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Development of STEM-Based Animated Video Media for Teaching Science Material on the Characteristics of Living Things

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ABSTRACT

Purpose - This research study aims to develop, test, and evaluate STEM animated science learning videos about the characteristics of living things for children in the lower elementary school. The purpose of this media is to convey scientific ideas and increase student participation through more meaningful, interactive presentations.

Methodology – The research and development (R&D) approach to this study followed the ADDIE model. This was a small-scale study involving 15 third graders at SDN Mulyoagung 01 Dau, Malang Regency. The learning included guided viewing of STEM-based animated videos, small-group activities using STEM-related worksheets (LKPD), and individual assessment. Information was collected using professional validation tools, student response questionnaires, classroom observations, group worksheets, and individual evaluation outcomes, and measures were conducted in both descriptive and quantitative, as well as qualitative, ways.

Findings – Based on assessments by subject matter and media experts, the STEM-based animated video has a very high level of feasibility (M = 84%). With a gain score of 0.84, limited trials show an increase in students' conceptual understanding. According to student responses, 86.7% found this media interesting, easy to understand, and helpful for visualizing the characteristics of living things. As a result, STEM-based animated videos have proven useful as an alternative for science instruction in lower grades.

Contribution – This study contributes to the creation of digital learning resources that incorporate STEM methods in elementary school science education. It also offers a media development model to help teachers and researchers improve students' science literacy from an early stage of education.

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INTRODUCTION

The modern science education in elementary schools is well established. In this type of classroom environment, teachers tend to focus on textbooks and blackboards, which can make learning difficult for students. This poses an especially pressing challenge for a generation that has grown up with digital technology. Instead, they have low motivation to learn, do not participate in class, and may be less motivated to learn than expected. This is especially evident in abstract material, such as living things. Many students feel that life is not as simple as they think or as straightforward as they see it. The fact is that this type of student is often misunderstood and sometimes misinterpreted (Armadhani et al., 2025; Lubis, 2024). In elementary school, learning is essential for establishing the knowledge and thinking skills that students need to face the challenges of modern life (Malanita et al., 2025). At this time, science subjects become a valuable component of children's learning, fostering scientific knowledge, curiosity, and analytical thinking. The limited ability of children to grasp abstraction has led to a new conceptual structure for first-time scientists, especially regarding the nature and characteristics of living objects. (Farwati et al., 2021) illustrate how technology can engage and involve students, improve clarity, and increase relevance to learning through the global curriculum revolution.

These findings are supported by the first field observations in lower elementary school, where science learning remains teacher-centered, with verbal explanations and textbooks, and minimal use of visual and interactive media. Students are passive, less engaged in conversation, and have difficulty addressing the conceptual questions of the difference between living and non-living things while learning. Some students can remember facts but still cannot distinguish recognizable characteristics or apply concepts in practice. Teachers also complain that students may be confused about separating living and non-living when a lesson is presented in abstract form and without sufficient visual support.

It is not yet possible for pupils to interact directly with the texts they are studying. It also allows people to do away with abstract concepts like the distinction between living and nonliving (Putri et al., 2024). This old-fashioned teaching style is not a way to help primary school pupils build powerful, long-lasting mental models that are useful in real life. As technology improves and the digital native generation grows, the need for education grows. It has become even clearer that we need relevant learning materials, even as the epidemic ended and many schools began using digital media or hybrid learning models to prepare for learning. Throughout the late epidemic, many schools began using digital media or hybrid learning models to learn more about learning, and it became clear that we need relevant content. Recently, studies (Tuhuteru et al., 2023) have shown that learning from multimedia and digital learning materials dramatically improved primary school science students' motivation, engagement, and learning outcomes. However, if media are not created according to educational principles and scientific substance, these advantages may be lessened (Firmansyah et al., 2024).

