17% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

Filtered from the Report

- Bibliography

Match Groups

81 Not Cited or Quoted 17%
Matches with neither in-text citation nor quotation marks

1 Missing Quotations 0%
Matches that are still very similar to source material

1 Missing Citation 0%
Matches that have quotation marks, but no in-text citation

0 Cited and Quoted 0%
Matches with in-text citation present, but no quotation marks

Top Sources

13% Internet sources
12% Publications
2% Submitted works (Student Papers)

Match Groups

- **81** Not Cited or Quoted 17%
  Matches with neither in-text citation nor quotation marks
- **1** Missing Quotations 0%
  Matches that are still very similar to source material
- **1** Missing Citation 0%
  Matches that have quotation marks, but no in-text citation
- **0** Cited and Quoted 0%
  Matches with in-text citation present, but no quotation marks

Top Sources

13% Internet sources
12% Publications
2% Submitted works (Student Papers)

Top Sources

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	Publication	
Henry Obiora Chukwudi, Babatope Osagbemiro. "Risk Awareness about Tetracycl...		1%
2	Internet	
www.malque.pub		1%
3	Internet	
journal-gehu.com		<1%
4	Internet	
rama.uniku.ac.id		<1%
5	Internet	
jppipa.unram.ac.id		<1%
6	Internet	
jurnal.stkippersada.ac.id		<1%
7	Publication	
Angger Putri Mahardini, Maratul Qiftiyah, Masfiyatul Asriyah, Hanifah Firdausi. "...		<1%
8	Internet	
digilib.uin-suka.ac.id		<1%
9	Internet	
eprints.binadarma.ac.id		<1%
10	Internet	
jurnalfkip.unram.ac.id		<1%

11	Publication	
Alfina Sukma Hayati Damanik, Rahmadina Rahmadina. "Problem-based learning ...		<1%
12	Publication	
Irmawati Irmawati, Daroe Iswatiningsih, Siti Inganah. "Development of Problem-...		<1%
13	Publication	
Umi Basyiroh, Akhmad Arif Musadad, Moh. Muchtarom, Abu Zarrin bin Selamat. ...		<1%
14	Internet	
journal.ummat.ac.id		<1%
15	Internet	
fkip.univetbantara.ac.id		<1%
16	Publication	
Dindin Abdul Muiz Lidinillah, Muhammad Rijal Wahid Muharram, Sania Nurronn...		<1%
17	Internet	
ijmmu.com		<1%
18	Internet	
ojspanel.undikma.ac.id		<1%
19	Publication	
Amelia Septiani Rizki, Anggita Putri Irawan, Annisa Risky Larasati, Hafidz Ahmad ...		<1%
20	Internet	
journal1.uad.ac.id		<1%
21	Internet	
repositori.uin-alauddin.ac.id		<1%
22	Internet	
www.classace.io		<1%
23	Internet	
ijcat.com		<1%
24	Publication	
Diana Sefti, Dodik Mulyono, Nur Fitriyana. "Development of Learning Modules o...		<1%

25	Publication	
Muhammad Syaipul Hayat, Sumarno , Noora Qotrun Nada, Ade Ihtiar. "Implemen...		<1%
26	Publication	
Zafrullah Zafrullah, Slamet Suyanto, Astri Wahyuni, Rizki Tika Ayuni, Fini Rezy Ena...		<1%
27	Internet	
revista.nutricion.org		<1%
28	Publication	
I Ketut Mahardika, Wachju Subchan, Rina Fatiya Rosida. "Development of multipl...		<1%
29	Publication	
Sinta Khairunnisa, Meti Maspupah, Idad Suhada. "Development of a Learning Me...		<1%
30	Internet	
ejournal.unuja.ac.id		<1%
31	Internet	
journal.unm.ac.id		<1%
32	Internet	
litere.univ-ovidius.ro		<1%
33	Internet	
repo.undiksha.ac.id		<1%
34	Internet	
thesai.org		<1%
35	Publication	
Ellysa Yuliani Ruhmana, Sutama, Adi Nurcahyo, Dwi Desmayanasari, Carla Maret...		<1%
36	Internet	
files.eric.ed.gov		<1%
37	Internet	
journal.berpusi.co.id		<1%
38	Internet	
journal.iaimnumetrolampung.ac.id		<1%

39 Internet
public-pages-files-2025.frontiersin.org <1%

40 Internet
repository.uir.ac.id <1%

41 Internet
www.bonoi.org <1%

42 Publication
Rif'atul Himmah, Budi Jatmiko, Binar Kurnia Prahani, Fasih Bintang Ilhami. "Validi... <1%

43 Internet
diva-portal.org <1%

44 Internet
journal.arimsi.or.id <1%

45 Internet
journal.unnes.ac.id <1%

46 Internet
rayyanjurnal.com <1%

47 Internet
www.atlantis-press.com <1%

48 Publication
Shalmita Sakinah, Fitri Arsih, Syamsurizal Syamsurizal, Helsa Rahmatika. "Develo... <1%

49 Publication
Suprianto, Fila Rofah, El Indahnia Kamariyah, Maimon Sumo. "Development of Ph... <1%

Journal of Mathematics Instruction, Social Research and Opinion
Vol. 5, No. 1, March 2026, pp. 389 - 401, https://doi.org/10.58421/misro.v5i1.1152
ISSN 2962-7842

Geogebra-Assisted Animation Video Development and Artificial Intelligence for Critical Thinking Skills

Mustika Indah Baitul Susanti[1], Kashardi[2], Masri[3]
[1,2,3]Universitas Muhammadiyah Bengkulu, Indonesia

Article Info

Article history:

Received 2026-01-15
Revised 2026-02-13
Accepted 2026-02-16

Keywords:

