



Scratch Assisted Educational Game Development on Data Presentation Material

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<i>Submitted: 21-05-2026</i>	<i>Revised: 23-05-2026</i>	<i>Accepted: 25-05-2026</i>	<i>Published: 05-06-2026</i>
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ABSTRACT

This study aims to develop a Scratch-based educational game for data presentation materials and to determine its feasibility and student responses. The research method used is Research and Development (R&D) with the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). This study was conducted at SMAN Jatininggal and involved two Mathematics Education lecturers from Siliwangi University as validators and 10th grade students as research subjects. Data were collected through validation sheets and student response questionnaires analyzed using a Likert scale. The results of the material expert validation showed that all aspects, including suitability, language accuracy, and presentation systematics, were in the very feasible category. Media expert validation on the interface display, navigation, supporting information, and learning design aspects also obtained a very feasible category. In the implementation phase, small group trials obtained a percentage of 90.42% and field trials increased to 93.66%, both of which were categorized as very practical. These findings indicate that the developed Scratch-based educational game is feasible and practical to be used as a mathematics learning medium for data presentation materials, and is able to increase students' interest and motivation in learning mathematics.

Keywords: educational games; data presentation scratch; development

INTRODUCTION

Education is a basic need for every human being because through education, knowledge, skills, and experience can be optimally developed. The quality of learning is a determining factor in improving the quality of education (Juliyana et al., 2024). Mathematics is the abstract science of numbers, quantities, and space, which can be applied both as pure concepts and in various disciplines such as physics and engineering (Agbata et al., 2024). However, in reality, many students seem uninterested in mathematics and often question the relevance of the time they spend studying the subject (Ningsih et al., 2021). Based on Minister of National Education Regulation Number 8 of 2024, one of the goals of mathematics learning is for students to have creative thinking skills that include the ability to generate new ideas, explain the relationships between concepts innovatively, and apply concepts flexibly, originally, flexibly, and precisely in solving mathematical problems (Kemendikbudristek, 2024). Furthermore, according to the NCTM (Hafriani, 2021), mathematics learning objectives encompass five basic skills problem-solving, communication, connections, reasoning, and representation.

Based on observations and interviews conducted at SMAN Jatininggal, it was found that students still experience a lack of interest in mathematics learning, particularly in materials that involve images, symbols, and formulas, such as data presentation. Fully

teacher-controlled learning without interactive media leads to students being less focused and less active during the learning process. A questionnaire distributed via Google Form to 31 students showed that 89.3% disliked mathematics, 85.7% used the lecture method in learning, and 89.3% had never used educational games in their learning. A total of 71.4% of students expressed interest when educational games were introduced into learning, and 32.1% of students played online games more than two to three times a day. This suggests that smartphone use by students is primarily directed towards entertainment, rather than supporting the learning process. Therefore, innovative learning media are needed to shift students' gaming habits toward more productive and educational ones.

Several previous studies have shown that educational games are feasible and can be used in the learning process and have received positive responses from users (Novianti, 2022). Scratch based educational games have proven effective in learning complex material, actively engaging students (Ali et al., 2024). Other research has also shown that educational games can improve students' conceptual understanding of mathematics (Setiawan & Nurhidayah, 2021). However, these studies have not yet examined the development of Scratch-based educational games focused on data presentation for high school students. This gap is identified because data presentation materials are often considered abstract and less engaging when presented through conventional methods, necessitating alternative interactive media tailored to students' needs. Therefore, this research has a novelty, namely developing a Scratch-based educational game specifically designed for data presentation materials at the high school level, which combines interactive visuals and game elements to make abstract statistical concepts more concrete and engaging. Unlike previous studies that only focused on general mathematics or other subjects, this study is expected to directly address the lack of interactive digital media for data presentation, providing a practical and feasible learning tool tailored to the characteristics and needs of high school students.

Scratch is a visual programming language useful for constructing mathematical images or concepts, creating story illustrations, learning videos, games, and interactive animations (Afrilianto et al., 2022). Rofik et al., (2025) proved that Scratch 3.0 based learning media was proven valid, feasible, and effective in improving student understanding, with a feasibility level reaching 98.71% and a significant increase in learning outcomes from an average pretest of 45.00 to 87.69 in the posttest. Educational games developed using Scratch provide an engaging and enjoyable learning experience because students can interact directly through playing, exploring, and interacting with game features. This is in accordance with research by Lazareva and Gorovik (2023) that interactivity and adaptability are one of the methods in developing educational games, where active student participation has been proven to improve the quality of learning (Lazareva & Gorovik, 2023). Therefore, researchers are interested in conducting research entitled "Scratch Assisted Educational Game Development for Data Presentation Materials".

