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Video Learning Media Simulation of Changes in Substance Form and Energy Form: Research and Development

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Abstract
IPAS (Social and Exact Science Education) is a subject in the Kurikulum Merdeka. This subject invite student to recognize natural anomalies by facts. However, results of the researcher's observations on the interest of 4th-grade elementary school students in learning science showed that 93.75% of students experienced difficulties in learning science, especially in the matter of changes in the state of matter and energy forms. So, based on the results of the theoretical formulation and potential problems, the researcher is interested in proposing the development of a simulation video product. This type of research is Research and Development (R&D) based on 7 stages, namely, potential and problems, data collection, product design, design validation, design revision, product testing, and product revision due to limitations of materials, time, and manpower. After the prototype product is completed, the researcher validates the content, media, and language with 9 experts, with each having 3 validations: (Content validators, Media validators, Language validators) The test results show that 86% of the material validation, 92% of the media expert validation, and 96% of the language validation, it can be concluded that the simulation video product is very feasible to use with minor revisions. Furthermore, the researchers carried out a teacher and student readability test on the simulation video media. The scores obtained were 91,2% for teachers and 89,2% for students. So that simulation video products able as media supplements in learning.

***Keywords*:** *Simulation Videos Development, Elementary Teaching Media, Changes in Substance Forms and Forms of Energi*

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1. INTRODUCTION

Natural and Social Sciences Learning (IPAS) is a new subject learned by students in grades IV, V, and VI in the implementation of the Merdeka Curriculum (Zubaedi, 2016). Natural Sciences (IPA) in particular is a subject in which students learn to recognize themselves and their surroundings (Andriana et al., 2020). Moreover, knowledge can cultivate students who are critical thinkers, responsive to their surroundings, and capable of solving everyday problems (Iskandar & Kusmayanti, 2018). So, learning science for elementary school students is essentially acquiring incredibly useful knowledge to understand the contextual nature of how the world works.

Recent developments based on researchers' observations indicate a declining trend in students' interest in science education. These findings align with preliminary studies conducted to identify the fundamental science learning processes in Blitar Regency. A significant 93.75% of the student sample reported that the science learning material is challenging. Specifically, the topics of changes in states of matter and forms of energy are often perceived as difficult by students due to several factors, including conceptual difficulties, language and terminology barriers, and limited practical experience. (National Research Council, 2007).

Simulation is essentially an artificial activity that mimics real-world conditions. By incorporating technology into learning, simulations can be presented in video format, showcasing activities to create experiences resembling the real world. Students can emulate and gain knowledge as demonstrated in the simulation videos. The application of simulation videos has been evidenced in various relevant previous studies, whose results can be studied as the foundation for this research. The relevant research by (Tarigan, 2020) It indicates that the counseling simulation video, utilizing cognitive dispute techniques, achieved a score of 68% for content validation, 86% for media validation, and 77.6% for user validation. These results suggest that the simulation video holds significant potential for use by Guidance and Counseling (BC) teachers in implementing student guidance in schools. Besides, (Zawawi, 2021) There is also relevant research on the implementation of simulation videos for learning mathematics. The findings show a 96.3% feasibility rate for media validation and an 88.57% feasibility rate for content validation. Due to the lack of studies that develop simulation videos for teaching the changes in states of matter and forms of energy in fourth-grade elementary school, the researchers are offering this research and development initiative.

The problem statement in this research is twofold: 1) How effective is the use of simulation videos as a learning medium for the topic of changes in states of matter and forms of energy? Secondly, the aim of this study is to evaluate the effectiveness of simulation video media for teaching the topic of changes in states of matter and forms of energy. The benefits of this development research include providing a reference source for future researchers, enhancing the quality of teaching and learning in schools, serving as a supplementary teaching tool for teachers on the topic of changes in states of matter and forms of energy, and motivating students in their learning process.