Animated Videos
Artificial Intelligence (AI)
Critical Thinking
GeoGebra
Triangle Congruence

ABSTRACT

Learning mathematics in the 21st century requires developing critical thinking skills. However, traditional methods still dominate the classroom, such as using textbooks as learning resources and whiteboards as learning media, making it difficult for students to understand triangle congruence visually and dynamically. This research aims to develop animated video media using GeoGebra and Artificial Intelligence (AI) on triangle congruence material for grade IX junior high school students and to describe their validity and practicality. The research uses *the Research and Development* (R&D) method with the ADDIE model, which includes the stages of *analysis, design, development, implementation,* and *evaluation.* The test subjects were 14 grade IX students and 1 mathematics teacher, with validation sheet instruments and practicality questionnaires. The results showed that the average validity of the media was 90% with the very valid category, while the practicality reached 89.11% with the very practical category. These findings show that GeoGebra and AI-assisted animation videos are feasible alternatives to modern, interactive mathematics learning media that facilitate students' critical thinking skills in triangle congruence materials.

Correspondence Author:

Masri
Faculty of Teacher Training and Education, Mathematics Education, University of Muhammadiyah Bengkulu
Email: masritan@gmail.com

1. INTRODUCTION

21st-century learning demands mastery of high-level thinking skills, especially critical thinking, including the ability to analyze information, evaluate arguments, solve problems, and make informed decisions across a variety of life contexts [1], [2]. Various studies have shown that critical thinking skills are not innate abilities but rather important outcomes of the learning process that must be developed through consciously designed and structured teaching practices and strategies [3], [4], [5]. Several studies have shown that by learning mathematics effectively through contextual approaches, problem-solving, and

mathematical reasoning, students can be trained to think rationally, make sound decisions, and be better prepared to face problems in daily life [6], [7].

The reality in the field shows that learning in schools is still often dominated by traditional methods that center on teachers and lack varied, interactive learning media, leading to less student engagement and suboptimal learning outcomes. [3] , [8], [9], [10]. Teachers generally rely on textbooks as the main source of learning and on whiteboards as the primary learning medium, while the use of technology-assisted media remains limited, leading to monotonous learning that quickly leaves students bored [8], [9], [10]. A number of studies report that the lack of the use of interesting and interactive learning media is one of the factors causing student motivation and learning outcomes, one of the areas of mathematics study that requires strong visualization is geometry, because it contains elements of visualization and spatial reasoning that are dominant, including congruence materials that require visualization skills [8], [10], [11], [12]. This condition affects students' low involvement in higher-level thinking, including critical thinking, because learning focuses more on conveying information than on encouraging students' analysis and argumentation [3], [4], [13], [14]. In the congruence material of triangles, students often mistakenly identify matching pairs of sides and angles and have difficulty imagining two triangles whose positions change but are actually congruent, so that students are less confident in concluding; This condition shows the need for dynamic visual media support to help understand the concept of congruence more concretely [11], [12], [15], [16], [17]. This shows the need for dynamic, visual, and interactive learning media to help understand geometry concepts.

Some previous studies have noted that one of the most recommended software packages for geometry visualization is GeoGebra, because, as a dynamic geometry software, it allows students to manipulate objects interactively and visualize geometric concepts more clearly [24], [25], [26]. Research on the development of GeoGebra-assisted teaching media and materials at the secondary school level shows that the use of GeoGebra can improve understanding of geometric concepts, mathematical representation (especially spatial ability), and students' motivation to learn geometry [17], [27], [28], [29]. Along with the rapid development of technology, *Artificial Intelligence* (AI) is increasingly used in education, including in the development of learning media [30], [31], [32]. *Artificial Intelligence* (AI) can assist teachers in various aspects of media creation, such as generating automated voice narration, compiling visual displays, and speeding up the video editing process, so that teachers can focus more on designing learning flows and reinforcing concepts [30], [31], [33]. Various previous studies have developed GeoGebra-assisted mathematics learning media in the form of e-modules, web-based worksheets, and learning videos, and have shown that these media can meet valid, practical, and effective criteria for mathematics learning outcomes [7], [12], [27].

On the other hand, a need study in secondary schools shows that mathematics learning media used in the classroom is still dominated by conventional forms and has not made much use of technology-assisted interactive animation videos, including GeoGebra, even though students and teachers urgently need animation video media that are more interesting, interactive, and relevant to technological developments to reduce boredom and

increase student motivation and learning engagement [34], [35], [36]. This condition indicates a gap between the demands of mathematics learning that encourage critical thinking and the availability of supportive learning media, as evidenced by students' low critical thinking skills and the limited use of interactive media [13], [36]. Some of these findings raised several main problems in learning triangle congruence in grade IX of junior high school, namely: (1) Above all, the use of visual, interactive, and dynamic learning media to help students visualize the relationship of two congruent triangles; (2) The level of student involvement in the learning process is so that high-level thinking activities, including critical thinking, have not developed optimally; and (3) The absence of the use of GeoGebra-assisted animation video media and artificial intelligence which are specifically designed to stimulate students' mathematical critical thinking skills on triangle congruence materials. Learning videos, especially animated videos, are seen as an effective alternative to improve learning quality, as they can clarify abstract concepts, increase motivation, and positively impact student learning outcomes [10], [18], [19], [20]. Learning videos can combine text, images, sounds, and gestures so that they activate more than one student's senses, clarify the presentation of abstract material, and improve memory of the concepts learned [21], [22], [23].

