Development of 3D Animation Media on Computational Thinking Skills Integrated with PISA Using a Deep Learning Approach

Siti Khaulah[1], Novianti[1*], T. Rafli Abdillah[2]

[1] Departement of Mathematic Education, Faculty of Teacher Training and Education, Almuslim University, Aceh, Indonesia.
[2] Departement of Computer Science, Faculty of Computer Science, Almuslim University, Aceh, Indonesia.

Abstract: The purpose of this study was to develop 3D animated video learning media for computational thinking skills integrated with PISA questions and to determine the feasibility and practicality of the learning media using the Plotagon application with the discussion of PISA questions. The research design used the 4D development model with ADDIE development, namely: analysis, design, development, and evaluation. The research instruments used were media and material expert assessments, practitioners, and student questionnaires. The results of the media validation development obtained a percentage of 93.25% with a very valid category. Material expert validation obtained a percentage of 91.45% with a very valid category. Practitioner validation obtained a percentage of 90.38% with a very practical category. Meanwhile, the results of the small group trial obtained a percentage of 85%, while the large group trial obtained a percentage of 83%. Therefore, the results of the 3D animated video media development research are very feasible and practical to be used and implemented in the learning process with a deep learning approach to computational thinking skills.

Keywords: 3D animation video; Computational thinking; Deep learning; PISA

Introduction

The use of learning media in today's digital era is technology-based, which has brought about significant changes in the world of education (Tai, 2024). However, some of the common problems in education in Indonesia today are the challenges related to the quality of teachers or educators in schools (Ediyani et al., 2020; Akmal & Festiyed, 2023). Limited qualified human resources and the gap in access to information and communication technology in the digital era have hampered the consistency and quality of teaching. Although the government is currently striving to improve the quality of education in Indonesia by improving the quality of teachers, revising the curriculum, increasing access to education, and implementation other measures, these efforts have not been fully realized in all educational institutions.

Therefore, the current problem is that the use of learning media greatly affects student learning outcomes and their ability to solve problems. One of the learning media used is 3D animated videos. 3D animated videos are designed as well as possible and adapted to the teaching material, so that students are more enthusiastic about learning (Permatasary et al., 2018). However, this condition often makes students less motivated to understand mathematics material and reduces their interest in learning. In fact, in the 5.0 era, students are faced with global competition and complex ways of thinking, so that students must be able to

overcome problems related to the Programme for International Student Assessment (PISA) questions (Robertson, 2021; Hu, 2022; Hu & Yu, 2021) and carry out the learning process by applying in-depth learning (a Deep Learning Approach). Solving PISA questions requires problem-solving concepts using Computational Thinking (CT) analysis skills (Novianti et al., 2024; Mukhibin & Juandi, 2023) ("Leadership in the Digital Era: Social Media, Big Data, Virtual Reality, Computational Methods, and Deep Learning," 2019). Basically, CT skills are essential for students to be able to solve problems. However, currently, students also find it difficult to develop and understand abstract and complex concepts (Huda & Rohaeti, 2024). Therefore, to improve CT skills, innovative and creative learning is needed (Mitrayana & Nurlaelah, 2023; Li et al., 2020) using digital learning media rather than conventional learning. In this case, the use of media in the learning process also greatly influences student learning outcomes so that they can master the skills to solve PISA questions. 3D animated video learning media (Sari et al., 2023) is one alternative solution to improve the understanding of Generation Z students who utilize technology in the 5.0 era and apply a deep learning approach (Nugraha, 2021; Raup et al., 2022).

In addition, the benchmark for current learning is the integration of 3D learning media with deep learning. This approach focuses on developing deep conceptual understanding, critical thinking skills, and the application of knowledge in various real-life contexts, which is highly relevant for preparing high school students to face global challenges (Mulyani & Suardiman, 2019). Unlike superficial learning, which only emphasizes memorization, this approach encourages students to integrate new knowledge with previous experiences, thereby forming a holistic understanding. The deep learning approach is characterized by the active involvement of students in their efforts to understand the material, enthusiastic interaction, and their ability to utilize and evaluate the learning resources provided. Students who adopt this approach tend to seek out basic principles and strive to connect existing knowledge with new understanding, while constantly questioning the logic and arguments presented. This approach focuses not only on mastery of the material, but also on the development of students' metacognitive and reflective abilities, enabling them to apply their knowledge in real-world situations (Sappaile et al., 2023).

