p-ISSN 2460-0768 e-ISSN 2597-6044 *GeoEco, Vol. 10, No 2. July 2024 Page. 173-191*
https://doi.org/10.20961/ge.v10i2.87091 https://jurnal.uns.ac.id/GeoEco/article/view/87091

THE DEVELOPMENT OF ANIMATION AND SIMULATION BASED LEARNING MEDIA IN THE COSMOGRAPHY COURSE

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ARTICLE INFO

Article History
Received : 28/05/24
Revised : 06/06/24
Accepted : 21/06/24

Citation:
Suherdiyanto, S., and Prihadi, A., (2024) The Development Of Animation And Simulation Based Learning Media In The Cosmography Course. GeoEco. Vol. 10, No. 2.

ABSTRACT

Learning media is a tool that can be used to facilitate the process of conveying knowledge in education. Media is very useful for describing subjects to make them clearer, shorter and more enjoyable. Because the availability and need for smartphones in universities is a priority, the use of animation and simulation-based learning media is an option. The objectives of this research are 1) to determine the level of suitability of material experts in animation and simulation-based learning media, 2) to determine the suitability of experts in animation and simulation-based learning media, 3) to determine the response to the use of animation and simulation-based learning media in cosmography courses. The method used in this research is a Research and Development approach (R & D) using a 4-D model (Four-D Models) which consists of four stages (Define, Design, Development, and Dissemination). The results of the research show: 1) the average assessment of material aspects by material experts obtained a score of 79%. The results of the assessment were in the range of 62.50, score ≤ 81.25% in the feasible category, 2) The average assessment by experts The media obtained a score of 81%, the assessment results were in the range of 81.25<score ≤100% in the very feasible category. 3) The response to using the animation and simulation-based learning media resulted in a calculation of 77.2 in the good category. These results can help learning activities, but there are obstacles from field conditions, as well as equipment and networks that must be developed further.

Keywords: *4-D model; animation; learning media; simulation.*

INTRODUCTION

The use of technology and information is currently widely taught in educational institutions. The conventional teaching-centered learning process has now developed into a student-centered approach, which is a way to help students become more active and enthusiastic by helping them find and develop relevant information. Such action is an aspect that is closely related to the development of the world of education and learning materials. Industrial Revolution 4.0 is a very interesting topic; both Indonesia and the world are already aware of the impact of this change. Technology is a new form of data collection that functions as a tool

and facilitator to make human life easier (Tian & Martin, 2011). Knowledge and technology continue to drive global industrialization and have helped create more modern goods for the industrial revolution over the decades (Belvedere et al., 2013). Starting in the 18th century with the use of steam engines, which helped make the production process more efficient (Prasetyo & Trisyanti, 2019). Furthermore, it continued to develop with the emergence of the discovery of electricity in the Industrial Revolution 2.0; then, in the 20th century, the revolution increasingly developed into the Industrial Revolution 3.0 with the discovery of computerization; and until today's civilization, the discovery of the internet network in the era of Revolution 4.0, which is increasingly advanced, makes it easier and supports activities in almost all fields felt by this change.

Even the realm of education is also experiencing the Industrial Revolution 4.0 by accompanying the learning process with technology such as the application of media. In general, education is a very important means of improving the quality of students in accordance with the 21st century curriculum (Amirullah & Hardinata, 2017). Considering this, the government is more focused on managing the education budget. The national education system is expected to be able to guarantee increased student performance and the effectiveness of managing the education system in facing changes that occur in local, national, and international life. Therefore, education reform must be carried out fairly, transparently, and cooperatively. The influence of the industrial era on education can also be felt in almost all regions of Indonesia. Effective use of technology contributes to facilitating the learning process (Rahmad et al., 2018). Technology used to support the learning process is often called learning media. Currently, there are many types of learning media, including audiovisual, visual, electronic, and print media. In general, media functions as a communication tool for learning. The use of media in learning is highly appreciated and well received by students (Rifai, 2018). Apart from its effectiveness, the use of media can also provide superior results compared to learning without using media (Prihadi et al., 2017). One of the development methods is animation and simulation-based learning media in the Cosmography course, with the aim and purpose of making learning with animation and simulation-based media easier for students to understand the

material being taught so that learning objectives are achieved. Cosmography is lecture material that contains many astronomical phenomena that exist outside the atmosphere and their relationship to life on Earth. This course has high complexity, so students often experience misconceptions and still have difficulty understanding the material; thus, they require animated images and videos as tools to make it easier to understand the concepts.