Based on the backgrounds above, the development of GeoGebra-assisted animation videos and Artificial Intelligence (AI) is needed to support critical thinking skills in triangle congruence materials. This media leverages GeoGebra object manipulation that helps students dynamically visualize the concept of triangle congruence, as well as *Artificial Intelligence* (AI) support to create automated voice narrations, compose automatic visual displays, and step-by-step learning flows, which encourage students to analyze, compare, and justify the congruence of two triangles as part of the critical thinking skills exercise, *Artificial Intelligence* (AI) used is *perplexity.ai* as a tool in creating short video clips, which then uses Canva for the video editing platform as a refiner. This research focuses on the media development process and tests its validity and practicality through expert assessments, teacher and student responses to limited trials, without measuring learning outcomes. Thus, this research is expected to provide an alternative learning medium that is more modern and better aligned with the demands of technology use in mathematics learning in junior high school. "Based on the previous description, the problems that will be discussed in this study are:" 1). What is the validity level of GeoGebra and *Artificial Intelligence* (AI)-assisted animation videos in the triangular congruence material developed?, 2). What is the practicality of GeoGebra and Artificial Intelligence (AI)-assisted animation videos for triangle congruence materials, based on teacher and student responses? "In line with the formulation of the problem, the objectives of this study are:" 1). Describe the validity level of GeoGebra and *Artificial Intelligence* (AI)-assisted animation videos on triangle congruence material based on expert assessment. 2). Describe the level of practicality of GeoGebra and *Artificial Intelligence* (AI)-based animation videos on triangle congruence materials based on teacher and student responses.

This research contributes theoretically to the field of mathematics education by expanding the application of technology-based media aligned with constructivist learning theory and the principles of cognitive development (Piaget, 1970; Vygotsky, 1978). In

practice, it provides teachers with modern technological tools that align with the learning demands of the digital age and enhance interactivity and motivation in lessons. The expected outcome is a valid and practical learning medium that empowers students to analyze, compare, and evaluate geometric relationships, with a core component of critical thinking. Unlike previous studies that focused on static GeoGebra modules or generic learning videos [7], [12], [27]. This research has novelty value in the development of GeoGebra-assisted animation video media and Artificial Intelligence (AI) designed to facilitate students' mathematical critical thinking skills in triangular congruence material at the junior high school level. Unlike previous research, which generally only uses GeoGebra as an interactive media or ordinary learning video, the novelty of this research lies in the integration of two technologies at once, namely GeoGebra and *Artificial Intelligence* (AI), in one learning medium that is visual, interactive, and adaptive. Through this integration, GeoGebra provides concrete, dynamic, and manipulable visualizations of geometric concepts, while Artificial Intelligence (AI) automates the creation of narratives, the configuration of visual displays, and the design of engaging, interactive learning flows. This research is oriented towards facilitating the development of mathematical critical thinking skills, namely, students' ability to analyze, compare, and evaluate congruence concepts through contextual and reflective video shows. The media is developed using the ADDIE development model, which includes *the stages of Analysis, Design, Development, Implementation,* and *Evaluation,* and is validated by experts and tested for practicality to ensure compatibility with the characteristics of junior high school students. In addition to producing valid and practical media, this research also provides innovative solutions to the limitations of mathematics learning media, which are still dominated by conventional forms and have not utilized artificial intelligence to support the learning process.

Thus, the new value of this research lies in the integration of GeoGebra technology and *Artificial Intelligence* (AI) in producing mathematical animation video media that is oriented towards the development of students' critical thinking skills, as designed in the research entitled Development of GeoGebra Assisted Animation Video Media and *Artificial Intelligence* (AI) for Critical Thinking Skills.

2. METHODS

The type of research used is Research *and Development* (R&D) because the main purpose of this research is to produce products in the form of GeoGebra-assisted animation videos and *Artificial Intelligence* (AI) on triangular congruence materials that are valid and practical, as carried out in various research on the development of animated video media with the help of GeoGebra and *Artificial Intelligence* (AI) in mathematics learning [37]. The development design used refers to the ADDIE model, which consists of five stages, namely *Analysis, Design, Development, Implementation,* and *Evaluation,* as commonly used in various research on the development of digital learning media and animated videos [10], [38]. ADDIE was chosen because it offers a systematic, simple, and widely used framework for developing GeoGebra-assisted mathematics learning media and animated videos [39], [40]. The following stages in the development of the ADDIE model media can be seen in Figure 1, which are as follows:

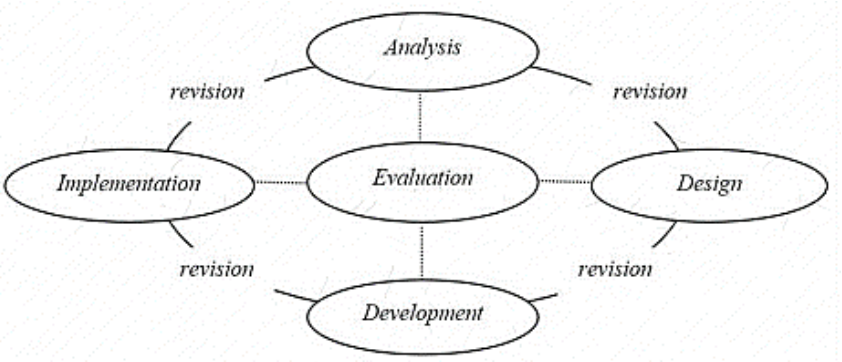


Figure 1. ADDIE Model Stages [41]

ADDIE's development model was used in this study. There are 5 stages that will be used, namely: 1) *analysis stage*, the researcher identifies problems and learning needs. The things studied generally include: student characteristics, classroom/infrastructure conditions, and the gap between expected and actual classroom conditions. 2) The *design stage* is to develop a design of learning solutions based on the results of the analysis. At this stage, learning objectives are usually formulated, scenarios/media are prepared, strategies/methods are chosen, and assessment instruments to be used are designed, 3) At *the development stage*, the design that has been realized becomes a real product. Activities are generally in the form of making/processing media or teaching materials, after which initial checks and repairs are carried out until the product is ready for testing. 4) The *implementation* stage is to test the product or media in a real learning situation. The researcher uses the product in class, collects user responses (students/teachers), 5) The *evaluation stage* is to assess the validity and practicality of the product and the learning process systematically. Evaluations can be formative (at each stage for repeated improvement) and summative (at the end to assess the feasibility and achievement of learning objectives).

