Primatika. J. Pend. Mat.
Vol. 14, No. 1, 2025, pp. 17–28

Development of learning animation media to improve students' mathematical understanding

Maria Ulpah*, Arfita Ade Nur Insani

Tadris Matematika, Fakultas Tarbiyah dan Ilmu Keguruan, Universitas Islam Negeri Prof. K. H. Saifuddin Zuhri, Purwokerto, Indonesia
*Korespondensi: maria_1511@uinsaizu.ac.id

Abstract

Mathematical comprehension ability is essential for students to achieve proficiency in mastering mathematical material. Innovation is needed, such as using animated learning media that can display illustrations visually to increase student interest. The purpose of this study was to develop valid and effective animated video learning media to improve the mathematical comprehension ability of grade VIII students. The method used was the Research and Development with the Bergman & Moore model. The instruments were questionnaires and tests. The study results showed that the learning animation video was valid and interesting with a percentage of validation by material experts of 81,3% (valid of a good predicate) and media experts of 89% (valid of a good predicate). The learning animation video effectively improved students' mathematical understanding abilities with an average class N-Gain score of 0,58 (moderate).

Keywords: Animation media, Understanding ability, Mathematics learning

Abstrak

Kemampuan pemahaman matematis penting bagi siswa untuk mencapai kemahiran dalam menguasai materi matematika. Diperlukan inovasi seperti penggunaan media pembelajaran animasi yang dapat menampilkan ilustrasi secara visual untuk meningkatkan kemampuan pemahaman siswa. Tujuan penelitian ini adalah mengembangkan media video pembelajaran animasi yang valid dan efektif untuk meningkatkan kemampuan pemahaman matematis siswa kelas VIII. Metode yang digunakan adalah Penelitian dan Pengembangan dengan model Bergman & Moore. Adapun instrumen yang digunakan adalah angket dan tes. Hasil penelitian menunjukkan bahwa video animasi pembelajaran valid dan menarik dengan presentase validasi ahli materi sebesar 81,3% (valid dengan predikat baik) dan ahli media sebesar 89% (valid dengan predikat baik). Video animasi pembelajaran efektif meningkatkan kemampuan pemahaman matematis siswa dengan rata-rata skor N-Gain kelas sebesar 0,58 (sedang).

Kata kunci: Media animasi, Kemampuan pemahaman, Pembelajaran matematika

How to Cite: Ulpah, M., & Insani, A. A. N. (2025). Development of learning animation media to improve students' mathematical understanding. *Primatika: Jurnal Pendidikan Matematika*, *14*(1), 17–28. https://doi.org/10.30872/primatika.v14i1.4738

INTRODUCTION

The ability to demonstrate an understanding of mathematical concepts being studied, explain relationships between concepts and apply concepts flexibly, accurately, efficiently, and appropriately in problem-solving, is an expected mathematical skill, which makes this mathematical understanding important for students. This ability is expected to be translated into material through various fields, including numbers, measurement and geometry, probability and statistics, trigonometry, algebra, and calculus, by the competency standards for mathematics learning materials (Novikasari & Ulpah, 2022). According to the National Council of Teachers of Mathematics, an indicator of mathematical understanding is the ability to comprehend and apply mathematical concepts, procedures, and reasoning in various contexts. This includes demonstrating conceptual understanding by explaining relationships between ideas, using multiple representations such as graphs, equations, and diagrams, and making connections between different mathematical domains. Procedural fluency, another key indicator, involves efficiently carrying out mathematical operations accurately and flexibly. Additionally, mathematical understanding is evident when students can construct logical arguments, justify their solutions, and apply problem-solving strategies to unfamiliar situations. These indicators help assess a learner's depth of mathematical comprehension and their ability to think critically about mathematical concepts (NCTM, 2000).

