Edumatica: Jurnal Pendidikan Matematika
Volume 15 Number 1 April 2025

Submited : 15 April 2025
Revised : 21 April 2025
Accepted : 30 April 2025

DOI: https://doi.org/10.22437/edumatica.v15i1.43073

Development of a Cartoon-Based Animated App to Improve Elementary Geometry Understanding

Verina Deawany Kurniawan[1], Anita Rahayu Nurfitriani[2], Setiyani[3*], Dina Pratiwi Dwi Santi[4]
[1,2,3,4]Program Studi Pendidikan Guru Sekolah Dasar, Fakultas Pendidikan dan Sains, Universitas Swadaya Gunung Jati
E-mail*: setiyani@ugj.ac.id

Abstract

The conventional learning approach, which is less relevant to technological advancements, causes students to find it difficult to engage actively in the learning process, thereby limiting their understanding of the material. Sixth-grade students at a public elementary school in Cirebon City experience difficulties in comprehending spatial geometry concepts, such as the properties of three-dimensional shapes, volume calculation, and surface area. To address this issue, an animated cartoon-based spatial geometry learning application was developed to enhance students' understanding interactively and enjoyably. The visually appealing element in the form of cartoon animation is expected to facilitate more concrete visualization of geometric concepts as well as increase students' motivation to learn. This study employed a Research and Development (R&D) model using the ADDIE approach, which includes analysis, design, development, implementation, and evaluation stages. The material validation results obtained a score of 90.00%, while media validation scored 91.12%, both categorized as "highly feasible" for implementation. Testing with small and large groups also demonstrated very high results with percentages of 88.4% for small-scale testing and 90.1% for large-scale testing. This cartoon animation-based application can serve as an innovative alternative to support mathematics learning processes, particularly on spatial geometry topics, at the elementary school level.

Keywords: cartoon animation; spatial geometry application; student understanding

INTRODUCTION

Learning three-dimensional geometry is often difficult for students to grasp when delivered only through verbal explanations or static illustrations. A deep understanding of spatial forms, dimensions, and the relationships between their elements is essential for mastering these concepts effectively. Optimal concept mastery is crucial for effective problem-solving. Teachers need to design engaging and varied instructional methods to foster interest in arithmetic learning (Hanan & Alim, 2023). However, many educators still rely on lectures and textbooks as the main instructional media for this topic. These conventional approaches are less effective in promoting students' deep understanding; many tend to memorize formulas without comprehending their applications.

In teaching, especially when it comes to calculating volume and surface area of three-dimensional objects, students are usually introduced to formulas without a comprehensive understanding of the geometric shapes and their properties. This mismatch makes it difficult for students to connect theory with practice, resulting in generally low levels of conceptual understanding (Mahardiko & Tuharto, 2016). The lack of interactive learning media that can effectively visualize 3D objects is one of the main contributing factors to this difficulty (Pagarra et al., 2022).

Based on observations at an elementary school in Cirebon City, it was found that many sixth-grade students struggle to understand the properties of 3D shapes and accurately calculate their volume and surface area. Teachers still predominantly use lectures assisted by textbooks, which have proven less effective, especially in today's digital era, where interactive media can enhance student engagement. This highlights the urgent need for innovative digital-based learning media that offer more interactive learning experiences and can realistically visualize spatial geometry concepts.

The development of a three-dimensional geometry application using cartoon-style animation offers an innovative solution to these challenges. Compared to conventional methods that rely solely on lectures or textbook exercises, this application delivers content dynamically and interactively. Through animated cartoons that display various perspectives of geometric solids and relate their properties to real-life contexts, the application enhances students' visualization skills while offering visually appealing content, thus improving information processing (Huda & Ardi, 2021).

Moreover, animated spatial geometry applications enable active student participation by allowing them to observe the movement and transformation of 3D shapes—something difficult to achieve with static images in textbooks alone. The application can also be designed with interactive scenarios in which students explore or solve challenges based on the animations, thereby increasing their motivation. Compared to passive traditional approaches, animation-based materials provide a compelling contextual learning experience expected to strengthen comprehensive concept mastery and make the learning process more enjoyable (Sofyan et al., 2023).

Several previous studies have shown the positive impact of using animation-based media in various educational fields. Huda & Ardi (2021) found increased understanding due to high visual appeal. Alifa et al. (2021) reported up to a 90% improvement after using animated videos in science learning. Hidayati et al. (2019) observed a 30% improvement following the use of animated instructional videos related to force concepts. However, most of these studies focused primarily on science education rather than mathematics, especially spatial geometry material. Pakpahan et al. (2024) emphasized the effectiveness of animated videos as dynamic educational tools, yet their use remains limited for mathematics topics such as 3D shapes, despite promising initial results (Alifa et al., 2021; Hidayati et al., 2019). This indicates that although the use of animation has proven beneficial in general, its application is still rare, especially in mathematics education, particularly for spatial geometry topics such as the properties of solids and the calculation of their volume and surface area at the elementary level.

This research aims to bridge that gap through the development of a cartoon-style animated application tailored to the cognitive characteristics of sixth-grade students, aligned with the demands of the digital era, and to evaluate its effectiveness compared to traditional methods. This study aims to (1) develop a cartoon-animated spatial geometry application that meets the needs of sixth-grade elementary students, (2) analyze the effectiveness of the application in improving students' understanding of

geometric properties and volume/surface area calculations compared to conventional methods, and (3) assess student responses and motivation toward using this modern learning tool.

It is hoped that the use of this innovative media can foster deeper conceptual mastery through engaging interaction, thereby making a significant contribution to the advancement of technology-integrated educational resources, particularly at the elementary education level. Furthermore, the research is also intended to serve as a valuable reference to support curriculum development that prioritizes the integration of digital media for effective, enjoyable, and student-centered learning experiences.

METHOD

This study employed a Research and Development (R&D) approach using the ADDIE model to design a Cartoon-Animated Geometry Application. The primary objective of the study was to develop and evaluate the feasibility and effectiveness of this learning medium (Prabowo, 2020). The ADDIE model consists of five systematic phases: Analysis, Design, Development, Implementation, and Evaluation (Ritonga et al., 2022).