The test subjects in this study were 14 grade IX students out of 22, while the product validators consisted of one mathematics education lecturer and one mathematics teacher as material experts, and media experts, as is common in learning media development research [42], [43]. The research is conducted at SMP Negeri 46 Seluma, with a total of 3 meetings. Instruments used in collecting data: 1) Media validation, 2) Media practicality questionnaire according to students and teachers. The data analysis technique used is: the media validation value is calculated using a percentage formula on an interval scale of 1 to 5.

Validity percentage formula:

$$\text{Percentage of validity (\%)} = \frac{Total\ score\ obtained}{maximum\ score} \times 100\% \quad (1)$$

The validity category used is shown in Table 1, which shows the value and category for the media's validity.

Table 1. Criteria for validity

Percentage Value	Category
81 – 100%	Very Practical
61 – 80%	Practical
41 – 60%	Quite Practical
21 – 40%	Less Practical
0 – 20%	Impractical

Source: [40]

The practicality value is calculated using a percentage formula on an interval scale from 1 to 4.
Practicality percentage formula:

$$\text{Practicality percentage } (\%) = \frac{Total\ score\ obtained}{maximum\ score} \text{x } 100\% \quad (2)$$

The practicality category used is shown in Table 2, which shows the value and category for practicality.

Table 2. Criteria for Practicality

Percentage Value	Category
81 – 100%	Very Practical
61 – 80%	Practical
41 – 60%	Quite Practical
21 – 40%	Less Practical
0 – 20%	Impractical

Source: [40]

3. RESULTS AND DISCUSSION

The resulting product is an animated video, assisted by GeoGebra and Artificial Intelligence (AI), on triangle congruence material for grade IX junior high school students. In this study, the ADDIE development model is used, consisting of five stages: *Analysis, Design, Development, Implementation,* and *Evaluation*. The description of the results and discussion of development research based on the ADDIE model is described as follows:

3.1. Analysis Stage

The results of the analysis of interviews and observations showed that Mathematics learning in grade IX at SMP Negeri 46 Seluma still uses conventional methods, such as lectures with the help of package books and whiteboards, without using technology-assisted media such as animated videos or GeoGebra applications. The teacher stated that "many students still have difficulty understanding the concept of confluence, especially because they are not yet able to visualize the relationship between two triangles that appear to be similar". This condition is reflected in students' low activity in asking questions and in

discussions during learning, as well as in limited opportunities for students to explore and think critically about examples of triangles that should be observed dynamically.

Based on these findings, it is considered necessary to develop learning media that are more visual, interactive, and dynamic, so that students can see movements and the suitability of sides and angles. GeoGebra and *Artificial Intelligence* (AI)-assisted animation video development was chosen as an alternative because video media and GeoGebra have been shown to help students understand concepts and visualize geometric objects more concretely and engagingly. Thus, the development of GeoGebra-assisted animation videos and *Artificial Intelligence* (AI) for triangle congruence materials is expected to overcome difficulties in students' understanding of triangle congruence while improving their activities and critical thinking skills in geometry learning.

This aligns with the finding that critical thinking skills will not develop optimally if lectures still dominate learning and do not provide space for exploration or discussion that challenges students. Rahmawati et al.'s research emphasizes that structured exercises, through tasks that encourage analysis and evaluation of arguments, are needed to foster the development of critical thinking skills in science and mathematics learning. The need for dynamic visual media in geometry materials is also supported by studies showing that geometry, especially congruence and coherence, demands strong spatial visualization capabilities and has the potential to cause misconceptions if taught only symbolically, this is in line with Xu and Meng's research which shows that the need for visual-interactive media in geometry materials, including the learning of triangle congruence, demands spatial visualization and reasoning strong. Thus, the results of the needs analysis in this study are consistent with the literature, which highlights the importance of visual-assisted learning media and technology in fostering high-level thinking.

3.2. Design Stage

The design stage in this study starts from creating a theme, designing the appearance of each scene in the video, starting from the beginning to the end and equipped with dialogue descriptions, narration, text, movements, and audio to be used (*storyboard*) of the animated video, a demonstration of two triangles driven using GeoGebra, as well as questions that trigger analysis and conclusion drawing by students. The design of storyboards, video flows, and the selection of visual and narrative displays in the form of animated videos is in line with the results of Dewi et al.'s research which shows that animation-assisted learning videos are effective in increasing student motivation and learning outcomes, The use of GeoGebra as a basis for visualizing triangle congruence in media design is also in line with Izdahara's systematic study which concluded that GeoGebra has been proven to be effective in improving understanding of concepts and abilities Spatial Student in Mathematics Learning in the Digital Era. The design of the use of *Artificial Intelligence* (AI) uses *perplexity.ai* to create automated animated videos, and Canva for voice narration, visual processing, and video editing to increase the attractiveness and efficiency of the production process, in line with the demands of the use of technology and *Artificial Intelligence* (AI) in the development of modern learning media, *Artificial Intelligence* (AI) in the process of creating voice narratives and processing video displays is in line with the recommendations of Reyes