This study has two research questions: the feasibility of a Scratch-based educational game for data presentation, and student responses to its use in learning. Therefore, this study aims to determine the feasibility of the developed game and understand student responses after using it. The main problem is that data presentation material is often considered abstract and difficult to understand when taught through conventional methods, while students already spend a lot of time playing digital games that can be diverted for learning. Therefore,

this study was conducted to provide interactive, practical, and engaging digital learning media specifically tailored to the needs and characteristics of high school students, so that their gaming habits can be diverted into more productive and educationally meaningful activities.

RESEARCH METHOD

This research is a research and development (R&D) that aims to develop a product in the form of an educational game assisted by Scratch on data presentation material. The development model used is the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) because this model is systematic, consistent, reliable, and allows the evaluation process to be carried out at each stage of development (Harefa et al., 2023). This research was conducted at Jatinunggal State Senior High School, Jatinunggal District, Sumedang Regency, West Java. The research subjects involved two lecturers of Mathematics Education at Siliwangi University as validators, media experts and material experts, as well as class X MIPA students at Jatinunggal State Senior High School as users of the educational game consisting of small groups and large groups in the field trial phase.

The instruments used in this study consisted of a media expert validation sheet based on technical quality criteria material expert validation sheet based on content and objective quality criteria (Maziyah & Zumrotun, 2025), and a student response questionnaire based on instructional quality criteria. All instruments were validated by two Mathematics Education lecturers at Siliwangi University and declared suitable for use after wording corrections were made to better suit the media being assessed.

Data collection in this study was carried out through three methods, namely

1. Semi-structured interviews with mathematics teachers and students to obtain initial information regarding learning problems
2. Validation sheets in the form of questionnaires given to media experts and material experts to assess the feasibility of educational games from the technical quality aspect as well as the quality of content and objectives
3. Student response questionnaires given after the use of educational games to measure the practicality of the media based on instructional quality criteria which include aspects of student responses and reactions.

The data obtained were analyzed quantitatively using a Likert scale. The feasibility assessment by media experts and material experts was calculated using the percentage formula from Arikunto in Santi & Kristanto,)2025) :

$$V = \frac{\sum x}{N} \times 100\% \dots (1)$$

Explanation:

V	=	Percentage value
$\sum x$	=	Score obtained
N	=	Maximum score

The results were interpreted into eligibility criteria ranging from very unfeasible to very feasible. Student response data was calculated using Purwanto's formula in Rahman et al. (2019):

$$NP = \frac{R}{SM} \times 100\% \dots (2)$$

Explanation:

- NP = Percentage value
- R = Total score
- N = Maximum score

The results are then interpreted into practicality criteria from very impractical to very practical according to the criteria table adapted from (Santi & Kristanto, 2025).

RESULTS AND DISCUSSION

Analysis

The analysis phase was conducted at SMAN Jatininggal through two stages: needs assessment and front end analysis. Based on the results of interviews with mathematics teachers and students, it was discovered that learning activities were still conventional, relying on the blackboard as the main medium. Students experienced difficulties in understanding the basic concepts of data presentation materials, especially in interpreting data in the form of tables, diagrams, symbols, and images. In addition, learning dominated by lecture methods caused students to quickly become bored, less active, and have low motivation to learn mathematics. This condition prompted the need to develop alternative learning media in the form of educational games assisted by Scratch that can present material in a more interesting, interactive, and enjoyable way.

In accordance with research by Mutia et al., (2025) which proves that digital media-based learning is more effective than conventional lecture methods, as shown by the N-Gain value of the experimental class of 0.52 which is higher than the control class of 0.28, as well as increased enthusiasm and active involvement of students during the learning process. This condition is in accordance with the results of research by Priyanto et al., (2025) who found that students' mathematical creative thinking ability at SMK Negeri 1 Pacet was in the high classification at 73.5%, but the use of social media as a learning tool did not have an effect on improving this ability.

In the front end analysis stage, information was obtained that the target users of this educational game are grade XI students of SMAN Jatininggal who are more interested in using smartphones as a learning tool. Mathematics learning at SMAN Jatininggal has never utilized game-based media, so the development of an educational game assisted by Scratch is considered relevant because the output is a website that can be accessed through various devices, both smartphones and laptops. The results of the task analysis show that the activities in the educational game are designed to help students understand the concepts of frequency distribution, dot plots, and histograms, as well as solve data analysis problems. Media analysis also shows that the media used is still very limited, so media is needed that supports active involvement, practicality, and efficiency of learning time.

