EDUHUMANIORA: Jurnal Pendidikan Dasar

Journal homepage: https://ejournal.upi.edu/index.php/eduhumaniora/

Development of Scratch 3.0-Based Science Educational Game on Solar System Material to Improve Learning Outcomes of 6th Grade Elementary School Students

Rizky Ayu Wachdani[1], M. Anas Thohir[2], Candra Utama[3]*

Department of Elementary School Teacher Education, State University of Malang, Indonesia
*Correspondence E-mail: ayurizkywachdani@gmail.com, anas.thohir.fip@um.ac.id, candra.utama.pasca@um.ac.id

ABSTRACT

This research and development aim to create a Scratch 3.0-based science education game product on solar system material that is valid, practical, and effective to improving students' learning outcomes. The method used is Research and Development (R&D) with the ADDIE development model. The subjects in this research consisted of material expert and media experts also 30 students and a 6th grade teacher of SDN Keniten 1. The data collection instrument consisted of a questionnaire, pre-test, and post-test. The validity test results based on material experts obtained an average percentage of 91.1%, while based on media experts obtained an average percentage of 95.3%, both of that were included in the very valid category. The practicality test from students obtained a score of 98.9% and from the teacher obtained a score of 95.4%, both of that were included in the very practical category. The results of the data prerequisite test were normally distributed and the results of the paired sample t-test effectiveness test obtained a Sig. (2-tailed) of 0.000 < 0.05. It can be summed up that $H0$ is rejected and Ha is accepted or there is a significant difference between the pre and post test results. Thus, the use of Scratch 3.0-based science educational games is declared very valid, practical, and significantly effective to improve students' learning outcomes on solar system material.

ARTICLE INFO

Article History:
Submitted/Received 22 July 2024
First Revised 04 Sept 2024
Accepted 08 Dec 2024
Available online 03 Jan 2025
Publication Date 03 Jan 2025

Keyword:
Educational games,
Learning outcome,
Scratch 3.0,
Solar system.

1. INTRODUCTION

Education in today's digital era faces new challenges in facilitating an effective and engaging learning process for students. With the advancement of information and communication technology, it provides a great opportunity in developing a more modern and innovative learning process with the use of technology. The use of technology in learning plays an important role in enabling students to increase motivation, interactivity, and participation in learning, so that it can create a better quality of education (Fauziah & Hadi, 2023). Technology can be integrated into various aspects of learning, starting from methods, resources, to learning media.

The use of learning media is very important, especially for elementary school students, given the cognitive abilities of students who are still at the concrete operational level. Where at this level the ability of students is still lacking to understand abstract concepts, so teachers must be able to guide and facilitate children in order to form the right concepts (Juwantara, 2019). Based on this statement, learning media has a role to assist teachers in conveying messages to students in a more concrete visualization form with the aim of avoiding misconceptions.

One of the interesting integrations of technology in learning is the use of educational games as learning media. Educational games are games that are fun and useful and are made with the aim of supporting the implementation of the learning process (Adrian & Apriyanti, 2019). For most parents, "game" is a scourge and is often considered the biggest carrier of negative impacts on children. Sari (2021) explained that children's focus on games rather than learning is a concern for parents. Even though if used wisely, games can train children to get used to technology, train creativity and problem-solving skills, and train children to follow rules and guidelines, especially if games can be integrated with learning materials. This is in line with the opinion of Pratama *et al.*, (2019), who stated that educational games have the potential to make learning more interactive, fun, and effective, especially when combined with the right learning concepts. Therefore, educational games can be a new opportunity that can present learning in an innovative and different way.

At the primary education level, especially at the 6th grade, learning science about the solar system can be a challenge for teachers and students. This material involves complex and abstract concepts such as planets and their characteristics and how planets work in the solar system. Because the solar system is an abstract material, teachers often have difficulty facilitating student learning because this material cannot be observed directly (Najib *et al.*, 2023). Therefore, the presence of a medium in the learning process is very important to help visualize the concept of the solar system which is still abstract.

Based on initial observations made at SDN Keniten 1, the school does not yet have media used for solar system material. However, teachers have previously utilized the Quizizz platform when teaching other materials. Quizizz is an application for game-based education (Silitonga & Irvan, 2021). When using Quizizz, students seem more enthusiastic during learning and students' learning outcomes are better through the learning process while playing. Based on this, teachers feel the need for more varied game media to help improve students' learning outcomes.

To explore further information, interviews with teachers and the distribution of students' needs analysis questionnaires were conducted. Based on the results of the interview, the teacher experienced difficulties when teaching solar system material, because the media available at school was still limited. Therefore, teachers feel that they

DOI: http://dx.doi.org/10. 17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457

need a variety of learning media, especially those based on technology. Furthermore, based on the questionnaire that has been given to students, the results show that as many as 46.8% of students consider the science subject of solar system material to be a difficult lesson to understand. In addition, as many as 62.5% of students do not understand science if only through thematic books.