The purpose of this course is to develop mobile learning media based on animation and simulation to provide students with more experience in cosmography material by displaying text, images, animation, audio visuals, simulations, and videos related to cosmography. This learning medium is packaged in electronic form so that it can be used on a smartphone. Previous research has been carried out by Arianti, (2020) on a cosmography course using the Edmodo application, which produced a good category for student level. Meanwhile, the use of learning media in animation and simulation research in cosmography courses has never been carried out; therefore, the researchers carried out an update on this research based on the experience and history of existing courses and research. The use of animated learning media has been carried out by Eryanto & Prestiliano, (2017), who stated that learning is better done by using animation and simulation because you can see what is being learned. Nowadays, learning media has become an alternative and is very suitable because lectures are no longer teacher centers but student centers with the latest information (Khomarudin & Efriyanti, 2018). Based on the problem above, the author is interested in researching the development of animation and simulation-based learning media in the Cosmography course.

MATERIALS AND METHODS

The research methodology used is the 4-D Model (Four-D Models) with a Research and Development (R&D) design approach, consisting of four stages (Fredyanan, 2016), namely: 1) the definition stage, which involves raising facts and potential solutions to facilitate deciding the first action; 2) the design stage of animation and simulation-based learning media, including the selection of materials and content in the creation of cosmography materials using chosen topics, media, formats, and digital-based learning languages; 3) the development

stage, which consists of two sub-stages: (1) expert assessment followed by revisions, and (2) development testing; and 4) the dissemination stage, where the development of this learning media is selected based on the researcher's level of understanding and competence in developing animation and simulation-based learning media. This is a research design approach for research and development (R&D) using the 4-D model. The research subjects were students in the first semester of the geography education study program, with a total of 40 students. Researchers conducted trials to get feedback from experts and people to determine the media created. Trials

The products of this research are as follows: 1) First, regarding the suitability of material experts, the product must be tested by material experts in relation to the findings of the study of the structure and meaning of the text as a learning resource for land geography practicum guides. 2) Eligibility of media experts, able to provide assessment offers in accordance with flow diagrams and learning media components. To assess the findings of the expert validation test as a digital practicum guide for land geography teaching materials, the test results were modified and refined. The research on the creation of cosmography learning media based on animation and simulation uses qualitative and quantitative data analysis as the data analysis techniques.

Using the following process, data analysis techniques for animation and simulation-based learning media: 1) Compile data received from validators for each assessment aspect and sub-factor available in the evaluation tool; 2) Utilize descriptive data to obtain the overall average value of each component.

The formula used is:

$$P = \frac{\sum x}{\sum x_i} x100\%$$

Information:

P=Percentage of each criterion

X= score each criterion

Xi= maximum score of each criterion

The analysis of this study, which is based entirely on statistical collection procedures, uses descriptive quantitative analytical methodology. The tool was used to measure the cost variable under investigation. A Likert scale with categories of strongly agree with a rating of five, agree with a rating of four, quite a score of three, not enough with a rating of two, and disagree with a rating of one can all be used to collect accurate

information. The following are the evaluation steps: 1) Calculate the average general score for each component. 2) Convert general ratings to costs with criteria. 3) Compare the sub-additives in the tool evaluation after adding them all up from the validators for each facet, as detailed in **Table 1**:

Table 1. Eligibility score criteria

Score	Criteria
81,25% < skor ≤ 100%	Very Suitable
62,50% < skor ≤ 81,25%	Suitable
43,75% < skor ≤ 62,50%	Less Suitable
25,00% < skor ≤ 43,75%	Not Suitable

Source: (Azwar, 2014)

In data analysis techniques, researchers use analysis to look at media trials. If there is a response from students using the digital practicum guide, then proceed with calculating the score, namely to determine the effectiveness of using the animation and simulation-based learning media. The data analysis technique used to determine student responses is as follows:

$$P = \frac{\sum x}{\sum x_i} \times 100\%$$

Information:

P = Percentage of respondent's answer score

$\sum x$ = Number of answers per respondent for each item

$\sum x_i$ = Total answer score if all respondents answered all

The calculation results are used as data to describe the results of the needs analysis. The reference for determining the assessment results criteria is presented in **Table 2** as follows :

Table 2. Criteria for Interpreting Student Responses

Persentase	Criteria
0% to 20%	Very Poor
21% to 40%	Poor
41% to 60%	Enough
61% to 80%	Good
81% to 100%	Very Good

Source: (Riduwan, 2010)

RESULTS AND DISCUSSION

This research is classified as development research in accordance with the research objective of developing a animation and simulation-based learning media. The research design used is a four-D model, which has four levels, including the outline level, At the outline level, researchers formulate an outline or basic framework of what will be developed. This includes identifying learning objectives, content that will be presented, as well as basic concepts and ideas that will be integrated in animation and simulation-based learning media; design level, At this level, researchers begin to design in more detail how learning media will be created. This includes creating initial sketches, storyboards, and visual and interactive design of the animations and simulations that will be developed.