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2. LITERATURE REVIEW

2.1 Learning Media

Learning media encompass all tools and resources related to the teaching and learning process, utilized to convey information (Hasan et al., 2021). In addition, a valuable tool for conveying messages or information in the communication process between senders and receivers is called media (Diahratri, 2022). Learning media offers benefits by making teaching and learning more engaging, facilitating easier comprehension for students, introducing variety in classroom teaching methods beyond mere lecturing, and enhancing student mobility in using learning media. Thus, it can be concluded that learning media constitutes a set of tools to catalyze and facilitate both theoretical and practical understanding among students in the classroom.

There are various types of learning media that teachers can utilize during teaching and learning activities. Teachers should be obligated to first understand the media they intend to use in the classroom. Learning media in line with (Arsyad, 2019) consists of, firstly, human-oriented media such as teachers, tutors, instructors, etc. Secondly, print-based media like books, sheets, and guides. Thirdly, visual-based media such as e-books, graphics, diagrams, maps, images/figures, slides, etc. Fourthly, audiovisual-based media such as videos, slides, television.

2.2 Simulation

Simulation method involves designing a model of a real system and conducting experiments with this model to understand system behavior or formulate strategies within specified constraints set by one or several criteria. This method enables the exploration of mathematical models that reflect the characteristics of the original system, empowering analysts to draw conclusions about real-world system behaviors (Giyantoro, 2018).

Simulation games are activities directly engaged in by students in groups, enabling them to actively think and exchange opinions during history lessons. Through these games, students are expected to acquire broader knowledge. Additionally, students compete to achieve game objectives, which can enhance their interest in the learning material. Therefore, this simulation-based learning model can develop students' learning skills (Anastasia, 2023).

2.3 Exact Science Education

Essentially, Natural Science (IPA) encompasses products, processes, and applications. As a product, IPA comprises a collection of systematically organized knowledge and concepts. As a process, IPA involves methodologies used to study subjects, discover, and develop scientific products. Meanwhile, as an application or attitude, IPA theories yield technologies that provide benefits and convenience in life. (Dewi et al., 2021).

Science learning encompasses three main elements: products, scientific processes, and fostering attitudes. Scientific products involve knowledge about nature presented as facts, concepts, principles, or laws, derived from scientific research. Scientific processes include methods for identifying and understanding natural phenomena through observation, experimentation, data analysis, and drawing conclusions.

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Fostering scientific attitudes aims to develop curiosity, openness to evidence, and perseverance in seeking answers. By understanding these three elements, science learning not only imparts knowledge but also teaches scientific thinking and attitudes that help students understand and explore the world in a holistic manner (Triapamungkas, 2022).

The study of Natural Sciences in schools, especially at the elementary level, is envisioned as a means for students to explore themselves and the world around them. Science education emphasizes hands-on experiences to develop students' abilities, enabling them to scientifically explore and understand nature. It aims to encourage students to inquire and take action, thus fostering a deeper understanding of the natural world. The approach used integrates scientific process experiences and understanding of scientific products into direct learning experiences, ultimately shaping students' attitudes (Rohmah, 2023).

3. METHOD

This study opts for research and development procedures, commonly referred to as Research and Development (R&D) (Sugiyono, 2019) This method aims to develop products that align with specific needs and must be tested for effectiveness. Research and development (R&D) typically consists of 10 stages: identifying potential and issues, data collection, product design, design validation, design revision, product testing, product revision, usability testing, product revision, and mass production. However, due to limited resources—both in terms of manpower and funding—focused solely on assessing readability in educational media development, these 10 R&D stages have been condensed and modified into 7 stages as follows:

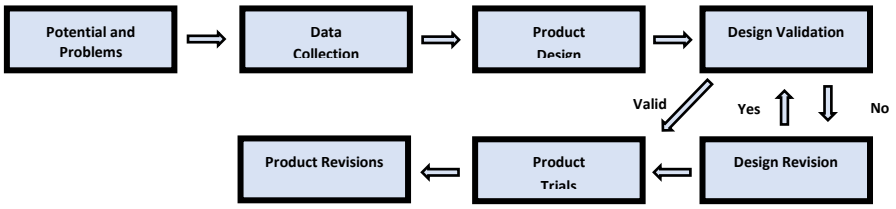

Figure 1. Modification of R&D Stage (Sugiyono, 2019)

