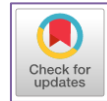# Development of STEAM learning media-based on coding scratch game on the material of the characteristics of living things for elementary school

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Abstract: This research aims to (1) Produce digital learning media from several STEAM (Science, Technology, Engineering, Art, and Math) disciplines based on scratch in the form of coding games on the material characteristics of living things for elementary schools, and (2) Knowing the feasibility of digital learning media STEAM based on scratch game coding on the material characteristics of living things for elementary schools. The type of research used is Research and Development (R&D) with the ADDIE model. The trial was conducted on 30 students of Muhammadiyah Purworejo University. The sampling technique of this research is purposive random sampling. Data collection used observation, interview, and questionnaire techniques. Data analysis techniques using quantitative descriptive statistical processing. The results of this study, namely: (1) STEAM learning media based on coding scratch game on the material of the characteristics of living things for elementary school. (2) The feasibility of STEAM learning media based on coding scratch games on the material characteristics of living things for elementary schools obtained a value in the aspect of ideas with a percentage of 95.83% very feasible category, the aspect of usefulness with a percentage of 95.00% very feasible category, the aspect of creativity with a percentage of 92.50% very feasible category, and the display aspect with a percentage of 93.33% very feasible category. Based on the results of the assessment of the aspects of ideas, usefulness, creativity, and appearance of STEAM learning media based on coding scratch games on the material of the characteristics of living things for elementary schools, it is declared feasible to apply with very feasible criteria. In addition, the digital learning media can harmonize existing technological developments in accordance with the times.

Keywords: Media Digital; STEAM; Coding; Scratch; Game

INTRODUCTION

Covid-19 has caused the isolation of all human activities in the world. The existence of this makes several industrial companies required to create a virtual web or application to overcome activities without leaving home. The industrial world has succeeded in developing artificial intelligence (AI), so that it can bring up web and applications that are still relied on, even developed every time until now, such as zoom, google meetings, and others that can streamline human time in activities (Sigit, 2023). The existence of artificial intelligence, also makes technology demanded to be more developed.

Technology began to develop when entering the 21st century (Fitriyah et al., 2021). The industrial revolution gradually occurred and could affect other countries. The ability and progress of the country is increasing as a result of the advancement of technology.

However, the development of the country can still have a positive impact as well as a negative impact on its citizens. The positive impact of the country's development occurs when there is a change for the better by utilizing technology to prepare a more qualified and competitive generation. One of them is through the authority of the state government which facilitates the education of students by learning technology starting from elementary school (Marnita et al., 2023).

Indonesia's education is still very concerning according to data from the United Nations Development Programme (UNDP) on Human Development Indicators which ranks 116 out of 189 countries. This reflects the welfare of the community in human development, including education, which is still low (Harmila et al., 2021). Therefore, technology can be utilized to improve learning in the field of education which can affect other fields (Candrasa & Cen, 2023).

Learning technology in education, indirectly requires schools to develop along with the times which causes curriculum changes according to the needs and characteristics of students (Satria et al., 2022). The development of increasingly sophisticated technology has made a shift from conventional learning to modern learning (Setyoningrum et al., 2022). With these changes, teachers are required to be able to use and develop technology as a learning media (Lestari et al., 2021). The role of technology will make it easier for teachers to convey material to students and make it easier for students to understand learning material (Herlina et al., 2022). Therefore, teachers must have the ability to use digital technology as a modern digital learning process following the development and era of generation Z life (Marnita et al., 2023).

Learning conditions with digital learning media are currently still very limited and only use platforms that have been used. In addition, the learning methods applied by teachers when teaching tend to use the lecture method, so that learning creates a passive atmosphere, and students tend to quickly feel bored or bored (Ngazizah et al., 2023). The impact of using media that is still limited and seems monotonous will make students less developed (Indra & Fitria, 2021). The learning process that is not monotonous and boring is an interesting learning process that encourages students to be more enthusiastic and enthusiastic about learning (Ngazizah et al., 2021). Therefore, this research introduces a digital coding platform in the form of scratch as one of the tools that can be used to create digital learning media (Novianti et al., 2022).

The word coding may be familiar to people who have been involved in the world of technology. Simply put, coding is a collection of programming codes that a person uses to speak to a computer and can carry out the instructions carried out. Therefore, coding is very useful for industrial development, and even beneficial for the development of students (Ningrum et al., 2023). This is because coding can hone computer skills, both technical and language mastery. In addition, coding can stimulate students' abilities to analyze, evaluate, create, make decisions, and solve problems (Wibowo et al., 2021) (Clavinova et al., 2024). So, to hone the abilities and skills of students, coding blocks in scratch are suitable for use as a forum for making learning media in the form of projects as needed in the school field where friends carry out teaching so that learning is more diverse, interesting, and can reduce the problems of teachers as well as students in the implementation of learning.

Scratch is very relevant to be used as learning media with STEAM (Science, Technology, Engineering, Art, and Math) learning method (Nurbayani et al., 2023). Through the features that have been provided, such as coding code blocks, sprites (characters), backdrops, sound, and some interesting editing features that can make sprites move, or

have sound effects, there are even chat bubbles that can be created according to the code commands used. Scratch can be accessed through digital platforms, in the form of applications and web on Google. Scratch can be used to create stories, animations, and games (Raihan & Arianto, n.d.). Stories, animations, and games made in scratch are audio-visual media, where the media can be added to have sound elements and image elements (Al Ramadhanty et al., 2022). Scratch coding projects can be shared with everyone in the world. Therefore, scratch has very diverse language features (Wardani et al., 2022).