The research was conducted during the odd semester of the 2024/2025 academic year at a public elementary school (SDN) in Cirebon City. This institution served as both the site for the application development and the implementation trial. The study involved 29 sixth-grade elementary school students as participants.

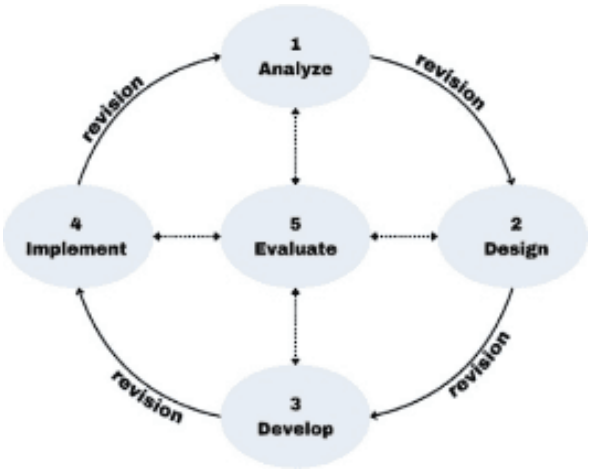


Figure 1. The ADDIE Development Model
Source: Prabowo (2018)

Analysis

The initial stage included a needs assessment and the determination of development objectives through direct observation at the research site. Observations revealed that sixth-grade students experienced significant difficulties in understanding geometric concepts, particularly in identifying the properties of three-dimensional shapes, calculating volumes, and determining surface areas. Teachers predominantly used lectures supported by conventional textbooks, which appeared inadequate in fostering deep conceptual understanding. To effectively address these challenges, it was deemed necessary to develop a learning aid in the form of worksheets integrated with cartoon animations aimed at enhancing students' comprehension of geometry. Additionally, the analysis results were critically reviewed to ensure accuracy; any inconsistencies or deficiencies identified were addressed before proceeding to the next stage.

Design

In this phase, worksheet-based learning media integrating cartoon animations were designed using Canva software, specifically targeting sixth-grade geometry material. The design was thoroughly

evaluated for completeness and alignment with instructional objectives; any identified shortcomings were revised accordingly.

Development

During this stage, the product was created based on the established design. Verification activities were carried out through the recording of learning sessions, which were validated by experts. Program files were converted into an operational application format. Feedback from mathematics education experts and educational media developers was systematically collected to refine the product quality by the initial specifications.

Implementation

This phase involved applying and testing the developed product through two main validation processes:

a) Expert Validation, which included: *Media Experts*, who assessed technical aspects such as usability, interactivity, and visual appeal. *Subject Matter Experts*, mathematics educators who evaluated content accuracy, mathematical correctness, and pedagogical appropriateness.

The validation results were analyzed using a structured questionnaire based on the adaptive percentage criteria from Akbar (2013), summarized as follows:

Table 1. Percentage Criteria

Percentage Range	Validity Level	Usage Context
81,26% – 100%	Highly Feasible	Indicates very high suitability & readiness
62,51% – 81,25%	Feasible	Acceptable with minor revisions
43,76% – 62,5%	Not Feasible	Requires significant revisions
25% – 43,75%	Highly Infeasible	Unsuitable; needs major redesign

This table applies equally to both Media Expert and Subject Matter Expert validations.

b) Student Trials, conducted in two stages: *a Small-Scale Trial involving purposively selected students based on their readiness and representation of varying academic abilities among sixth graders at SDN Cirebon; and a Large-Scale Trial* conducted later with a randomly selected sample of sixth-grade students from several classes to ensure broader demographic representation, including diversity in gender and previous academic achievement.

The main goal of the trials was to assess practical usability and measure effectiveness through pre-test and post-test assessments. The results were analyzed using the N-Gain statistic—a quantitative metric indicating improvement in students' understanding after using the media, where higher values represent greater comprehension gains.

Evaluation

Evaluation was conducted iteratively throughout all preceding stages—from analysis to implementation—as a means of monitoring success against established criteria and identifying areas for improvement before finalization. Validation focused on three primary domains, assessed via structured validation sheets containing targeted statements for expert judgment accompanied by qualitative feedback in the form of suggestions or constructive criticism: (1) *Content Validity*, assessed by elementary school teachers to ensure thematic relevance in line with curriculum standards; (2) *Media Validity*, evaluated by academic experts in educational technology to ensure technical robustness; (3) *Design Validity*, examining visual aesthetics and program functionality to ensure user-friendliness aligned with the characteristics of the intended student audience.

Data obtained from the validation process were quantitatively processed according to the percentage-based feasibility categories described earlier, enabling an objective determination of the product's readiness before wider implementation.

