the era of Society 5.0. Scratch media can hone students' creativity and computational mindset in solving problems in processing data in a structured manner with the right steps. This is evidenced by the results of the experts' validation test on Scratch-based learning media declared very valid. Then for the results of media trials to students and teachers, Scratch-based learning media get very good responses and follow student learning needs. Scratch-based learning media can be used as an illustration and guide for teachers and other researchers who want to develop Scratch-based learning media with varied materials and the application of more complex coding features.

ACKNOWLEDGMENT

The authors would like to thank DIKTI and LPPM Universitas Riau for funding this research under the DRTPM research grant number 20685/UN.19.5.1.3/AL.04/2024.

REFERENCES

1. UN: Quality Education. Available at: https://www.un.org/sustainabledevelopment/education/ (accessed 25 November 2024)
2. UNESCO: Bridging the digital and green transitions through education. Available at: https://www.unesco.org/en/articles/bridging-digital-and-green-transitions-through-education-new-paper-stefania-giannini?hub=343 (accessed 26 November 2024)
3. Muslim A. B., Harisca R. The Urgency of Enhancing Learning Arabic inside National Education Curriculum in Indonesia. *International Journal of Arabic Language Teaching*, 2021, vol. 3, no 1, pp. 66-81. DOI: 10.32332/ijalt.v3i01.3110
4. Kemendikbud: Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System. Ministy of Education, 2023. 42p. Available at: https://jdih.kemdikbud.go.id/sjdih/siperpu/dokumen/salinan/UU_tahun2003_nomor020.pdf (In Indo.)
5. Kemendikbudristek. Independent Curriculum Academic Study. *Curriculum and Learning Center,* 2024. 143 p. Available at: https://kurikulum.kemdikbud.go.id/file/1711503412_manage_file.pdf (In Indo.)
6. Smaldino S. E., Lowther D.L., Mims C. Instructional Technology and Media for Learning. New York, Pearson., 2019, 334 p.
7. Lumpkin A., Achen R., Dodd R. Focusing Teaching on Students: Examining Student Perceptions of Learning Strategies. *Quest*, 2015, vol. 67, no. 4, pp. 352–366. DOI: 10.1080/00336297.2015.1082143
8. Veronika R., Camelia C., Febriliana R., Yapen Y. E. Digital Literacy as a Social Mobilization and Learning Platform. *SEIKAT: Jurnal Ilmu Sosial, Politik dan Hukum*, 2023, vol. 2, no. 3, pp. 228–241. DOI: 10.55681/seikat.v2i3.544
9. Magunje C., Chigona A. E-Learning Policy and Technology-Enhanced Flexible Curriculum Delivery in Developing Contexts: A Critical Discourse Analysis. *Critical Studies in Teaching and Learning*, 2021, vol. 9, no. 2, pp. 83–104. DOI: 10.14426/cristal.v9i2.1814
10. Ruswan A., Rosmana P. S., Nafira A., Khaerunnisa H., Habibina I. Z., Alqindy K. K., Amanaturrizqi K., Syavaqilah W. The Effect of Using Technology-Based Learning Media in Improving Elementary School Students' Digital Literacy Skills. *Jurnal Pendidikan Tambusai*, 2024, vol. 8, no. 1, pp. 4007–4016. DOI: 10.31004/jptam.v8i1.13009 (In Indo.)
11. Nuridayanti N., Muryaningsih S., Badriyah B., Solissa E. M., Mere K. The Role of Educational Technology in the Implementation of the Independent Curriculum. *Journal on Teacher Education*, 2023, vol. 5, no. 1, pp. 88–93. DOI: 10.31004/jote.v5i1.16957 (In Indo.)
12. Handayani F., Hasyim D. M., Suryono W., Sutrisno S., Novita R. The Role of Educational Technology in Supporting the Effectiveness of the Implementation of the Independent Learning Curriculum in Higher Education. *Jurnal Review Pendidikan dan Pengajaran*, 2023, vol. 6, no. 4, pp. 1265–1271. DOI: 10.31004/jrpp.v6i4.20755 (In Indo.)
