Enhancing student interest and learning outcomes using the virtual tour by web-based 360 videos

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Abstract
This research aims to: 1) determine the feasibility of the product developed from the web-based 360 Degree Virtual Tour, 2) measure the enhancement in student interest, and 3) measure the enhancement in learning outcomes, focusing on disaster education. A research and development (R&D) approach was used with the Successive Approximation Model (SAM) in three iterative stages: evaluation, design, and development. The study involved 36 students from class XI IPS at MA Ahmad Yani Jabung, Indonesia. The feasibility of the product was assessed by a geography material expert, a media expert, students, and a teacher using questionnaires. The questionnaire instrument was used for learning interest, and the test instrument was used for learning outcomes. Data analysis used descriptive statistics to assess product quality, and a paired sample t-test was used to evaluate the effectiveness of a 360-degree web-based virtual tour on interest and learning outcomes. The results showed that 1) web-based 360-degree virtual tour development products have a high feasibility value based on the test results from geography material experts, media experts, teachers, and students. 2) Students' interest was enhanced after using the web-based 360-degree virtual tour. This media can present material interestingly through interactive features that actively involve students in the learning process. 3) Students' learning outcomes were enhanced after participating in learning by using a web-based 360-degree virtual tour. This media utilizes visual and interactive elements that can facilitate a deeper understanding of concepts so that student learning outcomes can improve. Future research is recommended to explore students' learning styles to enhance 360-degree virtual tour-based learning, expand the topic to include climate change and resource management, integrate AR/VR for interactivity, and develop the research for schools in Malang City and Batu City.

Keywords: development; web-based 360 degree; virtual tour; learning interest; learning outcomes.

INTRODUCTION

The use of media is one way to help students learn better. The use of media is very important in the learning process because it must be considered throughout the learning process (Hasan et al., 2021). The use of learning media is projected to increase student success and help fulfill national education goals (Arumsari, 2017). To help students achieve learning objectives, almost all subject matter, including geography, requires observation and field practice. This is related to the study of Geography, which includes content about physical processes that produce patterns on the face of the Earth, as well as ecological features and spatial distribution on Earth, so students must have direct experience during learning (Wijayanto, et al., 2020).

Based on the results of observations on geography learning at MA (*Madrasah Aliyah*/Islamic Senior High School) Ahmad Yani Jabung, Indonesia, it was found that students' enthusiasm for learning was relatively low, especially on disaster materials, with a value of 54%. This is indicated by the lack of student activity in learning. As a result, it has an impact on low learning outcomes with an average score of 53.71. Other observations show that the lack of resources in the form of inadequate digital-based learning media can affect the low interest and learning outcomes in disaster geography subjects. Therefore, targeted and integrated measures are needed both in terms of innovative teaching and the provision of more diverse resources such as digital-based learning media.

In addition, learning materials that are often used in the learning process at MA Ahmad Yani Jabung, Indonesia, are still limited to textbooks and PowerPoint presentations. The use of various media is considered less effective and efficient in conveying subject matter to students, especially material that is abstract and complicated, such as geography. The use of still images in textbooks causes students to be passive and less engaged because 2D image media is considered less beautiful, contains a lot of language, is dense, and does not provide feedback (Cahyono, et al., 2021; Liando, et al, 2022).

Ensuring that students have a strong understanding of disaster in geography requires educational innovation using media. Every learning process requires effective approaches, techniques, and media. Technology should provide a positive experience for learners. According to Agustian & Salsabila (2021), technology plays a crucial role in modern learning because it can support various activities, especially in education, so it becomes an important aspect of human life. Through the use of learning support technology, educators can use it as a mediator or educator in conveying knowledge to students. Making the material more interesting and less monotonous can attract student interest and maintain enthusiasm for learning activities (Ismail, 2020).

The utilization of current technological advances can improve the quality of learning in educational institutions. Schools as educational institutions play a role as a forum in implementing advanced technology-based learning media for students in 21st-century learning

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(Dahri et al., 2023; Khahro & Javed, 2022). Kurniawan et al. (2022) said that the results of an online survey of 140 students suggested that students require apps with sophisticated characteristics that mirror the real world for learning implementation, such as online meeting capabilities, 360 Virtual Reality Panorama, and Augmented Reality.

360-degree virtual is one type of media that can be used. Virtual-Tour 360 Degree is a medium that displays a simulated virtual world environment through a device. The 360-degree panoramic photo allows users to examine the contents of the neighborhood. An environmental condition can produce an interactive system for users by presenting information in visual form, which is packaged in the form of a running animation, and presents the actual situation (Falani et al., 2016; Hordiienko et al., 2020). The 360-degree-based learning media will help students understand the content of the material by showing it in a 3D space. As a result, students can visually explore each space in the disaster material in 3D and get a new learning experience (Kumar et al., 2023).

The Media of 360-degree video virtual tour in this research is based on its advantages. Abidin et al. (2020) stated that 360-degree video-based virtual tours provide a real impression and experience without having to observe the field directly. In addition, virtual tours are flexible in setting the time and location of observation. Results are immediately accessible, and there is no need to frequently go to the field to make observations (Špernjak & Šorgo, 2018).

Kasma, et al. (2023) found that the existence of a Virtual E-Tour of North Toraja Tourism can help the office promote tourism, and the general public has access to information about North Toraja Tourism. This is supported by research conducted Amarulloh, et al. (2022) shows that the use of 360-degree-based Virtual Tour provides complete information related to tourist attractions and is easily accessible to tourists and people who will visit. Research by Winata, et al. (2023) states that the use of virtual tours helps visitors learn and travel while enjoying the environment of the Gorontalo Provincial Museum. In line with that, research by Fatimah (2021) related to the use of Virtual Tour based on 360-degree video has a positive influence on Virtual Tour Museum as a learning media on students' Cognitive achievement at SMA Negeri 1 Menganti Gresik. Based on the analysis of previous research, the novelty of this research lies in the disaster geography material. The disaster geography material raised in this study is contextual and occurs around students.

In addition, the novelty of this study is based on the superiority of 360-degree web-based virtual media in increasing interest and learning outcomes. Student interest in learning is one of the key elements that determines the success of the educational process. Interest serves as an internal drive that makes students more motivated, focused, and actively involved in learning activities (Sofna et al., 2023; Zhu et al., 2024). Interest can build curiosity, increase perseverance, and encourage students to explore knowledge further. Masniari, et al., (2023) explained that when students have a high interest, it will be easier to understand the material, remember information, and apply knowledge in real life.

Conversely, if students have no interest in learning, the impact can be very detrimental. Empirically, research shows that students who lack interest often feel bored, lack motivation, and find it difficult to concentrate on learning (Fathonah & Sarwi, 2024; Nakanishi, 2015). Siregar, et al., (2023) Revealed that, in the long run, a lack of interest can also hinder the development of students' potential, trigger apathy towards education, and even increase the risk of dropping out of school. Self-Determination Theory by Ryan & Vansteenkiste (2023) explains that without interest, students' intrinsic motivation to learn decreases, so they tend to learn only to fulfill obligations without deep understanding. Similarly, Maslow's theory places interest as part of self-actualization, which suggests that students without interest find it difficult to reach their full potential (Takyi et al., 2023).