One important component of learning processes that can help students understand the concepts educators teach is the use of learning media. Teachers must also be able to create appropriate learning media that encourage student participation, such as animated videos (Hader et al., 2025). In the teaching and learning process, learning media are a critical component and have important implications for learning. Therefore, media selection needs to be carefully evaluated for the best results. The ability to bring learning media into the classroom is essential to the teacher's use of tools in presenting and using material, and it is imperative that students understand the concepts presented in the reading or taught in the correct order. (Rochmania & Restian, 2022; Sugiastutih et al., 2025). Many recent studies suggest that educational movies, especially animated ones, enhance students' attention, clarity, and accessibility to abstract concepts. (Mayer, 2024) Further developed the multimodal learning hypothesis, arguing that the simultaneous presentation of verbal and visual forms improves attention, working memory, and knowledge acquisition. Statistical studies in elementary education indicate that animation improves scientific literacy, motivation, and understanding of fundamental scientific concepts (Astuti et al., 2021; Cavanagh & Kiersch, 2022; Katrunanda et al., 2024). Animated videos help primary school students learn because they are a way to share information and a way to help them understand abstract scientific concepts. Animation can be a good way to show how things move,

change, and interact with each other. This helps students understand important concepts such as the basic needs, characteristics, and behavior of living things (Alim et al., 2025; Fields & E, 2025). Therefore, animated videos are very effective at connecting concrete learning needs with the limitations of conventional approaches used so far.

In many countries, STEM is also the tool most often used to foster creativity, solve problems, and develop the important science skills needed to succeed in the 21st century. This scientific and engineering approach makes learning more useful. It builds on scientific observation, theory, and engineering skills relevant to everyday life—the theoretical review of terrorism research by Abdurrahman et al. (2023). STEM teaching is a scientific subject, but it teaches students to think creatively and critically in the context of real-world applications and context-based problem-solving (Mamonto et al., 2024; Prayoga, 2025; Widayanti et al., 2023). The use of technology in elementary school will also integrate storytelling, visualization, exploration, and STEM into the curriculum.

Previous studies have shown that animations designed based on multimedia learning principles and framed within the STEM framework can improve students' critical thinking and problem-solving skills (Musriyenti, 2023). STEM-based animated video media can bridge the gap between abstract science concepts and concrete learning experiences for lower-grade students. The results of research on the development of science animation video media in Indonesia show that this media is feasible and effective in terms of expert validity, student acceptance, and learning outcomes (Listiani, 2023; Ngurah et al., 2024; Sudirman, 2024). Bibliometric research on science learning media in elementary schools shows that although many studies have examined science media, their development remains limited to certain types. Few studies explicitly analyze or create animation content using the STEM approach, especially when applied methodically to basic biological ideas. This condition reveals a gap between field needs and the research conducted (Widyaningrum et al., n.d.). In fact, material on the characteristics of living things is ideal when delivered through visual and interactive media.

In Indonesia, STEM has begun to be implemented at various levels of education as part of efforts to improve the quality of learning. This is part of a plan that takes into account how technology has changed and what people need today. According to Jayanto (2025), implementing STEM in elementary schools is a strategic step to improve students' science literacy and technological skills from an early age. However, there are still very few STEM-based science learning media tailored to the cognitive abilities of lower-grade students. More interactive, concrete, and contextual learning can be achieved through a combination of animated videos with a STEM approach. This model not only provides scientific visualization but also offers simple problem-solving tasks appropriate for students' cognitive development in the early grades. In addition, STEM-based videos provide a systematic learning structure that helps students understand the characteristics of living things scientifically and practically.

During the teaching process in this research study, learning activities were structured into traditional instruction, small-group work, and individual assessment. The students began classical learning by watching science-based form videos to build conceptual understanding. Next, students were randomly assigned to small groups to work on LKPD, STEM-based student worksheets that required observation, grouping, discussion, and simple problem-solving about living and non-living things. These group-work activities were designed to enable students to engage in conversation and to develop basic scientific reasoning appropriate to the characteristics of lower graders. For a second step in the collaboration process and to ensure understanding by the individual, students then completed individual assessment questions based on the video content and LKPD activities. Using video, LKPD, and individual assessment, the learning process was intended to support social knowledge building and individual mastery of STEM concepts.

To that end, this paper will develop and test STEM-based animated science learning videos on the characteristics of living things for lower elementary students. It will evaluate their effectiveness in stimulating learning, building conceptual understanding, and promoting science learning among students. Specifically, this study aims to answer the following questions: RQ (1) How valid and feasible are STEM-based science

animation videos according to experts and users? RQ2 How do students respond to and engage with this media? Moreover, (3) RQ3: How do STEM-themed animation videos of living things help elementary school students learn about them? So, this research study will be part of developing animated video media in STEM that assist student learning.