13. Loderer K., Pekrun R., Lester J. C. Beyond Cold Technology: A Systematic Review and Meta-Analysis on Emotions in Technology-based Learning Environments. *Learning and Instruction*, 2020, vol. 70, pp. 101162. DOI: 10.1016/j.learninstruc.2018.08.002
14. Popat S., Starkey L. Learning to Code or Coding to Learn? A Systematic Review. *Computers & Education*, 2019, vol. 128, pp. 365–376. DOI: 10.1016/j.compedu.2018.10.005
15. Liu D., Li Y., Lin J., Li H., Wu F. Deep Learning-Based Video Coding: A Review and a Case Study. *ACM Computing Surveys (CSUR)*, 2020, vol. 53, no. 1, pp. 1-35. DOI: 10.1145/3368405

16. Barron B., Hodges G. C., Bofferding L., Coppple C. Take a Giant Step: A Blueprint for Teaching Young Children in a Digital Age. Standford University, The Joan Ganz Cooney Center, 2011, 56 p.
17. Putro Y. T. M., Astuti R. Implementation of Scratch in Learning Coding for Elementary School Students. *Universitas Muhammadiyah Sidoarjo*, 2023, pp. 1–13. DOI: 10.21070/ups.1671 (In Indo.)
18. Cárdenas-Cobo J., Puris A., Novoa-Hernández P., Parra-Jiménez Á., Moreno-León J., Benavides D. Using Scratch to Improve Learning Programming in College Students: A Positive Experience from a Non-Weird Country. *Electronics*, 2021, vol. 10, no. 10, pp. 1–15. DOI: 10.3390/electronics10101180
19. Stewart W, Baek K. Analyzing computational thinking studies in Scratch programming: A review of elementary education literature. *International Journal of Computer Scince Education in Schools,* 2023, vol. 6, no. 1, pp. 35–58. DOI: 10.21585/ijcses.v6i1.156
20. Rodríguez-Martínez JA, González-Calero JA, Sáez-López JM. Computational thinking and mathematics using Scratch: an experiment with sixth-grade students. *Interactive Learning Environments*, 2020, vol. 28, no. 3, pp 316–327. DOI: 10.1080/10494820.2019.1612448
21. Kobsiripat W. Effects of the Media to Promote the Scratch Programming Capabilities Creativity of Elementary School Students. *Procedia - Social and Behavioral Sciences*, 2015, vol. 174, pp. 227–232. DOI: 10.1016/j.sbspro.2015.01.651
22. Jiang B., Li Z. Effect of Scratch on computational thinking skills of Chinese primary school students. *Journal of Computers in Education*, 2021, vol. 8, no. 4, pp. 505–525. DOI: 10.1007/s40692-021-00190-z
23. Fagerlund J., Häkkinen P., Vesisenaho M., Viiri J. Computational thinking in programming with Scratch in primary schools: A systematic review. *Computer Applications in Engineering Education*, 2021, vol. 29, no. 1, pp. 12–28. DOI: 10.1002/cae.22255
24. Amanullah K., Bell T. Analysing Students' Scratch Programs and Addressing Issues using Elementary Patterns. *2018 IEEE Frontiers in Education Conference (FIE)*, 2018, pp. 1–5. DOI: 10.1109/FIE.2018.8658821
25. Kemendikbudristek. Decree of the Head of the Education Standards, Curriculum, and Assessment Agency, Ministry of Education, Culture, Research, and Technology Number 008/H/KR/2022 Concerning Learning Achievements in Early Childhood Education at Elementary and Secondary Education Levels in the Independent Curriculum. 2020. https://kurikulum.kemdikbud.go.id/wp-content/uploads/2022/06/033_H_KR_2022-Salinan-SK-Kabadan-tentang-Perubahan-SK-008-tentang-Capaian-Pembelajaran.pdf (accessed 18 September 2024) (In Indo.)