Based on the analysis of the remaining data, the learning outcomes for data presentation include the ability to manipulate and interpret data through frequency distributions, histograms, dot plots, box plots, and scatter diagrams. To support the development of educational games, researchers also identified the technology needs, namely hardware and software. The following table 1 shows the researchers' technological needs:

Table 1. Researcher technology needs

Type	Component	Recommendation	Researchers
Hardware	CPU	Minimum 1 GHz	1,10 GHz
	RAM	Minimum 1 GB	16 GB
	Disk space	Minimum 4 GB	16 GB
	Screen resolution	Minimum 1024 x 762 px	1366 x 768 px
Software	Operating system	Minimum Windows 10	Windows 10
	Scratch	website version	Website version (Chrome)

Table 1 shows the computer specifications that must be used by researchers that have met the minimum requirements, for example the RAM and disk space available (16 GB) are far above the minimum limits (1 GB and 4 GB), and the software used is also up to standard. Identification of technological needs at this stage is in accordance with the research of Widuri et al., (2025) who developed computer-based learning media "HAK & NITNA" using the ADDIE model, where technological needs analysis is used to ensure that the media can be accessed and used optimally by students. Just like the research of Widuri et al. (2025), the development of educational games assisted by Scratch also considers hardware and software specifications so that the media can run smoothly on various devices owned by students, both smartphones and laptops, so that flexibility of access does not become an obstacle in the learning process.

Design

In the design stage, the researcher designed the contents of the educational game page consisting of an initial display containing the title, menu, time, logo, and points, as well as an about page, CP and TP, game rules, and a start page containing 20 questions with a total of 100 points. The design of the educational game content includes identifying the concept of data presentation, problem solving, data presentation in tabular form, and questions related to students' daily activities. This is in accordance that good design must consider various aspects, including learning objectives, student characteristics, and learning context (Ahyar et al., 2023).

The design stage in educational game development requires planning. In the development of the design, it focuses on the use of a learning management system architecture that incorporates gamification elements resulting in a 7-step learning process that includes story creation, script writing, storyboarding, media lists, voice recording, reflection, and distribution (Karapakdee & Wannapiroon, 2023). Rahmah & Risnani, (2023) in the design stage focused on creating a storyboard and arranging game assets including buttons, backgrounds, sounds, and characters as basic elements before developing techniques. This principle is in accordance with the theory explained by (Ahyar et al., 2023) that effective learning design must consider learning objectives, student characteristics, and learning context as considerations.

Development

In the development phase, researchers begin implementing the plans developed in the design phase by preparing a storyboard as an initial reference for product development. All assets, including images, sounds, and questions, are integrated into the Scratch platform

and connected through interactive navigation buttons. The initial product produced consists of several pages, namely:



Figure 1. Initial View of The Game



Figure 2. Homepage



Figure 3. Material page



Figure 4. Game Page

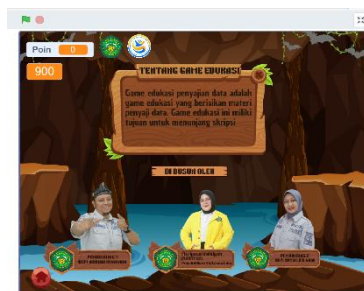


Figure 5. Profile Page



Figure 6. Game Rules Page

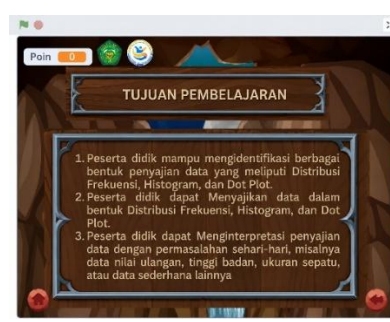
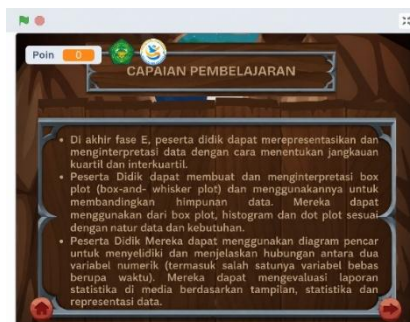


Figure 7. CP and ATP pages

After the initial product was developed, the first post-production stage was carried out in the form of validation by material experts and media experts to assess the product's feasibility. Validation by material experts was conducted on September 26 and 29, 2025, by a Mathematics Education lecturer from Siliwangi University and a mathematics teacher from Jatuninggal Senior High School, while validation by media experts was conducted on September 9 and 29, 2025, by the Head of TMG Research and lecturer Dr. Rianto. The

results of the assessment by both validators, along with their suggestions and input, are presented in full in Table 2.