Interest has a relationship with learning outcomes as it drives student motivation, focus, and engagement in learning (Alam, 2023; Fadliyana et al., 2023; Harefa et al., 2023). Students with a strong interest are more conscientious, engaged, and motivated to comprehend the content, which improves learning results (Alshammary & Alhalafawy, 2023; Amin et al., 2022). Research by Ateş & Köroğlu (2024) and Nursaid, et al., (2023) shows that students who are interested in certain subjects have a deeper understanding and higher academic grades. Interest also makes students more eager to invest greater time and effort in the learning process (Laine, et al., 2017).

Yurdugül & Çetin (2015) mentioned that students who do not have an interest tend to be lazy, lack discipline, and are easily distracted, so they have difficulty understanding the material or completing tasks, which makes learning outcomes decrease. Expectancy-value theory asserts that interest strengthens students' perceptions of the importance of learning and increases activity (Rubach et al., 2023). Without interest, intrinsic motivation will decrease, causing the learning process to be superficial and less meaningful. Therefore, fostering student interest is very important to achieve optimal learning outcomes.

Based on the description above, this research aims to 1) determine the feasibility of the product developed from the web-based 360 Degree Virtual Tour. 2) Measuring the effect of web-based Virtual Tour 360 Degree media on student interest. 3) Measuring the effect of web-based 360-degree virtual Tour media on student learning outcomes at MA Ahmad Yani Jabung, especially on disaster material.

METHOD

Malang Raya was chosen as the location for the media development of materials, such as Pujon District, Sumbermanjing Wetan District, Poncokusumo District, Pagak District, and Malang City. The selection of the location was based on the reason that these districts are in disaster-prone areas, with various natural threats that can affect sustainability and safety. The area is located in the southern mountainous zone of East Java, which has coarse and fine relief and is formed from tertiary volcanic rocks, making it prone to landslides. In addition, Malang is also located close to the southern coast, which is potentially exposed to tsunami threats, as

well as being in the area where the Indo-Australian and Eurasian tectonic plates meet, which increases seismic activity and the potential for earthquakes. The presence of the active Mount Semeru also adds to the vulnerability to volcanic disasters. On the other hand, Malang often experiences flooding during the rainy season due to inadequate drainage systems in some densely populated areas, as well as drought during the dry season, especially in low-lying areas that depend on a limited river water supply. All these factors make Malang a high-risk area for various types of natural disasters. The disaster areas in Malang Raya can be seen in Figure 1.
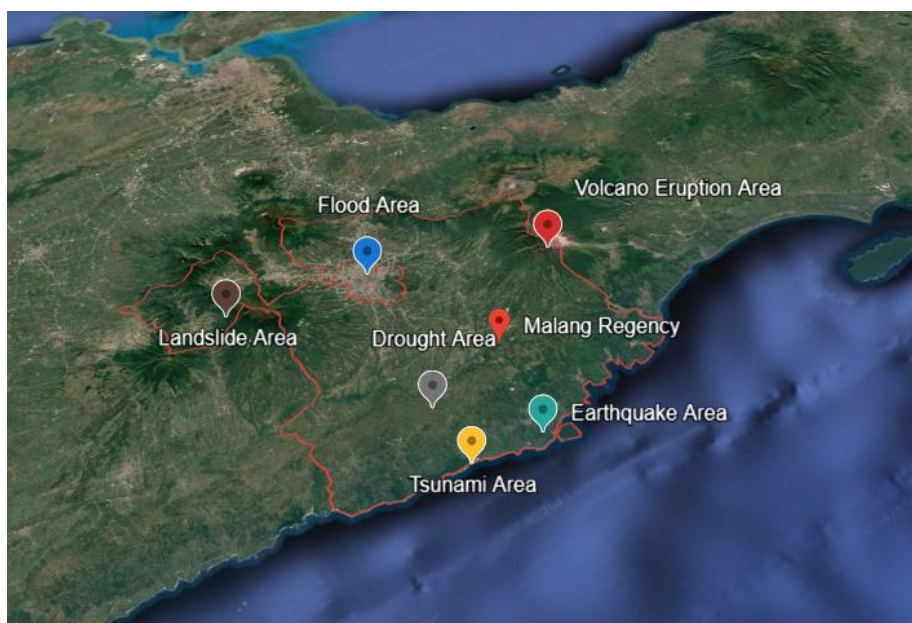

Figure 1. Disaster-prone locations in the Greater Malang Area

The application of the use of 360-degree web-based virtual tour media in this study was conducted at MA (*Madrasah Aliyah/*Islamic Senior High School) Ahmad Yani Jabung, Malang Regency, Indonesia. The selection of the school location as a place for media application is based on the reasons that 1) MA Ahmad Yani Jabung is included in the Greater Malang area, and 2) the school is located in a disaster-prone area, such as landslides, volcanic eruptions, floods, and earthquakes. The research subjects consisted of XI IPS (Social Science Studies) class students, totaling 36 students.

This research uses a Research and Development (R&D) approach with the Successive Approximation Model (SAM). This model is an advanced development of the ADDIE model (Allen & Sites, 2012). The SAM used in this study is SAM 1, which consists of three main stages, namely evaluation, design, and development, which are carried out in at least three rounds.

The evaluation stage is the initial and final stage in the development. The initial stage includes the analysis of ideas and needs from students in the form of observation data related to the learning process in the classroom. The final stage is the validation of the product that has

been developed by geography material experts and media experts to correct deficiencies in web media, including testing functionality, interface, and system performance. Web-based 360-degree virtual tour media is implemented in learning for students and teachers, then provides assessment and feedback.

The design stage designs a prototype that will be used in the development of a web-based 360-degree virtual tour, including menus and content. Then collect disaster materials, choose the main topics, design intuitive navigation, and arrange information systematically.

The development stage builds a website using the Lapentor platform and then integrates the framework into the web-based 360-degree virtual tour media. After that, return to the evaluation stage related to the validity of geography material experts and media experts. Furthermore, the implementation of 360-degree web-based virtual tour media for students. Briefly can be briefly seen in Figure 2.
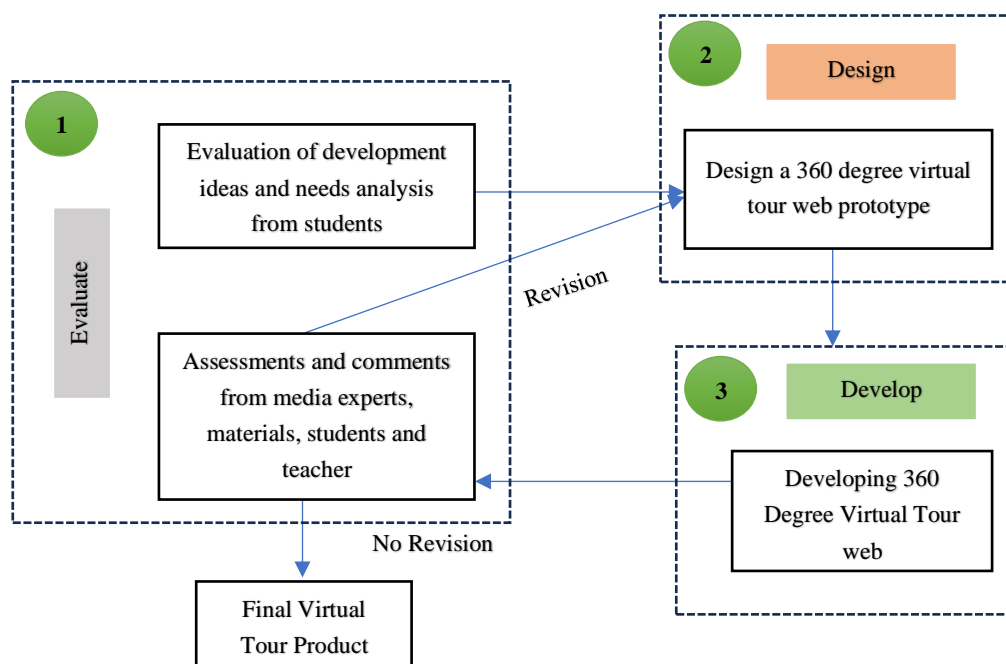