26. Lely M., Putra Z. H., Syahrilfuddin S. Fifth grade students' creative thinking in solving open-ended mathematical problems. *Journal of Teaching and Learning in Elementary Education*, 2020, vol. 3, no. 1, pp. 58–68. DOI: 10.33578/jtlee.v3i1.7829
27. Sakai K, Shiota S. A Practical Study Of Mathematics Education Using Gamification. *International Conferences ITS, ICEduTech and STE*, 2016. pp. 353–354. Available at: https://files.eric.ed.gov/fulltext/ED571606.pdf (accessed 28 August 2014).
28. Belawati T. Online Learning. Jakarta, Universitas Terbuka., 2019. 172p. Available at: https://repository.ut.ac.id/8813/1/EBOOK_PEMBELAJARAN_ONLINE.pdf (accessed 7 September 2024) (In Indo.)
29. Putra Z. H., Panjaitan I. O. D., Putri N. A., Wulandari T. R., Hermita N., Dahnilsyah D. Design and implementation of GeoGebra learning activities of area and perimeter of rectangles for primary school students. *Journal of Physics: Conference Series*, 2021, pp. 1–5. DOI: 10.1088/1742-6596/2049/1/012032
30. de Roock R. S., de Leon Espeña D. M., Lawrence S. R. Toward equity innovations: lower tracked students and classroom digital media use in Singapore. *Asia Pacific Journal of Education*, 2024, vol. 44, no. 2, pp. 311–325. DOI: 10.1080/02188791.2022.2145269
31. Dalimunte K. Z. R., Sabrina M. N., Kusdian N. A., Fauziah S. Analysis of the Effectiveness of Using Traditional and Modern Learning Media According to the Views of Students of the Education Study Program. *Journal of Innovation in Education*, 2024, vol. 2, no. 2, pp. 97–106. DOI: 10.59841/inoved.v2i2.1143
32. Claresta F.C., Mustoip S., Iqbal M., Ghozali A., Purwati R., Khozim A. A. Development of Powerpoint Macro & Prezi Based Science Learning Media for Class V Elementary. *Proceedings International Conference of Bunga Bangsa (ICOBBA)*, 2024, vol. 2, no. 1, pp. 42–58. Available at: https://journal.epublish.id/index.php/icobba/article/view/12 (accessed 17 August 2024)
33. Maloney J., Resnick M., Rusk N., Silverman B., Eastmond E. The scratch programming language and environment. *ACM Transactions on Computing Education*, 2010, vol. 10, no. 4, pp. 1–15. DOI: 10.1145/1868358.18683
34. Zhang L., Nouri J. A systematic review of learning computational thinking through Scratch in K-9. *Computer and Education*, 2019, vol. 141, pp. 103607. DOI: 10.1016/j.compedu.2019.103607
35. Nan Cenka B. A., Santoso H. B., Junus K. Using the personal learning environment to support self-regulated learning strategies: a systematic literature review. *Interactactive Learning Environment*, 2024, vol. 32, no. 4, pp. 1368–1384. DOI: 10.1080/10494820.2022.2120019
36. Belessova D, Ibashova A, Zhidebayeva A, Shaimerdenova G, Nakhipova V. The Impact of "Scratch" on Student Engagement and Academic Performance in Primary Schools. *Open Education Studies*, 2024, vol. 6, no. 1, pp. 1-10. DOI: 10.1515/edu-2022-0228
37. Wang Y. M., Harmer P. A. Reimagining Teacher Preparation: Digital Literacy in the Post-Pandemic Era. *Asian Journal of Education and Social Studies*, 2024, vol. 50, no. 3, pp. 152–158. DOI: 10.9734/ajess/2024/v50i31290

38. Harvey B., Mönig J. Bringing "No Ceiling" to Scratch: Can One Language Serve Kids and Computer Scientists? *Constructionism*, 2010, pp. 1–10. Available at: https://bjc.berkeley.edu/documents/2010%20Constructionism%20-%20Bringing%20No%20Ceiling%20to%20Scratch%20-%20Can%20One%20Language%20Serve%20Kids%20and%20Computer%20Scientists.pdf (accessed 3 September 2024).