The researcher explored the potential and challenges in 5 elementary schools located in Blitar Regency. These include SDN Ngeni 3, SDN Bajang 1, SDN Pojok 2, SDN Ngadipuro 1, and SDN Ngeni 5. At this stage, the researcher obtained observational results that align with the evidence presented in the introduction of this study, namely, 93.75% of students experience difficulties in learning Science (IPA) related to changes in the state of matter and forms of energy. These observational findings prompt the researcher to propose the development of a learning media in the form of simulation videos. The plan for these simulation videos includes content on changes in the state of matter and forms of energy to enhance student understanding during teaching and learning activities. Included are hypothetical designs for the media layout, hypothetical content layout, and hypothetical simulation video design.

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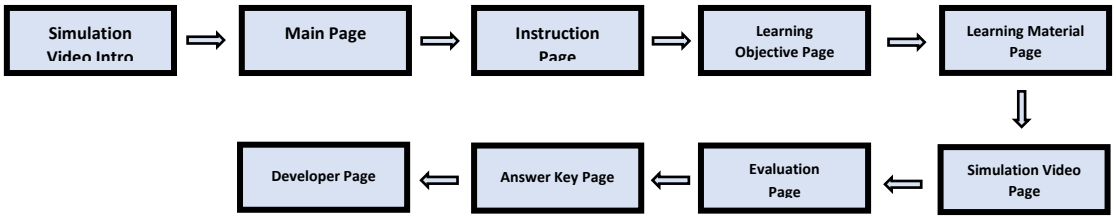

Figure 2. Conceptual Video Simulation of Hypothetical Product Model

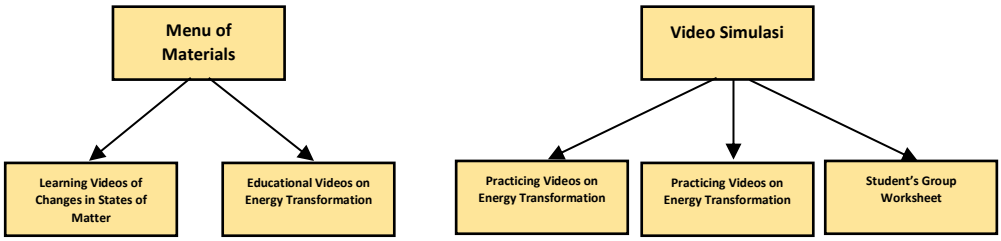

Figure 3. Hypothetical Chart Material Menu Page and Simulation Video

The simulation video media was designed by the researcher as a prototype and then followed by a validation scheme involving language experts, media specialists, and content experts. The validation process aims to incorporate feedback and critiques in line with the stages of Research and Development (R&D). Subsequently, the researcher tests the readability of the media, evaluates it again, and revises it repeatedly. The following outlines the planned design for the development of the simulation video product.

Table 1. Simulation Video Product Design Plan

Simulation Video Section	Information	
Display Design	1	It is a soft file that can be accessed via a link and can be installed or operated on all types of Android OS phones.
	2	The format is an application with a size of 89 megabytes.
	3	The product is equipped with a guidebook to explain the use of the video simulation learning.
	4	The guidebook is printed on A5 paper with a landscape orientation.
Content Design	1	The content presented aligns with the learning objectives and goals.
	2	The language used for the content is simplified to help students easily understand the material presented.
	3	The content also relates to the surrounding environment as a concrete example for learning.
	4	Additional images and experimental videos are included to support illustrative learning.

The prototype of the simulation video media is initiated by the researcher to refine the concept of creating this application so that it aligns with the intended purpose of this media. The considerations for developing this product include the instruction menu, learning objectives, learning materials, simulation videos, evaluation, answer keys, and development profile. Below is the layout of the application to be developed.

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Figure 4. Design Layout of the Simulation Video Page

In the product design phase, the researcher begins by compiling materials for Grade IV elementary students, covering the topics of changes in the state of matter and forms of energy. This material is sourced from the IPAS textbook of the Kurikulum Merdeka. Next, the researcher prepares the research instrument for the product in the form of a teacher readability response questionnaire. Additionally, the researcher creates a simulation video using the iSpring Suite 9 application. Subsequently, validation is conducted by media experts, language experts, and subject matter experts using validation instruments prepared by the researcher, to be revised based on the validation results. The following is a detailed outline of the validation instrument for media experts prepared by the researcher.