METHODOLOGY

Research Design

This study used a research and development (R&D) methodology. The framework used follows the ADDIE model, which consists of five main phases: analysis, design, development, implementation, and evaluation (Sugiyono et al., 2021). The decision to use the research and development methodology was considered appropriate because the research not only produced empirical results but also facilitated the creation of educational products whose feasibility and effectiveness could be assessed in accordance with the recommendations of the development study (Latip, 2022). It has been demonstrated that the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development paradigm can be used to create multimedia learning materials and that, by following a systematic procedure, it helps guarantee product quality (Restian et al., 2023; Spatioti et al., 2022).

Stage 1: Analysis

This is the phase where the ADDIE structure comes into play. This process determines primary outcomes of educational development, based on needs analyses and interviews. Many sources were used to collect reliable information about the selected topic: characteristics of living organisms (Pramasdyahsari et al., 2022). This phase is to discuss the state of facilities, infrastructure, and educational challenges in our own experience. During the analysis phase, direct observations within third-grade elementary school classrooms, interviews with classroom teachers, and analyses of curriculum documents and science textbooks were undertaken. Discussions focused on teachers' teaching practices, student participation, and students' failure to understand what the material represented about the characteristics of living things. Questions were asked about difficulties with learning, resources for media, and teachers' needs for visual and interactive learning media. Curriculum analysis aimed to map learning outcomes, basic competencies, and potential STEM participation in science learning. While observational interviews and studies were conducted with students, this analysis found inconsistencies in education, the learning environment, and the availability of school resources (Dharma & Agung, 2021; Restian et al., 2023). The results of this study indicate that visual learning media need to be more interactive and engaging in the third-grade science curriculum, with lecture instruction still prevalent (Suryani et al., 2023). This phase produces a description of learning problems, media needs, and initial specifications for STEM-based animated media.

Stage 2: Design

The animated characters are simple shapes in bright colors, depicted in ways that align with young learners' cognitive characteristics. Visual representations distinguish living and non-living objects based on visible characteristics such as movement, growth, and biological needs. Scene transitions are set up sequentially, so the concept is built slowly.

Audio narration is delivered in clean, age-appropriate language, with short sentences, and is accompanied by the most important visuals and minimal on-screen text. Media design adheres to the principles of multimedia learning, aiming for consistency among verbal, visual, and auditory information while reducing extraneous cognitive stress.

The video content before the reflective section integrates STEM. The science component is represented through guided observation of a visual illustration, in which living objects are distinguished from non-living objects. The primary instructional tool used is digital animated media, which conveys the technology portion. Engineering elements emerge from simple experiences, such as blowing up a balloon to illustrate human

respiration as a characteristic of life. As a result, mathematical thinking is anchored by a class or grouping of objects based on identifiable traits. The video concludes with brief, reflective questions grounded in the context, designed to encourage early scientific thinking so that learning is not only informative but also helps prepare students for critical analytical abilities. The media design was created with multimedia learning principles to combine text, narrative, and visual elements seamlessly. STEM integration comprises guided scientific activity, technological demonstrations, and basic engineering reasoning (Mujiwati, 2022).

Stage 3: Development

The final stage of development centered on producing valuable, practical animation videos in STEM on living things, as observed with lower elementary school students. This media evolved from animating a pre-made storyboard, which was based on Arka's journey to find the characteristics of living things with STEM and incorporating scenes that contextualize both living and non-living objects. To support concept development, the animation was presented as simple character movements and symbols with smooth transitions between scenes.

The content of this animated video focuses on the characteristics of living things, including breathing, moving, growing and developing, needing nutrition, responding to stimuli, and reproducing, and how these characteristics relate to STEM components of student learning.

Subject matter experts and media experts validated the media. Validation tests include verifying the scientific concepts, bringing clarity and style to the classroom, appropriate language and narration for students in lower grades, and integrating media with STEM learning principles. The evaluation is conducted according to the quality guidelines for learning media for elementary school students to ensure that the content, visual design, and instructional approach are consistent before media are used in learning. The output of this stage is a revised STEM-based animated video that is ready for testing.