This design must consider instructional and pedagogical design principles to ensure effectiveness in delivering learning materials to users; raise level, The raising stage involves the actual implementation and development of animation and simulation-based learning media. At this stage, the animations and simulations that have been designed will be produced in more detail and completeness. This includes creating animations, developing software or platforms for simulations, as well as initial testing to ensure that all functional and instructional elements work well; and spread level, The final stage of the four-D model is the spread level, which focuses on the distribution or dissemination of learning media to end users. At this stage, learning media will be introduced to the audience (Thiagarajan, 1974). This improved version of the animation and simulation-based learning media was chosen based on the researcher's level of expertise and ability in developing learning media. The following is an explanation of each level:

1. Definition Stage (Define)

Establishing and defining the situation and gaining an understanding of it is the goal of this stage. Based on the governing learning rule, an objective examination of conversational barriers takes precedence. There are five key steps at this stage (Johan et al., 2023), namely:

a. Front-End Analysis.
b. Learner/Student Analysis (Learner Analysis)
c. Task Analysis
d. Concept Analysis and
e. Formulation of Learning Objectives (Specifying Instructional Objectives).

The first analysis aims to identify and overcome astronomy-learning problems, so it is necessary to develop appropriate learning media based on animation and simulation. The second analysis is a study of student characteristics, which include the level of cognitive development, talent, and social activity.

The third analysis is that assignments function as a comprehensive procedure for identifying content in a class through the use of well-defined subject matter. The aim of concept analysis is to identify basic concepts that will be explained and arranged systematically, as well as connecting one concept with relevant related concepts. The findings from the project assessment and concept evaluation are used as a guide to develop behavioral indicators of learning

outcomes and learning objectives as an extension of the basic competency and skills standards in the learning implementation regulations.

Front-End Analysis

Preparing and outlining requirements in the learning process is carried out during the initial stages of tool development. Specifically, identifying learning objectives, limiting the learning material provided, assessing how well the learning objectives align with the IQF curriculum, measuring the level of student improvement, and determining knowledge needs are the first steps. Students' knowledge and awareness of concepts related to the subject matter are problems that arise in studying cosmography that can be identified. In addition, the information currently available online raises questions about characters at a fairly high cognitive level, which causes students to openly forget the basic concepts of cosmography and not be able to actualize the concept of cosmography as a whole.

Based on the problems above, it is determined that this is the key to identifying the learning media needed for smooth and effective teaching.

Learning media is introduced through the design of indicators for achieving student learning outcomes, media, media formats, language, assignments, and the use of concepts that will be discussed with students. Due to the fact that cosmography learning media based on animation and simulation is currently an operating system that is still used, learning materials based on animation and simulation were chosen. Animation and simulation-based learning media are comprehensive open-source platforms that can be used on smartphones.

Because animation and simulation-based learning media are integral parts of operating systems, which are currently experiencing rapid expansion, cosmography learning media are now available in the form of electronic animations and simulations. Therefore, many students use electronic-based learning media. It is recommended to increase student motivation and participation in the action. Students are also encouraged to understand contemporary technological products that are relevant to everyday life in order to improve their understanding of the material being taught.

Analysis of Learner Characteristics

According to school origin, the majority of students interviewed came from around Pontianak and West Kalimantan.

Therefore, a student is considered to have extensive knowledge. Students are also different from a sociocultural point of view. Compiling concepts from various cosmographic literature books is not practical, especially as information from the internet, which is supposed to support independent learning, tends to confuse students, according to initial assistance with learning resources available at the tertiary level. Therefore, it is very possible to implement learning

Task Analysis

Knowledge of learning activities is known as task analysis and is used to determine the structure of cosmographic content. Task analysis is used to describe the content of teaching materials so that it is clear what is being taught. Task analysis findings are presented in electronic and other learning resources used in the research.