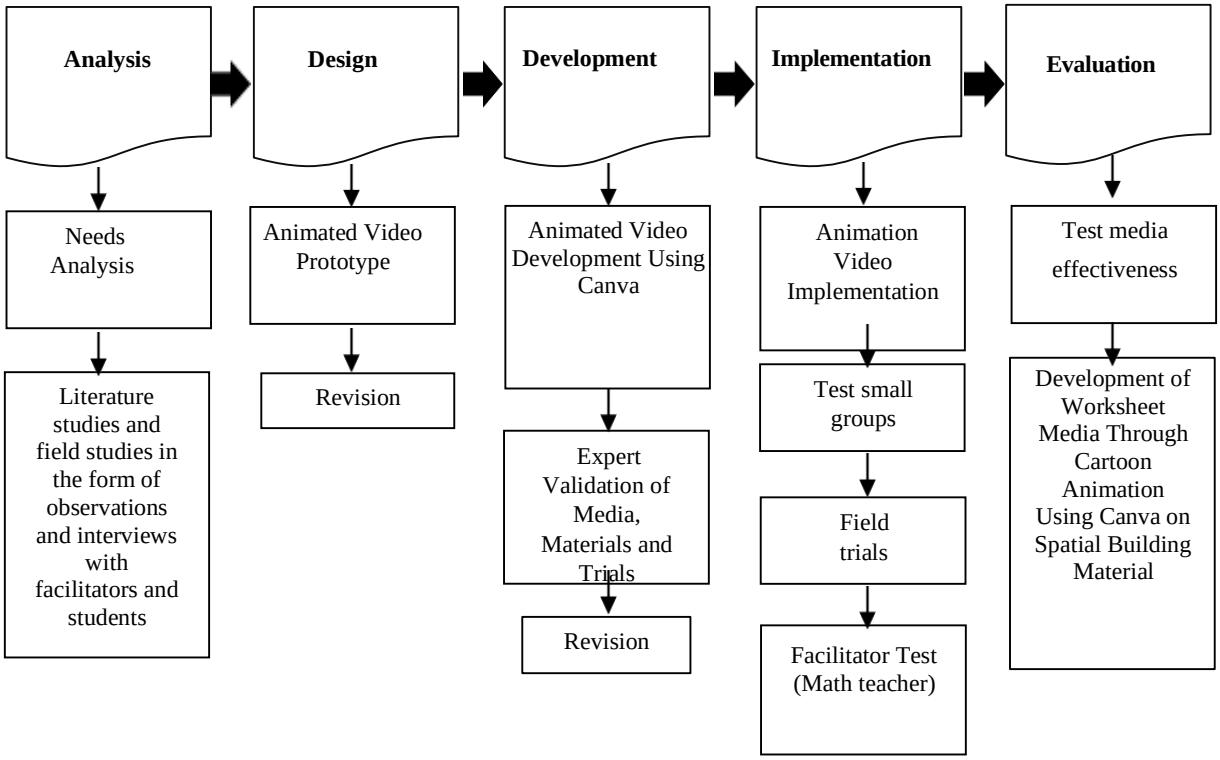


Figure 2. Development flow of the cartoon animation-based geometry application using Canva.

Figure 2 illustrates the development process of cartoon animation-based learning media using the ADDIE model, which includes five main stages: needs analysis through literature review, observation, and interviews; designing an animated video prototype followed by revisions; developing the animated video using Canva accompanied by expert validation of media and materials as well as product revisions; implementation involving trials with small student groups, field testing, and evaluation by a math teacher as facilitator; and finally, evaluating media effectiveness through the development of worksheet media based on cartoon animation specifically for spatial geometry material. This process is iterative, with validation and revision steps at each stage to ensure the quality and success of the learning product.

The data collection techniques in this study were carried out through several methods, including direct classroom observation to identify problems in students' geometry learning, distribution of validation questionnaires to media and subject matter experts to assess the feasibility of the developed product, as well as conducting both small-scale and large-scale trials with students using pre-tests and post-tests. In addition, informal interviews with teachers and written feedback from validators were also used to obtain qualitative data regarding the effectiveness of the developed learning media.

Data analysis was conducted both quantitatively and qualitatively. Quantitative data from expert validation results were analyzed using percentage-based feasibility categories according to Akbar's (2013) criteria, while improvements in student understanding were measured by calculating N-Gain statistics between pre-test and post-test scores. Meanwhile, qualitative data, such as suggestions or criticisms from validators and observation results, were analyzed descriptively to deepen the interpretation of the strengths and weaknesses of the product so that they could serve as a basis for improvement before wider implementation.

RESULTS

Description of the development that has been carried out using the ADDIE model:

Analysis

In this phase, a needs analysis was conducted to identify challenges in the 6th-grade learning process at an elementary school in Cirebon City. Based on the collected data, the researcher proposed solutions to address the identified issues. The analysis was carried out using two methods: observation and interviews. Observations were conducted in both direct and indirect forms. Direct observation involved monitoring classroom activities inside and outside the learning environment, while indirect observation was conducted through an analysis of scout activities shared on social media platforms. Based on the results of:

1. Work Analysis, at an elementary school in Cirebon City, particularly in 6th-grade mathematics, teaching methods are still predominantly based on lectures and conventional textbooks. This traditional approach presents challenges for students, particularly in understanding spatial geometry concepts.
2. Student Analysis, 6th-grade students encounter challenges in understanding spatial geometry concepts, including recognizing the properties of geometric shapes, calculating volume, and determining surface area. Based on assessments conducted by the mathematics teacher, some students' scores have not met the Minimum Passing Criteria (KKM). This issue may stem from the lack of interactive and engaging learning media that can effectively visualize the abstract concepts of spatial geometry more concretely and enjoyably. To provide a more comprehensive understanding, illustrative images will be incorporated to highlight each identified difficulty.

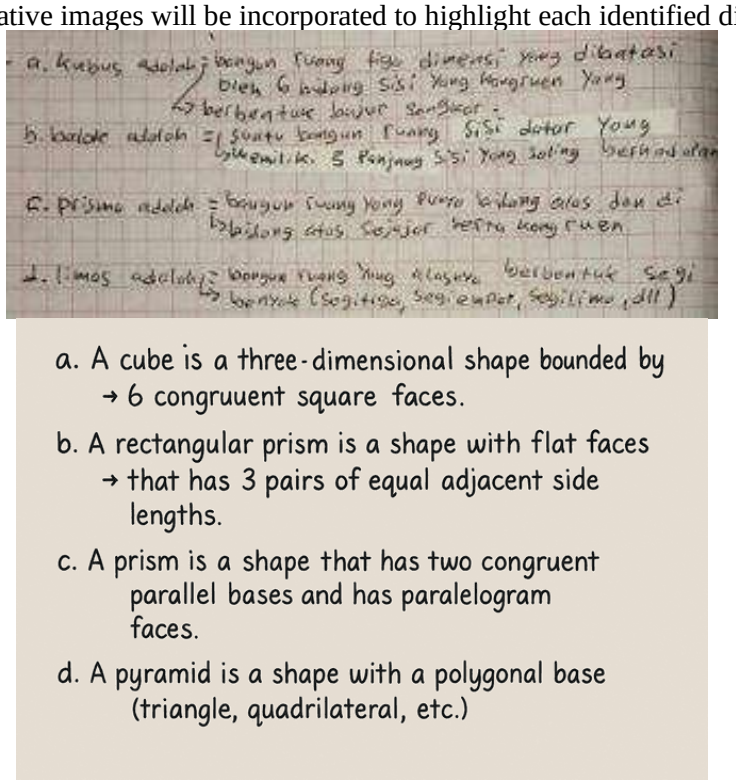


Figure 3. Challenges in Identifying the Characteristics of Three-Dimensional Shapes