Table 2. Media Validation Instrument

No	Description	Selection Criteria					Feedback/Suggestions/ Input for improvements
		5	4	3	2	1	
Display Quality							
1.	The accuracy in selecting icons or buttons used in the video simulation learning media.						
2.	The accuracy in presenting the display in the video simulation learning media.						
3.	The accuracy in choosing colors, font types, and sizes to support the appropriateness in the video simulation learning media.						
4.	The accuracy in selecting images and the proportion of images presented in the video simulation media.						
5.	The accuracy of the type and size of fonts used in the video simulation.						
Software Engineering							
6.	Ease of use in educational media operation						
7.	Ease of management and maintenance of video simulation learning media.						

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Efficiency of Media							
8.	Learning media can be used anywhere and anytime by teachers and students.						
9.	Video simulation learning media can be accessed using all versions of the Android operating system.						
10.	Simple visualization, not complicated so as not to reduce the clarity of the material content, and easy to understand.						
Total							

In addition to material validation, media expert validation for the development of this media is useful to state that the developed media can be used effectively by both teachers and students. The following is a table of material validation instruments.

Table 3. Material Validation Instrument

No	Description	Selection Criteria					Feedback/Suggestions/Input for improvements
		5	4	3	2	1	
Material Suitability							
1.	Clarity of learning objectives in simulation video media.						
2.	The relevance of learning objectives to the curriculum.						
3.	Scope and depth of learning objectives.						
4.	Accuracy of using learning strategies in video simulation media.						
5.	The depth of the material presented in the simulation video media.						
Material Suitability							
6.	Accurate selection of examples, images and illustrations in the material presented.						
7	Suitability between material, media, and evaluation with learning objectives.						
Encourage Curiosity							
8	Simulation video learning media encourages students' curiosity.						
9	Simulation video learning media increases student interest and learning.						
10	Simulation video learning media fosters students' learning motivation.						
Total							

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Finally, the researchers also tested the language validity for the use of good linguistic rules. The following is a table of validation instruments for linguists.

Table 4. Language Validation Instrument

No	Description	Choice Criteria					Feedback/Suggestions/Input for improvements
		5	4	3	2	1	
Straightforward							
1.	The accuracy of the sentence structure to represent the message and information to be conveyed.						
2.	The effectiveness of the sentences used.						
3.	The wife's habits are used according to function.						
4.	The language used in the application is easy for students to understand.						
5.	The separation between paragraphs is clear.						
Communicative							
6.	Makes it easier to understand messages or information.						
7.	Clarity of sentences used						
Dialogic and Interactive							
8	Able to provide motivation to students.						
9	Able to encourage students to think critically.						
10	The language used in the application is easy for students to understand.						
Total							

Furthermore, this research design aims to determine the readability of the developed teaching materials, as well as to gain in-depth information about the product. This study employs readability instruments for both teachers and students to gather feedback and suggestions for product improvement. The details are as follows:

Table 5. Teacher Readability Instrument

No.	Aspect	Indicator		Number
1.	Curriculum	1	Curriculum at school	1
2.	Learning	1	Barriers experienced by teachers	2 and 3
		2	Student science learning outcomes	
3.	Teaching materials	1	Teaching materials used by teachers	4, 5, and 6
		2	Utilization of technology in teaching materials.	
		3	Teaching materials that teachers expect for science learning	
4.	Teaching Media	1	Utilization of technology in teaching media.	7, 8, and 9
		2	Teaching media used by teachers when learning science	
		3	Teaching media that teachers expect for science learning	
5.	Learning Resources	1	Learning resources that teachers expect for the learning process.	10
Total				10