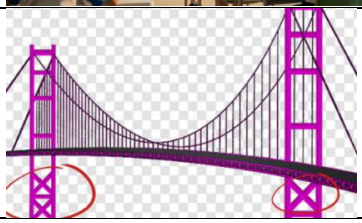
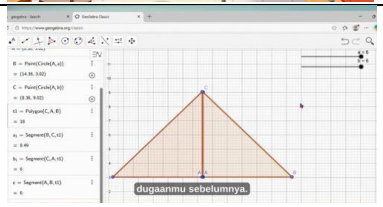
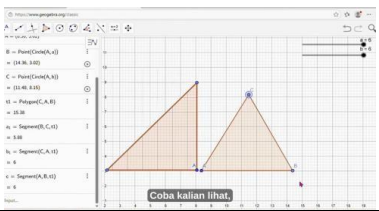
396 https://doi.org/10.58421/misro.v5i1.1152

et al. and Elsa Sabrina et al., which show that *Artificial Intelligence* (AI) can improve the work efficiency of teachers and the quality of the digital learning media produced. Design of research instruments: media validation sheets, student and teacher practicality questionnaire sheets.

3.3. Development Stage

This development stage is the stage when learning media begins to be really created, the researcher creates geometric objects and visualizes the congruence of triangles using the GeoGebra application, and Artificial *Intelligence* (AI) Technology is used to help the process of creating the initial display, and processing animations, while the display using GeoGebra is compiled manually so that the visualization of the congruence relationship of the triangle can be displayed dynamically. All of these components are combined into a single animated video using Canva's video processing software. The resulting video product is validated by subject matter and media experts and revised based on their suggestions and comments. This stage is carried out to obtain suggestions, improvements, and assessments of whether the media is suitable for use before being tested directly with students. The following displays learning media before and after the reflection, as shown in Table 3.

Table 3. Results Before and After Refining

Comments	Before Refisi	After Refisi
The initial appearance is made according to the class culture in Indonesia.		
Examples of the Congruent triangle in everyday life are shown invisibly.		
The existing animated videos do not present problems that are solved with GeoGebra, as an effort to trigger critical thinking skills.		 

Media validation was carried out by one media expert and one material expert using a scale of 1-5 across four aspects: content/material, design and visual, technical & GeoGebra,

and duration and flow. The validity value is calculated using the percentage formula. Based on the results of the media validation that has been developed, the average validity score of the two validators was obtained, namely 90% with very valid criteria in line with the findings of Rahmandhani and Utami which show that the ADDIE model is widely used to produce digital learning media that is valid and suitable for use in the classroom, can be seen in the following table 4.

Table 4. Expert Validation Results

Remarks	Value
Validation results by media experts	100%
Validation results by subject matter experts	80%
Average	90%
Validity criteria	Very valid

Although the validity score is very high, the validator still provides some input for media improvement, suggesting improvements to the voice aspect, so the researcher revises the narrative voice settings to make it clearer, and the validator suggests using the researcher's voice as a form of appreciation for the researcher. The revision improves the quality of the video presentation without altering the substance of the material, which has been considered valid.

3.4. Implementation Stage

In the implementation stage, a trial of the learning media, in the form of GeoGebra-assisted animation videos and Artificial Intelligence (AI), is carried out to determine the practicality of the learning media developed. The limited trial of learning media in the form of GeoGebra and *Artificial Intelligence* (AI)-assisted animation videos was carried out after the developed learning media was declared valid by the validators of media experts and material experts, this limited trial was carried out in 3 meetings, and utilized LCDs/projectors and computers available in schools to show videos to 14 students who were the subjects of the study. During implementation, students watch the video and then work on the assigned tasks. The practicality of learning media through GeoGebra and *Artificial Intelligence (AI)-assisted animation videos* developed is seen from the results of the response questionnaire and the assessment of student answers.

The practicality questionnaire, based on responses from 14 students and 1 mathematics teacher, was conducted after using the media developed on a scale of 1-4 across five aspects: ease of use, clarity of concept, exploration involvement, critical thinking stimulation, and duration efficiency. Based on the results of the validation of the media that has been developed, an average practicality score of 89.11% is obtained where the teacher's practical value is slightly different from the average student but overall is still in the range of the very practical category, so that the learning media developed is feasible and practical to be used both from the perspective of students and teachers, to support the application of media in learning activities in the classroom, in line with the research of Jubaidah and Wahyudi, who developed an animated video of flat building material and obtained media with practical categories to be very practical to use in learning.

The results of observations during the trial also showed a positive change in student activities. When the video plays, all the students pay attention to the impression and follow the flow. Students began to ask questions and engage in discussions actively, Increased students' attention while listening to the video, the emergence of questions, and their involvement in the discussion support the findings of Mita Aswatun & Haifatrrahmah and Pradana that animated videos can increase students' motivation and learning engagement in the classroom, so that the opportunity to practice their critical thinking becomes more open, in line with Wardani and Fiorintina's idea that learning that emphasizes problem-solving and reasoning can build the ability to think critically in the 21st century. The results of the practicality assessment are shown in Table 5 below.

Table 5. Media Practicality Questionnaire Results

Remarks	Value
Media practicality according to teachers	100%
Media practicality according to students	78,21%
Average score	89,11%
Eligibility criteria	Very Practical

3.5. Evaluation Stage

The Evaluation Stage is carried out formatively at each stage of ADDIE and summatively after the product trial. Formative evaluation involves revising product content and display based on expert and teacher input, as explained by Syahid et al. and Rahmandhani & Utami, and emphasizes the importance of a continuous revision cycle to ensure media quality. In contrast, summative evaluation is carried out by examining the results of validation and the practicality of the developed media, aligned with the recommendations of Melati & Argarini and Suprayogo & Putri, which place user feedback as an important component in the development of learning media. Thus, the evaluation stage not only ensures that the media meet valid and practical criteria but also demonstrates the suitability of the development process to theoretical and empirical standards in learning media development research.