Based on the results of observations, interviews, and questionnaires, it can be inferred that teachers and 96.8% of students needs an educational game as an innovative learning media with technology integration in it. The goal is to help students understand solar system material in a fun way. In this context, the development of Scratch 3.0-based science educational games that combine various types of games as learning media can be a new and different option.

Scratch 3.0 is a simple programming language that allows users to create games, animations, and interactive stories more easily (Scratch Foundation, 2013). Scratch created a campaign that aims to create creative teaching and learning, which is in line with the purpose of using the media (Pebrianti, 2019). By integrating solar system learning with Scratch 3.0-based games, students can learn about concepts in a more engaging and interactive way. Furthermore, Scratch has several advantages, including being able to support the programming of various types of projects (games, animations, or stories), easy to operate, and can develop students' ability to think logically through problem solving (Arfiansyah *et al.*, 2019; Nuraenahfisah & Toheri, 2013).

Scratch-based media development has been the object of previous research. Based on previous research, the use of Scratch as a learning media can help students improve student's comprehension, create interactivity, and increase students' enthusiasm in learning (Khalil & Wardana, 2022; Satria *et al.*, 2022; Wardani *et al.*, 2022). Furthermore, the development of educational games in learning has also been the object of previous research. It is known based on previous research, the use of educational games can train students' logic and problem-solving skills (Easter *et al.*, 2022; Pratama *et al.*, 2019). However, there is no research that develops educational games using Scratch 3.0. In addition, the type of game developed is still limited to choosing the correct answer option or writing the answer in the space provided, so the attractiveness is lacking and instead looks like a quiz instead of a game.

Based on the background that has been described, the development of learning media in the form of Scratch 3.0-based science educational games needs to be done in order to help improve student learning outcomes on solar system material. This research and development aim to create a Scratch 3.0-based science education game product on solar system material that is valid, practical, and effective for improving student learning outcomes. The development of Scratch 3.0-based science education games is expected to be an interesting media for students, so that it can create a positive impact on improving students' learning outcomes on solar system material.

2. METHODS

The method used to develop Scratch 3.0-based science education games on solar system material is the Research and Development (R&D) method. In more detail, the method used can be described below.

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457

2.1. Development Procedure

This research and development uses the ADDIE model which includes Analyze, Design, Development, Implementation, and Evaluation (Branch, 2009). The ADDIE model is used because the manufacture of products using the ADDIE design model leads to short stages but there are revisions at each stage to improve the product to meet the expected development objectives. The ADDIE model consists of five research stages which are arranged systematically, which can be seen in **Figure 1.**

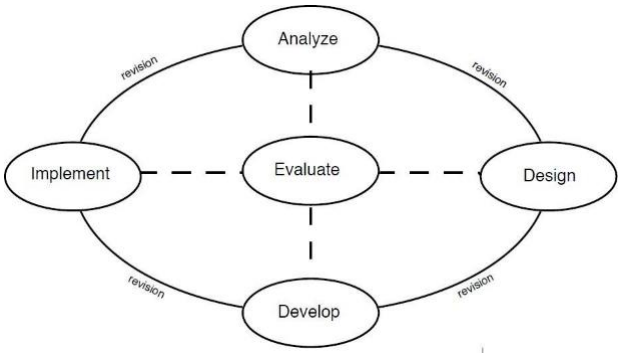

Figure 1. ADDIE Research Stages
Source: Branch (2009)

The analyze stage includes needs analysis, curriculum analysis, and student character analysis. This stage is carried out through observation activities, structured interviews with teachers, and distributing needs analysis questionnaires to 6th grade students. The next stage is design which begins with making the initial design, collecting assets, and designing the flow of the product. Then proceed with designing lesson plans and drafting research instruments. The third stage is develop, which is realizing the product planning that has been done at the design stage. After completing the product development, validity testing and small-scale trials of game products were carried out.

After developing, the next step is to implement by conducting large-scale trials of educational game products. At the implement stage, the media effectiveness test was carried out by giving students a pre-test before using the game and a post-test after using the game. Then proceed with the media practicality test by giving questionnaires to users, that is students and teacher. Finally, the evaluate stage is carried out at each stage of research and development, so that it is expected that Scratch 3.0-based science education game products are feasible to use for learning science solar system material.

2.2. Participants

This research and development involved 3 categories of participants, including expert validators, teacher, and students. Expert validators consisted of 2 lecturers from the Elementary School Teacher Education study program at State University of Malang. Material expert validators have a concentration of expertise in the field of science, so they are competent in assessing the content validity of game product material regarding the solar system. Meanwhile, media expert validators have a concentration of expertise in the field of learning resources and media technology, so they are competent in assessing the validity of the educational game products developed.