Figure 2. Virtual tour development procedures

The feasibility of 360-degree virtual tour media products was evaluated using a questionnaire validated by: 1) A geography material expert through 16 questions with indicators of content accuracy, suitability to the curriculum, relevance to learning objectives, and the ability of the media to visualize geographical concepts. 2) A learning media design expert through 16 questions with indicators of visual appearance, navigation, interface structure, and functionality of interactive features. 3) 36 students through 16 questions with indicators of quality of media design and display, clarity, and cohesiveness of material, effectiveness of media in learning, and appropriateness and ease of access. 4) A teacher, through 16 questions with indicators, asks the

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same questions as students. This questionnaire uses a Likert scale rating of 1 (strongly disagree) - 5 (strongly agree).

Furthermore, the student learning interest assessment instrument uses a questionnaire measured on a Likert scale of 1 (strongly disagree) - 5 (strongly agree), totaling 15 items. This questionnaire was given to students before and after learning by using a 360-degree web-based virtual tour media. Indicators of learning interest in this study include: 1) positive feelings when learning; 2) comfort when learning; and 3) ability to learn (Dan & Todd, 2013). The student learning interest assessment instrument has been tested for validity using the Corrected Item Total Correlation with a value of $\alpha > 0.2$. The results of validity test of the student learning interest instrument were conducted on 30 students outside the research subject. The recapitulation of the validity test results is described in Table 1.

Table 1. Learning the interest validity test result

Item	Corrected Item-Total Correlation	α	Decision
P01	0.392	0.2	Valid
P02	0.369	0.2	Valid
P03	0.644	0.2	Valid
P04	0.385	0.2	Valid
P05	0.615	0.2	Valid
P06	0.441	0.2	Valid
P07	0.307	0.2	Valid
P08	0.357	0.2	Valid
P09	0.564	0.2	Valid
P10	-0.076	0.2	Invalid
P11	0.596	0.2	Valid
P12	0.501	0.2	Valid
P13	0.287	0.2	Valid
P14	-0.087	0.2	Invalid
P15	-0.080	0.2	Invalid

Based on Table 2, items P10, P14, and P15 were declared invalid and removed from the instrument used. Furthermore, the reliability test was carried out. See Table 2.

Table 2. Reliability test results of the learning interest instrument

Cronbach's Alpha	N of Items
0.769	12

Based on Table 3, the results of testing the reliability of the learning interest instrument on 30 students in this study are reliable.

The instrument for assessing student learning outcomes uses a multiple-choice test of 25 questions that focus on the cognitive aspects of disaster material. Before use, the test instrument was carried out 1) validity test using the Corrected Item Total Correlation technique; 2) reliability using Cronbach's Alpha; 3) test the differentiation of questions; and 4) test the level of difficulty of the questions.

Table 3. Learning Outcome Instrument Testing Results

Item	Corrected Item-Total Correlation	α	Validity Decision	Differentiability Decision	Difficulty	Decision	Reliability (Cronbach's Alpha)
P1	0.395	0.2	Valid	Enough	0.73	Easy	
P2	0.765	0.2	Valid	Good	0.70	Medium	
P3	0.750	0.2	Valid	Good	0.47	Medium	
P4	-0.072	0.2	Invalid	-	-	-	
P5	0.659	0.2	Valid	Good	0.70	Medium	
P6	0.712	0.2	Valid	Good	0.70	Medium	
P7	0.512	0.2	Valid	Good	0.60	Medium	
P8	0.719	0.2	Valid	Good	0.73	Medium	
P9	0.678	0.2	Valid	Good	0.80	Medium	
P10	0.724	0.2	Valid	Good	0.67	Medium	
P11	-0.024	0.2	Invalid		-	-	
P12	0.698	0.2	Valid	Good	0.67	Medium	
P13	-0.087	0.2	Invalid	-	-	-	0.930
P14	0.721	0.2	Valid	Good	0.60	Medium	
P15	0.712	0.2	Valid	Good	0.70	Medium	
P16	0.404	0.2	Valid	Good	0.50	Medium	
P17	0.435	0.2	Valid	Good	0.73	Easy	
P18	0.628	0.2	Valid	Good	0.47	Medium	
P19	0.426	0.2	Valid	Good	0.80	Medium	
P20	-0.053	0.2	Invalid	-	-	-	
P21	0.561	0.2	Valid	Good	0.60	Medium	
P22	0.686	0.2	Valid	Good	0.70	Medium	
P23	-0.180	0.2	Invalid	-	-	-	
P24	0.484	0.2	Valid	Good	0.83	Easy	
P25	0.746	0.2	Valid	Good	0.60	Medium	

Based on Table 4, questions P4, P11, P13, P20, and P23 were declared invalid and not used. The test of the differential ability of the questions shows good results, meaning that the questions can clearly distinguish between students with high and low understanding. The difficulty test showed that the questions had a medium level of difficulty. The reliability test results indicate that the instrument used is reliable, meaning that it can provide consistent and reliable results to measure student learning outcomes.

The feasibility data of the development product was analyzed using the percentage formula (Arikunto et al., 2021):

$$\text{Percentage (\%)} = \frac{\sum(\text{overall questionnaire answer score})}{N \times n \times \text{highest value}} \times 100\% \qquad (1)$$

Description:

N = Number of respondents

n = Total number of questionnaire items

The following are clauses used to provide context and make choices.

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Table 4. Criteria for the percentage score

Achievement Level (%)	Qualification	Decision
≥ 86	Very Effective	Feasible
≥ 71 – < 86	Effective	Feasible
≥ 56 – < 71	Moderately Effective	Not Feasible
≥ 41 – < 56	Less Effective	Not Feasible
< 41	Very Less Effective	Not Feasible

Furthermore, inferential statistical analysis was utilized to assess the impact of 360-degree web-based virtual tour media on student interest and learning outcomes. The following tests were used: descriptive statistical test, normality test, homogeneity test, and t-test. The difference test was conducted using a paired sample t-test. SPSS 23.0 for Windows was used to assess the data analysis in this study at a significance level of 0.05.