Table 2. Recapitulation of Validation Results, Suggestions from Material Experts, Media Experts

Validator	Aspect	Expert 1	Expert 2	Conclusion
Subject matter expert	Compliance	96.67%	99.33%	Very worthy
	Language Accuracy	80%	90%	Very worthy
	Presentation Systematics	100%	95%	Very worthy
Media expert	Interface View	100%	100%	Very worthy
	Navigation	92.5%	92.5%	Very worthy
	Supporting Information	100%	100%	Very worthy
	Learning Design	96.67%	96.67%	Very worthy

Based on table 2, the assessment results from the material expert validator and media expert validator were assessed as having a high score (above 80%) which can be concluded as "Very worthy", meaning that this product is declared very worthy both in terms of content and media appearance. Based on the suggestions and input from experts, a series of revisions were made from the 2nd to 5th post-production stages. These revisions included grammar and typo corrections in the material, sentence corrections in the questions, the addition of a time feature on certain pages, and the removal of personally identifiable information from the developer on the about page. Each revision began with an updated storyboard as a reference before re-production. In the 5th post-production stage, all suggestions and input from the validators had been fully followed up so that no further improvements were needed, and the educational game was declared ready to proceed to the implementation stage.

Implementation

In the first implementation phase, the Scratch-assisted educational game was piloted on 15 grade X students of SMAN Jatininggal through a small group trial. Each student was asked to provide an assessment using a questionnaire instrument that covered two aspects, namely response and reaction. The results of the questionnaire recapitulation showed that the response aspect obtained a percentage of 89.77% and the reaction aspect 91.2%, so that the overall average total reached 90.42% with the Very Practical category. In addition to quantitative assessments, students also provided qualitative criticism and suggestions. Some of them mentioned that the graphics in the game were not clear enough, there were bugs in character movement, and the writing was not legible. This input was then used as the basis for conducting stage II revisions before proceeding to the field trial (large group).

In the second implementation phase, a field trial was conducted involving 35 grade X students of SMAN Jatininggal. The assessment results showed an improvement compared to the small group trial, where the response aspect obtained a percentage of 94.09% and the reaction aspect was 93.14%, with a total average of 93.66% which fell into the Very Practical category. The stability and improvement of the results in both trial phases indicated that the educational game was very well received by students. Qualitatively, most students stated that this game was interesting, fun, easy to use, and able to make learning mathematics feel less boring. Some students even suggested that similar games be developed for other mathematics materials, which shows their high enthusiasm and motivation to learn towards the developed media.

This aligns with research by Maryati & Yulianti, (2024) that found that using digital application-based learning media like Canva and Wordwall can increase students' confidence in solving math problems. This demonstrates that interactive and engaging learning media not only enhances conceptual understanding but also positively impacts students' attitudes and motivation to learn.

Evaluation

Evaluation of the development of a scratch-assisted educational game was conducted through validation by media experts, validation by material experts, and small group trials and field trials. The validation results from both experts indicated that the educational game was deemed very feasible in all assessment aspects. Meanwhile, the results of the small group trial obtained a percentage of 90.42% and the field trial increased to 93.66%, both of which are in the Very Practical category. The stability and improvement of results in both trial stages prove that the developed educational game has met the criteria of feasibility and practicality, making it suitable for use as a mathematics learning medium for data presentation materials.

The findings of this study are consistent with and extend previous research that has proven the effectiveness of Scratch as a learning medium. Agustin et al., (2025) proved that Scratch-based educational games are suitable for use in social skills for autistic children with a feasibility rate of 89%, while Ma'wa & Ratnaningrum, (2025) showed similar results in science learning with a feasibility score of 92% from media experts and 84% from material experts. This study expands on these findings by proving that Scratch is not only suitable in terms of content, but also very practical for students to use directly, as in the research of Matahelumual & Maharbid, (2026) who concluded that Scratch is effective in increasing student interest and engagement through interactive game-based learning, and Ali et al. (2024) who proved an increase in student understanding by 35.2% after using the Scratch educational game.

The results of this study have implications for mathematics teachers that Scratch-based educational games can be used as an alternative learning medium that is practical and interesting. According to Putri et al., (2025), Scratch can be a solution for teachers in delivering material more interactively through digital devices. However, this study has limitations because it only focuses on data presentation material and is conducted in a limited scope, so generalization of the results needs to be done carefully. Future developments need to expand the scope of the material and research subjects so that the benefits of Scratch can be felt more widely in various learning contexts.

CONCLUSION

This development research resulted in a Scratch-assisted educational game for data presentation material developed using the ADDIE model. Based on the validation results by material experts and media experts, this educational game obtained a very feasible category in all assessment aspects. In addition, the results of the small group field trial obtained a percentage of 90.42% and the results of the field trial increased to 93.66%, both of which are in the Very Practical category. Therefore, the developed Scratch-assisted educational

game has met the feasibility and practicality criteria so that it is suitable for use as a mathematics learning medium for data presentation material in class X of SMAN Jatiunggal.

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