The next participant was a 6th grade teacher of SDN Keniten 1 who is a professional teacher and has 8 years of teaching experience. The teacher was involved in this study to

DOI: http://dx.doi.org/10. 17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457

assess the practicality of the media. Lastly, the student participants consisted of 30 grade 6th students of SDN Keniten 1, where 6 students selected using simple random sampling technique participated in the small-scale trial and 24 other students participated in the large- scale trial.

2.3. Data Collection Technique

The techniques used to collect data for research and development of Scratch 3.0-based science educational game are questionnaire and test. The questionnaire consists of four, namely two questionnaires to measure the validity of the media and two questionnaires to measure the practicality of the media. The media validity questionnaire consists of 8 aspects of assessment, including: (1) suitability of material content, (2) completeness of material presentation, (3) accuracy of material presentation, (4) feasibility of material presentation techniques, (5) language suitability, (6) media display, (7) completeness of components, and (8) improving students' cognitive learning outcomes. Meanwhile, the user practicality questionnaire consists of 3 aspects of assessment, including: (1) ease of use, (2) media attractiveness, and (3) media usability.

The test instrument used consists of two, that is pre-test and post-test. The test instruments given previously have been tested for validity and reliability using the construct validity test and the Cronbach Alpha reliability test. Of the 18 questions that have been developed, 15 questions are valid and reliable, so they can be used to measure the effectiveness of the media. There are 3 indicators in the pre-test and post-test, where each indicator consists of 5 questions. The indicators used include: (1) identifying planets in the solar system, (2) determining the position of planets in the solar system, and (3) differentiating planets in the solar system based on their characteristics.

2.4. Data Analysis Technique

The research data obtained has been analyzed, including validity data analysis, practicality data analysis, and media effectiveness data analysis. Validity data obtained from a questionnaire filled out by material and media experts in the form of a Likert scale with a range of 1—4, then calculated using the formula from Akbar (2013) as follows.

$$\textbf{Vah} = \frac{Tse}{Tsh} \times 100\%$$

Description:
Vah = Expert validation
Tse = Total score achieved
Tsh = Total expected score

The percentage of validity test results from material experts and media experts can then be categorized by referring to **Table 1** below.

Table 1. Category Criteria for Validation Results

Value Achievement (%)	Category
85,01 - 100	Very valid
70,01 - 85,00	Valid enough
50,01 - 70,00	Less Valid
01,00 - 50,00	Invalid

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457

Source: Akbar (2013)

Based on the categorization criteria, Scratch 3.0-based science educational game is said to be valid and can be used if the percentage reached is above 70%.

Meanwhile, data on the results of the practicality test were obtained from filling out a questionnaire by teachers on a Likert scale ranging from 1—4 and students on a Guttman scale of yes or no. The data were then processed into percentages referring to the formula from the teacher's questionnaire. Furthermore, the data was processed into a percentage by referring to the formula from Akbar (2013) as follows.

$$\mathbf{NPr} = \frac{\mathbf{Ts}}{\mathbf{Ts\ max}} \times \mathbf{100\%}$$

Description:

NPr = Percentage score
Ts = Total score selected
Ts max = Total maximum score

The scores of the practicality test results from the teacher and student response questionnaires can then be categorized by referring to **Table 2** below.

Table 2. Practicality Result Category Criteria

Value Achievement (%)	Category
75,01 - 100	Very Practical
50,01 - 75,00	Practical enough
25,01 - 50,00	Less Practical
01,00 - 25,00	Not Practical

Source: Akbar (2013)

Based on categorization criteria, Scratch 3.0-based science educational game is said to be practical and can be used if the percentage achieved is above 50%.

Furthermore, the effectiveness data analysis was obtained from the results of the pre-test and post-test which were then processed using SPSS. The data obtained has gone through two stages of testing, namely the normality prerequisite test and hypothesis testing. If in the prerequisite test the significance value is more than 0.05 (sig > 0.05), then the data is normally distributed. Meanwhile, if the significance value is less than 0.05 (sig < 0.05), then the data is not normally distributed.

Data that have been tested for normality prerequisites are then subjected to paired sample t-test hypothesis testing because the data meet the prerequisites of normal distribution. The basis for decision making is based on the level of significance obtained. If the significance value < 0.05 then $H0$ is rejected and Ha is accepted, meaning that there is a significant difference between the pre-test and post-test results. Meanwhile, if the significance value is > 0.05 then $H0$ is accepted and Ha is rejected, meaning that there is no significant difference between the results of the pre-test and post-test.