Table 6. Students Readability Instrument

No.	Aspect	Indicator		Number
1.	Learning materials	1	Difficult science material in Semester 2	1
2.	Teaching materials	1	Teaching materials that teachers have used to learn science	2 and 3
		2	Teaching materials that students want to learn science	
3.	Method	1	Learning methods that teachers have used to learn science	4 and 5
		2	The learning environment that teachers have applied to learn science	
4.	Media	1	Media that teachers have used to learn science	6, 7, 8, 9, and 10
		2	The learning media that students want to learn science	
		3	Students' interest in digital-based learning media	
		4	Student interest in video-based learning media	
		5	Students' interest in image-based learning media	

Finally, this media development research is based on the Likert scale to measure the opinions, attitudes, and views of individuals or groups regarding *social phenomenon* (Sugiyono, 2019). This instrument serves as a yardstick to gauge the outcomes of the teacher readability survey, with scores ranging from 1 to 5.

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4. RESULTS

4.1 Production Design and Development of Video Simulation

The simulation videos are designed to harmonize Learning Outcomes (LO), Learning Objectives (LO), and Learning Objective Flow (LOF). Researchers selected the subject matter of changes in states of matter and forms of energy for Grade IV Elementary School Phase F. Subsequently, researchers designed the simulation video product starting from the interface tailored to elementary school student preferences, incorporating colors, images, and animations. Content design is adjusted according to the number of displayed parts, which include simulation videos, instruction menus, learning objective menus, content menus, simulation video menus, guided worksheets (LKK), student activity sheets (LKPD), and developer menus. Then, the material is organized using Microsoft Word 2016 application, and images are sourced from freepik.com with the following details.

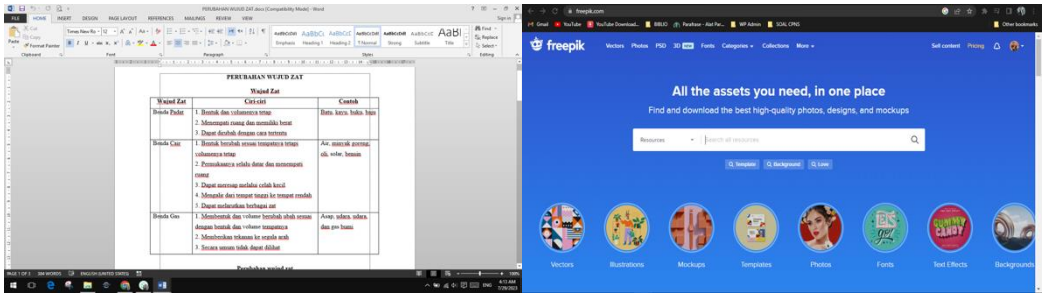

Figure 5. Content Compilation and Image Searching for Video Simulation

The researcher proceeded by designing the background for the application's display and interface elements such as buttons, images, etc., using CorelDraw X7. Next, they integrated the pages of the simulation video application with iSpiring Suite 9 software, detailing the process as follows.

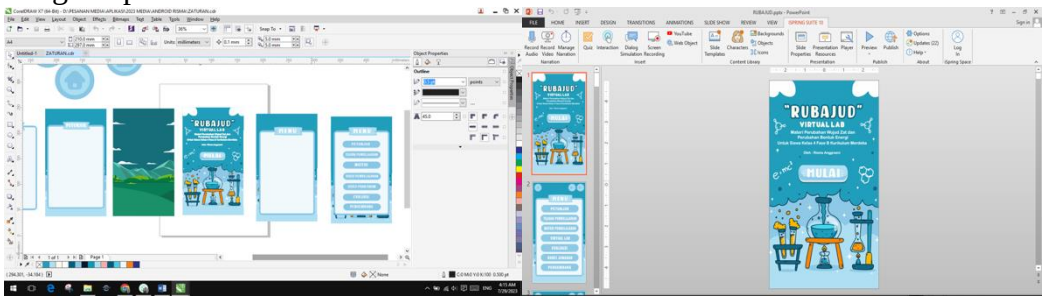

Figure 6. Creation and Designing of Application Interface

This process signifies that the application development is complete and ready for validation by experts, which will be covered in the next section.