In this study, the authors developed a digital game media with scratch on elementary school science material (Natural Science) characteristics of living things with the STEAM method approach as a step to reduce monotonous learning using the lecture method. (Cahayu et al., 2024; Tarigan et al., 2024). In addition, it reduces the problem of boredom of students in science learning (learning related to the natural environment), even the difficulty of learning math (learning related to the concept of arithmetic) (Mufidah et al., 2022). This is because the STEAM learning method has math learning inserts (Yulianisa & Sudihartinih, 2022). In addition, students can directly practice making scratch coding projects through fun learning (Setiawan, 2022). Children at elementary school age not only need to learn to achieve success, but they also need their own fun, namely playing (Yulia, 2023). Teachers can maximize learning through fun activities, but still carry substantial rule values by integrating educational games into classroom management (Susanti & Darmansyah, 2024).

This research has little in common with previous research, "Development of Educational Science Games Media Assisted by Appsgeyser Application Based on PBL Model to Increase Environmental Care Character of Elementary School Students" by (Indra & Fitria, 2021) in terms of science learning game media. It's just that this research uses different research platforms and theories. Therefore, based on the above problems and links, the material on the characteristics of living things can be conveyed by learning the coding scratch game with the STEAM method developed in this study, namely: (1) Science, in the form of material on the characteristics of living things. (2) Technology, in the form of technology used such as chromebooks, tablets, computers, laptops, or the like. (3) Engineering, in the form of coding techniques. (4) Art, in the form of creativity from editing or taking colors, as well as language arts. (5) Math, in the form of time, points, protractors, and measurements. The many benefits of STEAM coding and the problems in the previous paragraph, this research has a novelty from existing research according to relevant studies that educational learning uses the novelty of scratch coding and STEAM learning methods on the material of the characteristics of living things in elementary school.
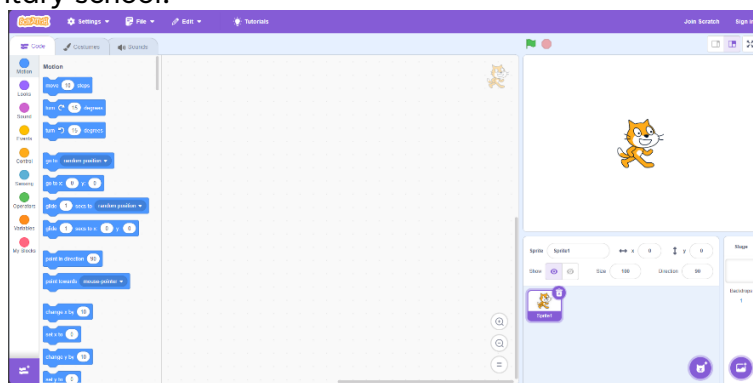

Figure 1. Scratch Platform Initial View

METODE

This research uses the Research and Development (R&D) research type with the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). (Ngazizah et al., 2022). This research was conducted on several students of Muhammadiyah Purworejo University totaling 30 respondents using purposive random sampling technique. The ADDIE development model that the author did in the first stage, namely analyzing the problems that exist in elementary school students with observation, interview, and questionnaire techniques related to learning media as well as learning with the level of difficulty and even boredom in the learning model according to Muhammadiyah Purworejo University students during their involvement in the community both when interacting with the community, doing college assignments, and when campus internships teach at school. The second stage, namely designing or designing products developed to solve the problems found. The third stage is to develop digital learning media. The fourth stage is introducing and implementing the product. The fifth stage is evaluation to determine the feasibility of digital learning media.

This research was conducted at Muhammadiyah Purworejo University, limited to showing videos of how to make media projects and project results used through the scratch web. The tools used are technology, such as laptops, chromebooks, computers, gadgets and the like. Meanwhile, the material is the coding code that has been available on the scratch web. Making STEAM (Science, Technology, Engineering, Art and Math) learning media based on scratch game coding on the material of the characteristics of living things for elementary school. The stages of the STEAM method are in accordance with the EDP (Engineering Design Process)(Lestari et al., 2020), namely (1) Ask is finding problems and solutions. (2) Imagine is describing or imagining the product. (3) Plan is planning the product to be made. (4) Create is making the product. (5) Improve, namely innovating. Data analysis techniques refer more to quantitative descriptive statistics (Sugiyono, 2024), because the data obtained is in the form of numbers from a Linkert scale which is processed in general by finding the average and then finding the percentage (additional).

$$M = \frac{£x}{N}$$ .... 1]

In Equation 1, M represents the average score obtained by dividing the total score of learners ($£x$) by the number of respondents (N). This average score is used to describe the overall performance or results of the learners in a given measurement.