Table 1. Validation Aspects of STEM-Based Animated Video Media

No	Aspect	Description
1	Visualization and Visual Design	Color harmony, readability, and neat visual layout.
2	Media Characteristics	ease of use, duration, and smoothness of the video flow.
3	Quality of Sound and Animation	The story is clear, the animation is good, and the sound effects are right.
4	Being in line with STEM values	A combination of STEM ideas and how they relate to third graders.
5	Usefulness and Integration of Media	The advantages of media in education enhance student comprehension.

Stage 4: Implementation

The implementation stage included limited trials of the strategy on 15 purposively selected third-grade elementary school students. Science learning was primarily through animated videos focused on STEM fields. As part of the learning process, the researcher observed the students' participation, completed student response questionnaires, and conducted individual and group concept comprehension tests to determine how the use of media affected learning about the features of living things. This phase was to evaluate students' practice and initial reaction to the new media. (Sari, 2025). The output of this stage was student response data, learning observation data, and student learning outcomes.

Stage 5: Evaluation

This final step occurred during a limited classroom study that was part of the implementation phase of the ADDIE model. The STEM-based animated video was the primary instructional medium. At the same time, classroom observations, student response questionnaires, and learning outcome assessments were used to

collect information on student engagement, media usability, and conceptual understanding during implementation. The evaluation involved analyzing data from expert validation, instructional trials, and student learning outcomes to determine whether the media were feasible, attractive, practical, and effective. These results prompted the final decision of whether the STEM animated video will be of quality and appropriate for elementary science instruction (Komarudin et al., 2024).

Using the ADDIE model in this study, the media development process could be carried out sequentially to address real-world needs in the field, with expert validation and learning trials. This approach also coincides with the practice of learning media development research, which is widely applied in basic education studies and learning innovation in Indonesia.

Participants

The research subjects comprised scientific and learning media professionals who acted as validators in the final testing phase, alongside content experts who assessed the material's accuracy. Additionally, 15 third-grade students from SDN Mulyoagung 01 Dau, Malang Regency, participated in a short trial to evaluate the efficacy of STEM-based media. This group was chosen because third graders are the best age group for testing products.

Data Collection

This study collected data through two main stages: expert validation and limited classroom trials. During the validation phase, STEM animation videos were evaluated by subject matter experts and media specialists. The experts looked at how well the content fit, how well the ideas were conveyed, how well the visuals worked, and how well the STEM elements were used. Before schools could use it, experts gave suggestions and improvements to make it better. The next phase involved data collection through limited trials with third-grade students. The students first watched an animated film, then worked in small groups to complete worksheets, and finally took individual tests at the end of the lesson. Students were also invited to take surveys to find out what they thought of the media used. The researchers used observation sheets to track how students answered questions, how much they participated, and how they learned throughout the procedure. People used all this information to figure out how well the media helped youngsters learn about science.

Instrument

The research uses multiple devices to deliver accurate, thorough data. The primary tool used is an expert validation sheet that checks whether animated movies, student worksheets, and instructional materials are suitable for teachers. Experts use this sheet to assess factors such as the accuracy of the content, how well the materials align with the curriculum, whether the language is suitable, and how well the animation is. Experts do not just give scores; they also provide feedback and suggestions that help improve the product.

The kids did worksheets together after the movie. The goal of these tools was to determine how well pupils understand the concept of living things by directly talking to them. After the worksheet activity, each student received an individual test to assess how well they understood the content, even though they were working in groups.

Researchers used observation sheets during the teaching process to add to the data they had already collected. Researchers carefully noted how students reacted, how the class worked, how groups interacted, and any technological problems that came up during the adoption of media. These observations gave a clear picture of how students used and thought about the media.

After the session, students were invited to complete a questionnaire containing statements about their interactions with the animated film. Using this questionnaire, researchers determined whether the media was easy to understand, engaging, and valuable for learning. Working together, these instruments provided a broad picture of the quality and effectiveness of the media created.