Students' mathematical understanding remains low, as evidenced by various studies and assessments. For instance, the *Programme for International Student Assessment (PISA)* results indicate that many students struggle with basic mathematical concepts, problem-solving, and reasoning skills. In the 2022 PISA assessment, only 18,35% of students in Indonesia achieved proficiency level 4 or higher in mathematics, indicating difficulty in applying mathematical knowledge to real-world problems (OECD, 2024). Similarly, data from teacher interviews shows that students' mathematical understanding abilities are still low. These findings highlight persistent challenges in students' conceptual understanding, procedural fluency, and ability to engage in higher-order mathematical thinking. Addressing these issues requires improved instructional strategies, more vigorous foundational learning, and increased emphasis on reasoning and problem-solving. This also happened in MTsN 2 Brebes. From the results of preliminary observations, information was obtained that students' mathematics understanding ability was still low. Students still had difficulty understanding abstract mathematics material. 43,5% of students received grades below the minimum completion criteria for mathematics lessons. The learning uses a teacher-centered approach with minimal learning media.

Several factors influence students' mathematical understanding, including cognitive abilities, instructional quality, learning environment, and motivation. Mental factors such as working memory, logical reasoning, and prior knowledge are crucial in processing mathematical concepts and problem-solving. Additionally, the quality of instruction, including teaching strategies, curriculum design, and using manipulatives

or technology, significantly impacts students' comprehension (Purwanto, 2007). A supportive learning environment, characterized by positive teacher-student interactions and opportunities for collaborative learning, fosters deeper engagement with mathematical ideas. Moreover, motivation and attitudes toward mathematics, influenced by self-efficacy and parental support, affect students' willingness to engage with complex problems. Research suggests that students with higher self-confidence in mathematics tend to perform better and develop stronger conceptual understanding (N. R. Wulandari & Tasriyah, 2024).

One of these factors is the use of technology-based media. Mathematics learning that rarely utilizes learning media can negatively impact students' engagement, conceptual understanding, and problem-solving abilities (Sya'diyah & Arifin, 2024). Learning media, such as visual aids, interactive software, and manipulatives, help bridge abstract mathematical concepts to real-world applications, making learning more accessible and meaningful (Rahmawati & Jamaluddin, 2024). Without these tools, students may struggle with visualization, especially in geometry, algebra, and data interpretation. Research indicates that the use of multimedia and hands-on learning materials enhances students' comprehension and retention of mathematical concepts (Mayer, 2021). Furthermore, traditional lecture-based instruction without media often leads to passive learning, reducing students' motivation and interest in mathematics (Muhaimin & Juandi, 2023). Integrating diverse learning media into instruction can significantly improve students' mathematical reasoning and academic achievement.

Mathematics learning incorporating animation as a learning medium can significantly enhance students' mathematical understanding by making abstract concepts more concrete and engaging (Yuliyanto et al., 2024). Animated visuals help illustrate complex mathematical ideas, such as geometric transformations, algebraic functions, and probability distributions, dynamically and interactively. Research shows that animations improve students' cognitive processing by reducing cognitive load and enhancing conceptual visualization (Mayer, 2021). Additionally, animated media can cater to different learning styles, making mathematics more accessible to visual and auditory learners. A study found that students feel happy learning with animated videos and all students can understand well, this is seen when at the end of the video, students can retell the material that has been listened to. The school is happy with this activity and it motivates teachers to create engaging media for learning both mathematics and other subjects (Warmi et al., 2024). Thus, integrating animation into mathematics education can foster active learning, improve retention, and enhance students' mathematical proficiency. Other studies also concluded that animated video media influences students' mathematics learning outcomes (Dita Wahyuni et al., 2024). This is because animated video learning media is considered interesting and innovative in the classroom learning.

Based on the explanation, it is known that animation media affects students' mathematics learning outcomes. However, the media needs to be developed for broader mathematics materials. The formulation of the problem is how the validity and

effectiveness of animated media improve students' mathematical understanding abilities.