Meanwhile, in Equation 2, R refers to the percentage calculated from the comparison between the score for each aspect (SS) and the ideal score (SI), which is then multiplied by 100 to obtain the result as a percentage. This percentage indicates how closely the achieved score approaches the expected ideal score (Hamsir, 2017).

$$R = \frac{SS}{SI} \times 100$$ .... 2]

Tabel 1. Category of Each Aspect Viewed from the Average

No.	Interval	Category
1.	>3,25 – 4,00	Very Feasible
2.	>2,50 – 3,25	Worth
3.	>1,75 – 2,50	Decent Enough
4.	1,00 - 1,75	Less Feasible

RESULT AND DISCUSSION

Results

This research produces STEAM learning media based on coding scratch games on the material of the characteristics of living things for elementary schools. Previously, research was carried out using the ADDIE development model with the STEAM EDP stage for prospective elementary school teachers at Muhammadiyah Purworejo University. The stages found in the EDP stage, namely:

Ask, which is finding problems and solutions after conducting observations and interviews that there is a lack of digital-based learning media in elementary schools; the ability to think critically, focus, creativity, collaboration, and communication of elementary school students is less honed; the skill of operating a computer/laptop in rural schools is still low; there are not many digital learning media about STEAM; elementary school students have difficulty learning math, science, and language that is comprehensive to all aspects with learning that seems boring; and in ordinary learning children cannot listen to material and immediately make projects. So, the solution I found was to make developments in scratch web-based learning media with a STEAM coding approach in the form of games related to the material of the characteristics of living things in which there are other multidisciplines.

Imagine, which is describing or imagining the product by paying attention to the problems and solutions of all aspects. The product model developed is digital media with STEAM methods related to the material characteristics of living things. Students will learn computer technology and programming languages, foreign languages, science, art, math, as well as coding that can produce projects.

Plan, namely product planning is made by paying attention to the purpose of digital media images using features on the scratch web both sprites, backdrops, as well as editing and color selection. In this planning, the author chose living things in the sea, namely octopus. This is because it pays attention to the material characteristics of living things and the development of learning media as a tool to facilitate students in learning where octopuses actually have environmental adaptations by being able to secrete black ink (excretion) on their bodies to protect against enemies, sensitive to threats (irritability), can move, breathe, grow, develop, require food, reproduce for the survival of their kind and so on.
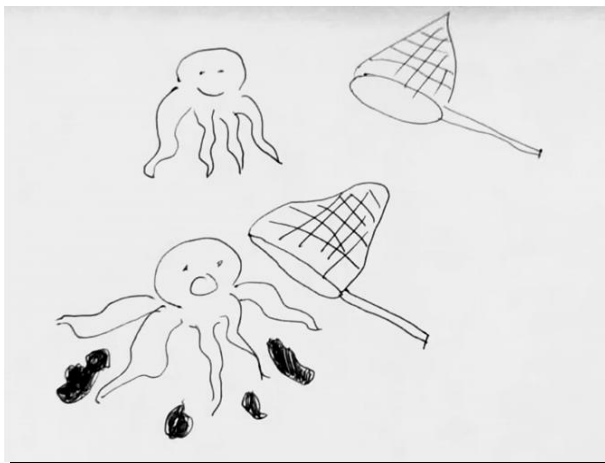

Figure 2. Sketch of Game Creation Plan

In this development, the development media design plan also instills moral values for

not over-catching marine animals (Figure 2). Where when the octopus will be caught using a net, the octopus will release black ink and move away. In this media, sound effects are also given as well as bubble chat effects to illustrate that octopuses can speak. In addition, when the net touches the octopus, a coding point will be given and make the octopus move away from the net.

Create, which is creating a product through web scratch. The first step is to prepare the sprite. Here the author uses an octopus sprite with octopus movements added with ink like a black ball on the costumes feature on the sprite (Figure 3). And create an octopus net with the wizard hat feature and then add wood as a net handle (Figure 4).
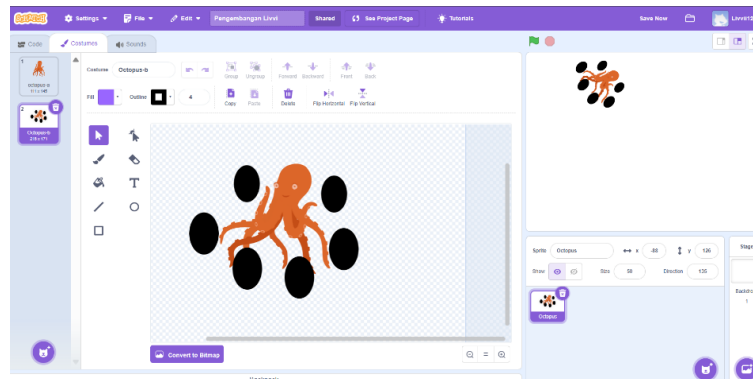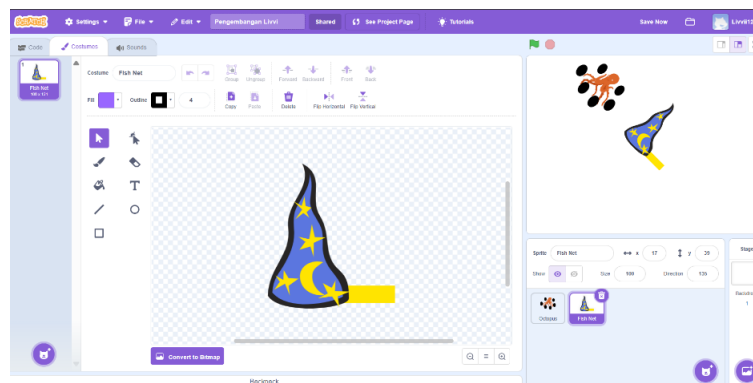