Data Analysis

The research data were analyzed using qualitative and quantitative methods. In the quantitative segment, scores from the expert validation sheet were used to assess the media's suitability. The scores for each criterion were averaged and then converted into percentages to ensure quality classification. Based on descriptive statistics such as average scores and compliance percentages, individual evaluation data were collected using assessment metrics, including students' understanding of the use of post-media material. The LKPD Group's research supports these findings as it demonstrated students' ability to apply concepts in a simple talk.

Alternatively, qualitative analysis was conducted through classroom observation and student response surveys. These two tools allowed researchers to observe students' use of media, understand video content, and participate in learning. This combination of quantitative and qualitative data provides more detailed information. Qualitative data describes the learning experiences occurring in the classroom, while quantitative data measures the performance of media in meaningful ways. It is thus the overall analysis that provides an excellent basis for assessing the feasibility of developing STEM-based animated video media.

FINDINGS

The present research draws conclusions based on the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), which describes the process of developing and testing video educational products based on science animations. The study's findings include a needs analysis, expert validation, learning trials, student responses, and student learning outcomes measured through individual assessment questions and group-based Student Worksheets (LKPD).

Analysis

This needs analysis reveals that in third-grade elementary science instruction, the predominant instructional mode is lecture and textbook use, with little visual or interactive media. Classroom observations revealed low levels of student participation and difficulty learning abstract concepts, such as the difference between living and non-living things. Teaching interviews revealed students' misunderstanding of learning media and a need for more concrete, engaging media that better meet the cognitive needs of lower-grade students. These results led to animated science learning videos, which were used as a form of STEM.

Design

Designs included media designs with learning goals, material flow, and STEM animated video storyboards. The storyboards presented the ideas sequentially, with simple visuals, short narration, and explicit STEM content. For the first time, experts indicated that the media designs align with the concepts of multimedia learning and the needs of elementary science learning; therefore, they are well-suited for continued development.

Development

The development phase produced animated STEM science education products that were then evaluated by experts in subject knowledge and media. The validation findings showed that the media ranged from very valid to highly valid across all assessment areas. Advisory input was used to make changes, such as lengthening the narration, visually highlighting key ideas, and ensuring clear transitions between scenes.

Expert Validation

Science subject matter experts and learning media experts validated the suitability of STEM-based science learning animation videos. The issues addressed were conceptual clarity, language fit, visual and animation quality, STEM integration, and media use. The testing results indicated that the media is highly valid across all aspects of the assessment; therefore, it is appropriate for use in the learning process.

Table 2 shows the results of media expert validation

No	Aspects Evaluated	Average	Demonstration of Suitability	Criteria
1	Visualization and Visual Design	21	84%	Highly Suitable
2	Media Properties	21	84%	Highly suitable
3	Sound and Animation Quality	22	88%	Very Good
4	Alignment with STEM Values	21	84%	Highly suitable
5	Media Integration and Usefulness	20	80%	Suitable

The validation results in Table 2 show that this STEM-based animated video achieved an acceptability level of 84% and is considered very ready for use in learning. Each part of the examination got a score of over 80%, with audio and animation quality getting the maximum score of 88%, which means the presentation was very good. The parts that got an 88% score were appearance, media quality, and how well it fit with STEM principles. Overall, this media meets pedagogical and technical requirements and can help students better understand science concepts.

Implementation

During the implementation phase, animated videos using STEM subjects were used in a limited trial with 15 third-grade elementary students. Students were more engaged and observed in the learning process. Students' responses to the media ranged from positive to very positive, especially regarding visual appeal and ease of incorporating information.

LKPD Group Work

Students' shared learning experiences were assessed through group student worksheets that integrated STEM components. The LKPD required students to look at group objects, speak in simple terms, and discuss in groups the characteristics of living and non-living things. The LKPD test results indicated that most groups completed the tasks quickly, particularly in visual observation and grouping by key characteristics. Group discussion sessions enabled students to develop their ideas and begin the process of scientific thinking.