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4.2 Expert-Validated Outcomes of Simulation Videos

The developed simulation video media will be validated by 9 validators consisting of 3 subject matter experts, 3 language experts, and 3 media experts. Here is an exposition of the validation results from these nine validators. Firstly, the content validation involves 2 lecturers holding Master's degrees in Education and Science, as well as 1 primary school teacher in Blitar District. Validation was conducted by filling out the content validation instruments, yielding the following outcomes.

Table 7. Validation Test Results of the Material

Question Number	Validator 1	Validator 2	Validator 3	Total
1	4	3	5	12
2	5	4	5	14
3	4	4	4	12
4	4	4	5	13
5	4	4	4	12
6	4	4	5	13
7	4	4	5	13
8	4	4	5	13
9	4	4	5	13
10	4	5	5	14
Total				129
Criteria Score				150
Percentage				86%

The validation results of the material show that a score of 86% within a 100% interval was achieved by this product. Thus, it can be concluded that the simulation video is highly suitable for use in teaching and learning by teachers. The highest validation score is found in the statement "relevance of TP to the curriculum, which can motivate students." Meanwhile, the lowest validation score for material testing is found in the statement "clarity of TP related to the depth of the material presented in this product." Therefore, the researcher revised the validation results of the material.

Next, validation was conducted with media experts. The validators included two education master's degree holders and one dedicated teacher from an elementary school in Blitar Regency. Validation was performed using a media validation instrument questionnaire, yielding the following results.

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Table 8. Validation Test Results of the Media

Question Number	Validator 1	Validator 2	Validator 3	Total
1	5	4	5	14
2	4	5	5	14
3	5	5	4	14
4	4	5	4	13
5	5	5	5	15
6	4	4	5	13
7	5	4	5	14
8	5	5	5	15
9	4	5	5	14
10	4	4	4	12
Total				138
Criteria Score				150
Percentage				92%

The validation results of the material indicate that 92% out of a possible 100% score deem this media highly suitable for use. The highest validation process was found in the statement, "accuracy of font type and size used in video simulation educational media" and "media can be used anytime and anywhere." Meanwhile, the lowest score was obtained for the statement, "simplicity in visualization, not overly complex to maintain content clarity and ease of recall."

The final validation is linguistic validation. This validation targets two experts who are professors holding a Master's degree in Education and one influential teacher working at an elementary school in Blitar Regency. The language validation process for the simulation videos is also conducted through filling out a language validation instrument, with the detailed results as follows.

Table 9. Results of Language Validation Testing

Question Number	Validator 1	Validator 2	Validator 3	Total
1	5	5	5	15
2	5	5	5	15
3	5	5	4	14
4	5	4	5	14
5	4	5	5	14
6	5	5	4	14
7	5	5	5	15
8	5	5	4	14
9	5	5	4	14
10	5	5	5	15
Total				144
Criteria Score				150
Percentage				96%

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The results above show a validation score of 96% with a 100% confidence interval for the language validation of the video simulation. This score indicates highly suitable criteria for use. The language validation process revealed highest scores in statements such as "accuracy of sentence structure to convey the intended message and information," "effectiveness of the sentences used," "clarity of the sentences used," and "language that is easily understood by students." In contrast, the lowest language validation scores were found in statements regarding "rigidity of terminology used according to function," "use of communicative sentences," "clear paragraph separators," "enhancement of understanding of the message or information," "ability to motivate students," and "ability to encourage critical thinking among students." These results prompted the researchers to make minor revisions based on validator suggestions, such as adjusting the language to match the educational level and ensuring appropriate use of punctuation.

4.3 Testing and Product Evaluation

After revising the simulation video based on the validation of content, media, and language, the researcher conducted a readability test of the simulation video product. This test targeted 5 fourth-grade teachers at SDN Babadan 1 Blitar and students at SDN Babadan 1. The readability test was conducted to identify the readability level of the simulation video product through questionnaire completion. Here are the results of the teachers' readability test.