Concept Analysis

In essence, the ideas presented in animation and simulation-based learning media are interconnected. Therefore, the ideas studied need to be arranged according to the information and abilities that students have learned since the last session or meeting so that they can easily understand them. In media development, concepts and tasks are arranged sequentially, starting with a discussion of basic knowledge and continuing with knowledge that is more complex.

e. Formulation of Learning Objectives (Specifying Instructional Objectives).

The concept of creating learning media and studying for exams is contained in this collection of objectives. The following is a description of the core objectives of the cosmography lecture.

- Students can describe the concept of astronomical scope.
- Students can describe the theory of the formation and members of the solar system.

2. Designing Stage (Design)

The aim of this level is to prepare a prototype of animation and simulation-based learning media by carrying out the following actions: The first stage that connects degree definition with development level is assessment education (creating test criteria). Learning outcome indicators are used to design tests, which are then prepared based on these results. Media selection is done by looking at the format that suits the curriculum, while format selection is done by looking at the suitability of the format to the content of the material, then

making an initial design of learning media.

The design stage, namely media selection and initial device design, can be explained as follows:

Preparation of Learning Outcome Test Instruments (Criterion-Test Construction)

This research creates an evaluation tool (a test) for understanding concepts according to the objectives.

The research is to determine students' understanding of cosmography learning material through learning media. Based on the findings of the development of indicators for understanding concepts and learning objectives, a test instrument was created. Exams are one of the tools used to measure the increase in students' conceptual knowledge after the learning process using animation and simulation-based learning media, so the test design is a pre-posttest design.

Apart from concept understanding test instruments to find out the picture of learning by applying learning media, other forms of learning evaluation instruments were also developed. The form of instrument in question is the student's perspective on animation and simulation-based learning media. This questionnaire is distributed at the end of all learning activities.

Media Selection and Learning Resources (Media Selection)

Learning media selection activities are modified based on task analysis findings, student characteristics, lecturer skills, and environmental factors. Students must be able to:

- Follow the learning process in a relaxed atmosphere without feeling pressured after using animation and simulation-based learning media.
- Developing lecturer independence directly by carrying out activities (learning by doing).
- Find facts through experiments that show symptoms and get used to applying them in everyday life.

Media Format Selection and Initial Design (Format Selection and Initial Design)

Findings from content analysis, task analysis, development indicators, learning objectives, selection of learning media, and integrating learning resources into learning media will all be applied in this research. It is necessary to create animation and simulation-based learning media that are in accordance with specific

research objectives to test the effectiveness of the media.

On mobile devices (running devices), which consist of an operating system, middleware, and core applications, digital practicum guides are part of a software type. According to Enterprise, (2018), electronic learning media can be operated on a tablet or smartphone. In order for users to engage with the device and use the programs available on it, the operating system can be seen as a bridge between the device and its use. Another source claims that electronic learning media is an operating system specifically designed for mobile devices such as smartphones and tablets (Bousmah et al., 2015). Because the operating system for this learning media is open source, a large community of programmers flocked to create applications or modify them. For this open source reason, programmers have a great opportunity to be involved in creating animation and simulation-based learning media. The results of the design and development of animation and simulation-based learning media are as follows :

a) *Designing the main page*

Figure 1. Main Page Design

On the main page of animation and simulation-based learning media materials (see **Figure 1**), there are several items, including:

- Title, is a display of a topic that will be discussed in a scientific work or in other forms.
- Design, is the display of supporting images in a topic, where the images displayed are images that lead to the aesthetic graphics of the front view.
- Supporting information is a sentence or information that can help the title to summarize the information in a title.

b) Design of the Material Table of Contents Page

On the material table of contents page, there is a selection of learning materials for cosmography courses contained in animation and simulation-based learning media, accompanied by a frame design

display to give an aesthetic impression (see **Figure 2**).

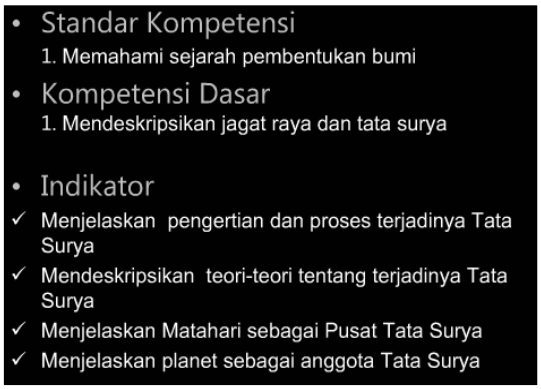

Figure 2. Material List Page Design

c) *Designing the content design*

Figure 3. Page Design Design

On the competency page (**Figure 3**), there is a display design as follows:

- Sentences from the content of the cosmography course learning material
- Design of the edges of the display of learning materials for the cosmography course
- 4) Designing animation and simulation pages

Figure 4. Animation page design

In the animation and simulation pages (**Figure 4**), explanations of the material have been linked to the browser application, so that it can make it easier to play the learning material for the Cosmography course.