METHODS

This is a research and development with the subjects being class VIII students of MTsN 1 Brebes. This study aims to develop learning media on probability material for junior high school students in an effort to improve students' mathematical understanding abilities. The animation media development procedure consists of the following stages based on the Bergman and Moore Model:

1. Analysis. At this stage, the class targets and tasks, the materials, the students' initial abilities, and the learning facilities or media needed are analyzed.
2. Design. At this stage, the materials for the learning animation video are determined, including character creation using the Zepeto application, creating materials and animations of materials on the whiteboard using Microsoft PowerPoint 2010, finding non-copyrighted backgrounds, and preparing media such as smartphones, voice recorders, laptops, OBS Studio applications, and Camtasia Studio 2019.
3. Development. At this stage, the presentation of the material is developed using written documents such as storyboards and audio scripts. Then the data in the form of these documents is collected for the next stage.
4. Production. At this stage, production is carried out in the form of media, starting from the storyboard implemented into the interface display along with its components, and the audio script is processed into audio recording, subtitles, and selection of background. After the production process is complete, it is continued to the merging stage using animated video creation software, namely OBS Studio and Camtasia Studio 2019.
5. Integration. In this stage, the OBS Studio and Camtasia Studio 2019 animation video creation software integrate the components of the production stage, which in the use of the software has activities in their respective functions. These stages are adjusted from unification and testing (preview) to setting to see the smoothness and improvements before continuing the validation process.
6. Validation. This stage compares the product with the target, and the purpose of validation is to see whether the product is feasible in terms of material and appearance. For that, there is a revision (with conditions on the questionnaire), which then becomes material to increase product effectiveness. Validation consists of making validation instruments for implementation and analyzing findings into official reports for the next stage.

The instruments were validation sheets for material experts, media experts, questionnaires, and tests. The data analysis technique uses n-gain (Hake, 1999).

Table 1. Validity Criteria of Media

Interval (*i*)	Criteria
90 % ≤ *i* ≤ 100%	Valid of a very good predicate
80 % ≤ *i* < 90%	Valid of a good predicate
70 % ≤ *i* < 80%	Valid of an enough predicate
0 % ≤ *i* < 70%	Not valid

Table 1 shows that media is categorized as valid if the percentage of expert assessment results is more than 70% (Wulandari, 2017).

Table 2. N-Gain Value Criteria

Interval (g)	Criteria
$g > 0,7$	High
$0,3 \leq g \leq 0,7$	Moderate
$g < 0,3$	Low

Table 2 shows that media is categorized as effective for improving mathematical understanding skills if n-gain is more than 0,3.

RESULTS AND DISCUSSION

The animation media development process involves six main stages i.e. analysis, design, development, production, integration and validation. Each stage is described in detail into sub-sections.

Analysis

Based on the observation results, it was known that students still need learning resources other than teachers to develop understanding. There were differences in learning styles between students and time constraints, learning media is one solution that can be provided. This factor occured because learning in the odd semester was still half online, so it was difficult to monitor students' learning activities at home. The material studied was probability because the material has quite a lot of broad subsections such as experiments, sample spaces, and sample points, compiling members of sample spaces, definitions, probability values, expected frequencies, and the relationship between empirical and theoretical opportunities. In this case, students often had difficulty distinguishing how empirical and theoretical opportunities differ in one question. Students' mathematical understanding, as reviewed from the results of previous daily assessments, was very low. Therefore, the use of animated learning videos presents material that students can learn in order to better understand the concept and can also be accessed from anywhere with any learning style, either visually or audibly.

Design

At this stage, a design was made to create an animated character using an avatar with the help of the Zepeto application on a smartphone. The character was adjusted to the desires, goals, and needs. After the avatar was created, a voice recording was made to be used as an animated character video. Kida can choose the right pose to match with

other objects. After recording the avatar and voice in Zepeto, then save and collect them into one to be combined with other designs.

Figure 1. Design view on Zepeto

Figure 1 shows an example of a character design in the media created using Zepeto. The character explains the material about probability in the order. Then, the use of Microsoft PowerPoint 2010 in this learning media was a graphic design media to adjust the shape of the whiteboard which was a rectangle. This PowerPoint was used to animate the material and explain the stages and contents of the media to be delivered.