The decision-making process is based on hypothesis testing of data collection, scores of interests, and learning outcomes. The decision-making criteria are sig. ≥ 0.05, Ha is acceptable. If Sig. I < 0.05, the hypothesis is rejected. The hypothesis in this study is as follows:

Ho1 : 360-degree web-based virtual tour media does not affect student learning interest.

Ha1 : 360-degree web-based virtual tour media affects student learning interest.

Ho2 : 360-degree web-based virtual tour media does not affect student learning outcomes.

Ha2 : 360-degree web-based virtual tour media affects student learning outcomes.

RESULTS AND DISCUSSION

Geo 360 Disaster Product Development

The product of this research is Web Media named GEO 360 DISASTER. This Geo 360 Disaster web media aims to facilitate students and teachers in the classroom learning in Geography subjects, especially disaster material. The stages of developing this media include Evaluate, Design, and Develop.

Evaluation Stage

At the initial stage, researchers began by conducting an analysis or evaluation related to the situation, needs, and goals of the XI IPS MA Ahmad Yani Jabung students. Researchers conducted observations and unstructured interviews. The following results were obtained by researchers, namely: (a) learning activities are less interactive, (b) learning experiences are less memorable for students, (c) students rarely use media, especially PowerPoint, due to a lack of facilities and infrastructure, and (d) there are only worksheets.

In the last stage, researchers conducted in-depth validation with material experts and media experts to identify and correct existing deficiencies in the web media. This validation process includes testing the functionality, interface, and performance of the system to ensure all features run well and are easy to use. Once all the issues are resolved and the researcher is confident in the quality of the web, the next step is implementation to students and teachers during learning to get feedback and further improvements. The implementation of the media to the MA Ahmad Yani students can be seen in Figure 3.

(a)

(b)

Figure 3. Implementation of media for students

Design Stage

In the design stage, researchers developed an outline of the menu and content to be included and collected data in the form of disaster materials to be integrated into the Geo 360 Disaster web platform. This process involved selecting key topics, designing an intuitive navigation structure, and systematically collecting and organizing information to make it accessible and easy for students to access and understand. In addition, the researcher also ensured that all the content collected was relevant and of high quality to support effective learning objectives.

Development Stage

In the development stage, the researcher designed and built the website using the Lapentor app platform and incorporated the framework into the Geo 360 Disaster Web. Next, we conducted in-depth validation with material experts and media experts to identify and correct any deficiencies in the web media. Teachers and students can access the learning web through

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the following link: https://geoislamika.geopedia.online/. An example of the product display can be seen in Figure 4-7.

This Geo 360 disaster web product has the main advantage of presenting interactive education about disaster and science with an immersive visual experience. Equipped with quizzes to reinforce understanding, the platform aims to increase awareness, preparedness, and user engagement through broad and easy access.
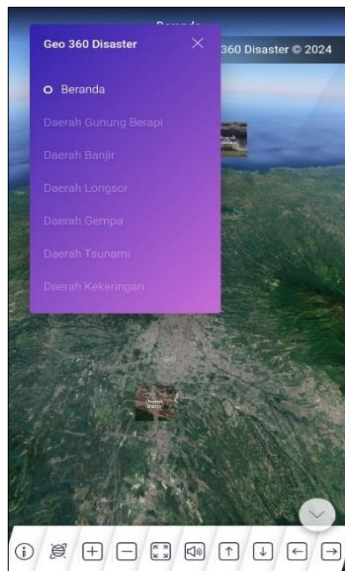

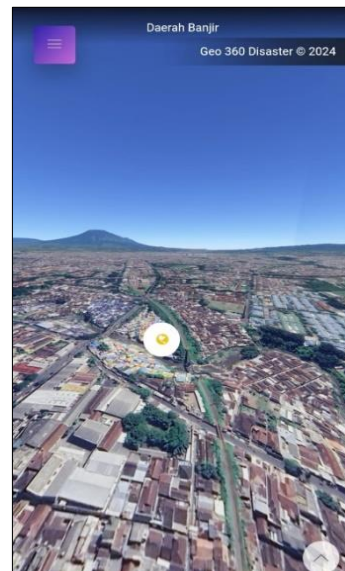
Figure 4. Home view

Figure 5. 360-degree virtual tour aerial view

Figure 6. 360-degree virtual view

Figure 7. Display of questions to students

Furthermore, there are assessments conducted by media experts, material experts, students, and geography teachers. The following are the results of the evaluation per questionnaire item on Web Geo 360 Disaster learning media, along with the score or percentage obtained. The recapitulation of product assessment results can be seen in Tables 5, 6, 7, and 8.

Table 5. Results of the media expert assessment of Geo 360 disaster media

No.	Items	Score
1.	Media design follows disaster material	5
2.	The typeface used is clear and legible	4
3.	Media packaging according to disaster material	5
4.	Media design is attractive to look at	4
5.	Media design presents real examples of disaster material	5
6.	Selection of colors in the media	4
7.	Selection of unique media	5
8.	Contains the integration of the concept of disaster material	4
9.	The media display is attractive and easy to carry/move	5
10.	Given a title/description of the media	5
11.	Media presentation can develop spatial abilities	4
12.	Video is related to the material	5
13.	The video sound used is clear	5
14.	Between video and sound is appropriate	5
15.	Presentation of material in the media is done coherently	5
16.	Media presentation supports students to be involved in learning	5
	Total	**75**
	Percentage (%)	**93.75**

Table 5 shows that the assessment of media experts on Geo 360 Disaster products has a percentage value of 93.75%, which means that this product has very effective qualifications.

Table 6. Result of the material expert assessment of Geo 360 disaster media

No.	Items	Score
1.	Breadth of Disaster material	5
2.	Depth of Disaster material	4
3.	Accuracy of facts	5
4.	Correctness of the theory or concept	5
5.	Logicality of concepts	5
6.	Conciseness of concept	5
7.	Correctness of principles/laws	5
8.	Accuracy of procedures/methods	4
9.	Suitability with the development of science	5
10.	Relevance of features and references	4
11.	Fostering a work ethic	5
12.	Fostering competitiveness	5
13.	Fosters curiosity	5
14.	Provides a challenge to learn further	5
15.	Develops academic skills	5
16.	Presents material contextually	5
	Total	**77**
	Percentage (%)	**96.25**

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Based on Table 6, the results show that the assessment of geography material experts on Geo 360 Disaster products has a percentage value of 96.25%, which means that this product has a decent decision with very effective qualifications.

Table 7. Result of the student's assessment of Geo 360 disaster media

No.	Items	Score of Percentage per Item of 36 Students (%)
1.	Geo 360 Disaster Web media display	89.57
2.	Presentation of material in the media is coherent	89.57
3.	The size and type of font used are easy to read	81.74
4.	Clarity of learning objectives	84.35
5.	Clarity of exposure to Lithospheric Dynamics material	93.04
6.	The level of conformity between images/video and material	87.83
7.	The examples given help you understand the material	86.09
8.	The videos provided help you understand the material	80.87
9.	Suitability of worksheets and test questions with the material	76.52
10.	Worksheets and test questions help improve your understanding of the material	93.91
11.	Geo 360 Disaster Web Media makes it easier for you to understand the Lithospheric Dynamics material	80.00
12.	Geo 360 Disaster Web Media motivates learning	85.22
13.	Geo 360 Disaster Web Media increases your engagement in learning	86.09
14.	Geo 360 Disaster Web Media is easy to operate	92.17
15.	Geo 360 Disaster Web Media is flexible and easy to access	91.30
16.	Geo 360 Disaster Web Media is suitable to be applied to learning	86.96
	Average	**86.58**

Based on Table 7, the results show that the students' assessment of the Geo 360 Disaster product has a percentage value of 86.58%, which means that this product has a decent decision with very effective qualifications.