Based on the results of surveys and observations conducted in several high schools in Bireuen Regency, and the results of research from previous years, it was found that high school students' learning outcomes are good and their fear of mathematics has decreased, but their computational thinking skills in solving PISA questions are still lacking. This is supported by the initial survey results regarding students' knowledge and ability to solve PISA questions, with an average score of 65%. This is also supported by data from the Education Report Card Achievement Results, which are categorized as moderate.

Based on the results of the survey above, there is a need for innovative learning approaches in designing fun and inspiring learning media. This is so that learning objectives can be achieved through Computational Thinking skills in problem solving. The problems that arise are: (1) How to design 3D animated video learning media so that it can be utilized during the learning process; (2) How learning can be carried out by improving Computational Thinking skills in solving PISA questions; and (3) How teachers and students respond to learning conducted using a deep learning approach.

Method

The method used in the development of 3D animation media uses research and development (R&D), namely the ADDIE model (Nababan, 2020; Allo & Suhendra, 2022). The ADDIE method consists of five stages, namely Analysis, Design, Development, Implementation, and Evaluation.

Figure 1. ADDIE development phases

Analysis
The analysis stage involves analyzing the requirements and feasibility tests to be carried out during the research. It begins with an analysis of the media or methods previously applied in relation to student needs, the learning environment, and other factors.

Design
The activities carried out in the design stage are designing 3D animation learning media with material that has been prepared in advance. The team will

collaborate in designing attractive and interactive media.

Development

During the development stage, the research team will develop the material that has been created into 3D animation media using the Plotagon Story application. The steps taken are data collection, planning, product design development, product validation (initial testing), product revision, field testing, revision (product refinement), usage testing, product revision or final product refinement, and final product preparation and mass production.

Implementation

The animated video media design that has been created will be implemented in schools, where the media will have been validated in advance by a team of validators in terms of content, language, and media.

Evaluation

This evaluation stage is carried out once the implementation stage has been completed. The team will evaluate the learning outcomes that have been achieved and provide feedback to the users. The results of this evaluation will lead to further revisions of the designed media. There will also be an evaluation of the improvement in computational thinking skills among students through the distribution of questionnaires to students and teachers.

Data collection techniques conducted at school are as follows: questionnaires, used to obtain student responses regarding the feasibility, understanding, and responses to the student learning process that has been carried out, and documentation, obtained by documenting all activities carried out in the learning process in the form of photos and videos in accordance with the research design. The assessment instrument techniques used were the validation of the designed 3D animated video media, namely: media validation questionnaires and material validation (Maulida, 2020).

Results and Discussion

Validity and Practicality Results

The activities were carried out according to plan, beginning with an analysis of the needs of students at SMA N 3 Bireuen. The next activity was the design phase, which involved preparing the materials to be designed for the 3D animation learning media.

In the analysis phase, researchers identified specific needs and competencies that students must achieve, as well as solutions that can be provided to achieve learning objectives, as emphasized in the development of similar media (Hartini, 2022). This process involves identifying the most relevant and effective types of media, often beginning with a literature review and interviews with potential users to understand the context and challenges involved (Aklimawati et al., 2023). In addition, a needs analysis from the interview results concluded that the students had never completed PISA questions, and some students had never even heard of the term PISA questions. This was due to the lack of reference sources, technological media, textbooks, and teachers who had never provided questions related to PISA. Therefore, students were first given guidance and explanations regarding the PISA context and its relevance to the Computational Thinking skills to be achieved, as well as the 3D animated video used as a learning medium.

The Design Phase focuses on designing the concept of 3D animated media, including the storyline, characters, and interactivity tailored to integrate PISA questions and computational thinking. Regarding the design of 3D animated media, it is necessary to prepare a storyboard, which involves several things that must be prepared, namely: Theme and Objectives: First, determine the theme of the 3D animated media being designed, which is Solving PISA Questions.; Characters: The characters designed are those that appear in school learning, such as teachers, students, and several school settings, plantations, and minimarkets, which are tailored to the story line that has been designed; Storyline, which consists of the opening, presentation of questions, discussion/resolution, closing, and reflection; Scene Description per Scene where visual depictions are consistent with the narrative/dialogue.

The steps taken in designing or creating 3D animated learning media (Saragih & Sirait, 2023) are an introduction to Plotagon Story and Plotagon Studio; installing the Plotagon Story application; creating and adding characters/actors; adding educational content scenes; creating animated dialogues; adding sound effects and music; creating subtitles; adding Narrator Text; and rendering video into files.