39. Meerbaum-Salant O., Armoni M., Ben-Ari M. (Moti). Learning computer science concepts with scratch. *Proceedings of the Sixth International Workshop on Computing Education Research*, 2010, pp. 69–76. DOI: 10.1145/1839594.1839607
40. Yensy N. A., Sasongko R. N., Kristiawan M., Apryani D., Hidayatulloh H. The Effectiveness of Project-Based Learning Models in Improving Understanding of Statistical Concepts. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 2022, vol. 11, no. 2, pp. 1297-1305. DOI: 10.24127/ajpm.v11i2.5102
41. Anggela D. L., Satria T. G., Febriandi R. Development of Student Worksheets (LKS) in Mathematics based on Discovery Learning on Statistics Material for Fourth-Grade Students of SD Negeri 46 Lubuklinggau. *Jurnal Ilmiah Aquinas*, 2021, vol. 4, no. 2, 246–259. DOI: 10.54367/aquinas.v4i2.1247 (In Indo.)
42. Sulistyawati NLG, Suarjana IM, Wibawa CIM. Development of Google Sites-based Website Media for Fourth Grade of Elementary on Statistics Material. *Jurnal Pendidikan dan Konseling*, 2022, vol. 4, no. 4, pp. 895–905. DOI: 10.31004/jpdk.v4i4.5341 (In Indo.)
43. Setiawan E. P. Analysis of Statistical Literacy Content in 2013 Curriculum Mathematics Textbooks. *Pythagoras: Jurnal Pendidikan Matematika*, 2019, vol. 14, no. 2, pp. 163–177. DOI: 10.21831/pg.v14i2.28558 (In Indo.)
44. Branch RM. Instructional Design: The ADDIE Approach. New York, NY: Springer; 2009. Available from: http://link.springer.com/10.1007/978-0-387-09506-6
45. Piaget J. Piaget's theory. In: Inhelder B., Chipman H. H., Zwingmann C., (eds). Piaget and His School. Springer Study Edition. Berlin, Heidelberg: Springer. 1976, pp. 11–23. DOI: 10.1007/978-3-642-46323-5_2
46. Hatip A., Setiawan W. Bruner's Cognitive Theory in Mathematics Learning. *PHI: Jurnal Pendidikan Matematika*, 2021, vol. 5, no. 2, pp. 87–97. DOI: 10.33087/phi.v5i2.141 (In Indo.)
47. Fitrianti L. The Principle of Continuity in Evaluating the Learning Process. *Al-Ishlah: Jurnal Pendidikan*, 2018, vol. 10, no. 1, pp. 89–102. DOI: 10.35445/alishlah.v10i1.68 (In Indo.)
48. Fudholi D. H., Kurniawan R., Jalaputra D. P. E., Muhimmah I. Development of Virtual Reality Applications with the ADDIE Model for Prospective Educators of Children with Autism. *Jurnal RESTI: Rekayasa Sist dan Teknol Informasi*, 2020, vol. 4, no. 4, pp. 672–681. DOI: 10.29207/resti.v4i4.2092 (In Indo.)
49. Gusteti M. U., Neviyarni N. Differentiated Learning in Mathematics Learning in the Independent Curriculum. *Jurnal Lebesgue: Jurnal Ilmiah Pendidikan Matematika, Matematika, dan Statistika*, 2022, vol. 3, no. 3, pp. 170–184. DOI: 10.46306/lb.v3i3.180 (In Indo.)
50. Fahma M. A., Purwaningrum J. P. Piaget's Theory in Mathematics Learning. *MUST: Journal of Mathematics Education, Science and Technology,* 2021, vol. 6, no. 1, pp. 31-42. DOI: 10.30651/must.v6i1.6966
51. Gunawan Y., Putra Z. H., Antosa Z., Dahnilsyah D., Tjoe H. The Effect of Gender on Fifth-Grade Students' Computational Thinking Skills. *Mosharafa: Jurnal Pendidikan Matematika*, 2023, vo. 12, no. 3, pp. 465–476. DOI: 10.31980/mosharafa.v12i3.820
52. Schmitz B. What teachers can do to enhance students' well-being: Discussion. *Learning and Instruction*, 2024, vol. 94, pp. 101980. DOI: 10.1016/j.learninstruc.2024.101980
53. Fitrianawati M., Sintawati M., Marsigit M., Retnowati E. Subject Specific Pedagogy (SSP) Development Scheme based on Ethnomathematics to Improve Elementary School Students' Mathematical Literacy. *Prosiding Seminar Nasional Etnomatnesia*, 2018, pp. 360–366. Available at: https://202.162.35.16/index.php/etnomatnesia/article/view/2348. (accesed 23 August 2024) (In Indo.)