Based on **Figure 3**, students face challenges in recognizing the characteristics of three-dimensional shapes. First, a lack of visual understanding, where students struggle to imagine 3D geometric shapes. For example, they may fail to differentiate between a triangular prism and a triangular pyramid solely from textbook images without physical models or concrete manipulatives. Second, difficulty in connecting with real-world contexts, as students struggle to understand geometric properties without real-life examples provided by teachers. Third, errors in identifying geometric characteristics**,** such as confusion in determining the number of faces, edges, and vertices, difficulty distinguishing similar shapes, and misconceptions about the relationship between surface area and volume.

3. Analysis of learning objectives, in mathematics learning, particularly in the topic of three-dimensional shapes, aspects such as recognizing geometric properties, calculating volume, and determining surface area require the development of instructional media. This development aims to enhance students' understanding and comprehension of the subject matter.

Based on the analysis, the researcher requires several elements to support the learning media design process. These requirements:

1. Functional Requirements
   a. The hardware used for designing this instructional tool includes a PC/laptop with specifications: 8 GB RAM, Core i5-3340, to manage application algorithms, and a smartphone with iOS 17.5, 4 GB RAM, 128 GB storage for designing the application interface. The hardware required for operating the product includes an Android smartphone with a minimum specification of Android 8.0 (Oreo) and 4 GB RAM**.**
   b. The software used for product development is Canva.
   c. The learning media should provide access to educational content, including text, videos, audio, and images**.**
   d. The platform must facilitate interaction between students and the material through quizzes and educational games**.**
   e. The learning media should incorporate an evaluation system where students can complete practice exercises and receive instant feedback when answering incorrectly.
   f. The designed learning media should adjust to students' needs based on unachieved learning objectives.
2. Non-Functional Requirements
   a. The primary color of the application is blue, chosen to evoke a sense of trust and reliability (Broeder & Wildeman, 2019)**.**
   b. Pre-test and post-test questions require periodic updates and are provided on a separate page within the application to facilitate easy modifications and improvements.

Design

The design phase involves developing a product based on the results of the needs analysis. This study focuses on creating worksheet-based learning media using cartoon animation through Canva. The learning media workflow illustrates the process students will follow when engaging with the digital content.

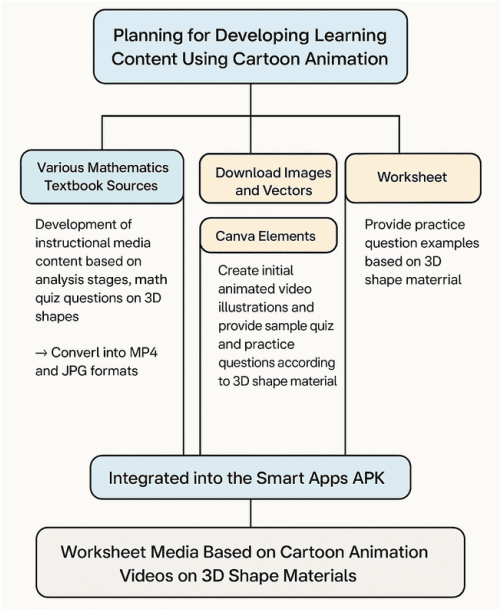


Figure 4. The structured framework of digital Learning Animation

This study utilizes digital media, such as animated videos accessible via Android smartphones, to enhance students' understanding during the learning process. The initial stage in designing the animated video begins with framework development using Microsoft Word and worksheet-based exercises. This step is crucial as it defines the layout of the animation, including material placement, images, and quizzes. Once the framework is completed, the animated video is converted into MP4 and JPG formats. The quiz is then systematically arranged using Canva. Additional supporting elements, such as an introductory learning video, are developed using Canva. Subsequently, reinforcement images featuring cartoon elements are created. The final stage involves producing digital learning animation, the structured framework of the digital learning module, as illustrated in **Figure 4**.

Development

After all components are assembled, the next step is testing through a program preview. Once testing is completed, the layout is refined using a **s**martphone, as the editing layout on a PC may differ from the final display on mobile devices. After finalizing the layout, the next step is to export the program file into an application**.** The results of the application development are presented in **Appendix 1**.

The validation of the cartoon animation Three-Dimensional Shape Application design was conducted. Validation allows the researchers to identify potential errors in the development of the learning media and collect feedback from validators, which will be utilized to improve the quality of the educational tools. The cartoon animation video was evaluated by one content expert and two design experts.

The primary objective of this validation is to evaluate both the strengths and weaknesses of the application as a learning video. The results of the validation process are presented in Table 2.

Table 2. Content Expert Validation Result

Validator	Empirical Score	Maximum Score	Percentage	Category
A	27	30	90.00%	High Feasible

Table 2 shows the results of material validation by a validator involved in the development process of the learning media. Validator A gave an empirical score of 27 out of a maximum total score of 30, which translates to an achievement percentage of 90.00%. This percentage indicates that the developed material has met quality criteria very well. Based on these results, the feasibility category of the material is declared as "Highly Feasible" for use in the learning process. Therefore, it can be concluded that the content is already aligned with standards and learning needs, making it ready to be implemented and further tested in the implementation phase.