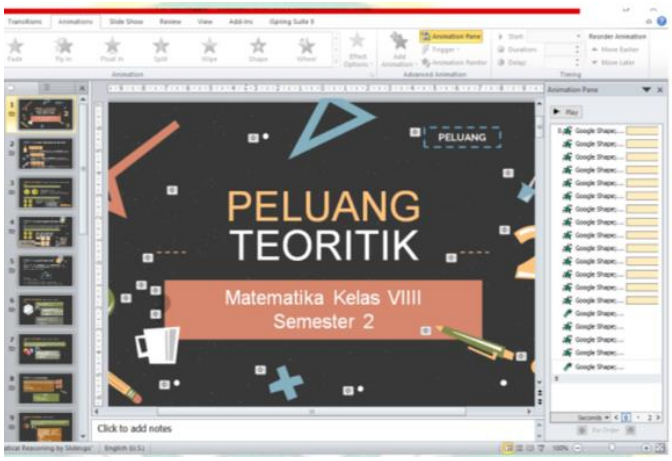

Figure 2. Design view on PowerPoint

Figure 2 shows the images that will be displayed in the media according to the order in the probability material. The images are created per slide containing explanations for each material.

Development

At this stage, the sequence of the material was roughly arranged, and subtitles were made for the video. Figure 3 shows the subtitle plan that will be included in the video. The subtitles are arranged according to the order of the images in the video based on their duration. Figure 4 shows a storyboard, which is a series of image sketches arranged sequentially, functioning as a visual planning tool to describe the storyline in a video.

Figure 3. View of subtitles design

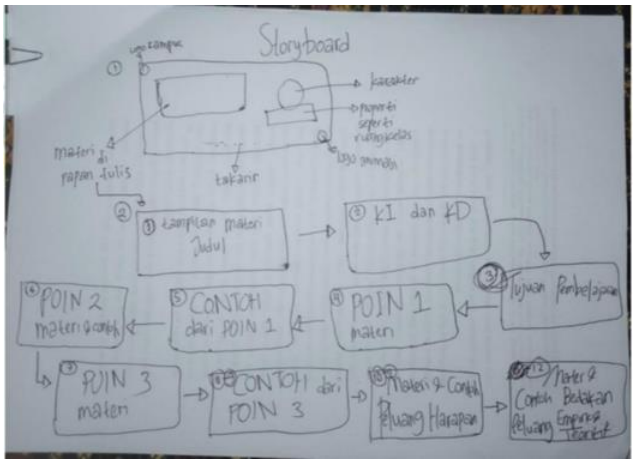

Figure 4. View of storyboard

Production

At this stage, adjustments were made to the design, storyboard, and subtitles to ensure that the video production process enters the final stage, namely combining the materials that have been developed into one unit which was then processed in the integration stage.

Integration

At this stage, the merger was carried out using two application software that were accessed via a computer/PC, namely the OBS Studio application and TechSmith Camtasia Studio 2019. OBS Studio was an application that allows its users to open source or add certain objects and arrange the layout of the objects so that they are combined into one unit according to the rough picture that has been arranged in the storyboard (Qorib et al., 2021).

Figure 5 shows an example of the image display according to the order that has been designed in the storyboard. This image is equipped with audio to explain the probability material being discussed. However, this application cannot save files with the extension .mp4, so it was necessary to have other application software to save the file format into the extension .mp4 which was TechSmith Camtasia Studio 2019.

Figure 6 shows an example of a display of TechSmith Camtasia Studio 2019 that changes the format from OBS Studio to .mp4. This is done so that compatibility was wider and the file size was smaller.

Figure 5. View of OBS Studio

Figure 6. View of TechSmith Camtasia Studio 2019

Validation

At this stage, validation was carried out by material expert and media expert. Here are the results:

Table 3. Assessment Result of Material Expert

No.	Aspect	Assessment
1	Appropriateness of content	80% (Valid of a good predicate)
2	Suitability of presentation	80% (Valid of a good predicate)
3	Language compatibility	83% (Valid of a good predicate)
	Average	81,3% (Valid of a good predicate)

Table 3 shows the results of the validation of material experts, the percentage for the aspect of appropriateness of content is 80% (valid of a good predicate), the percentage for the aspect of suitability of presentation is 80% (valid of a good predicate), and the aspect of language compatibility is 83% (valid of a good predicate). The average is 81.3% (valid of a good predicate). Therefore, this animated video mathematics can be tested.