3. RESULT AND DISCUSSION

The product produced in this development research is a Scratch 3.0-based science education game with the title "Space Adventure". The game was developed using the Scratch 3.0 visual programming language that can be accessed through a browser and operated using a Personal Computer (PC) or laptop. The game developed focuses on solar

DOI: http://dx.doi.org/10. 17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457

system material, precisely on planetary sub-materials and their characteristics. There are 3 parts in the game, namely: opening part, core part, and closing part. The results of the development of Scrtach 3.0-based science education game products can be described as follows.

Figure 2 shows the opening section which contains the game's home page. In the opening section there is a play button, the title of the game, and the developer's name.

Figure 2. Game Home Page

Figure 3 shows the main menu that will appear after the user presses the play button. On this page, there are guide, learning, and playing menus. In addition, on this page, there is a volume setting feature.

Figure 3. Main Menu

Figure 4 shows the contents of the guide menu which consists of an explanation of the features on the game, learning objectives, and the function of the icons so that users are not confused when operating the game.

Figure 4. Guide Menu

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457

Figure 5 shows the content part of the learning menu which consists of exposure to solar system material that can be accessed by users before playing the game

Figure 5. Learning Menu

Figure 6 shows the content section of the play menu which consists of 3 stages with three types of games, including: Guess Who I Am, Planet Puzzle, and Planet Riddle.

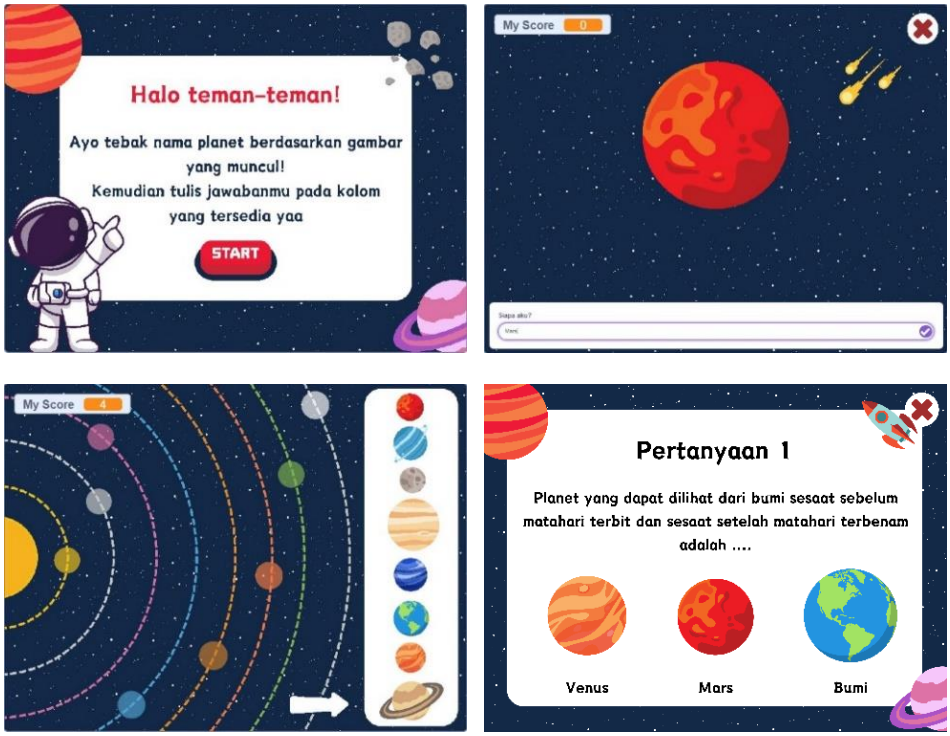

Figure 6. Playing Menu

Figure 7 shows the closing section which contains the final score and star category, reference list, and developer profile.

DOI: http://dx.doi.org/10. 17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457

Figure 7. Closing

3.1. Validity of the Media

The Scratch 3.0-based science educational game media that has been developed, before being tested on students, is first tested for validity by material experts and media experts. Material and media validators consist of two lecturers from the Elementary School Teacher Education (PGSD) program at the State University of Malang. The results of the Scratch 3.0-based science education game media product test are presented in **Table 3** below.

Table 3. Material Expert Validation Results

No	Assessment Aspect	Material Expert	Media Expert	Validaty on Value	Category	Test Decision
1.	Content suitability	75%				
2.	Completeness of material presentation	100%				
3.	Accuracy of the material	87,5%				
4.	Feasibility of material presentation techniques	100%		93%	Very Valid	Can be used without revision
5.	Keseuaian bahasa	100%	91,6%			
6.	Language compatibility		92,9%			
7.	Media display		96,8%			
8.	Completeness of components	83,3%	100%			
	Average	**91,1%**	**95,3%**			

Based on **Table 3**, the results of media expert validation in general show that all aspects of the assessment are included in the very valid category with the decision to test the product can be used without revision. The assessment aspects that get the highest results are the completeness of the material presentation and the feasibility of the material presentation technique with a percentage of 100%. This means that the game developed already has a complete and systematic presentation of material as well as the selection of games and questions that are feasible. This is supported by the statement Sarip *et al.* (2022) that a media must have a systematic arrangement of material, so that it can achieve effective learning. Furthermore, the selection of game types must be in accordance with the characteristics of elementary school students who are curious and have a desire to try a lot. So that the selection of various types of games in Scratch 3.0-based science educational games is feasible to use. The lowest percentage of media

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457

validity is found in the aspect of suitability of material content, which is 75%. Based on this value, it can be interpreted that the game developed is sufficiently in accordance with the indicators and learning objectives that have been prepared before.