Table 8. Results of teacher assessment of Geo 360 disaster media

No	Items	Score
1.	Geo 360 Disaster Web media display	5
2.	Presentation of material in the media is coherent	4
3.	The size and type of font used are easy to read	5
4.	Clarity of learning objectives	5
5.	Clarity of material exposure	4
6.	The level of suitability between images/video and material	5
7.	The examples given help students understand the material	4
8.	The video provided helps students understand the material	5
9.	The suitability of the quiz to the material	3
10.	Quizzes help improve students' understanding of the material	5
11.	Geo 360 Disaster Web Media makes it easier for students to understand the material	5
12.	Geo 360 Disaster Web Media motivates learning	4
13.	Geo 360 Disaster Web Media increases student engagement in learning	5
14.	Geo 360 Disaster Web Media is easy to operate	5
15.	Geo 360 Disaster Web Media is flexible and easy to access	5
16.	Geo 360 Disaster Web Media is suitable to be applied to learning	4
	Total	**73**
	Percentage (%)	**91.25**

Based on Table 8, the results show that the teacher assessment of the Geo 360 Disaster product has a percentage value of 91.25%, which means that this product has a decent decision with very effective qualifications. The results of all validators and respondents on Geo 360 Disaster media are shown in Table 9 below.

Table 9. Results of Expert and Respondent Validation

No	Correspondent	Percentage (%)	Qualification	Decision
1	Material Expert	93.75	Very Effective	Feasible
2	Media Expert	96.25	Very Effective	Feasible
3.	Students	86.58	Very Effective	Feasible
4.	Teacher	91.25	Very Effective	Feasible
	Average	**91.95**	**Very Effective**	**Feasible**

Source: Data processed

Based on Table 9, it can be concluded that the web learning media have met the appropriate standards. This is proven by the average results of expert validation and the limited trial, which scored 91.95%.

There were suggestions for improvement from media experts, geography material experts, students, and teachers. Media experts and material experts suggested enhancing the interactivity of concept maps and materials, as well as making quizzes more varied. The teacher recommended improving the clarity of instructions and offering additional learning resources for better comprehension. Students expressed the need for more engaging and diverse content to maintain their interest. The researcher made improvements based on these suggestions and coordinated with the media expert to revise the learning design accordingly, ensuring it addressed feedback from media experts, teachers, and students.

The results of this study are in line with several previous studies that discuss the development of learning media, especially related to the use of 360-degree virtual tours. Research by Winata et al. (2023), Amarulloh et al. (2022), Falani et al. (2016), and El-Said & Aziz (2022) also, show that the use of virtual tour-based technology can increase student engagement and facilitate understanding of learning materials more interactively. In addition, this study is in line with the findings of Fatimah (2021) and Kim, et al., (2022) who revealed that the use of technology-based learning media has a positive effect on student learning outcomes.

Web-based 360-degree virtual tour media development products applied to the MA Ahmad Yani Jabung students for disaster Geography material have various advantages. The advantages of this 360-degree virtual tour media, among others: are 1) interactive and immersive presentation of material, allowing students to virtually explore disaster-prone areas, to deepen their understanding of disaster phenomena; 2) ease of navigation with interactive buttons that make it easier for students to access more in-depth information according to the topics studied, such as volcanic eruptions, earthquakes, or tsunamis; 3) attractive and realistic display design, which can increase student motivation to learn in a more fun and interesting way; 4) the existence of student worksheets that can be accessed and done online, allowing students to directly apply what they have learned through interactive activities; and 5) online learning media

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that can be accessed anytime, anywhere, and under any conditions, providing flexibility in learning, especially in situations that require distance or additional learning.

Effect of Geo 360 Disaster Media on Learning Interest

The measurement of the effect of Geo 360 Disaster media on student interest in learning was analyzed using a pretest and posttest. The results of the acquisition of an interest in learning can be seen in Table 10.

Table 10. Recapitulation of results on learning interest

Indicator	Pretest	Posttest	Gain Score
Positive Feelings while Learning	63.00	82.56	19.56
Comfort when Learning	57.50	80.42	22.92
Ability to Learn	54.07	85.74	31.67
Average	**58.19**	**82.91**	**24.72**

Source: Data processed

The data in Table 10 compares pretest and post-test scores on three learning indicators: 1) feelings while learning increased from 63.00 to 82.56 (Gain: 19.56), 2) comfort while learning increased from 57.50 to 80.42 (Gain: 22.92), and 3) ability to learn showed the most significant increase, from 54.07 to 85.74 (Gain: 31.67). On average, scores increased from 58.19 to 82.91, with an average increase of 24.72. The data highlights significant improvements across the three key learning indicators, with the ability to learn showing the most notable improvement.

Furthermore, the effectiveness of the product was tested using normality and homogeneity for paired sample t-tests. The results of normality and homogeneity are shown in the following table.

Table 11. Normality and homogeneity test results

Test	Shapiro-Wilk	Levene Statistic
	Sig.	
Pretest Learning Interest	0.226	0.281
Posttest Learning Interest	0.103	

Source: Data processed

Table 11 shows the results of the normality test using Shapiro-Wilk because the sample is less than 50, and the homogeneity test using Levene's Statistic on pretest and post-test data for learning interest variables. Based on the Shapiro-Wilk results, the significance values for all data are above 0.05 (Sig. > 0.05), which indicates that the data are normally distributed. In addition, the Levene Statistic value also shows significance above 0.05 (Sig. > 0.05), which indicates that the variance between groups is homogeneous. The data has fulfilled the assumptions for parametric analysis using the Paired Sample T Test in Table 12.

Table 12. Paired sample t-test results

Variable	Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
		Lower	Upper			
Learning Interest	23.306	24.493	32.118	15.073	36	0.000

The results in Table 13 show a significance value of 0.000 < 0.050 for learning interest variables and learning outcomes. This indicates that there is a significant effect on increasing students' interest in learning after using Geo 360 Disaster media on disaster material.

The research findings indicate that web-based learning media, notably those with virtual tour elements, play an important role in raising students' interest in learning. This media provides a more interactive, immersive, and personalized learning experience, thus being able to effectively meet individual learning needs (El-Said & Aziz, 2022; V. Lin et al., 2023). This is supported by the research of Wu & Lai (2022) and Simonetti et al. (2022) which revealed that web-based interactive media can increase student learning motivation. This happens because web-based media, including 360-degree virtual tours, can present material interestingly with interactive features that actively involve students in the learning process (Othman et al., 2022).