Table 4 shows the results of the validation of media experts, the percentage for the aspect of suitability of presentation is 83,3% (valid of a good predicate), the percentage for the aspect of language compatibility is 90% (valid of a very good predicate), and the aspect of attractiveness of appearance is 90% (valid of a very good predicate). The average is 88,3% (valid of a good predicate). Therefore, this animated video mathematics can be tested.

Table 4. Assessment Result of Media Expert

No.	Aspect	Assessment
1	Suitability of presentation	83,3% (Valid of a good predicate)
2	Language compatibility	90% (Valid of a very good predicate)
3	Attractiveness of appearance	90% (Valid of a very good predicate)
Average		88,3% (Valid of a good predicate)

The next step was to try out the animation media with students in learning. Before the learning process begins, the researcher gave a pretest to measure students' initial understanding abilities. In the first meeting, the researcher used Islamic context-based mathematics teaching materials to explain the material on relations and functions. In the second meeting, the researcher used animated media to explain the material on probability. In the last meeting, the researcher gave a posttest to measure students' final understanding abilities. The pretest and posttest were given to students to find out the picture before and after the application of the product. The N-gain test was used to determine the increase in students' mathematical understanding abilities after the application of the product. The following are the results of measuring the increase in students' mathematical understanding abilities.

Table 5. Results of Measurement on Students' Mathematical Understanding

Treatment	Value
Average of Pretest	64,24
Average of Posttest	85,45
Maximum Score	100
N-Gain	0,58

Table 5 shows that the average mathematical understanding ability of students before learning was 64,24 and after using the product changed to 85.45. Based on the N-gain results, the increase in students' mathematical understanding ability was 0.58. This shows that the increase in students' mathematical understanding of learning after using the developed product is moderate.

Students showed higher enthusiasm and engagement when learning mathematics with animation media, as it made abstract concepts more visually appealing and interactive. This is in accordance with other studies that have developed animated video learning media that the media indicates a significant increase in student engagement and comprehension (Diah et al., 2024). Animated content captured students' attention more effectively than static images or traditional lectures (Walsh & Henderson, 2022), fostering curiosity and motivation to explore

mathematical ideas. Research suggested that multimedia-based instruction, including animations, enhanced student interest and enjoyment, leading to a more positive attitude toward learning. This is in line with research that developed PowToon animation media for mathematics learning (Awalia et al., 2019). The study concluded that PowToon animation media can provide students with an understanding of mathematics subjects. This study is also in line with other research that developed animated video-based mathematics learning media (Firdaus et al., 2023) which concluded that the media was good and suitable for use as a mathematics learning media to improve mathematical literacy. The results of this study are also in line with other studies (Nasir & Ansar, 2021) which conclude that there was an increase in students' mathematics learning outcomes through animated media.

CONCLUSION

The results of the study showed that the learning animation video was valid and interesting with a percentage of validation by material experts of 81,3% (valid of a good predicate) and media experts of 89% (valid of a good predicate). The learning animation video effectively improved students' mathematical understanding abilities with an average class N-Gain score of 0,58 (moderate).

REFERENCES

Awalia, I., Pamungkas, A. S., & Alamsyah, T. P. (2019). Pengembangan media pembelajaran animasi powtoon pada mata pelajaran matematika di kelas IV SD. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *10*(1), 49–56. https://doi.org/10.15294/kreano.v10i1.18534

Diah, D. U. N., Fahmi Surya, A., & Susiloningsih, E. (2024). Application of animated video learning media to enhance elementary students' ability to understand intrinsic elements of short stories. *EduStream: Jurnal Pendidikan Dasar*, *8*(2), 100–112. https://doi.org/10.26740/eds.v8n2.p100-112

Dita Wahyuni, Wella Asmada Yanti, & Zura Vazira. (2024). Pengaruh penggunaan media video animasi terhadap hasil belajar matematika kelas IV SD. *Semantik : Jurnal Riset Ilmu Pendidikan, Bahasa Dan Budaya*, *2*(3), 125–131. https://doi.org/10.61132/semantik.v2i3.782

Firdaus, D., Suripah, & Angraini, L. (2023). Development of animated video-based mathematics learning media using adobe after effect on the three-dimensional material to improve mathematical literacy. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *14*(2), 267–279. https://doi.org/10.15294/kreano.v14i2.39628

Hake, R. R. (1999). *Analyzing change/gain scores.* American Educational Research Association's Division D, Measurement and Research Methodology. https://web.physics.indiana.edu/sdi/AnalyzingChange-Gain.pdf

Mayer, R. (2021). *Multimedia learning*. Cambridge University Press.