Table 10. Teacher Readability Test Result

Statement Number	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teacher 5	Total
1	5	4	4	5	5	23
2	5	5	4	4	4	22
3	4	5	5	4	4	22
4	5	5	5	5	5	25
5	5	4	5	5	5	24
6	4	5	5	5	4	23
7	5	5	5	5	5	25
8	5	5	5	5	5	25
9	5	4	4	4	5	22
10	4	4	4	5	4	17
Total						228
Criteria Score						100%
Percentage						91,2%

The results indicate that the video simulation product is highly suitable for real-world field conditions. Teachers can utilize the video simulation product to supplement classroom learning. Beyond lectures, integrating video simulations into teaching can catalyze student engagement and enhance their performance in science subjects, particularly in topics covering changes in states of matter and forms of energy. Furthermore, the results of student readability tests are presented in the following table.

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Table 11. Student Readability Test Results

Statement Number	Student 1	Student 2	Student 3	Student 4	Student 5	Total
1	4	5	4	4	4	17
2	5	4	4	4	5	22
3	5	4	5	5	4	23
4	5	5	5	5	5	24
5	5	5	5	5	4	24
6	5	4	5	5	5	24
7	4	4	4	4	4	20
8	5	5	5	4	4	23
9	5	4	5	5	5	24
10	5	5	4	4	4	22
Total						223
Criteria Score						100%
Percentage						89,2%

The results above indicate that simulation products are highly suitable for student use in learning. Students can utilize simulation media to enhance their skills and understanding of material on changes in the state of matter and forms of energy in science. Furthermore, researchers conducted a product evaluation aligned with field observations. The product evaluation aims to assess the feasibility of the simulation video product, summarizing its strengths and weaknesses. Regarding strengths, the content in the simulation video is presented sequentially and systematically. The animations are engaging, combining text, images, colors, background music that can be toggled on and off, and language that is easily understandable for students. Additionally, interactive exercises are presented in an appealing manner. However, the weaknesses of the simulation video include the inability to automatically stop background music when the educational video is playing, the application only provides material on changes in the state of matter and forms of energy, accessibility limited to Android devices, and the product contains advertisements.

5. DISCUSSION

The developed simulation video has undergone content validation with a validation rate of 86%. Strengths were identified in the indicators of "relevance to learning objectives and curriculum" and in the "Virtual Lab learning media that stimulates student motivation." However, weaknesses were observed in the clarity of learning objectives and content coverage, which tended to be at a lower cognitive level. This validation aligns with the concept (Arifin, 2015), which emphasizes recognition of material types for teaching effectiveness.

The development process of video simulation media has achieved a validation rate of 92%, excelling in the accuracy of font type and size usage. However, it faces challenges in maintaining simplicity in representation, ensuring clarity of instructional content, and managing overly dense visualization. This validation aligns with the perspective (Miarso, 2004) exploring the role of media in conveying inspiring messages that stimulate thought and capture attention.

Language validation for simulation media reaches 96%, demonstrating the effectiveness of sentence structure and clarity. Despite weaknesses related to technical terms and paragraph separation, overall language validation is highly commendable. These findings are consistent with the viewpoint (Sanjaya, 2012) exploring the role of media in enhancing learning efficiency.

Video simulations contribute positively to the learning process by fostering student engagement, aiding in understanding social issues, stimulating imagination, and enhancing motivation to learn. Validation for both teachers and students indicates a high level of readability, with strengths in clarity of content and instructions. However, some weaknesses, such as lack of appeal in the material, require attention for further improvement. Overall, it can be concluded that video simulation-based learning media have great potential to support more effective and engaging learning experiences.

6. CONCLUSION

From the R&D results of the video simulation product, it can be concluded that the produced media specifically covers the topics of changes in substance states and forms of energy for 4th-grade elementary school students. The developed product has been validated by 3 content experts, 3 media experts, and 3 language experts proficient in their disciplines, achieving validation scores of 86% for content, 92% for media, and 96% for language.

The validated product proceeded with readability testing to assess comprehension in video simulation media among 4th-grade teachers and students in elementary schools in Blitar Regency. The results showed a readability percentage of 91.2% for teachers, categorized as highly suitable. Meanwhile, students achieved a readability score of 89.2%, also deemed highly suitable. Consequently, the video simulations can be concluded as a valuable supplement to classroom learning on the topics of changes in states of matter and forms of energy.

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