Learning ability is one of the highest indicator measures in assessing web-based learning success because it directly relates to the quality of learning experience that learners gain. Immersive and interactive web-based media increases students' engagement in learning, allows them to understand the material better, and supports differentiated learning styles (Salem et al., 2024; Sayed et al., 2023). Furthermore, this success is due to the design of the media following modern learning principles, such as the use of visualization, animation, and interactive navigation, as well as 360-degree virtual tours that allow in-depth exploration of the material taught in a virtual environment (Tsai, 2022). The flexibility of time and place provided by web-based media allows students to learn at their own pace and learning style. Kim, et al., (2022) explained that the 360-degree virtual tour feature provides an immersive learning experience, such as a simulated visit to a location relevant to the learning material, so that students can understand concepts visually and contextually.

According to Yang, et al., (2021), web-enhanced courses based on virtual tours are very effective because the design is attractive, easy to use, and facilitates the systematic organization of material. When students access various disaster sites, such as volcanic areas or earthquake zones, they can virtually see firsthand the geographical conditions of the disaster areas, which makes them more interested and engaged. In addition, the material presented in the media has been structured coherently and completely, such as the existence of material in text, explanations in the form of audio, and material sourced from videos.

With the addition of the 360-degree virtual tour feature, learning becomes more immersive as students can realistically explore virtual environments, such as simulated disaster areas or natural landscapes, that are relevant to the learning topic (Caciora et al., 2021; Xiao Wu & Lai, 2021; Xie, et al., 2021). Resta et al. (2021) also asserted that web-based learning media have a high level of validity and reliability, so the materials and media design are considered suitable for effective learning.

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Effect of Geo 360 Disaster Media on Learning Outcomes

The measurement of the effect of Geo 360 Disaster media on student learning outcomes was analyzed using a pretest and posttest. The results of the acquisition of learning outcomes can be seen in Table 13.

Table 13. Recapitulation of learning outcomes

Indicator	Pretest	Posttest	Gain Score
Identify the concepts of disaster, mitigation, and adaptation	56.48	76.85	20.37
Identify factors that cause disasters	48.89	86.11	37.22
Analyze the impact of disasters on economic life	56.94	87.50	30.56
Analyze the impact of disasters on social life	56.94	79.86	22.92
Analyze mitigation before a disaster occurs	44.44	74.07	29.63
Analyze during and after a disaster	50.93	76.85	25.92
Average	**52.44**	**80.21**	**27.77**

The data in table 13 compares pretest and posttest scores on six learning indicators: 1) identifying the concepts of disaster, mitigation, and adaptation increased from 56.48 to 76.85 (Gain: 20.37), 2) identifying factors causing disasters, which increased from 48.89 to 86.11 (Gain: 37.22), 3) analyzing the impact of disasters on economic life increased from 56.94 to 87. 50 (Gain: 30.56), 4) analyzing the impact of disasters on social life increased from 56.94 to 79.86 (Gain: 22.92), 5) analyzing mitigation before disasters increased from 44.44 to 74.07 (29.63), and 6) analyzing during and after disasters increased from 50.93 to 76.85 (Gain: 25.92). On average, scores increased from 52.44 to 80.21, with an average gain of 27.77. The data highlighted significant improvements across all six indicators, with the Identification of disaster causal factors showing the most notable improvement.

Then, the effectiveness of the product was tested using normality and homogeneity for paired sample t-tests. The results of normality and homogeneity are shown in Table 14.

Table 14. Normality and Homogeneity Test Results

Test	Shapiro-Wilk	Levene Statistic
	Sig.	
Pretest Learning Outcomes	0.418	0.283
Posttest Learning Outcomes	0.84	

Table 14 shows the results of the normality test using Shapiro-Wilk because the sample is less than 50, and the homogeneity test using Levene's Statistic on pretest and post-test data for learning outcome variables. Based on the Shapiro-Wilk results, the significance values for all data are above 0.05 (Sig. > 0.05), which indicates that the data are normally distributed. In addition, the Levene Statistic value also shows significance above 0.05 (Sig. > 0.05), which indicates that the variance between groups is homogeneous. The data has fulfilled the assumptions for parametric analysis using the Paired Sample T Test in Table 15.

Table 15. Paired sample t-test results

Variable	Mean	95% Confidence Interval of the Difference		t	Df	Sig. (2-tailed)
		Lower	Upper			
Learning Outcomes	28.333	22.628	34.038	10.083	36	0.000

The results in Table 16 show a significance value of 0.000 <0.050 for the learning outcomes variable. This indicates that there is a significant effect on improving student learning outcomes after using Geo 360 Disaster media on disaster material.

The results of this study indicate that Geo 360 Disaster media have a significant effect on improving student learning outcomes. This media offers a different learning experience from traditional learning methods by utilizing visual and interactive elements that can facilitate a deeper understanding of concepts (Argyriou et al., 2020; Harari et al., 2021). In the context of disaster material, Geo 360 Disaster allows students to explore natural disaster simulations in a realistic virtual environment, providing students with the opportunity to learn through hands-on experience that is difficult to achieve with conventional methods.

The use of Geo 360 Disaster in disaster learning has a positive impact as it allows students to understand and identify different types of disasters, their impacts, and mitigation measures that can be taken. This is evidenced by the indicator of identifying the causes of disasters being the indicator with the highest score. The 360-degree virtual tour feature allows students to tour disaster-affected locations, such as earthquake-prone areas or areas affected by flooding, giving them a clearer and more tangible picture of the topic being studied. This encourages students' active engagement and strengthens their understanding of the material (Wallgrün et al., 2020).

In addition, Geo 360 Disaster also supports independent and collaborative learning. Students can access this media anytime and anywhere, which provides flexibility in the learning process (Kyrlitsias et al., 2020; Mah et al., 2019). Interactive features in this media, such as quizzes or assignments integrated with the virtual tour, help students to test their understanding directly. This virtual tour-based learning allows students to learn more deeply and contextually, which improves information retention and understanding of the concepts taught (Ryu et al., 2019).

In addition to the content aspect, the design and structure of Geo 360 Disaster also play an important role in improving learning outcomes. Bennett & Saunders (2019) explained that the virtual tour is designed with attractive visualization and easy navigation, so students can easily access the information needed without feeling burdened by the complexity of the interface. The success of this media is supported by Chiao et al. (2018), which shows that the use of interactive web-based media, as done in Geo 360 Disaster, can increase interest or engagement. This contributes to improved learning outcomes as more motivated students will be more focused and active in participating in learning (Harefa et al., 2023; Permatasari et al., 2019).

In line with the findings of Ikhsan et al., (2019) dan Lin & Wu (2016) which shows that web-based media can increase student interest in learning. The use of Geo 360 Disaster provides greater opportunities for students to interact with the material and explore disaster topics more interestingly. The 360-degree virtual tour feature embedded in this media allows students to

visit disaster-related locations, which not only increases learning interest but also provides a better understanding of different types of disasters and their impacts. Improved learning outcomes are also influenced by the flexibility offered by Geo 360 Disaster media. Learning can be done anytime and anywhere, giving students the freedom to manage their learning time (Sari et al., 2025; Stanciulescu et al., 2024). Students can learn independently according to their style and rhythm, which has a positive impact on their understanding in learning.