3. Development Stage (Develop)

At the initial form development stage (development) of learning media in the cosmography course, what was done was to create animation and simulation-based learning media according to the appearance that had been created at the design stage. The creation of animation and simulation-based learning media that has been carried out in research is demonstrated by several direct image visualization displays. A visualization of the appearance of animation and simulation-based learning media can be presented in the image below.

a) Main Page Development

Main Page Development shown in **Figure 5.**

p-ISSN 2460-0768 e-ISSN 2597-6044
https://doi.org/10.20961/ge.v10i2.87091

GeoEco, Vol. 10, No 2. July 2024 Page. 173-191
https://jurnal.uns.ac.id/GeoEco/article/view/87091

Figure 5. Main page development results

b) Material List Page Development

Material list page development shown in **Figure 6**.

Figure 6. Results of Material List Page Development

c) Page design development

Page design development shown in **Figure 7.**

Figure 7. Result of Material Contents Page Development

d) Animation Page Development

Animation Page Development shown in **Figure 8**.

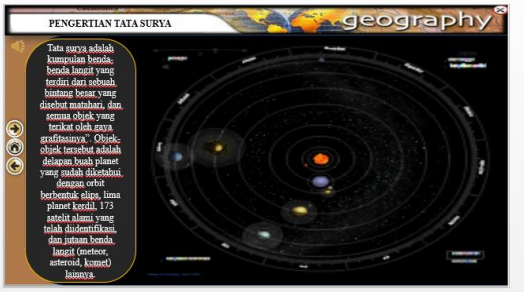

Figure 8. Animation Page Development

Evaluation is the part that presents the findings of the data analysis collected during research and development. The purpose of statistical analysis is to address research problems. The information collection method is a questionnaire with five options for experts and five options for students. The following are the results of the analysis:

Analysis of material expert data and media data.

The techniques and results of teaching activities and knowledge acquisition can be influenced by the practice of learning media. Material experts check and collect material discussions before checking them with a questionnaire. A 5-scale score interval is created using information from the assessment of mastery of the material components. The questionnaire for material experts consists of 20 items, and it is clear that the minimum overall rating is 20 and the

highest score is 100, shown in the **Table 3.**

Table 3. Analysis of material expert results

No	Assessment Aspects	Score obtained	Average value	Percentage	Category
1	Material	69	3,83	77	Decent
2	Question	47	3,92	78	Decent
3	Language	16	4,00	80	Very decent
4	Implementation	24	4,00	80	Very decent
	Total	**156**	**3,90**	**79**	**Decent**

Adjusting animation and simulation-based learning media into appropriate categories based on the approval of material experts. Based on the table above, it can be concluded that the material and question factors obtained with a percentage of 77% and 78% with an average score of 3.83 and 3.92 are included in the decent category, while the language and implementation obtained with a percentage of 80% with a score of The average score of 4.00 is included in the very decent category. Overall, material specialists gave a rating of 79%, with an average score of 3.90 in the decent category. After carrying out several tests, the results of the validation tests received a high score, which shows that overall, these criteria can be used or implemented in learning. Media from the perspective of material experts is appropriate and can be applied to learning (Hapsari & Wulandari, 2020). Results are sufficient for a valid device to proceed to the next level (Hamdani et al., 2019).

The main component of learning aids is media. The way in which coaching and learning activities are conducted and their outcomes may be influenced by how the media handles flowcharts. Media experts research, identify, and then corroborate media using questionnaires. Material element data from the media for learning assessment is translated into five-scale ratings. With 24 items in the questionnaire for experts, it is possible to see that the highest score is 100 and the lowest overall rating is 94, shown in the **Table 4.**

Table 4. Analysis of media expert results

No	Assessment Aspects	Score obtained	Average value	Percentage	Category
1	Software	100	4,17	83	Decent
2	Visual Communication	94	3,92	78,3	Decent
		194	4,04	81	Very Decent

Based on the software component, it was found that a score of 83% for the software category fell within the value range and was 81.25 < 100 in the very decent category, while the percentage of 78.3% for the visual communication category fell into the value range and was 62, 50 < 81.25 in the eligible category. Experts in the media gave it an overall score of 81, with the overall evaluation results falling into the very decent bracket of a score of 81.25 to 100%. Adjusting animation and simulation-based learning media into the "very decent" category based on media expert approval.

