Development of Web-Based Virtual Reality as Media Learning for Baluran Conservation Area with Geographical Characteristics

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Abstract. This study has developed virtual reality learning media based on web learning as Mobile Virtual Field Trips (M-VFTs) with the object of the Baluran Conservation Area. The preparation of content is based on Geographical characteristics so that it can be used as a learning media to analyze phenomena in conservation areas. The development uses a plomp development model with formative assessments from teachers and students. Based on formative assessments, this media is suitable to be used as a Geography media learning, especially in understanding flora and fauna conservation material. Based on the findings in the field, this media can increase students' learning motivation and curiosity about flora and fauna conservation material. However, this media still requires future content design and instruction optimization. M-VFTs require integration with appropriate learning models. The suggested learning model is student-centred, so the teacher only functions as a guide. In addition, in optimizing the content design, it is possible to add stop sites from increasing student options in virtual visits to recognize the geographical characteristic of Baluran better.

Keywords: M-VFTs · geographical characteristics · conservation · baluran

1 Introduction

Geography Learning for high school students requires a fun learning experience and can analyze field phenomena directly. Students need to get this experience through Actual Field Trip (AFT) learning [1–3]. In addition, AFT learning can improve critical thinking competence, observation skills, and basic concept understanding [4, 5]. However, the implementation of AFT has obstacles due to the Covid-19 pandemic [6, 7]. As a result, students cannot carry out AFT learning directly. Therefore, it is necessary to have media as a complementary AFT learning, one of which is using Virtual Reality (VR) technology.

VR technology cannot serve as a substitute for AFT learning. However, VR technology has the advantage of providing a Geography learning experience through an immersive spatial object [8, 9]. This technology displays panoramic photos with the integration of supporting content on a 360 view [10]. Furthermore, VR packaging, as

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a complement to AFT learning, can use the concept of Mobile Virtual Field Trips (M-VFTs) with Autostereoscopics Display so that it is practical, flexible [11–13], and the user has complete control of it (human-machine interactions) [14]. M-VFTs display VR on Autostereoscopics Display with a web-based application with content arranged according to the instructional design.

The development of instructional design on M-VFTs needs to adapt to student learning needs. M-VFTs require an instructional design that provides a necessary learning experience in a virtual environment [15, 16]. Furthermore, M-VFTs, as an immersive technology, tend to be instantaneous, so students only absorb a little learning [17]. Therefore, teachers need several techniques to understand students, mainly by emphasizing the material's summary at each stop site [2] and providing conclusions in the final learning activity [17]. In addition, teachers can also arrange material on the media based on a Geography approach which consists of spatial studies, ecology, and interactions between regions [18]. Furthermore, high school Geography material that can be studied geographically is Flora Fauna Conservation.

Students need to learn complex flora and fauna conservation materials through M-VFTs. Spatial patterns, ecology, and interactions between regions in conservation areas can form phenomena, such as the distribution of flora and fauna at a certain point [19, 20]. In this regard, the phenomena that occur in conservation areas need to be studied geographically [21]. The use of M-VFTs can provide spatial understanding to students [22] while minimizing deficiencies in conservation learning activities [23, 24]. In addition, the media has the potential to assist students in studying geological processes [25], ecological processes [2, 23], and environmental concepts (ecosystem, biodiversity, and environment) [26].

M-VFTs as an innovative learning media for Geography have inspired many researchers to carry out further developments. Several studies present virtual conservation areas by presenting real-world scenes arranged through several panoramic photos. However, most studies present an exploration of a conservation area only by highlighting its immersive atmosphere. In a study by Nelson et al. [27] and Phipps et al. [28], in-depth development of M-VFT can increase sympathy and environmental awareness in conservation-based conservation. However, the study is still not explaining the characteristics of the area and its relation to the phenomena that occur. Students not only learn about environmental awareness but also analyze phenomena based on ecosystem characteristics. So, the Conservation Area presentation material in this study is based on the geographical characteristics of the area. Exploration of conservation areas based on geographical characteristics can assist students in carrying out critical virtual field observations [29].

Based on the explanation above, this study aims to develop M-VFTs web-based application as a media for learning Geography, especially on flora and fauna conservation materials. The development of M-VFTs media integrates the Geography approach with a fun concept through a VR web-based application. Furthermore, M-VFTs are expected to make it easier for students to understand the characteristics of conservation areas and socio-culture and study the phenomena therein. Thus, the development of M-VFTs content contains 360-degree photos at each stop site and is equipped with data in the form of multimedia, regional maps, location descriptions, and learning materials.