Figure 3. Preparing the Octopus Sprite

Figure 4. Preparing the Sprite Fish Net

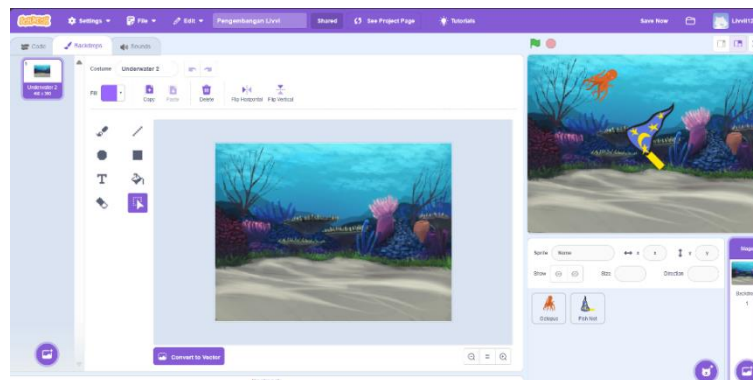The second step is to design the learning media to be attractive by adding a back-drop (Figure 5).

Figure 5. Adding a Backdrop

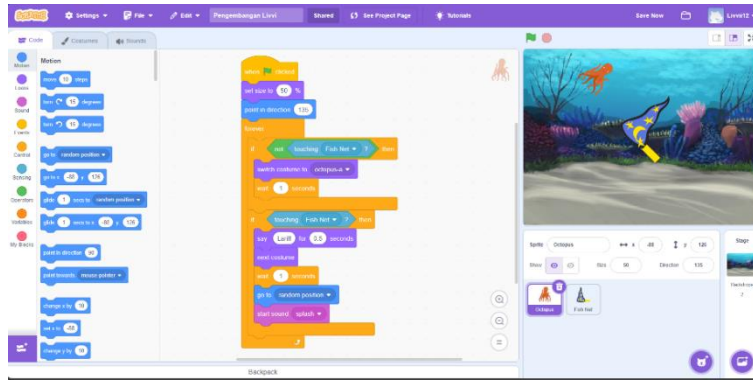In the third step, the writer assembles the code block coding to get the game (Figure 6).
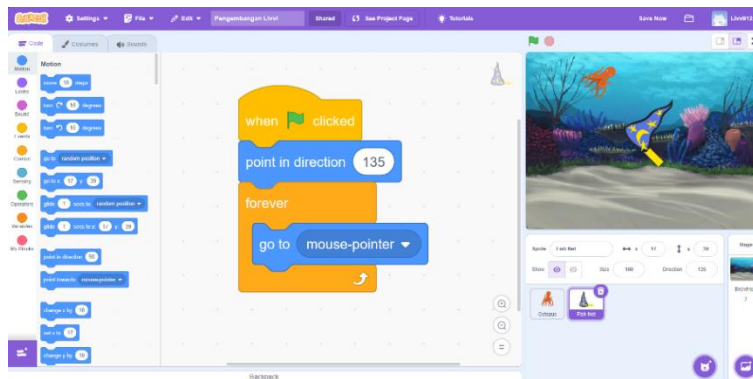
Figure 6. Assembling the Octopus Code Block

Figure 7. Assembling the Fish Net Code Block

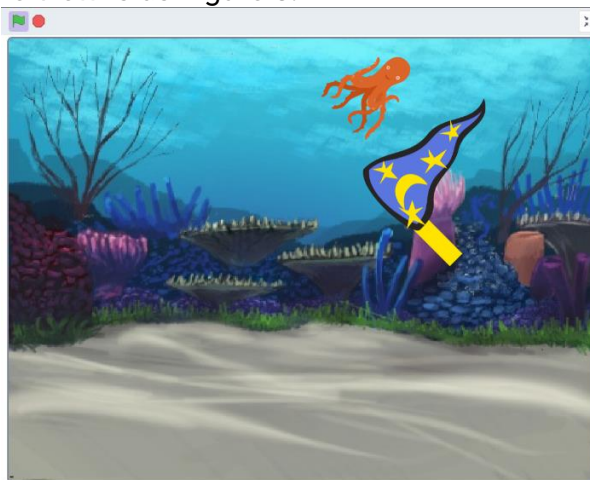Then, a simple game view is as Figure 8.