A display must meet the level of practicality to continue to a higher level (Wulandari, 2017). Media analysis said the study maintained extensive due diligence. After several trials were carried out, the results of the validation check obtained a very good rating, which shows that the standard as a whole can be used or applied to mastery. The validation test for animation and simulation-based learning media components received a response from media expert validators, who gave a score of 81% with an average of 4.04 out of the best score of 5, namely the very feasible category. A display must meet the level of practicality to continue to a higher level (Wulandari, 2017).

Student response to the digital practicum guide

Knowing the magnitude of the response to the digital practicum guide can be seen from several calculation steps. The first is to look at the results of the percentage of students using this learning media. **Table 5** contains the results of percentage calculations.

Table 5. Analysis of student response results

No	Assessment Aspects	Percentage	Category
1	Attractiveness	78,9	Decent
2	Help level	76,9	Decent
3	Benefit	76,8	Decent
Total		**77,2**	**Decent**

Based on the data in the table above, the results of the questionnaire responses applied animation and simulation-based learning media to students in the 6th semester of the cosmography course. The results of the questionnaire responses for all students obtained a result of 77.2 in the good category. The result of this improvement is the success of an animation and simulation-based learning media that can be implemented and is successful, with a good category. The use of animation and simulation-based learning media is very effective in application so that it can motivate and understand abilities (Kumar et al., 2023). In line with the opinion of Saroinsong et al., (2020) which states that the use of animation and simulation-based learning media is easier to operate to improve student-learning outcomes, Obtaining appropriate animation and simulation-based learning media encourages active learning and maintains interest, thereby improving academic performance (Atabhotor & Kofoworola, 2020). The level of appropriateness of the media can also provide a level of effectiveness for learning, so that it can provide an interesting experience for students (Väätäjä, 2023). The use of animation and simulation-based learning media has interactive features, encourages student visualization, and improves problem solving in learning (Tajvidi & Fang, 2015). According to learning, using successful animation and simulation-based learning media can bridge the delivery of material in order to increase understanding (Ahmad et al., 2021). The use of learning media can also provide increased achievement compared to using animation and simulation-based learning media (Fang & Guo, 2016). From the explanation above, the use of learning media can have a positive impact on the learning process. The results of such responses obtained can also be influenced by the condition of students' supporting devices and networks when using smartphones to support animation-based learning media and learning simulations.

Development of animation and simulation-based learning media in the cosmography course, which aims to determine the feasibility and response to student learning in this course. From a series of questionnaire responses carried out, the results obtained from the validation test obtained a good score, so overall; the criteria were suitable for use or application in learning. Two material expert validators gave marks to the validation test in the aspect of

cosmography material content. In terms of material considerations, media considerations, and users of animation and simulation-based learning media, namely students, the resulting animation and simulation-based learning media were practical for use as learning resources. The following are findings regarding the validity and applicability of animation and simulation-based learning media, such as media aspects for each topic in the questionnaire submitted to material experts, which are considered feasible with an average score of 156 and the largest percentage of 79%, while for media experts, it is considered very feasible with a score 194 and a percentage 81%. The response to the use of animation and simulation-based learning media obtained a good category of 77.2%. Such results can also provide evidence that there are several other factors that can influence it, such as supporting devices and the strength of the internet network.

CONCLUSIONS

Based on data analysis and evaluation, it can be concluded that the development of animation and simulation-based learning media in cosmography courses is feasible and beneficial for both study programs and students. The main display page is an important aspect of information, ensuring that only holders of animation and simulation-based learning media can access the information. The research and development process uses a combination of qualitative and quantitative data analysis techniques, including collecting data from validators and using descriptive data to calculate average scores. Assessment of animation and simulation-based learning media is carried out using a Likert scale. The development of animation and simulation-based learning media aims to increase learning independence and enrich student knowledge, providing unlimited access to resources regardless of time and distance. Based on these findings, this research recommends that learning media continue to be developed so that they are better and more targeted. Colleges must consider students' needs for reference resources. Appropriate feedback from students regarding the use of animation and simulation-based learning media learning resources is needed as well as more information sources from learning media in libraries and other references. The successful use of animation and simulation-based learning media in the geography study program, cosmography

course, can also help other study programs, and can even be developed to a wider level at other universities.

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