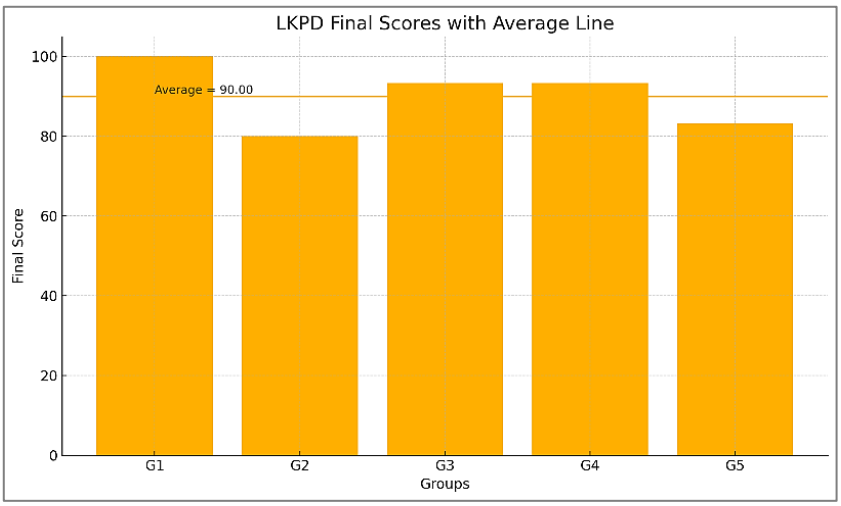

Figure 1. LKPD Final Scores with Average Line

The LKPD assessment results showed that all groups received good to excellent scores, with an average of 90.00. Group 1 received a perfect score, while the other groups with lower scores were still in the good category. Students demonstrated that they truly understood the work steps and applied them correctly, as shown by their achievements across activities, especially in Activity 3, which was completed by all groups with perfect scores. Overall, these results indicate that the use of STEM-based media helps students complete LKPD better.

Individual Evaluation

Students also learned the concepts themselves through assessment questions posed after watching animated STEM videos. The assessment questions were designed to test students' abilities to recognize the characteristics of living things, distinguish between living and non-living things, and apply concepts in everyday contexts.

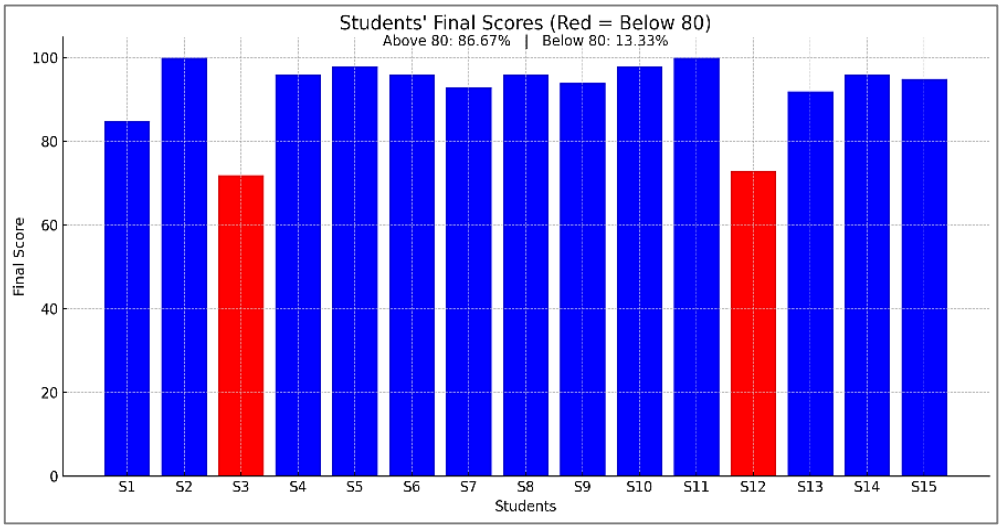

Figure 2. Students' Final Scores (Individual Evaluation Scores)

Figure 2 shows the final scores of 15 students in science. Red is shown on the bar chart for students with scores below 80 and blue for students with scores above 80. The results show that 2 students (13.3%) failed to achieve 80 points, while the other 13 students (86.7%) exceeded that score. This shows that most students have achieved learning completeness. In addition, these findings indicate that STEM-based animation media have a significant impact, as most students can understand the material and achieve satisfactory learning outcomes.