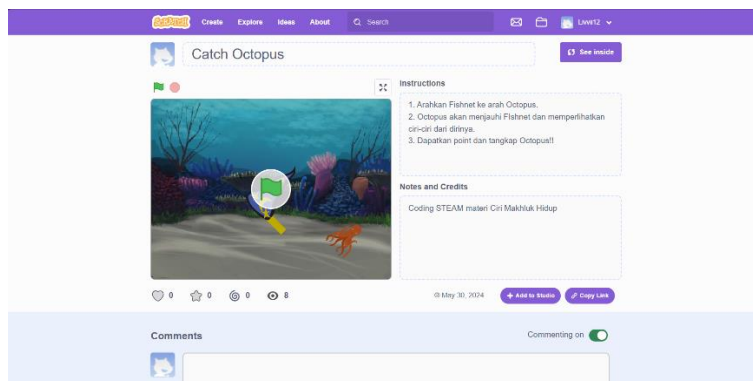**Figure 8.** Game Display Before Development

Figure 9. Game Instruction Display Before Development

Improve, which is innovating the game to make it more interesting and fun by adding a point system when the octopus can escape by adding code variables set point to and change point to set points when successfully escaping. In addition, it also adds a life system for the lives of escaped octopuses that are finally caught (suggestions from several students).
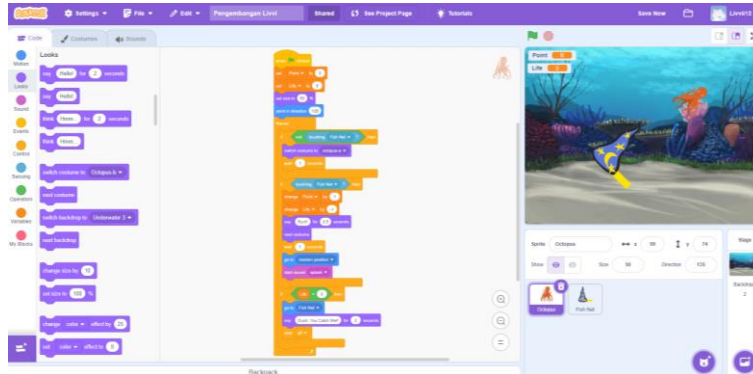

Figure 10. Adding *Code*

So, the game interface that has been developed before validation can be accessed through: Catch Octopus on Scratch (mit.edu)
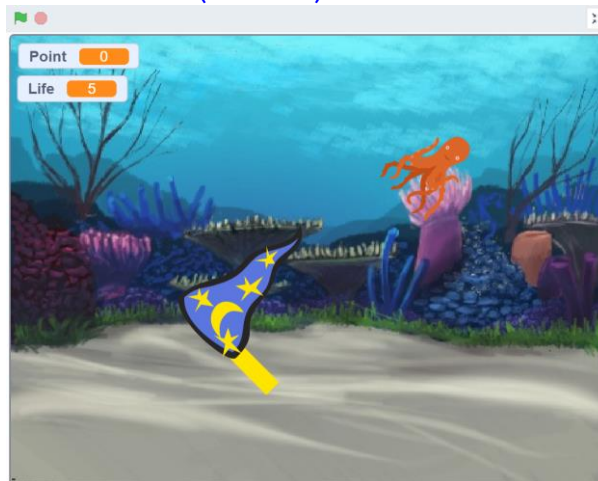

Figure 11. Game Display After Development Additional Points and Octopus Lives (Before Validation)

Figure 12. Initial Game View After Development (After Validation)

Researchers conducted validation to material experts and media experts to increase the usefulness of this learning media. The results of the game display after development are game concepts with prefixes and suffixes, changes in the jarring pattern to make it

more real, and more detailed instructions are added. So, the display of learning media that has been validated can be accessed through: Pengembangan Catch Octopus PGSD FKIP UMPwr Livvi on Scratch (mit.edu)
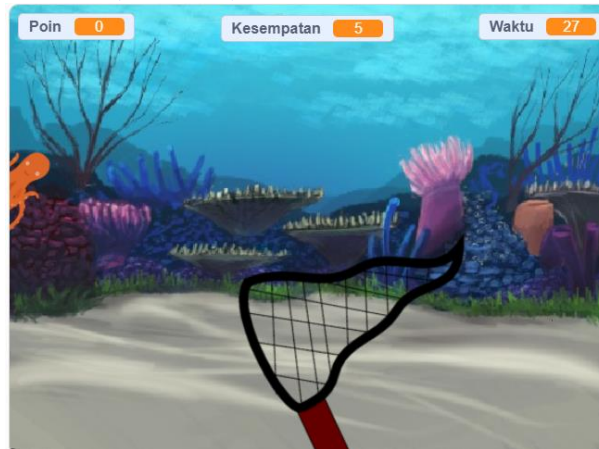

Figure 13. Game Content Concept View After Development (After Validation)

Figure 14. Game End View win the game (Win if you can catch the octopus within 30 seconds) (After Validation)

Figure 15. End Game view of losing the game (Lose if you cannot catch the octopus within 30 seconds) (After Validation)