In addition to conducting the assessment, the validator also provided some suggestions and input to improve media development. The material expert validator gave a suggestion related to the suitability aspect of the material content. The advice given is that the questions in stage 3 of the game need to be reviewed and improved to suit the learning objectives. This is in accordance with the statement Fakhrurrazi (2018) that to achieve effective learning, learning needs to be in accordance with basic competencies (KD), indicators, and learning objectives. In addition, at the end of the game, it is necessary to add a 2-star achievement category which previously only had 1 and 3 star categories. The 1-star achievement category is for scores < 52, 2-star starts from the score range 52 - 75, and 3-star for scores > 75. Meanwhile, the suggestion given by the media expert is that the game would be better if it is equipped with a volume setting feature to make it easier for students to adjust the desired volume. Furthermore, the game needs to be equipped with a list of references from the material used and a brief developer profile needs to be added.

3.2. Practically of the Media

The Scratch 3.0-based science education game products developed were not only tested for validity, but also for practicality. The practicality of the game products developed is based on the results of the practicality questionnaire that have been fiiled out by users, that is teacher and students. The trial was conducted twice, firstly a small-scale trial and secondly a large-scale trial. The results of the game media practicality test from teachers and students are presented in **Table *4*** as follows.

Table 4. Teacher Practicality Test Results

No.	Assessment Aspect	Students		Teacher	Category	Test Decision
		Small Scale	Large Scale			
1.	Ease of use	96,7%	98,3%	95%	Very practical	Can be used without revision
2.	Media attractiveness	100%	100%	91,6%		
3.	Media usability	100%	100%	100%		
Average		**98,5%**	**99,2%**	**95,4%**		

Based on **Table 4**, the results of the practicality test based on students and teachers in general show that all aspects of the assessment are included in the very practical category with the decision to test the product can be used without revision. The aspect of assessment that gets the highest result is the usability of the media with a percentage of 100%. These results are in line with the responses of students who are more enthusiastic and excited about learning when using Scratch 3.0-based science education games, so that they can help students understand solar system material. In addition, teachers feel that Scratch 3.0-based science education games can help create a fun learning experience for students. The developed game can also stimulate students to actively participate in the learning process. Because this game is designed so that students can operate it independently with supervision from the teacher.

The results of the practicality questionnaire were supported by positive opinions from the students. The students indicated that the educational game was user-friendly and

DOI: http://dx.doi.org/10. 17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457

easy to navigate, which contributed significantly to a smooth trial implementation. They reported experiencing no significant difficulties at any stage of the process, from the moment they opened their chromebooks, to accessing the Scratch website, and even while operating the game itself, the entire experience was seamless. Furthermore, students felt that the selection of game types in educational games was interesting and varied. These results are a novelty from previous research, where the game developed still has only 1 type of game (Amirulloh *et al.*, 2019; Yulianto *et al.*, 2019; Lestari & Sudihartinih, 2022).

In addition to providing an assessment, the teacher also provided positive feedback, namely that the Scratch 3.0-based science education game media is easy to use anytime and anywhere. Because, the game was developed with a web-based that can be accessed online, so users do not need a device with large storage to access it. These results are a novelty from previous research, where the game developed still uses Scratch 2.0 software that requires installation on the device (Wardani *et al.*, 2022; Siregar *et al.*, 2024).

However, there were a few obstacles during the small-scale trial, namely the process of accessing the game which took quite a long time due to the unstable internet network, so that some objects in the game could not appear. Based on these obstacles, the solution carried out during the large-scale trial was to prepare additional internet hotspots and move the location to the computer laboratory room to be closer to the wifi router. Another obstacle that occurred was during learning, there were a small number of students who were observed accessing other things after finishing using the game, so that students did not focus on listening to instructions from the teacher. Therefore, during the large-scale trial, teachers and researchers conducted stricter supervision.

3.3. Evectiveness of the Media

The use of science educational game media based on Scratch 3.0 can improve student learning outcomes. The effectiveness of the media to improve learning outcomes is measured through pre and post tests given to 24 6th grade students. The test used consists of 15 items that cover 3 learning objectives based on KD 3.7 IPA in the 6th grade. The average results of pre and post test scores for each indicator are presented in **Figure 2**.