Students' Response

During the learning process, questionnaires were used to collect student responses. Most students said that the animated videos were interesting, easy to understand, and helpful in understanding the material.

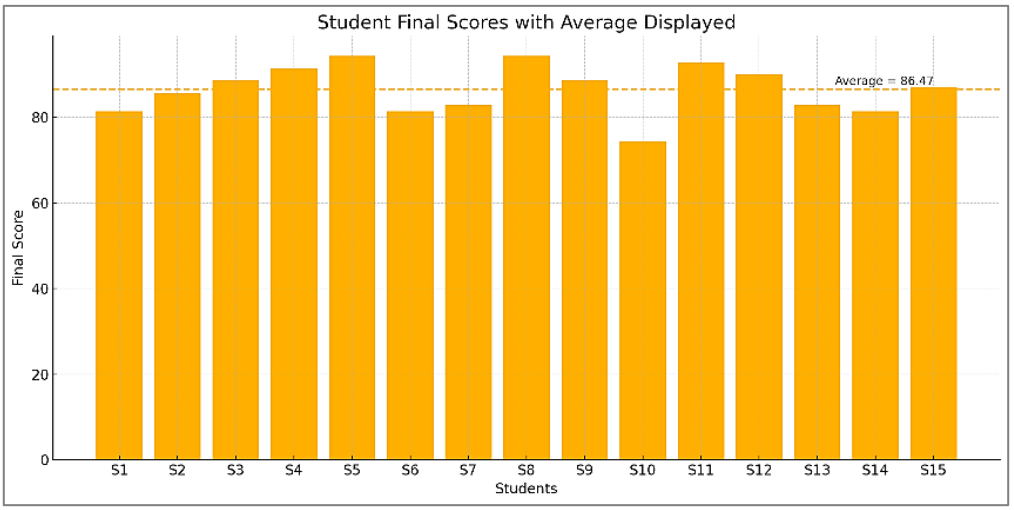

Figure 3. Student Final Scores with Average Displayed

Based on the survey results, the bar chart shows 15 students, each with one bar, and the dotted line shows the overall average of 86.47, indicating that most students scored above average. This shows that they are very responsive to application learning. Only a few students scored slightly below average, but still above average.

The average line helps to show the distribution of scores more clearly and indicates that the students' response rate is relatively high and even. This graph shows that students liked the learning they received and that it helped them understand and engage positively.

Observational Findings (Qualitative)

Classroom observations indicate that pupils exhibited authentic interest throughout the learning process. After the animated video started, almost all students immediately turned their attention to the screen and engaged with the narration very seriously. In addition, they often reacted spontaneously to the visual stimuli and narration presented. Students appeared to actively inquire, express their viewpoints, and even relate the film material to their everyday lives at different intervals. Group discussions flowed really well. Students shared information, explained what they understood, and used the videos as a starting point for doing their work.

Educators also observed that students' understanding of the characteristics of living organisms increased significantly when concepts were illustrated through engaging animations. The clarity of visual representations helps them understand the course's main ideas. In short, field observations show that STEM-focused animated videos not only help explain concepts but also foster a more dynamic, interactive, and enjoyable learning environment. Videos that incorporate STEM elements, such as examples of technological applications or techniques, help students appreciate the relationship between scientific material and real-world contexts. Student interaction appears much stronger than in previous learning experiences, as evidenced by their collaboration on worksheets and discussions.

Evaluation

The assessment step was based on expert validation findings, student responses, individual evaluation scores, and group LKPD results. Overall, animated STEM media were appropriate, practical, and effective in teaching elementary school students science concepts. However, the results of this study should be understood in light of several data limitations. First, the small sample size of 15 students also limits the generalizability of the results. Second, the short implementation time did not allow for much observation of the potential for short-term learning impacts. Third, it was conducted in a single school, so please be cautious about applying the findings to multiple settings. However, the results of this research study provide the first evidence to date that animated video media in STEM helps elementary school students better understand science concepts.

Before animated STEM videos, science learning was primarily based on verbal explanations and textbooks, resulting in low student participation and limited conceptual understanding. Students responded more readily to this media, were better able to differentiate and explain the nature of living things, and achieved better learning outcomes, as measured in their individual assessments and group worksheets. These findings suggest that STEM animated videos provide an interactive, conceptually meaningful learning experience more than conventional learning.