The game concept has a beginning, core, and end, making the required backdrop 4 parts, namely the initial bacdrop of starting the game, the core, and the end which is divided into 2 again for the state of winning or losing the game. In addition, there are several codes that regulate several backdrop conditions, as follows:
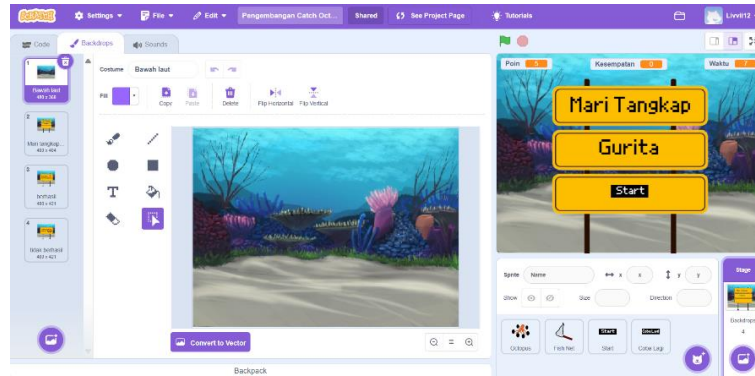
Figure 16. Variety of Backdrop
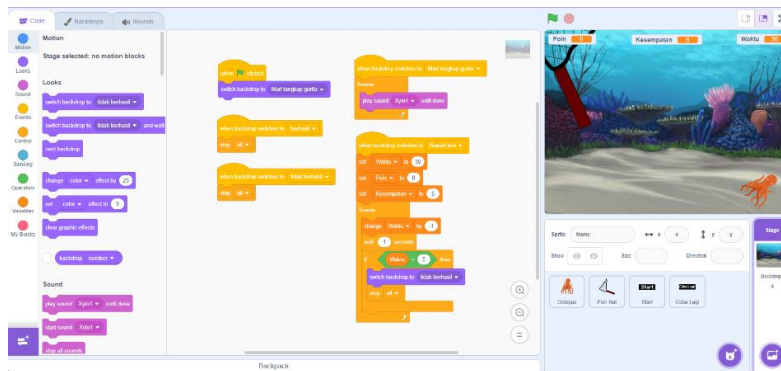
Figure 17. Code on the Backdrop

With the addition of some game concepts and sprite details, the coding that governs the game has changed, as follows:

Figure 18. Additional Code Octopus

Figure 19. Additional Fish Net Code

Figure 20. Fish Net Display Changes

Figure 21. Additional Start Sprite and Start Code

Figure 22. Additional Retry Sprite and Retry Code

Figure 23. Game Instruction Display After Developedment (After Validation)

The results of the data analysis of material validators through a Linkert scale

questionnaire get data (Table 2).

Table 2. Analysis of Material Validator Data Acquisition

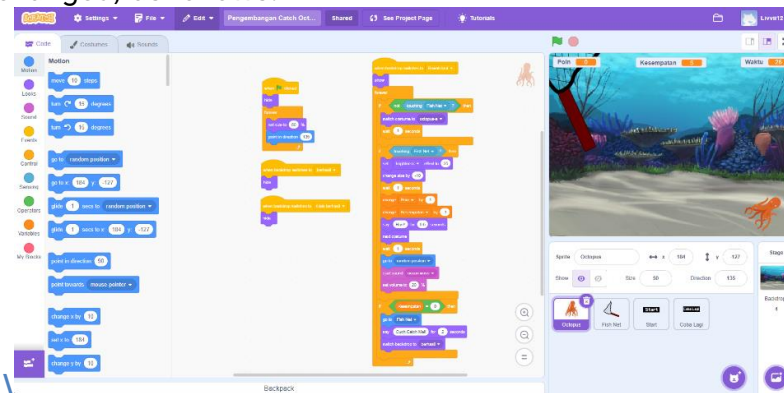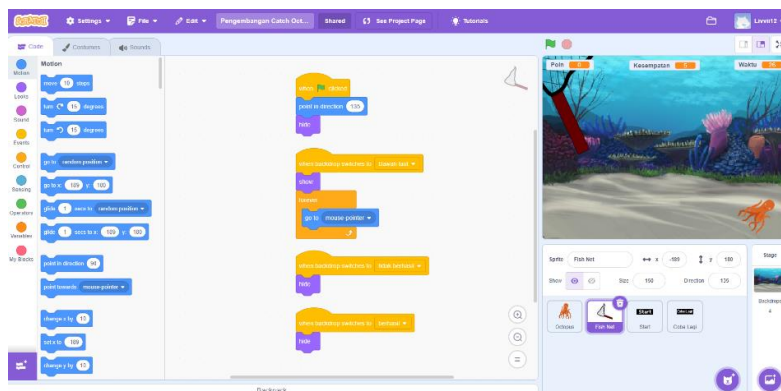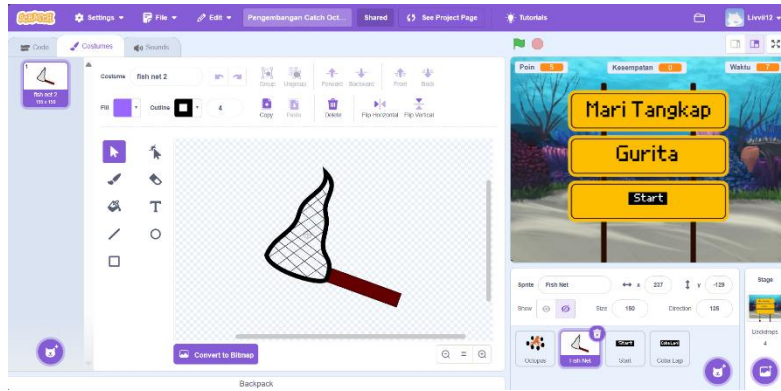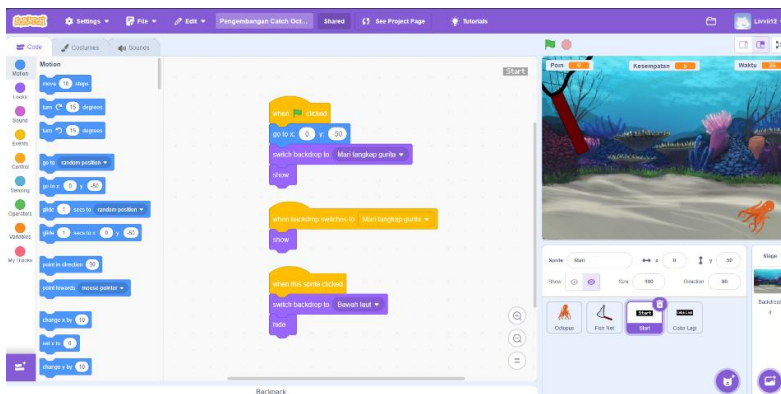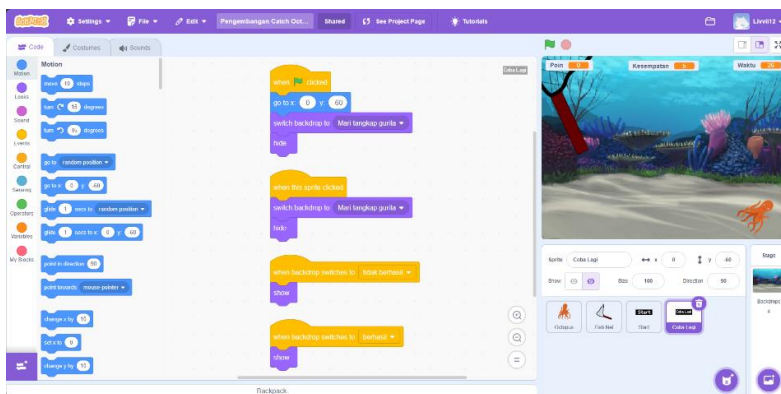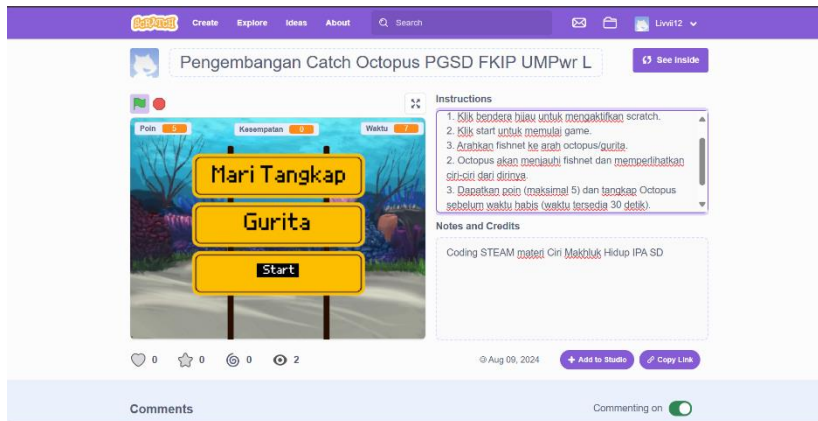| No.	Aspects	Average	Percentage
1.	Learning	3,90	94,08%
2.	Contents	3,95	95,52%