CONCLUSION

Geo 360 Disaster web media was developed to enhance disaster education for geography students at MA Ahmad Yani Jabung, Malang. Following a structured process of evaluation, design, and development, the platform meets high educational standards and addresses specific learning needs. 1) The creation of this platform began with a needs analysis to identify gaps in traditional learning approaches. The content was carefully designed to align with learning objectives and validated by experts with a score of 91.95, which means it is fit for use. Geo 360 Disaster features interactive elements, immersive 360-degree visuals, quizzes, and online worksheets, fostering engagement and deeper understanding. 2) Geo 360 Disaster significantly increased students' interest in learning, as reflected by the increase in interest score by 24.72 points (from 58.19 to 82.91). Based on the paired sample t-test results, the sig value < 0.05 indicates that this media has a significant influence on student learning interest. 3) The platform also improved learning outcomes, with an increase of 27.77 points (from 52.44 to 80.21). Based on the paired sample t-test results, the sig value < 0.05 indicates that this media has a significant influence on student learning outcomes.

This virtual tour-based media can be an innovative solution for improving student engagement, material understanding, and learning outcomes, especially on complex topics such as disasters. The use of this technology also opens up opportunities for the development of similar learning media in various subjects to support modern learning that is more interactive and flexible. In addition, this research provides a basis for teachers and developers to further utilize technology in experiential learning to significantly improve student motivation and learning success.

Suggestions for future research are to examine students' learning styles to tailor 360-degree virtual tour-based learning media to the way students process information, to increase student effectiveness and engagement. In addition, material development should include other geography topics, such as climate change and natural resource management, to broaden students' knowledge. The addition of more varied materials can provide a more holistic picture of geography and disaster. It is also recommended to integrate technologies such as augmented reality (AR) or virtual reality (VR) to increase interactivity and immersion in the learning experience. Then, the research location can be continued at schools in the city of Malang and the city of Batu because the content of the material in the media coverage area is in the Malang region.

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REFERENCES

Abidin, R., Suryani, N., & Sariyatun. (2020). Students' Perceptions of 360 Degree Virtual Tour-Based Historical Learning About the Cultural Heritage Area of The Kapitan and Al-Munawar Villages in Palembang City. *International Journal of Social Sciences and Management*, *7*(3), 105–112. https://doi.org/10.3126/ijssm.v7i3.29764.

Agustian, N., & Salsabila, U. H. (2021). Peran Teknologi Pendidikan dalam Pembelajaran. *ISLAMIKA: Jurnal Keislaman dan Ilmu Pendidikan*, *3*(1), 123–133. https://doi.org/10.36088/islamika.v3i1.1047.

Alam, A. (2023). Improving Learning Outcomes through Predictive Analytics: Enhancing Teaching and Learning with Educational Data Mining. *2023 7th International Conference on Intelligent Computing and Control Systems (ICICCS)*, 249–257. https://doi.org/10.1109/ICICCS56967.2023.10142392.

Allen, M. W., & Sites, R. (2012). *Leaving ADDIE for SAM: An Agile Model for Developing the Best Learning Experiences*. Virginia: American Society for Training & Development.

Alshammary, F. M., & Alhalafawy, W. S. (2023). Digital Platforms and the Improvement of Learning Outcomes: Evidence Extracted from Meta-Analysis. *Sustainability*, *15*(2), 1305. https://doi.org/10.3390/su15021305.

Amarulloh, R., Muslih, M., & Arianti, N. D. (2022). Implementation of the Togaf Framework on A Virtual Tour of Web-Based Ciletuh Geopark Tourist Attractions. *Jurnal Teknik Informatika (Jutif)*, *3*(5), 1329–1336. https://doi.org/10.20884/1.jutif.2022.3.5.357.

Amin, S., Sumarmi, S., Mkumbachi, R. L., Prastiyono, H., & Aliman, M. (2022). Development of Mobile Learning App Based on Islamic and Science Integration to Improve Student Learning Outcomes. *Jurnal Iqra': Kajian Ilmu Pendidikan*, *7*(1), 219–235. https://doi.org/10.25217/ji.v7i1.2317.

Arikunto, S., Supardi, & Suhardjono. (2021). *Penelitian Tindakan Kelas: Edisi Revisi*. Jakarta: Bumi Aksara.

Arumsari, D. (2017). Pengaruh Media Pembelajaran dan Keterampilan Pengelolaan Kelas Terhadap Prestasi Belajar Siswa SMK Negeri 5 Madiun. *Assets: Jurnal Akuntansi Dan Pendidikan*, *6*(1), 13–25. https://doi.org/10.25273/jap.v6i1.1290.

Enhancing student interest and learning outcome using virtual tour by web-based 360 videos

Ateş, H., & Köroğlu, M. (2024). Online Collaborative Tools for Science Education: Boosting Learning Outcomes, Motivation, and Engagement. *Journal of Computer Assisted Learning*, *40*(3), 1052–1067. https://doi.org/10.1111/jcal.12931.

Cahyono, D. N., Khumaedi, M., & Hadromi, H. (2021). The Impact of Audio-Visual Media on Learning Result in the Subject of Seizing Picture. *Journal of Vocational and Career Education*, *6*(1), 9-16. https://doi.org/10.15294/jvce.v6i1.32488.

Dahri, N. A., Al-Rahmi, W. M., Almogren, A. S., Yahaya, N., Vighio, M. S., Al-maatuok, Q., Al-Rahmi, A. M., & Al-Adwan, A. S. (2023). Acceptance of Mobile Learning Technology by Teachers: Influencing Mobile Self-Efficacy and 21st-Century Skills-Based Training. *Sustainability*, *15*(11), 8514. https://doi.org/10.3390/su15118514.

Dan, Y., & Todd, R. (2013). Examining the Mediating Effect of Learning Strategies on the Relationship Between Students' History Interest and Achievement. *Educational Psychology*, *34*, 799–817. https://doi.org/10.1080/01443410.2013.792331.

Fadliyana, A., Ardianti, S. D., & Santoso, D. A. (2023). The Influence of Interest in Learning on The Learning Outcomes of Grade Iv Students in the Eyes Maths Lessons. *JPMI (Jurnal Pendidikan Matematika Indonesia)*, *8*(2), 120–126. https://doi.org/10.26737/jpmi.v8i2.4538.

Falani, A. Z. Z., Ramadan, H. H. A. S., & Setiawan, E. S. (2016). Implementasi Sistem Virtual Tour Berbasis E-Panorama Untuk Pengenalan Kampus Universitas Narotama Surabaya. *Insand Comtech: Information Science and Computer Technology Journal*, *1*(1), Article 1. https://doi.org/10.53712/jic.v1i1.101.

Fathonah, S., & Sarwi, S. (2024). The Relationship of Learning Interest in Nutrition and Learning Environment with Nutritional Literacy. *Proceedings of the 5th Vocational Education International Conference (VEIC-5 2023)*, 1088–1095. https://doi.org/10.2991/978-2-38476-198-2_154.

Fatimah, A. R. (2021). Pengaruh Virtual Tour Museum Sebagai Media Pembelajaran Terhadap Capaian Kognitif Siswa Pada Mata Pelajaran Sejarah Kelas XI IPS 2 SMA Negeri 1 Menganti Gresik. *AVATARA: e-Journal Pendidikan Sejarah*, *10*(3), 1–26.