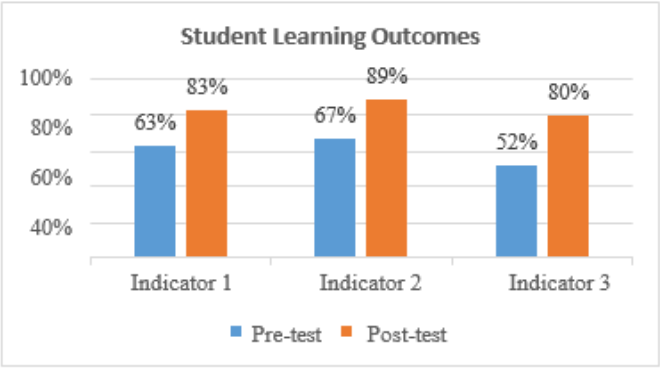

Figure 2. Graph of Student Learning Outcomes

Description:
Indicator 1 = Identify the planets in the solar system
Indicator 2 = Determine the position of the planets in the solar system

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457

Indicator 3 = Differentiate planets in the solar system based on their characteristics

Based on **Figure 2**, the average scores persentages on each indicator of student learning outcomes after using Scratch 3.0-based educational games experienced an upward trend compared to student learning outcomes before using Scratch 3.0-based educational games. Indicator 3 experienced the largest increase in learning outcomes, which is 28%, while indicator 1 experienced the smallest increase in learning outcomes, which is 20%. Thus, it can be concluded that Scratch 3.0-based science educational game media can improve student learning outcomes.

Furthermore, to determine the effectiveness of Scratch 3.0-based science educational game media, the pre-test and post-test data obtained will be tested using SPSS version 29.0. But before the hypothesis test is carried out, the prerequisite test is first carried out using the Shapiro Wilk normality test. Based on the results of the normality test, it was found that the Sig. pre-test value was 0.323 and the Sig. post-test value was 0.55 where the value was > 0.05, so it can be said that the data were normally distributed. Therefore, the hypothesis test using the paired sample t-test can be continued. The paired sample t-test results of student learning outcomes are presented in Table 5 below.

Table 5. Paired Sample T-Test Results of Learning Outcomes

		Paired Samples Test				
		Mean	**Std. Deviation**	**t**	**df**	**Sig. (2-tailed)**
Pair Indicator 1	Pre – Post Test	-1.000	.978	-5.009	23	.000
Pair Indicator 2	Pre – Post Test	-1.125	1.076	-5.122	23	.000
Pair Indicator 3	Pre – Post Test	-1.417	1.176	-5.899	23	.000
Pair Total	Pre – Post Test	-23.542	5.964	-19.339	23	.000

Description:
Indicator 1 = Identify the planets in the solar system
Indicator 2 = Determine the position of the planets in the solar system
Indicator 3 = Differentiate planets in the solar system based on their characteristics

Based on **Table 5**, the paired sample t-test results on indicator pairs 1, 2, and 3 get a Sig. (2-tailed) value < 0.05, it can be summed up that $H0$ is rejected and Ha is accepted or there is a significant difference between the pre-test and post-test results on each indicator. Furthermore, the total pair results get a Sig. (2-tailed) value of 0.000, where the significance value is < 0.05. Therefore, it can be inferred that the use of Scratch 3.0-based science educational games can significantly improve student learning outcomes on solar system material.

The highest increase in learning outcomes is found in indicator 3 which is "differentiate the planets in the solar system based on their characteristics" with an average percentage of 31%. The highest increase is because during learning using educational games there is a "Learning" menu that contains material related to the characteristics of planets in the solar system. In the learning menu, not only is an explanation of the characteristics or popular nicknames of each planet presented. However, it is also accompanied by an explanation of the "reason" behind the planet's popular nickname. This shows that the educational game developed has a complete and systematic presentation of material, as evidenced by the results of the material expert validation which received a score of 100% on this aspect. In line with this, Sarip *et al.*, (2022)

DOI: http://dx.doi.org/10. 17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457

explained that a media must have a systematic arrangement of material, so that it can achieve effective learning. After completing the material on the learning menu, students can use the "Planet Puzzle" game in the game to practice their understanding. As a result, students can understand and differentiate the characteristics of the planets in the solar system as a whole and correctly.

Indicator 1 which is "identifying the planets in the solar system" shows a moderate increase with an average percentage of 23%. However, there is one item on the indicator 1 pre-test that gets low results, where the question asks about the causes of the planets being able to rotate regularly around the sun. Based on the pre-test results, only 1/3 of the students were able to answer correctly. However, during the post test, students who could answer correctly almost doubled. This is because in the educational game there is an illustration of the orbit of each planet when circling the sun which is presented clearly to make it easier for students to absorb the material being taught (Hidayat *et al.*, 2020).