54. Mukarromah A., Andriana M. The Role of Teachers in Developing Learning Media. *Journal of Science and Education Research*, 2022, vol. 1, no. 1, pp. 43–50. DOI: 10.62759/jser.v1i1.7 (In Indo.)
55. Sjunnesson H. Initializing phase of lesson study: communication a special didactic tool in mathematics. *International Journal for Lesson and Learning Studies*, 2020, vol. 9, no. 3, pp. 261–275. DOI: 10.1108/IJLLS-02-2020-0007
56. Olsson J., Granberg C. Teacher-student interaction supporting students' creative mathematical reasoning during problem solving using Scratch. *Mathematics Thinking and Learning*, 2024, vol. 26, no. 3, pp. 278–305. DOI: 10.1080/10986065.2022.2105567
57. Widyasari N., Safitri N. S., Dindiany Y., Iswan I., Yuliana Y., Sari I. Analysis of Number Sense Ability of Lower Grade Students. *Yaa Bunayya: Jurnal Pendidikan Anak Usia Dini*, 2021, vol. 5, no. 2, pp. 64–70. DOI: 10.24853/yby.5.2.64-70 (In Indo.)
58. Hartanti T., Yahfizham Y. The Influence of Programming Algorithm Implementation on Independent Curriculum. *Journal of Informatics and Busisnes*, 2023, vol. 1, no. 3, pp. 76–79. Available at: https://jurnal.ittc.web.id/index.php/jibs/article/view/370 (In Indo.)
59. Febriandi R. F., Susanta A. S., Wasidi W. W. Validity of Mathematics Worksheet with Outdoor-based Scientific Approach on Plane Building Material. *Jurnal Pembelajaran dan Pengajaran Pendidikan Dasar*, 2019, vol. 3, no. 1, pp. 148–158. DOI: 10.33369/dikdas.v3i1.10612 (In Indo.)
60. Purba W. A., Parapat S. H., Harahap H. A., Siregar A., Adristi A. S., Yusnaldi E. Development of Animated Video-Based Learning Media on the Material of Various Types of Jobs for Grade IV Students of SDN 101765 Bandar Setia. *Jurnal Multidisiplin Sahombu*, 2024, vol. 4, no. 2, pp. 465–471. Available at https://ejournal.

seaninstitute.or.id/index.php/JMS/article/view/5811 (accesed 24 September 2024)
61. Brandmiller C., Schnitzler K., Dumont H. Teacher perceptions of student motivation and engagement: longitudinal associations with student outcomes. *European Jounal of Psychology of Education*, 2024, vol. 39, no. 2, pp.1397–1420. DOI: 10.1007/s10212-023-00741-1
62. Loopers J. H., Kupers W. E., de Boer A. A., Minnaert A. E. M. G. Changes in need-supportive teaching over the course of one school year: differences between students with special educational needs and typically developing students. *European Journal of Specail Needs Education*, 2023, vol. 38, no. 5, pp. 688–703. DOI: 10.1080/08856257.2022.2159279
63. Zhang H., Lyu X., Qiu Y. Effective Teacher Professional Development and Its Influencing Factors: A Cross-National Comparison of the United States, China, Finland, and Singapore. *Journal of Teacher Education*, 2024, vol. 75, no. 5, pp. 502–515. DOI: 10.1177/0022487124125477
64. Öhrstedt M., Käck A., Reierstam H., Ghilagaber G. Studying online with special needs: A student perspective. *Journal of Research in Special Educational Needs*, 2024, vol. 24, no. 3, pp. 771-785. DOI: 10.1111/1471-3802.12670

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The author's declared no conficts of interest