4. CONCLUSION

This research produced GeoGebra- and Artificial Intelligence-assisted animation videos on triangular congruence for grade IX junior high school students that meet the validity and practicality criteria and facilitate dynamic, interactive visualization of the concept of congruence, supporting the development of students' mathematical critical thinking skills. These findings imply that the integration of GeoGebra and AI in animated videos can be a strategic alternative to overcome the dominance of conventional learning that lacks high-level thinking activities, while providing a digital media development model that is relevant to junior high school mathematics teachers and can be adapted to other geometry topics that demand strong spatial visualization. However, this study still has limitations because it tests the validity and practicality using a limited sample from one school and does not measure the effectiveness of media on learning outcomes and indicators of critical thinking ability quantitatively. Hence, the generalizability of the findings and the

claims of academic impact still needs to be further studied. Therefore, further research is recommended to involve a wider sample, use experimental or quasi-experimental designs to test the effectiveness of media on learning outcomes and critical thinking skills, as well as develop higher interactivity features, such as adaptive quizzes and AI-based automated feedback, so that students' engagement, reflection, and independent learning can be further enhanced, and oriented towards the development of thinking skills high level of students.

ACKNOWLEDGEMENTS

The author would like to thank the parents, who have been the most important figures in providing prayers, support, enthusiasm, and motivation throughout the process of compiling and completing this research. The author also thanked Reno Bayu Saputra, the author's younger brother, for being willing to help the author during the research preparation. The author also expressed his gratitude to the SMP Negeri 46 Seluma, especially the principal, mathematics teachers, and grade IX students, who actively participated and provided support during the implementation of research and experiments on animated video media. The highest appreciation was conveyed to the lecturers, Mr. Dr. Kashardi, M.Pd, as supervisor 1, and Mr. Drs. Masri, M.Si, as supervisor 2, as well as validators (material experts and media experts) who have taken time, energy, and provided constructive input so that the products produced are better and suitable for use. In addition, the author thanks all other parties who cannot be mentioned individually, including institutions or funding support parties, if any, for their moral and material assistance in completing this research properly.

REFERENCES

[1] Y. Ngatminiati, Y. Hidayah, and Suhono, "Keterampilan Berpikir Kritis untuk Siswa Sekolah Dasar," *J. Rev. Pendidik. dan Pengajaran*, vol. 7, no. 3, pp. 8210–8216, 2024, [Online]. Available: https://journal.universitaspahlawan.ac.id/index.php/jrpp/issue/view/353

[2] O. Sarıgöz, "Teaching the 21st Century Learning Skills with the Critical Thinking Technique Based on the Argumentation Method," *Educ. Policy Anal. Strateg. Res.*, vol. 18, no. 1, pp. 196–218, 2023, doi: 10.29329/epasr.2023.525.9.

[3] A. S. Rahmawati, I. Hamidah, A. Samsudin, and D. Rochintaniawati, "Review of Relevant Literature About Critical Thinking Skills in a Science Perspective," *J. Penelit. Pendidik. IPA*, vol. 11, no. 5, pp. 56–67, 2025, doi: 10.29303/jppipa.v11i5.9687.

[4] B. Golden, "Enabling critical thinking development in higher education through the use of a structured planning tool," *Irish Educ. Stud.*, vol. 42, no. 4, pp. 949–969, 2023, doi: 10.1080/03323315.2023.2258497.

[5] I. S. Wardani and E. Fiorintina, "Building Critical Thinking Skills of 21st Century Students through Problem Based Learning Model," *JPI (Jurnal Pendidik. Indones.*, vol. 12, no. 3, pp. 461–470, 2023, doi: 10.23887/jpiundiksha.v12i3.58789.

[6] Reska Dina Putri, Putri Yuanita, and Kartini, "Analisis Indikator Berpikir Kritis Matematis Pada Soal Matematika Pisa Konten Data Dan Ketidakpastian," *Pros. Semin. Nas. Pendidik. Mat.*, vol. 2, pp. 228–239, 2024, doi: 10.20527/nxsk3305.

[7] E. E. Muchlis, N. Priatna, and J. A. Dahlan, "Development of a web-based worksheet with a project-based Development of a web-based worksheet with a project-based learning model assisted by GeoGebra," *J. Ris. Pendidik. Mat.*, vol. 8, no. 1, pp. 46–60, 2021, doi: 10.21831/jrpm.v8i1.40985.

[8] I. Hidayati and E. F. Asda, "Pengaruh Metode Pengajaran Problem Based Learning terhadap hasil belajar Siswa," *NAWASENA J. Math. Sci. Technol. Educ.*, vol. 1, no. 2, pp. 1–6, 2025, [Online]. Available: https://educationalresearchjournal.com/ejr/index.php/njmste%0APengaruh

[9] M. Maulidiya, N. R. F. Qhusna, D. F. Larasati, and B. R. Kurniawan, "Analisis Kemampuan Pemecahan Masalah Mahasiswa pada Materi Hukum Newton," *J. Cendekia J. Pendidik. Mat.*, vol. 7, no. 3, pp. 3216–3228, 2023, doi: 10.31004/cendekia.v7i3.2913.

[10] N. K. K. Dewi, A. I. W. I. Y. Sukmana, and A. H. Simamora, "Inovasi Media Pembelajaran: Video

Pembelajaran Berbasis Animasi Meningkatkan Hasil Belajar Matematika Siswa Sekolah Dasar," *J. Media dan Teknol. Pendidik.*, vol. 4, no. 2, pp. 149–157, 2024, doi: 10.23887/jmt.v4i2.64378.