Indicator 2 which is "determining the position of the planets in the solar system" experienced the lowest increase with an average percentage of 21%. This condition is because students' initial knowledge on this indicator is quite good as evidenced by the highest pre-test results compared to other indicators. In indicator 2, most students can already sort the planets well because of the song taught by the teacher beforehand, so the increase is not as high as other indicators.

The significant increase in students' pre-test and post test results occurred because the Scratch 3.0-baseds science education game can present a pleasant learning atmosphere and can increase students' enthusiasm and involvement in the learning process. With increased enthusiasm and student involvement, the use of this educational game can help students in obtaining higher learning outcomes on solar system material (Prykhodchenko *et al.*, 2020; Yu *et al.*, 2021; Wardani *et al.*, 2022). The materials and games in the Scratch 3.0-based science education game are systematically arranged based on 3 indicators that have been compiled, so that this game can help students improve learning outcomes on solar system material significantly.

4. CONCLUSION

This research and development produce Scratch 3.0-based science education game products on solar system material with the title "Space Adventure" which are valid, practical, and effective for improving students' learning outcomes. Based on the results that have been described, it can be concluded that the Scratch 3.0-based science education game is very valid to be used as learning media on solar system material. The educational game developed is very practical to be used by students and teachers, so that the level of student participation increases and can help teachers create a pleasant learning experience. In addition, Scratch 3.0- based science educational games can significantly improve students' learning outcomes on solar system material. For further research, when accessing Scratch 3.0-based science education game media, you should pay attention to the stability of the internet connection so that it can be used optimally without any obstacles when processing the game. In addition, strict supervision from teachers or other adults is needed to students when operating games through chrome books, so as to minimize the possibility of students misusing the device during the learning process. Furthermore, supervision from the teacher is also needed when students take the test, so that the results obtained are a representation of the true ability of each student.

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457

5. REFERENCES

Adrian, Q. J., & Apriyanti, A. (2019). Game edukasi pembelajaran matematika untuk anak SD kelas I dan II berbasis android. *Jurnal Teknoinfo*, 13(1), 51. https://doi.org/10.33365/jti.v13i1.159

Akbar, S. (2013). *Instrumen perangkat pembelajaran*. Bandung.

Amirulloh, T. R. A., Risnasari, M., & Ningsih, P. R. (2019). Pengembangan game edukasi matematika (operasi bilangan pecahan) berbasis android untuk sekolah dasar. *Jurnal Ilmiah Edutic: Pendidikan dan Informatika*, 5(2), 115–123. https://doi.org/10.21107/edutic.v5i2.5355

Arfiansyah, L. P., Akhlis, I., & Susilo. (2019). Pengembangan media pembelajaran berbasis scratch pada pokok bahasan alat optik. *Unnes Physics Education Journal*, 8(1), 66–74. https://doi.org/10.15294/upej.v8i1.29515

Branch, R. M. (2009). Instructional design: The ADDIE approach. Springer US. https://doi.org/10.1007/978-0-387-09506-6

Easter, F., Palilingan, V. R., & Djamen, A. C. (2022). Pengembangan game edukasi bahasa inggris berbasis mobile untuk siswa PAUD. E*dutik: Jurnal Pendidikan Teknologi Informasi dan Komunikasi*, 2(2), 259–267. https://doi.org/10.53682/edutik.v2i2.4679

Fakhrurrazi, F. (2018). Hakikat pembelajaran yang efektif. *At-Tafkir*, 11(1), Article 1. https://doi.org/10.32505/at.v11i1.529

Fauziah, R., & Hadi, M. S. (2023). Analisis efektivitas dan manfaat quizizz paper mode dalam pembelajaran interaktif di kelas III SDN Singabraja 02. *JIM: Jurnal Ilmiah Mahasiswa Pendidikan Sejarah*, 8(3), 2721–2730.

Hidayat, H., Mulyani, H., Nurhasanah, S. D., Khairunnisa, W., & Sholihah, Z. (2020). Peranan teknologi dan media pembelajaran bagi siswa sekolah dasar di dalam pembelajaran pendidikan kewarganegaraan. J*urnal Pendidikan Kewarganegaraan Undiksha*, 8(2), Article 2. https://doi.org/10.23887/jpku.v8i2.24759

Juwantara, R. A. (2019). Analisis teori perkembangan kognitif piaget pada tahap anak usia operasional konkret 7-12 tahun dalam pembelajaran matematika. *Al-Adzka: Jurnal Ilmiah Pendidikan Guru Madrasah Ibtidaiyah*, 9(1), 27. https://doi.org/10.18592/aladzkapgmi.v9i1.3011