Table 3. Media Expert Validation Result

Validator	Empirical Score	Maximum Score	Percentage	Category
A	40	45	88.90%	High Feasible
B	42	45	93.33%	High Feasible
Total	41	45	91.12%	High Feasible

Based on Validator A, it can be explained that in Validation 1, Three-Dimensional Shape Application through the cartoon animation learning video achieved a score of 88.90%**,** classified as highly valid. Subsequently, the researcher made improvements to the media based on suggestions and feedback from media experts, such as adding formulas for volume and surface area of three-dimensional shapes. The teaching aids used in this animated story media were considered excellent, with the content presented engagingly and in alignment with learning needs. Furthermore, the animation visualization effectively supported the understanding of concepts and increased student engagement in learning. Therefore, this media is deemed suitable for a trial run without further revisions and can be used as an innovative learning aid. Based on Validator B, it can be explained that Validator B evaluated the Three-Dimensional Shape Application through animated video learning and achieved a score of 93.33%**,**

categorized as very valid. The researcher made improvements to the media based on suggestions and comments from the media expert. To optimize the learning media, several adjustments were necessary. First, the font size should be increased to make it easier for students to read. Second, the wording in the multiple-choice questions should be revised to avoid the use of question words, as the questions are not in an essay format. Third, formulas for volume and surface area should be included in each section to help students better understand the concepts. Fourth, a Three-Dimensional Shape Application should be added to the learning media, particularly on the main menu page, to facilitate easier access and enhance interactivity during the learning process. So, the average total score is 41 out of a maximum of 45, resulting in an overall percentage of 91.12%, which is categorized as "highly feasible" for use. This indicates that the validated media has a high level of feasibility according to the media experts. The following table presents the revisions made by Validator A & B:

Table 4. Revision Validator A

Validator	Before Revision	After Revision
A		
B		

After revisions were made, the cartoon animation-based Three-Dimensional Shape Application has been enhanced with more detailed explanations, including the incorporation of key formulas in each section of the material. The addition of volume and surface area formulas in the instructional video aids students in understanding the concepts in a more systematic and applied manner. By presenting the formulas visually and interactively, students can more easily connect theoretical knowledge with its practical application in solving mathematical problems. Furthermore, the animation, accompanied by step-by-step illustrations, clarifies the calculation concepts, making the learning process more effective and engaging. With these improvements, it is expected that students will have a better understanding of three-dimensional shapes and be able to solve problems independently with greater confidence.

Cartoon Animation-Based Three-Dimensional Shape Application is now equipped with a direct link to the worksheet within the learning video. This addition enables students to access practice exercises immediately after understanding the material, allowing them to apply the concepts they have learned right away. With the integration of video and worksheet, students can engage in a more structured learning process, from conceptual understanding to independent practice. Furthermore, this feature also assists teachers by providing clearer guidance during the learning process, ensuring that each student can easily access and complete the exercises more interactively and effectively.

Implementation

The implementation stage of this study aims to examine the effectiveness of utilizing cartoon-based animated worksheets in enhancing the understanding of sixth-grade elementary school students regarding three-dimensional geometric shapes. The research was conducted at an elementary school in Cirebon, with the research subjects being sixth-grade students who faced difficulties in comprehending

geometric concepts, such as recognizing the properties of geometric shapes, calculating volume, and determining surface area. Before being tested on students, the instructional media underwent validation by experts to ensure its feasibility and effectiveness.

The validation was conducted through two evaluations: media experts assessed aspects such as visual presentation, interactivity, and technical feasibility, while content experts evaluated the alignment of the material with the curriculum and its comprehensibility for students. The validation results confirmed the feasibility of using this media, with a percentage score of 88.90% from media experts and 93.33% from content experts. The average total score is 41 out of a maximum of 45, resulting in an overall percentage of 91.12%, which is categorized as "highly feasible" for use.

Table 5. Small Group Trial

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
NGain_skor	10	.60	1.00	.8838	.16267
NGain_persen	10	60	100	88.38	16.267
Valid N (listwise)	10				

After the validation, the media were tested on students through two phases: a small-group trial and a large-group trial. The small-group trial involved ten sixth-grade students and aimed to observe students' initial responses to the developed media. The teacher introduced the instructional media, and students utilized them to understand three-dimensional geometric concepts. After using the media, students completed questionnaires and were observed to measure their comprehension and responses. The results of the small-group trial indicated a feasibility percentage of 88.4%, classifying the media as highly feasible.

Table 6. Large Scale Group Trial

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
NGain_score	29	.60	1.00	.9012	.12974
NGain_persen	29	60.00	100.00	90.1232	12.97449
Valid N (listwise)	29				

The large-scale group trial was conducted with 29 students to evaluate the effectiveness of the media on a broader scale. Students were given a pretest before using the media and a posttest after the learning process to measure their improvement in understanding. Based on the N-Gain test analysis, the average score obtained was 0.9012, which falls into the high category (>0.7), with a percentage increase in students' understanding reaching 90.12%. This result demonstrates that the animated cartoon-based worksheet is highly effective in enhancing students' comprehension of geometric shapes.

Table 7. N- Gain Category

N-Gain Value	Category
$g > 0,7$	High
$0,3 \leq g \leq 0,7$	Middle
$g < 0,3$	Low

Source: Melzer in Syahfitri (2008, p. 33)

The implementation results confirm that the animated cartoon-based worksheet significantly strengthens students' understanding of geometric shapes. The N-Gain test results indicate that most students experienced a substantial improvement in comprehension after utilizing the media. The average N-Gain score of 0.9012, classified as high (>0.7), suggests that this media is highly effective in assisting students in understanding geometric concepts, including recognizing the properties of geometric shapes, calculating volume, and determining surface area. The 90.12% increase in students' understanding

further indicates that this media not only facilitates conceptual comprehension but also enhances students' motivation to learn.

The results of students' comprehension tests on the topic of three-dimensional shapes use gain scores as an indicator of learning improvement. The data includes each student's pre-test and post-test scores, the difference between these two scores, as well as calculations of ideal scores and N-gain values that indicate the level of understanding improvement. From this table, it can be seen that most students experienced significant improvement with N-gain values above 0.7, categorized as "High," while some others fall into the "Medium" category with N-gain between 0.6 and 0.7. The average pre-test score was approximately 64.83, which increased to an average post-test score of about 96.72, with an average gain score of 0.90, classified as high. This indicates that the cartoon animation-based application successfully enhanced students' understanding of three-dimensional shape concepts effectively. This improvement also shows that interactive learning media can help students better understand the properties of three-dimensional shapes and calculate volume and surface area more effectively compared to previous conventional methods.