This approach is in line with the ADDIE model, which emphasizes the design of valid and practical products to improve learning effectiveness (Tanjung & Zarnelly, 2021).

Development Stage

During the development stage, the media was designed using the Plotagon Story application. Before designing using this application, the story script was designed in accordance with PISA material in the context of Algebra. In solving the PISA algebra questions, four foundations of Computational Thinking skills were linked, namely: Decomposition, Pattern Recognition, Application of Abstraction, and Application of Algorithms. After the media was

designed with PISA questions on CT skills, several validators were involved to check the suitability of the media for use, so that the media product was suitable for use.

Designing functional 3D animated media products often involves a process of validation and initial testing to ensure their feasibility and quality (Ravilla et al., 2023; Hasanah et al., 2023). However, some studies show that the implementation and evaluation stages sometimes cannot be fully carried out due to resource constraints such as time and cost, which can hinder comprehensive validation of the effectiveness of media involving the application of media in real learning environments to observe its effectiveness in improving students' computational thinking skills, particularly in the context of PISA questions.

The validation process for this media involves expert review, which reflects the methodology used in the development of other educational videos, including validation of existing material in animated videos and validation of media in 3D animation principles.

The validation stage was carried out to obtain guidance on whether the product was suitable for use before being taken directly to the classroom for testing. Media and material validation was designed by filling out an open assessment consisting of 15 questions that were validated by Almuslim University lecturers according to their respective fields of expertise. The validation results can be seen in the following table.

Table 1. Validation results by expert

Aspects	Percentage (%)	Qualifications
Media	93.25	Highly Valid
Material	91.45	Highly Valid
Average	92.35	Highly Valid

Based on Table 1, it can be seen that the validity of 3D animation media on PISA integrated computational thinking skills, the percentage of media expert validators is 93.25 with a very valid category, while material validators are 91.45% with a very valid category, so that the average value for the expert validation percentage is 92.35% with a very valid qualification. Therefore, it can be concluded that the 3D animated video media that has been designed is very suitable for use.

Prior to field testing, the practicality of 3D animated video media on PISA-integrated computational thinking skills was assessed to determine the results of practitioner validation. The validation data provided by practitioners was used to assess the practicality of 3D animated video media.

Table 2. Practitioner validation results

Validator	Percentage (%)	Qualification
Practitioner 1	92.75	Very Practical
Practitioner 2	90.23	Very Practical
Practitioner 3	82.45	Very Practical
Practitioner 4	95.35	Very Practical
Practitioner 5	91.15	Very Practical
Average	90.38	Very Practical

Based on the questionnaire results in Table 2, it can be concluded that the validation results of the 3D animated video media are categorized as "very practical" and suitable for use as a teaching reference. This high level of acceptance and validation indicates that this media effectively meets students' learning needs while aligning with pedagogical best practices, thereby supporting its widespread adoption. This strong validation confirms that the developed 3D animated video media not only enhances cognitive understanding but also actively encourages student engagement and interaction, echoing findings from other studies on effective learning technologies.

Specifically, the integration of interactive animated media has been proven effective in improving learning outcomes in various subjects, including mathematics, due to its ability to combine text, graphics, animation, audio, and images into a cohesive and engaging learning experience. This approach provides useful learning concept reinforcement and can facilitate programming skills through visualization in a 3D environment, similar to how virtual reality game- based applications support computational thinking competencies.

Evaluation of Development Stages

Based on Table 3, improvements were made to the 3D animation media in accordance with the suggestions from the validators. The media improvements were made with the aim of refining the media to align with the learning objectives so that the learning media that had been designed became interactive learning media in accordance with the context of solving PISA questions on computational thinking skills.