Khalil, N. A., & Wardana, M. R. (2022). Pengembangan media pembelajaran matematika menggunakan aplikasi scratch untuk meningkatkan higher order thinking skill siswa sekolah dasar. *Jurnal Kiprah Pendidikan*, 1(3), 121–130. https://doi.org/10.33578/kpd.v1i3.45

DOI: http://dx.doi.org/10. 17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457

Lestari, A., & Sudihartinih, E. (2022). Pengembangan media pembelajaran matematika berjudul game learn with adventure menggunakan scratch. *Buana Matematika: Jurnal Ilmiah Matematika dan Pendidikan Matematika*, 12(2), Article 2. https://doi.org/10.36456/buanamatematika.v12i2.5451

Najib, M., Syawaluddin, A., & Raihan, S. (2023). Pengembangan multimedia pembelajaran interaktif sistem tata surya berbasis literasi sains untuk siswa SD. *Jurnal Inovasi Pedagogik dan Teknologi*, 1(1), 1–13.

Nuraenahfisah, N., & Toheri, T. (2013). Pengaruh penggunaan scratch terhadap kreativitas berfikir matematis (studi eksperimen terhadap siswa kelas viii mts negeri ketanggungan Kabupaten Brebes). *Eduma: Mathematics Education Learning and Teaching*, 2(1). https://doi.org/10.24235/eduma.v2i1.65

Pebrianti, F. (2019). Kemampuan guru dalam membuat media pembelajaran sederhana. Seminar Nasional Pendidikan Bahasa dan Sastra, 93–98.

Pratama, L. D., Lestari, W., & Bahauddin, A. (2019). Game edukasi: Apakah membuat belajar lebih menarik?. *At- Ta'lim: Jurnal Pendidikan*, 5(1), 39–50. https://doi.org/10.36835/attalim.v5i1.64

Prykhodchenko, S. D., Prykhodchenko, O. Y., Shevtsova, O. S., & Semenov, S. Y. (2020). Gamification of learning scratch in elementary school. First International Computer Programming Education Conference (ICPEC 2020).

Sari, N. Y. (2021). Ikatan emosional guru dan siswa (peran guru dalam meningkatkan disiplin belajar siswa di era digital). *Islamic Elementary School (IES)*, 1(1), 53–63. https://doi.org/10.55380/ies.v1i1.106

Sarip, M., Amintarti, S., & Utami, N. H. (2022). Validitas dan keterbacaan media ajar e-booklet untuk siswa SMA/MA materi keanekaragaman hayati. J*UPEIS: Jurnal Pendidikan dan Ilmu Sosial,* 1(1), Article 1. https://doi.org/10.57218/jupeis.Vol1.Iss1.30

Satria, E., Syaefudin Sa'ud, U., Sopandi, W., Tursinawati, T., Hayati Rahayu, A., & Anggraeni, P. (2022). Pengembangan media animasi interaktif dengan pemograman scratch untuk mengenalkan keterampilan berpikir komputasional. J*urnal Cerdas Proklamator,* 10(2), 217–228. https://doi.org/10.37301/cerdas.v10i2.169

Scratch Foundation. (2013). Scratch 3.0 (3.0) [Computer software]. https://scratch.mit.edu/

Silitonga, H., & Irvan, I. (2021). Pembelajaran menyenangkan dengan aplikasi quizizz di tengah pandemi covid-19. Jurnal Penelitian, *Pendidikan dan Pengajaran: JPPP*, 2(2), 144.

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457

Siregar, T., Ardian, R., Harahap, S. R., & Nasution, A. A. (2024). Media pembelajaran berbasis ict menggunakan software scratchpada materi peluang di SMPN 2 Portibi. *SINERGI: Jurnal Riset Ilmiah*, 1(1), Article 1. https://doi.org/10.62335/b6a7cf11

Wardani, P., Permana, E., & Wenda, D. (2022). Pengembangan media game scratch pada pembelajaran ipa kelas v materi alat pernapasan pada hewan. *Edusaintek: Jurnal Pendidikan, Sains, dan Teknologi,* 9(1), 40–49.

Yu, Z., Gao, M., & Wang, L. (2021). The effect of educational games on learning outcomes, student motivation, engagement and satisfaction. *Journal of Educational Computing Research,* 59(3), 522–546. https://doi.org/10.1177/0735633120969214

Yulianto, F., Yulianto, F., Utami, Y. T., & Ahmad, I. (2019). Game edukasi pengenalan buah-buahan bervitamin c untuk anak usia dini. *Jurnal Nasional Pendidikan Teknik Informatika (JANAPATI)*, 7(3), 242. https://doi.org/10.23887/janapati.v7i3.15554

DOI: http://dx.doi.org/10. 17509/xxxx.xxxx
p- ISSN 2085-1243 e- ISSN 2579-5457