The students' response to this spatial geometry application has been highly positive. Based on survey results and observations, students reported increased interest and found the material easier to understand compared to traditional teaching methods. The use of cartoon animation in the application allows students to view spatial shapes more concretely and interactively, aiding in the development of a better understanding. Additionally, students were more engaged in the learning process, particularly when completing interactive exercises provided within the application. This indicates that technology-based learning, with visually appealing displays, can enhance student engagement in the learning process.

Regarding its advantages, the application offers several aspects that support the effectiveness of learning. First, the engaging animation visualization helps students grasp the material more tangibly and enjoyably, reducing boredom in the learning process. Second, interactive features such as quizzes and exercises within the application provide opportunities for students to directly assess their understanding. Third, the flexibility of its usage allows students to learn independently or with teacher guidance in the classroom. With these various strengths, the cartoon-based spatial geometry application can serve as an innovative solution in mathematics education, particularly in the topic of spatial geometry.

Evaluation

After the development phase of the cartoon animation-based three-dimensional shapes application was completed, a comprehensive evaluation was conducted to measure the feasibility and effectiveness of this learning media. The evaluation was carried out using several instruments and methods as follows:

Two experts competent in educational media and mathematics content assessed the application using prepared validation instruments.

1. Media Validation showed an average score of 88%, indicating that aspects such as visual appearance, application navigation, and interactivity met very good criteria;
2. Content Validation obtained a score of 90%, signifying that the material content aligns with the curriculum and is accurate in terms of mathematical concepts.

A small-scale trial was conducted on 10 sixth-grade students at SDN Cirebon to gather initial feedback regarding ease of use and appeal of the animation. Based on results from this trial, there was a significant improvement in students' understanding of three-dimensional shapes after using the cartoon animation application. The average pre-test score increased from 64.8 to 96.7 on the post-test. The calculated N-Gain scores showed that most students (approximately 83%) experienced "High" category improvement with N-Gain values above 0.7, while others fell into the "Medium" category. This indicates that cartoon animation-based learning media effectively enhance conceptual understanding significantly while motivating students to engage more actively.

The large-scale trial involved 29 sixth-grade students as a representative sample to test broader effectiveness in learning using this application. Concept comprehension measurements demonstrated that the cartoon animation app effectively improved sixth graders' understanding of three-dimensional shapes, with an average score increase from 64.83 to 96.72, along with an N-Gain value of 0.90 categorized as high-level achievement. This proves that animation-based learning media can be an

innovative solution for overcoming difficulties in spatial geometry learning significantly, while making it enjoyable for learners.

Student feedback after one full cycle of usage indicated that about 90% felt motivated to learn mathematics because this interactive learning medium attracted their attention visually and was practical for understanding three-dimensional shapes, considered difficult material.

Teachers provided positive responses regarding the ease of integrating this app into daily teaching processes, along with observed increases in student participation during lessons.

Based on these evaluation results, it can be concluded that developing a cartoon animation-based three-dimensional shape application is feasible as an alternative elementary school learning medium, especially for grade six, because it significantly improves geometric concept comprehension while simultaneously boosting student motivation through interactive visual approaches.

DISCUSSION

The implementation of spatial understanding of geometric shapes through cartoon animation-based learning within a contextual approach has proven to be both effective and appropriate (Rohman, 2024). These findings align with the systematic development process guided by the ADDIE model, which effectively supports learning activities for both students and teachers (Islami et al., 2024). The use of audiovisual tools, particularly animated media, enhances educational outcomes by increasing student enthusiasm and facilitating the mastery of complex material (Salsabila & Utami, 2022). Such tools strengthen students' memory by linking abstract concepts to everyday situations, making learning more meaningful (Setyowati et al., 2020).

Supporting this perspective, Pokhrel (in Azijah et al., 2025) found that cartoon animation-based educational tools empower students to master subject matter independently, without constant direct guidance from teachers. This self-directed learning is crucial for fostering deeper conceptual understanding as well as cultivating consistent, self-regulated study habits.

Rachmayani (2015) emphasized that instructional facilities serve as essential mediators or supportive tools used by teachers to deliver content effectively. These media assist students in understanding information more easily. This pedagogical principle resonates with the teachings of the Qur'an:

> *"Invite to the way of your Lord with wisdom and good instruction, and argue with them in the best manner."* (Surah An-Nahl, verse 125)

This verse affirms that learning media should convey messages positively and respectfully. When faced with objections or misunderstandings from students, teachers are encouraged to provide logical explanations to achieve clarity. Accordingly, spoken language combined with supportive media serves as an effective channel for conveying educational messages.

Consistent with this theoretical foundation, research by Sabrina et al. (2023) revealed that cartoon animation media significantly outperformed static image-based materials in improving students' mathematical understanding. Experimental classes using cartoon animations demonstrated higher levels of comprehension compared to control groups relying solely on static visuals. Similarly, Susanti & Zaitun (2024) emphasized key criteria for the effectiveness of cartoon animation media: they must attract students' attention, relate closely to their experiences, and be developmentally appropriate in terms of age and cognitive level. Meeting these criteria enables such media to exert a greater impact than conventional teaching aids in reinforcing concept mastery.

These findings support earlier studies such as that of (Yuniarti & Trisna, 2022), in which the quality scores of the developed learning tools reached a very high average (~4.9/5). (Widiastuti et al., 2017) further confirmed the validity and functionality of instructional materials developed through similar approaches, reinforcing confidence in multimedia instructional design models.

Inferential analysis in the present study reveals a positive impact from the use of worksheet-based cartoon animation learning at a public elementary school in Cirebon. Students demonstrated increased learning effectiveness and enthusiasm when engaging with this medium. Additionally, the data show that the use of such interactive worksheets significantly enhanced student understanding compared to traditional methods without interactive media support.