[11] B. R. T. Azwar Anwar, Luluk Nirwana, James, "Analisis Kecerdasan Spasial Siswa Dalam Menyelesaikan Soal-Soal Geometri Berdasarkan Tingkat Berfikir Van Hiele," vol. 5, no. level 3, pp. 116–125, 2022, doi: https://doi.org/10.31539/judika.v5i2.4778.

[12] Ratnasari Ratnasari, Nikmah Nurvicalesti, and Ami Sulistia Wati, "Implementasi Pembelajaran Mendalam terhadap Kemampuan Berpikir Kritis Matematis Siswa," *Algoritm. J. Mat. Ilmu Pengetah. Alam, Kebumian dan Angkasa*, vol. 3, no. 4, pp. 43–50, 2025, doi: 10.62383/algoritma.v3i4.576.

[13] P. Y. Rahayu, "An Analysis of Factors Influencing Low Critical Thinking Skills among University Students in Learning," vol. 5, no. 2, pp. 56–63, 2025.

[14] W. Xu and Q. Meng, "The Development of Mathematical Model Consciousness in Junior Secondary Students: A Lesson Study of the Instruction of Congruent Triangles," *Sci. Insights Educ. Front.*, vol. 14, no. 1, pp. 1991–2012, 2023, doi: 10.15354/sief.23.or088.

[15] Z. . Windy.H, Agung.B, Nurul.N, Rebecca., "Analisis Miskonsepsi dan Perbaikan Konsep Kesebangunan dan Kekongruenan pada Buku Matematika SMP dengan Metode Library Research (Studi Pustaka)," vol. 10, no. September, pp. 2477–2143, 2025.

[16] Lis Sugianto, H. Hikmah, T. B. Kriswinarso, S. Sukmawati, and F. Basir, "Pengembangan Media Pembelajaran dengan Teknologi Augmented Reality pada Materi Bangun Ruang Sisi Lengkung dan Pengaruhnya terhadap Hasil Belajar Matematika Siswa," *Venn J. Sustain. Innov. Educ. Math. Nat. Sci.*, vol. 4, no. 3, pp. 227–241, 2025, [Online]. Available: https://journal.web.id/journals/venn/article/view/302

[17] S. Wahyuni, D. Puspita, and S. Arviana, "Pengembangan Media Pembelajaran Interaktif Berbantu Software GeoGebra Untuk Meningkatkan Kemampuan Spacial Siswa," vol. 17, no. 1, pp. 37–48, 2025.

[18] N. S. Mita Aswatun, Haifatrrahmah, "Efektivitas Video Pembelajaran Animasi Dalam Meningkatkan Motivasi dan Hasil Belajar Siswa Sekolah Dasar," vol. 10, 2025.

[19] C. H. Navre Avrela Surya, "Peran Video Animasi Pembelajaran Matematika Terhadap Pemahaman Konsep, Minat Belajar, dan Hasil Belajar Siswa SMP," pp. 332–342, 2025.

[20] NURDIN, "Penggunaan Media Video Pembelajaran Melaui Youtube Untuk Meningkatkan Pemahaman MASBUK Dalam Shalat Peserta Didik di MTs Maarif Kabupaten Pinrang," p. 6, 2025, [Online]. Available: https://www.city.kawasaki.jp/500/page/0000174493.html

[21] S. Ramadhan, P. B. Adnyana, K. Srie, and M. Julyasih, "Pengembangan Media Pembelajaran Video Animasi Interaktif Menggunakan Aplikasi Powtoon pada Materi Bioteknologi Kelas XII," *J. Pendidik. Biol. Undiksha*, vol. 11, no. 2, pp. 1–16, 2024.

[22] D. D. A. Simanjuntak, D. P. M. Sitorus, and B. T. Gultom, "Pengaruh Media Pembelajaran Audio Visual Dan Variasi Mengajar Guru Terhadap Hasil Belajar Siswa Kelas IX Mata Pelajaran IPS SMP Negeri 11 Pematangsiantar," *J. Sains Student Res.*, vol. 1, no. 2, pp. 708–718, 2023, [Online]. Available: https://doi.org/10.61722/jssr.v1i2.280

[23] S. Pradana, "Efektivitas Penggunaan Video Animasi sebagai Media Pembelajaran Interaktif di Sekolah Dasar," *J. Transform. Pendidik. Dasar*, vol. 1, no. 1, pp. 33–39, 2025, [Online]. Available: http://synergizejournal.org/index.php/JTPD/index

[24] Ananda Dwi Putri and Hanifah Fitriyani, "Analisis Kesulitan Belajar Matematika Materi Geometri Pada Siswa Kelas 4 Sekolah Dasar," *J. Pendidik. Mat.*, vol. 2, no. 1, pp. 1–8, 2024, doi: 10.47134/ppm.v2i1.1112.

[25] A. ten Voorde, M. Piroi, and R. Bos, "A taxonomy of didactic roles of dynamic visualization in animated mathematics videos," *Teach. Math. its Appl.*, vol. 44, no. 1, pp. 47–67, 2025, doi: 10.1093/teamat/hrae007.

[26] T. S. Putri Rosadi, Syarfuni, "Penggunaan Aplikasi GeoGebra Pada Materi LIngkaran Untuk Meningkatkan Aktivitas Dan Penguasaan Komptensi Siswa Kelas XI Di SMAN 1 Krueng Barona Jaya," pp. 7–8, 2025.

[27] I. Dini Izdahara, "A Systematic Literature Review on the Effectiveness of GeoGebra in Mathematics Education in the Digital Era," *Infin. J.*, vol. 14, no. 3, pp. 655–672, 2025, doi: 10.22460/infinity.v14i3.p655-672.