Implementation

During the implementation stage, the previously validated and tested 3D animation media was applied in a real learning environment to measure its impact on improving students' computational thinking skills. This application includes the use of this media in actual classroom learning scenarios, where students' responses and interactions with the material presented through 3D animation were observed and analyzed qualitatively and quantitatively.
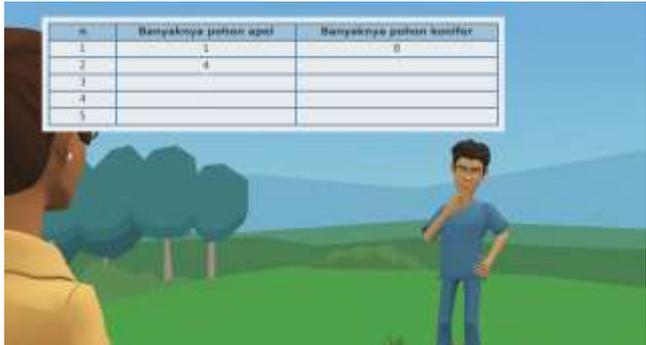
Specifically, this implementation phase focuses on analyzing the effectiveness of 3D animation media in

improving aspects of computational thinking, such as decomposition, pattern recognition, abstraction, and algorithms, which are crucial components in solving complex problems.

This implementation testing is divided into two main phases: small-scale trials for initial refinement and large-scale trials for comprehensive external validation, in accordance with the ADDIE model practice (Komalasari et al., 2022; Novianti et al., 2023). This process involves in-depth data collection on product performance, including its effectiveness in facilitating learning objectives and measuring the achievement of those objectives.

Table 3. Improvements to 3D animation media based on expert advice

3D animation media before Improvements	3D animation Media Display after Improvements
Before revision, there was no title or explanation related to 3D media	After revision, the research team added information about the theme to be discussed in the 3D animated video media
Before revision, the example problem study was unclear and there was no text description	After revision, the research team added image items so that image descritions were included

The data collected included observations of student activities, user response questionnaires, and analysis of the results of student computational thinking ability evaluations after using 3D animation media (Lyanda et al., 2023). The results of this implementation stage were then analyzed to identify the extent to which the 3D animation media succeeded in improving students' computational understanding and skills, as well as to identify areas that needed further improvement. In a small group trial of 3D animated video media, the results were obtained from student response questionnaires.

Eight students with different ability levels, namely low, medium, and high, were tested. At this stage, learning was conducted using a deep learning approach. 3D animation media was tested to assess student interaction during the learning process so that there was interaction in the learning process. Meanwhile, testing on a large-scale group was conducted after testing on a small group. The large-scale trial was conducted after improvements were made to the learning process. All 24 students in class 2A of SMA N 3 Bireuen participated in the large-scale trial. The summary of the assessment results obtained from the questionnaire can be seen in the following table.

Tabel 4. Summary of teacher and student questionnaire

Criteria	Score (%)
Teacher Responses	87
Small Group Trial	85
Large Group Trial	83

Based on Table 4 above, the results of the feasibility of 3D animation media show that the results of the

teacher response questionnaire reached a percentage score of 87% and were categorized as "very practical." The results of the small group trial showed an 85% assessment percentage and were categorized as "very practical," while the large group trial obtained an 83% score and was categorized as "very practical." Therefore, it can be concluded that 3D animation media for PISA-integrated computational thinking skills is feasible for use in the learning process using a deep learning approach.

Evaluation

The findings of this study show a significant increase in students' computational thinking skills, especially in areas assessed by PISA, after the implementation of 3D animated video media (Setiawan & Permana, 2021). This improvement is due to the attractive and interactive nature of the media, which facilitates a deeper understanding of complex computational concepts (Rafli et al., 2023). This is in line with previous research showing that multimedia-based learning, such as animated videos, can significantly improve learning outcomes and concept mastery in various disciplines (Tjahjono & Wibawa, 2019). Furthermore, the iterative design process inherent in the ADDIE model, coupled with continuous feedback from student and teacher questionnaires, ensures the alignment of media with pedagogical needs and enhances its overall effectiveness in stimulating cognitive engagement and skill development (Sari & Ningsih, 2023). Moreover, the positive reception of the media developed by students and educators underscores its potential as a viable and effective tool for integrating computational thinking into the PISA framework, particularly in addressing areas where traditional teaching methods may be inadequate (Robertson, 2021). A rigorous validation process, which included expert review and user feedback from teachers and students, demonstrated the high quality and pedagogical alignment of the media, making it a powerful tool for educational innovation.

Conclusion

Based on the results of the above research, it can be concluded that the development of 3D animation media for computational thinking skills integrated with PISA questions has produced a 3D animated video learning media developed using the ADDIE development model. The feasibility test results for the 3D animated video learning media were declared valid and very practical, and the responses from teachers, small group tests, and large group tests were categorized as very practical in discussing PISA questions with algebra material conducted at SMA N 3 Bireuen.

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