These results are further supported by research from Andrianto et al. (2024)In which students' motivation to learn chemistry improved through a peer-tutoring model enhanced by animated videos created using Kinemaster software at SMAN 61 Jakarta. Their study reported an N-Gain score of 0.52, indicating a moderate improvement following the intervention. Likewise, the study by Torasila et al. (2024) demonstrated the practicality of animated videos for improving the understanding of fourth-grade students, with effectiveness reaching up to 82.5%.

Despite these promising outcomes, several limitations of the study must be acknowledged: (1) The participants were limited to sixth-grade students at a single public elementary school in Cirebon, restricting the generalizability of the findings to other regions or educational levels; (2) The duration of application usage during the trial period was relatively short, limiting insights into long-term retention effects and sustained changes in student motivation; (3) Technological constraints, such as access to devices or internet connectivity, were not explored in depth, yet may significantly impact implementation, especially outside controlled environments.

Future research is recommended to expand the sample diversity across multiple schools and extend the intervention duration to allow for longitudinal impact assessment. Additionally, exploring integration challenges related to hardware and software infrastructure will offer valuable guidance for scalable implementation strategies.

CONCLUSION

The development of a spatial geometry application using cartoon animation, aimed at enhancing elementary students' understanding, was successfully carried out using Canva. The ADDIE model was employed as the development framework due to its straightforward stages and iterative evaluation process, allowing continuous adjustments based on the needs of potential users.

Following validation by media and content experts, with the media validation scoring a high percentage indicating strong feasibility, the application proceeded to trial stages involving actual users. These trials demonstrated that the cartoon animation-based learning media effectively improved students' comprehension of spatial geometry concepts, such as three-dimensional shapes, volume, and surface area.

Overall, this study confirms that the integration of cartoon animation in educational applications can offer an engaging and interactive learning experience while supporting deeper conceptual understanding for elementary-level students. Future research is recommended to broaden the scope of implementation across diverse schools and to explore the long-term effects on students' mathematics achievement.

It is recommended that the development of this cartoon animation application be continuously improved by adding more varied interactive features and expanding the coverage to other mathematics topics. Furthermore, further research with larger and more diverse samples should be conducted to test the effectiveness of this media more comprehensively across various learning contexts. Teachers are also encouraged to optimally integrate this media into the learning process to enhance students' motivation and understanding.

ACKNOWLEDGMENTS

The researcher would like to thank the school principal for granting permission to conduct the research, the teachers and 6th-grade students who participated, and the lecturers who guided us so that this research could be carried out.

REFERENCES

Akbar, S. (2013). *Instrumen Perangkat Pembelajaran*. Remaja Rosda Karya.

Alifa, N. S., Hanafi, S., & Nulhakim, L. (2021). Pengembangan Media Video Pembelajaran Animasi Berbasis Kinemaster untuk Meningkatkan Pemahaman pada Mata Pelajaran IPA Siswa Kelas IV

SDN Kedaleman IV. *JTPPm (Jurnal Teknologi Pendidikan Dan Pembelajaran) : Edutech and Intructional Research Journal*, *8*(2). https://doi.org/10.62870/JTPPM.V8I2.13125

Andrianto, D., Sumiyati, & Purba, L. S. L. (2024). Peningkatan Motivasi Belajar Kimia Siswa SMA Melalui Pembelajaran Tutor Sebaya Berbasis Video Animasi. *Jurnal Pendidikan Kimia Undiksha*, *8*(1). https://doi.org/10.23887/jjpk.v8i1.77698

Azijah, S. N., Jennah, R., & Rizal, S. U. (2025). Pengembangan Media Video Interaktif Pada Materi Sejarah Perkembangan Fikih. *Didaktika: Jurnal Kependidikan*, *14*(1 Februari), 695–704. https://doi.org/10.58230/27454312.1676

Broeder, P., & Wildeman, N. (2019). Colour in online advertising: Going for trust, which blue is a must? *Marketing from Information to Decision Journal*, *2*(1), 5–15. https://doi.org/10.17015/EJBE.2020.025.05

Hanan, M. P., & Alim, J. A. (2023). Analisis Kesulitan Belajar Matematika Siswa Kelas VI Sekolah Dasar pada Materi Geometri. *Al-Irsyad Journal of Mathematics Education*, *2*(2), 59–66. https://doi.org/10.58917/ijme.v2i2.64

Hidayati, A., Adi, E., & Praherdhiono, H. (2019). Pengembangan Media Video Pembelajaran untuk Meningkatkan Pemahaman Materi Gaya Kelas VI di SDN Sukoiber 1 Jombang. *JINOTEP (Jurnal Inovasi Dan Teknologi Pembelajaran) Kajian Dan Riset Dalam Teknologi Pembelajaran*, *6*(1), 45–50. https://doi.org/10.17977/um031v6i12019p045

Huda, A., & Ardi, N. (2021). *Teknik Multimedia dan Animasi*. UNP Press.

Islami, N. F., Ilmi, L. A., & Ati MZ, A. F. S. (2024). Urgensi Pengembangan Media Pop-Up Book Digital Berbasis Powerpoint sebagai Media Pembelajaran Bahasa Indonesia Siswa Sekolah Dasar. *Jurnal Studi Guru Dan Pembelajaran*, *7*(2), 704–714. https://doi.org/10.30605/jsgp.7.2.2024.4195

Mahardiko, S., & Tuharto, T. (2016). Pengaruh Pendekatan Kontekstual Terhadap Pemahaman Konsep Siswa pada Materi Bangun Ruang Sisi Datar. *Jurnal Pedagogi Matematika*, *5*(2). https://doi.org/10.21831/JPM.V5I2.690

Pagarra, H., Syawaluddin, A., Krismanto, W., & sayidiman, sayidiman. (2022). Media Pembelajaran. In M. R. Pradana (Ed.), *Badan Penerbit UNM*. Badan Penerbit UNM. https://eprints.unm.ac.id/25438/

Pakpahan, A. Y. C., Ali, E. Y., & Ismail, A. (2024). Pengembangan Video Animasi Menggunakan Multimedia dalam Meningkatkan Pemahaman Siswa Kelas V Materi Ekosistem. *Al-Madrasah Jurnal Pendidikan Madrasah Ibtidaiyah*, *8*(4), 1535. https://doi.org/10.35931/am.v8i4.4079

Prabowo, M. (2020). *Metodologi Pengembangan Sistem Informasi*. LP2M Press Salatiga.