[28] T. O. Pratiwi and R. M. M. Sari, "Analisis siswa dan Strategi Dalam Memahami Kekongruenan Pada Pembelajaran Geometri Siswa Sekolah Menengah: Systematiy Literature Review," *JP2M (Jurnal Pendidik. dan Pembelajaran Mat.*, vol. 11, no. 1, pp. 394–403, 2025, doi: 10.29100/jp2m.v11i1.7026.

[29] N. Ulya and Hasanuddin, "Penggunaan Geogebra untuk Meningkatkan Pemahaman Konsep Kesebangunan : Analisis Bibliometrik," *Bilangan J. Ilm. Mat. Kebumian dan Angkasa*, vol. 3, no. 3, pp. 18–31, 2025.

[30] N. I. I. Tajuddin *et al.*, "Content Validity Assessment Using Aiken's V: Knowledge Integration Model for Blockchain in Higher Learning Institutions," *Int. J. Adv. Comput. Sci. Appl.*, vol. 16, no. 6, pp. 601–

608, 2025, doi: 10.14569/IJACSA.2025.0160659.
[31] K. P. Reyes, M. G. Leongson, H. C. Garbin, A. S. Siroma, and N. E. Malaluan, "Utilization of AI in Enhancing Teachers' Instructional Materials and Work Efficiency," vol. 8, no. 4, pp. 997–1007, 2025.
[32] N. I. S. Elsa Sabrina, Dira Safira, Jeremia Sitepu, Nisa Safitri and Shahdana, "Kecerdasan Buatan Dalam Pengembangan Media Pembelajaran Interaktif Berbasis Digital: Literature Review," vol. 5, no. 1, pp. 169–177, 2025.
[33] S. Mariyah, W. Gunawan, and N. Nurjati, "Development of Artificial Intelligence-Based Digital Video Media with the Addie Model for Intrinsic Elements of Short Stories," *J. Teknol. Pendidik. J. Penelit. dan Pengemb. Pembelajaran*, vol. 10, no. 4, pp. 799–810, 2025, doi: 10.33394/jtp.v10i4.18237.
[34] A. T. H. Muhammad Haikal , Yeni Listiana, "Analisis Kebutuhan Pengembangan Media Pembelajaran Visual Berbantu GeoGebra Untuk Mendukung Kemampuan Pemecahan Masalah Matematis," vol. 5, pp. 33–41, 2025.
[35] I. R. Windatul Hasanah and Dase Erwin Juansah, "Peran Media Digital dalam Meningkatkan Motivasi dan Hasil Belajar Matematika Siswa Sekolah Dasar di Era Digital," *J. Basicedu*, vol. 5, no. 5, pp. 3(2), 524–532, 2020, [Online]. Available: https://journal.uii.ac.id/ajie/article/view/971
[36] S. Nurhati Suci Tama, "Analisis kebutuhan siswa terhadap media video animasi dalam pembelajaran matematika," vol. 13, no. 2, pp. 315–324, 2022.
[37] N. N. S. Binti Jubaidah and Wahyudi, "Development of Animated Video Media for Teaching the Perimeter and Area of Plane Shapes in Grade 4 at SDN Dermo 2 Kediri," vol. 2, no. 2, pp. 131–141, 2026, doi: 10.63709/ajppp.v2i2.3.
[38] S. Belia, P. Dewi, and D. Kusuma, "Pengembangan Media KACATUNG (Kartu Cara Hitung) pada Materi Penjumlahan dan Pengurangan Untuk Meningkatkan Pemecahan Masalah Siswa Sekolah Dasar," vol. 14, no. 3, pp. 4901–4924, 2025.
[39] H. N. Rahmandhani and E. Utami, "Comparative Analysis Of ADDIE And Assure Models in Designing Learning Media Application," vol. 7, no. 2, pp. 123–138, 2022.
[40] K. A. Fadila, A. Amrullah, G. Primajati, and N. Hikmah, "Pengembangan Media Interaktif Pada Materi Geometri dengan Website Berbasis Geogebra Siswa Kelas IX di SMPN 9 Mataram," *Mandalika Math. Educ. J.*, vol. 7, no. 2, pp. 639–649, 2025, doi: 10.29303/jm.v7i2.9231.
[41] I. M. Syahid, N. A. Istiqomah, and K. Azwary, "Model Addie Dan Assure Dalam Pengembangan Media Pembelajaran," 2024.
[42] N. V. Melati and D. F. Argarini, "Pengembangan Media Pembelajaran Mappa Math Dalam Materi SPLDV," vol. 6, no. 2, pp. 305–313, 2025.
[43] D. Suprayogo and D. A. A. Putri, "Pengembangan Media Pembelajaran Matematika Berbentuk Permainan Kartu Red Or Blue Geometry Kelas IV Sekolah Dasar," *J. Algoritm.*, vol. 11, no. 1, pp. 1–11, 2013.
[44] S. B. P. Utami, N. Riska, R. Rusilanti, and A. Gumelar, "Evaluation of Content Validity for an Educational Media Instrument to Enhance Early Childhood Education (PAUD) Teachers' Nutrition Knowledge," *J. Pendidik. dan Pembelajaran Indones.*, vol. 5, no. 4, pp. 1801–1808, 2025, doi: 10.53299/jppi.v5i4.2531.
[45] M. Praseptiawan, A. N. C. Pee, M. H. Zakaria, and A. Noertjahyana, "Advancing the Measurement of MOOCs Software Quality: Validation of Assessment Tools Using the I-CVI Expert Framework," *Int. J. Eng. Sci. Inf. Technol.*, vol. 5, no. 3, pp. 138–145, 2025, doi: 10.52088/ijesty.v5i3.911.