DISCUSSION

This research study aims to answer three main questions: (1) The validity and viability of STEM-based science animation videos according to experts and users; (2) Students' reaction and engagement to media use; and (3) the extent to which STEM-based animation videos can aid elementary school students in understanding living things more thoroughly than conventional learning. The results of this study suggest that the developed media meet the criteria of validity, practicality, and effectiveness, but that effectiveness depends on several pedagogical and contextual factors.

The effectiveness of STEM-based animated videos hinges heavily on the cognitive capabilities of those students at the grade level who are still in the concrete operational stage of thinking. Visual media and animation offer an alternative to presenting abstract science concepts in a more tangible, observable way, providing students with a better basis for conceptual understanding (Aryfien et al., 2025; Sinambela & Pratiwi,

2024). These results are consistent with previous studies indicating that animated media can engage and motivate elementary school students towards science concepts and understandings (Angelika & Mahendra, 2025; Ilaturizki et al., 2025).

Another important consideration is the role of teachers in maximizing the use of media. Animated videos are not content and are most helpful when combined with discussions and worksheets. (Hartono et al., 2025; Utami et al., 2025) have established that the success of interactive media is highly dependent on the teacher's instructional effectiveness in facilitating learning and on the alignment between media and learning objectives. The school environment, particularly the limitations associated with interactive media before, also influenced students' strong positive response, as animated media was a somewhat new learning experience relative to traditional learning.

Unlike studies that present STEM only as an approach or value, this study shows how STEM was used in functional, quantifiable animated videos. This science component is implemented through visual-guided observation of the characteristics of living things, encouraging students to look at and compare the simplest natural phenomena. This technology component also includes a digital representation and a science representation, used by students to gather and process information (Munif & Subali, 2025).

This engineering dimension is anchored in rational reasoning, grounded in simple demonstrations, such as balloon analogies to explain the breathing process. This approach aligns with the findings of Amriyah et al. (2025), who found that STEM in elementary school is best realized through small, everyday modeling activities relevant to students. The mathematics element is added between the videos and worksheets that involve the classification, grouping, and comparison of objects. They also noted that, as Munif and Subali (2025) reported, the group worksheets led students to initially engage in a broader STEM thinking process by enabling them to organize information and justify their group's decision.

In general, earlier research has shown that animated and multimedia materials are effective at motivating and improving students' science learning outcomes (Artanti et al., 2025; Sinambela & Pratiwi, 2024). Most of these studies focus on visual and motivational effects without describing how STEM is directly engaged with media content. This paper makes an additional contribution by showing that STEM can be embedded in animation for lower graders and directly tied to collaborative learning through worksheets and authentic assessment. In addition, the contextual assessment used in this study employs expert validation, group worksheet assessment, and individual assessment questions rather than pre-test or post-test designs. This method enables a more realistic depiction of student learning in the elementary school classroom. It reinforces this study's position in the literature on the development of STEM-based science learning media in Indonesia (Utami et al., 2025).

Its outcomes were helpful, but this study has some limitations, including a small sample size (15 students), a short implementation period, and the use of classroom observation and authentic assessment. Therefore, further studies are recommended to include a larger, more diverse sample, a longer intervention duration, and to use a comparative or quasi-experimental design that strengthens the validity and generalisability of the results. Future research may explore the use of animated media from STEM for other sciences and how animation can help develop higher-order thinking and long-term science knowledge.

CONCLUSION

Conclusions from this study indicate that the animation videos for science learning relevant to STEM studies are valid and appropriate for use, based on findings from assessments by subject-matter experts, media experts, and users, and are of good quality in terms of conceptual accuracy, language, visuals, and STEM integration. On top of that, positive student reactions and engagement with the media were evident in increases of attention, active participation, and excitement during science instruction. Also, the evaluations presented as individual assessment questions and group worksheets show that animated video media with STEM content can more effectively advance elementary students' basic understanding of the features of living things than traditional instructional methods based on lectures and textbooks. Such media, in addition to being

visual, serve as learning aids that promote the use and contextualization of STEM in elementary school science learning.

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