Muhaimin, L., & Juandi, D. (2023). The role of learning media in learning mathematics: A systematic literature review. *JMME: Journal of Mathematics and Mathematics Education*, *13*(1), 85–107. https://doi.org/10.20961/jmme.v13i1.74425

Nasir, M., & Ansar. (2021). Peningkatan hasil belajar matematika melalui media animasi pada Siswa SMP Negeri 1 Turikale Maros. *ELIPS: Jurnal Pendidikan Matematika*, *2*(1), 1–15. http://dx.doi.org/10.47650/elips.v2i1.186

NCTM. (2000). *Principles and standards for school mathematics.* Reston, VA.

Novikasari, I., & Ulpah, M. (2022). The development of islamic context learning materials to facilitate the conceptual understanding of mathematics. *JTAM (Jurnal Teori Dan Aplikasi Matematika)*, *6*(3), 488–497. https://doi.org/10.31764/jtam.v6i3.8364

OECD. (2024). *PISA 2022 Results Paris*. OECD Publishing.

Purwanto, N. (2007). *Psikologi pendidikan*. Remaja Rosdakarya.

Qorib, A., Hamid, A., Salehuddin, M., & Wahyudi, W. (2021). Developing interactive learning media using obs to create video lecturer for "Preaching islamic hospitality." *Al Ulya: Jurnal Pendidikan Islam*, *6*(1), 56–69. https://doi.org/10.36840/ulya.v6i1.438

Rahmawati, S., & Jamaluddin, M. (2024). Development of game-based mathematics learning media to improve mathematical understanding abilities. *Riemann: Research of Mathematics and Mathematics Education*, *6*(2), 202–214. https://doi.org/10.38114/pnn19445

Sya'diyah, Z. & Arifin. (2024). Development of android learning media to improve students' mathematical communication skills on social arithmetic material. *International Journal of Research in Mathematics Education*, *2*(2), 119–130. https://doi.org/10.24090/ijrme.v2i2.10361

Walsh, T., & Henderson, M. (2022). *The impact of video in the K-12 classroom: A scoping study of instructional video research*. Monash University. Report. https://doi.org/10.26180/19614093

Warmi, A., Adirakasiwi, A. G., Hidayati, N., & Roesdiana, L. (2024). Pemanfaatan video animasi dalam pembelajaran matematika di Sekolah Dasar. *J-ABDIPAMAS (Jurnal Pengabdian Kepada Masyarakat)*, *8*(1), 19–25. https://doi.org/10.30734/j-abdipamas.v8i1.3670

Wulandari. (2017). Kelayakan aspek materi dan media dalam pengembangan buku ajar sastra lama. *Jurnal Gramatika: Jurnal Penelitian Pendidikan Bahasa Dan Sastra Indonesia*, *3*(2), 162–172. https://doi.org/10.22202/jg.2017.v3i2.2049

Wulandari, N. R. & Tasriyah. (2024). The effect of interactive multimedia-based discovery learning on students' ability to understand mathematical concepts. *International Journal of Research in Mathematics Education*, *2*(2), 175–186. https://doi.org/10.24090/ijrme.v2i2.11577

Yuliyanto, A., Ramdani, R., Andriyantono, A., & Sofiasyari, I. (2024). Exploring canva-based animation media on mathematical self-efficacy and creative thinking skills of students. *AULADUNA: Jurnal Pendidikan Dasar Islam*, *11*(2), 105–121. https://doi.org/10.24252/auladuna.v11i2a1.2024