Harefa, D., Sarumaha, M., Telaumbanua, K., Telaumbanua, T., Laia, B., & Hulu, F. (2023). Relationship Student Learning Interest to the Learning Outcomes of Natural Sciences. *International Journal of Educational Research & Social Sciences*, *4*(2), 240–246. https://doi.org/10.51601/ijersc.v4i2.614.

Hasan, M., Milawati, M., Darodjat, D., Harahap, T. K., Tahrim, T., Anwari, A. M., Rahmat, A., Masdiana, M., & Indra, I. M. (2021). *Media Pembelajaran*. Sukoharjo: Tahta Media Group.

Hordiienko, V. V., Marchuk, G. V., Vakaliuk, T. A., & Pikilnyak, A. V. (2020). Development of a Model of the Solar System in AR and 3D. *CEUR Workshop Proceedings, 2731*, 217–238.

Ismail, I. (2020). *Teknologi Pembelajaran Sebagai Media Pembelajaran*. Makassar: Cendekia Publisher.

Kasma, S., Rusmala, R., & Siaulhak, S. (2023). Pengembangan Aplikasi Virtual Tour 360 Derajad sebagai Media Informasi Destinasi Wisata Toraja Utara. *BANDWIDTH: Journal of Informatics and Computer Engineering*, *1*(2), 90–98. https://doi.org/10.53769/10.53769.

Khahro, S. H., & Javed, Y. (2022). Key Challenges in 21st Century Learning: A Way Forward towards Sustainable Higher Educational Institutions. *Sustainability*, *14*(23), 16080-16098. https://doi.org/10.3390/su142316080.

Kumar, A., Saudagar, A. K. J., Alkhathami, M., Alsamani, B., Khan, M. B., Hasanat, M. H. A., Ahmed, Z. H., Kumar, A., & Srinivasan, B. (2023). Gamified Learning and Assessment Using ARCS with Next-Generation AIoMT Integrated 3D Animation and Virtual Reality Simulation. *Electronics*, *12*(4), 835-850. https://doi.org/10.3390/electronics12040835.

Kurniawan, B., Shrestha, R., Astina, I. K., Hadi, N., Irawan, L., Kurniawati, E., & Wiradimadja, A. (2022). Developing a Virtual Nature Laboratory of Faculty Social Science (LAV-FIS) to Assists Field-Based Learning during Pandemic: A Need Analysis Review. *International Journal of Interactive Mobile Technologies (iJIM)*, *16*(7), 22–37. https://doi.org/10.3991/ijim.v16i07.28481.

Laine, E., Veermans, M., Lahti, A., & Veermans, K. (2017). Generation of Student Interest in an Inquiry-Based Mobile Learning Environment. *Frontline Learning Research*, *5*(4), 42–60. https://doi.org/10.14786/flr.v5i4.306.

Liando, N. V. F., Tatipang, D. P., Tamboto, G., Poluan, M., & Manuas, M. (2022). Pictures as a Learning Media in Teaching Vocabulary. *Jurnal Ilmiah Universitas Batanghari Jambi*, *22*(3), 1944–1949. https://doi.org/10.33087/jiubj.v22i3.2832.

Masniari, D., Turaqulov, B., & Kigo, J. (2023). Attitude of Students' Interest in Learning Physics. *Schrödinger: Journal of Physics Education*, *4*(3), 59–63. https://doi.org/10.37251/sjpe.v4i3.697.

Nakanishi, T. (2015). A Meta-Analysis of Extensive Reading Research. *TESOL Quarterly*, *49*(1), 6–37. https://doi.org/10.1002/tesq.157.

Nursaid, N., Nuraini, S., & Novitasari, D. R. (2023). How "Influence" do Media, Facilities, and Learning Interests Influence Students' Economic Learning Outcomes?. *Assyfa Journal of Multidisciplinary Education*, *1*(1), 41–49. https://doi.org/10.61650/ajme.v1i1.350.

Rubach, C., Dicke, A.-L., Safavian, N., & Eccles, J. S. (2023). Classroom Transmission Processes Between Teacher Support, Interest Value and Negative Affect: An Investigation Guided By Situated Expectancy-Value Theory and Control-Value Theory. *Motivation and Emotion*, *47*(4), 575–594. https://doi.org/10.1007/s11031-023-10013-6.

Ryan, R. M., & Vansteenkiste, M. (2023). Self-Determination Theory: Metatheory, Methods, and Meaning. In *The Oxford handbook of self-determination theory* (pp. 3–30). Oxford: Oxford University Press.

Enhancing student interest and learning outcome using virtual tour by web-based 360 videos

Siregar, T. I., Anilafiza, U., Atia, S., & Lestari, H. I. (2023). Analyze Students Learning Interest in the Subjects They Like. *International Journal of Education and Teaching Zone*, *2*(1), 139–147. https://doi.org/10.57092/ijetz.v2i1.77.

Sofna, A., Sakinah, Y., Misbah, M., & Pentang, J. T. (2023). Analysis of Student Learning Interest In Physics In Subject Force Material. *International Journal of Education and Teaching Zone*, *2*(1), 25–39. https://doi.org/10.57092/ijetz.v2i1.58.

Špernjak, A., & Šorgo, A. (2018). Differences in Acquired Knowledge and Attitudes Achieved with Traditional, Computer-Supported, and Virtual Laboratory Biology Laboratory Exercises. *Journal of Biological Education*, *52*(2), 206–220. https://doi.org/10.1080/00219266.2017.1298532.

Takyi, M. E., Chen, M., Ntim, S. Y., & Gabrah, A. (2023). Analysing Dewey's Vocational Aspects of Education and Maslow's Theory of Motivation in Support of Vocational Education and Training. *Discover Education*, *2*(1), 18-28. https://doi.org/10.1007/s44217-023-00042-1.

Wijayanto, B., Sutriani, W., & Luthfi, F. (2020). Kemampuan Berfikir Spasial dalam Pembelajaran Abad 21. *Jurnal Samudra Geografi*, *3*(2), 42–50. https://doi.org/10.33059/jsg.v3i2.2495.

Winata, F. N., Rohandi, M., & Yassin, R. M. T. (2023). Implementasi Virtual Tour dengan Teknologi Video 360 di Museum Provinsi Gorontalo. *Diffusion: Journal of Systems and Information Technology*, *3*(1), 59–69. https://doi.org/10.37031/diffusion.v3i1.15999.

Yurdugül, H., & Çetin, N. M. (2015). Investigation of the Relationship between Learning Process and Learning Outcomes in E-Learning Environments. *Eurasian Journal of Educational Research*, *15*(59), 57–74. http://dx.doi.org/10.14689/ejer.2015.59.4.

Zhu, Z., Li, S., Liu, Y., Zhang, X., Feng, Z., & Hou, Y. (2024). High-Level Preferences as Positive Examples in Contrastive Learning for Multi-Interest Sequential Recommendation. *World Wide Web*, *27*(2), 21-32. https://doi.org/10.1007/s11280-024-01263-6.