Data analysis from material validators obtained an average learning aspect value of 3.9 with a percentage of 94.08% very feasible category and an average material content aspect value of 3.95 with a percentage of 93.52% very feasible category.

The results of the media validator data analysis through a Linkert scale questionnaire get data (Table 3).

Table 3. Analysis of Media Validator Data Acquisition

No.	Aspects	Average	Percentage
1.	Visual Clarity	4,00	100%
2.	Steps	3,75	93,75%
3.	Aesthetics	3,50	87,5%%
4.	Learning Design	3,75	93,75%
5.	Consistent	4,00	100%

Analysis of the data obtained in the media validator gets an average visual clarity aspect value of 4 with a percentage of 100% very feasible category, the Step aspect value gets an average of 3.75 with a percentage of 93.75% very feasible category, the aesthetic aspect gets an average value of 3.5 with a percentage of 87.5% very feasible category, the value of the learning design aspect gets an average of 3.75 with a percentage of 93.75% very feasible category, and the consistent aspect gets an average value of 4 with a percentage of 100% very feasible category.

The results of data analysis obtained according to 30 students of Muhammadiyah Purworejo University in the aspects of ideas, usefulness, creativity, and appearance using a Linkert scale questionnaire (Table 4).

Table 4. Analysis of Data Acquisition from 30 Students Before the Product is Developed

No.	Aspects	Average	Percentage
1.	Idea	3,56	89,16%
2.	Usability	3,43	85,83%
3.	Creativity	3,36	84,16%
4.	View	3,23	80,83%

Table 5. Analysis of Data Acquisition from 30 Students After the Product was Developed

No.	Aspects	Average	Percentage
1.	Idea	3,83	95,83%
2.	Usability	3,80	95,00%
3.	Creativity	3,70	92,50%
4.	View	3,73	93,33%

The feasibility of STEAM learning media based on coding scratch games on the material of the characteristics of living things for elementary schools on products that have not been developed obtains a value in the aspect of ideas with an average of 3.56 and a percentage of 89.16% very feasible categories, aspects of usefulness with an average of 3.43 and a percentage of 85.83% very feasible categories, aspects of creativity with an average of 3.36 and a percentage of 84.16% very feasible categories, as well as display aspects with an average of 3.23 and a percentage of 80,83% very feasible categories. Meanwhile, the feasibility of STEAM learning media based on coding

scratch games on the material of the characteristics of living things for elementary schools on products that have been developed obtains a value in the aspect of ideas with an average of 3.83 and a percentage of 95.83% very feasible category, the aspect of usefulness with an average of 3.80 and a percentage of 95.00% very feasible category, the aspect of creativity with an average of 3.70 and a percentage of 92.50% very feasible category, and the aspect of appearance with an average of 3.73 and a percentage of 93.33% very feasible category.