Rachmayani, A. N. (2015). *Faktor–Faktor yang Behubungan dengan Perilaku Penggunaan Kontrasepsi pada Wanita Usia Subur (WUS) di Sumatera Utara (Data SDKI 2012)* [UIN Syarif Hidayatullah Jakarta]. https://repository.uinjkt.ac.id/dspace/handle/123456789/37534

Ritonga, A. P., Andini, N. P., & Iklmah, L. (2022). Pengembangan Bahan Ajaran Media. *Jurnal Multidisiplin Dehasen (MUDE)*, *1*(3). https://doi.org/10.37676/mude.v1i3.2612

Rohman, A. A. (2024). Implementasi Media Digital Interaktif untuk Meningkatkan Pemahaman Konsep Geometri. *Jurnal Ilmu Pendidikan, Bahasa Dan Sastra*, *1*(2), 35–41. https://jurnal.naiwabestscience.my.id/index.php/jumps/article/view/63

Sabrina, N. A., Maharaja, L. R., Naingglan, M. M., & Gaol, M. L. (2023). Pengaruh Pengembangan Media Ajar Visual Terhadap Siswa Sekolah Dasar dalam Memahami Konsep Matematika Secara Visual. *Jurnal Pendidikan Matematika*, *1*(1), 11. https://doi.org/10.47134/ppm.v1i1.113

Salsabila, S., & Utami, S. D. (2022). Peran Media Pembelajaran Audio Visual Pada Mata Pelajaran Akuntansi Sebagai Sarana Meningkatkan Motivasi Belajar Siswa. *Proceedings of National Seminar on Accounting, Finance, and Economics (NSAFE)*. http://conference.um.ac.id/index.php/nsafe/article/view/3128

Setyowati, E., Hidayati, I. S., & Hermawan, T. (2020). Pengaruh Penggunaan Multimedia Interaktif Terhadap Pemahaman Konsep dalam Pembelajaran Matematika di MTs Darul Ulum Muhammadiyah Galur. *Intersections*, *5*(2), 26–37. https://doi.org/10.47200/intersections.v5i2.553

Sofyan, A., Firdusi, R., Faizah, E., Lestari, N. S., & Mahmudah, M. (2023). *Strategi Pembelajaran di SD*. Pidie: Yayasan Penerbit Muham.

Susanti, A., & Zaitun, Z. (2024). Penerapan Media Film Animasi untuk Meningkatkan Kemampuan Berpikir Kritis Siswa pada Materi Teks Ulasan di SMP Labschool FIP UMJ. *Prosiding SEMNASFIP*, *0*(0). https://doi.org/10.23887/JPBSI.V12I4.62364

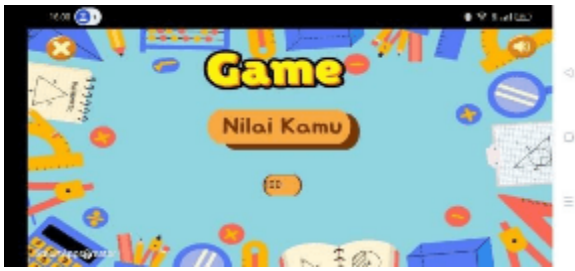
Torasila, D., Baderiah, B., & Laswi, A. S. (2024). Pengembangan Media Pembelajaran Video Animasi Berbasis Aplikasi Kinemaster Materi Gaya Kelas IV SDN 10 Tomarundung. *Refleksi Jurnal Pendidikan*, *12*(4). https://www.p3i.my.id/index.php/refleksi/article/view/306

Widiastuti, S., Yuanita, L., & Wasis, W. (2017). Implementasi Peta Konsep Menggunakan Model Pembelajaran Kooperatif TPS sebagai Cognitive Diagnostic Assessment (CDA). *JPPS (Jurnal Penelitian Pendidikan Sains)*, *2*(2), 218. https://doi.org/10.26740/jpps.v2n2.p218-223

Yuniarti, N. P. M., & Trisna, G. A. P. S. (2022). Efektivitas Media Pembelajaran Videoscribe Connected terhadap Minat Belajar Siswa. *Jurnal Pedagogi Dan Pembelajaran*, *5*(1), 160–171. https://doi.org/10.23887/jp2.v5i1.47009

Appendix 1.
Display of Three-Dimensional Shape Application Through Cartoon Animation (in Design Stage)

Figure	Descriptive
	**Screen** The initial display of the application features a "START" button, allowing users to begin their learning experience on the topic of Properties of Three-Dimensional Shapes**.**
	**Main Menu** The application provides two main menu options: Video Menu: Contains educational content on Properties of Three-Dimensional Shapes in the form of an animated video. Quiz Menu: Designed for evaluation, offering quizzes in the form of an educational game to assess students' understanding.
	**Video display** The video menu presents learning materials in animated video format, providing an engaging and interactive way for students to understand the properties of three-dimensional shapes.
	**Screen Before Quiz** Before starting the quiz, the application displays an introductory screen with a brief description or prompt about the topic, which is Properties of Three-Dimensional Shapes, preparing students for the quiz.

	**Question Display** The quiz questions are presented sequentially, starting from the first question and continuing until the last, each focusing on the topic of Properties of Three-Dimensional Shapes. This format ensures that students go through the material progressively and in an organized manner.
	**Score/Grade Display** After completing the quiz, the application provides an immediate score or grade, allowing students to see their performance and offering feedback on their understanding of the material.