Based on the results of the assessment of the aspects of ideas, usefulness, creativity, and appearance of STEAM learning media based on coding scratch games on the material of the characteristics of living things for elementary schools for elementary schools declared before and after development worthy of application with very feasible criteria. In addition, the digital learning media can harmonize existing technological developments in accordance with the times.

Discussion

Based on the results of the research analysis of digital learning media STEAM based coding scratch game on the material of the characteristics of living things for elementary schools get very good qualifications. This research produces learning media that is valid and feasible to use in elementary schools. The feasibility of STEAM learning media based on coding scratch games on the material characteristics of living things for elementary schools obtained a value in the aspect of ideas with an average of 3.83 and a percentage of 95.83% very feasible categories, aspects of usefulness with an average of 3.80 and a percentage of 95.00% very feasible categories, aspects of creativity with an average of 3.70 and a percentage of 92.50% very feasible categories, as well as display aspects with an average of 3.73 and a percentage of 93.33% very feasible categories. This is in line with previous research that digital learning using technology is an innovative and creative learning in the school environment that can improve students' understanding of digital literacy according to the times (Latip, 2022). Moreover, with the Covid-19 pandemic, many teachers and students have experienced difficulties in organizing face-to-face learning (Putro & Astuti, 2024). Teachers lack ideas in making interesting learning media. The utilization of school facilities as learning media has not been maximized so that students show their disinterest when the teacher explains the subject matter. Students are less interested and motivated to learn so they do other activities (Handayani et al., 2023). Learning resources only come from books and student worksheets which make them bored with learning and the material in the book is still shallow, making students less understanding of the material presented (Maola & Irianto, 2023).

The solution is to develop interactive digital multimedia-based learning media where students can directly learn and even create their own projects. Multimedia is one of the strategies in improving the quality of education and improving student learning outcomes (Pangestika & Yansaputra, 2021). Interactive multimedia is very suitable for use in the learning process because of its broad scope, interactive multimedia makes it easier for students to understand the material (Sabil & Jambi, 2024). In line with the previous, the results of the study state that interactive multimedia-based learning media is feasible to use as a learning tool in schools (Candrasa & Cen, 2023) In an era where technology is increasingly integrated into various aspects of life, the application of technology in education has become a significant research topic. One tool that has been used in early childhood learning is scratch. Scratch is a visual programming language developed by the Lifelong Kindergarten Group at the MIT Media Lab. It is

specifically designed for children and beginners in the world of coding, allowing them to create visual interactions by combining blocks of code.

Advantages of using scratch in learning. First, the visual environment of scratch allows children to develop a better understanding of programming concepts through intuitive graphical representations. They can understand how changes to blocks of code can produce different results in the games or applications they create. In addition, utilizing scratch programming in simple game design can help children develop problem-solving skills. They have to plan a logical sequence of actions to achieve the goals in the game, and through this process, they can exercise their analytical and critical abilities (Lady et al., 2021). Learning media that presents games can make students happy and excited in learning.

Therefore, the author has an idea to develop game learning media through the scratch platform juxtaposed with the STEAM method to be more useful in the future for students. In addition, it can reduce the problems that exist in the scope of learning. This media development is STEAM-based with the results of project-based learning design. In education, this is a new learning design which in its implementation can combine various fields of science, namely Science, Technology, Engineering, Art and Mathematics (Parniati et al., 2021). STEAM components contained in digital multimedia learning media on elementary school material on the characteristics of living things. First, science in this development is in the form of material on the characteristics of living things. Second, technology in the form of technology used such as chromebooks, tablets, computers, laptops, or the like. Third, engineering, in the form of block coding techniques applied. Fourth, art in the form of creativity from editing or taking colors, as well as the art of programming languages and foreign languages. Fifth, math in the form of time, points, protractors, and measurements used in the block code.

CONCLUSIONS

This research has (1) Produce STEAM learning media based on coding scratch games on the material of the characteristics of living things for elementary schools that have broad benefits in learning in the world of education; (2) Based on the results of this media research, it is classified as very feasible to use where it gets an assessment on the aspect of ideas with an average of 3.83 and a percentage of 95.83% very feasible category, the aspect of usefulness with an average of 3.80 and a percentage of 95.00% very feasible category, the aspect of creativity with an average of 3.70 and a percentage of 92.50% very feasible category, and the aspect of appearance with an average of 3.73 and a percentage of 93.33% very feasible category. By directing students to follow what we do when creating learning media projects, students have indirectly learned many things for their lives. In addition, STEAM coding can overcome the problems found in learning both teachers and students. How to use and make it easy. Scratch uses code blocks in its application, so learners only put each code together like a puzzle to be able to create and play learning media that they make themselves.

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