Table 1. Product feasibility criteria

No.	Score Range (%)	Category
1.	81–100	Excellent
2.	61–80	Good
3.	41–60	Enough
4.	21–40	Less
5.	0–20	Poor

2 Research Methodology

2.1 Subject of Research

This study was conducted at Madrasah Aliyah Negeri (MAN) 2 Tulungagung to assess teachers and students on learning media 360. MAN 2 Tulungagung has good facilities and technological capacity. In addition, the school requires M-VFTs as a media for learning Geography in the material for Flora Fauna Conservation Areas with complex objects, namely the Baluran Conservation Area. In its implementation, the sample of the selected product test was 34 students from the large group. Furthermore, sampling uses a purposive sampling technique. The selection of this sampling technique is based on the students' technological competence level, which is known from the results of interviews with teachers. As a result, the sample was 34 students from classes XI IPS 1 and XII IPS 1.

2.2 Data Analysis

We collected data using primary data and secondary data. Primary data was obtained by direct field observation of Baluran National Park, while secondary data was obtained from scientific articles and publications from good sources. As a result, combining the two data is used to develop M-VFTs.

M-VFTs were tested for feasibility by media experts and materials experts through a mixed questionnaire. As a formative assessment, this questionnaire was adapted from as stated in Ref. [30], emphasizing the description of the material based on the Geography characteristics of Baluran National Park and the flexibility of the use of media. Furthermore, formative assessment data was taken to get responses from students and teachers. Finally, the overall assessment results were analyzed using descriptive quantitative techniques to obtain a media feasibility rating scale. As stated in Ref. [31], the reference criteria for the feasibility scale can be seen in Table 1.

2.3 Research Methods

This study belongs to the type of research and development (R&D). R&D is a method to produce a product in natural sciences, engineering, and social humanities, such as education [31]. In addition, this method can produce a product following the standards of

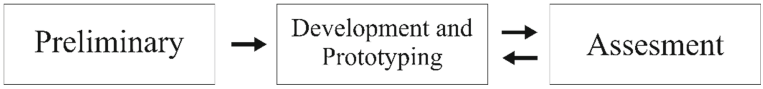

Fig. 1. Media Development Flow

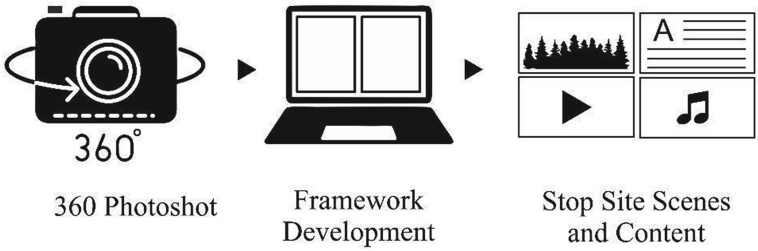

Fig. 2. Three Main Components M-VFTs

effectiveness and quality [32]. The method used adopted the Plomp development model [33]. Furthermore, the use of the model in R&D serves as a design in implementing the study through specific and accountable stages [34]. The Plomp model consists of 3 development stages that are (1) Preliminary investigation, (2) Development or prototyping phase, and (3) Assessment Phase [35]. However, the development stage is carried out repeatedly as a product evaluation according to the assessment results. For example, the media development flow can be shown in Fig. 1.

Preliminary investigation begins with observing schools and taking needs analysis data in curriculum, materials, and students. In addition, the implementation of this stage has the achievement of knowing the potential of adequate technology-based Supporting Facilities and Infrastructure, student interest in using technology in this research location, and problems in the form of obstacles to implementing learning in the era of the covid-19 pandemic. In addition, teachers and students must also ensure that they have good technological competencies to use the media well. Furthermore, the results from this stage are used as the basis for the prototyping and developing M-VFTs.

This M-VFTs media aims to help students interact directly in virtual real-world learning. The development of this media is a visual representation of flora and fauna conservation learning. Furthermore, integrating various media such as photos, satellite imagery, 360 views, maps, and articles with exploratory learning activities is an essential component of the M-VFTs media system. The M-VFTs media system was formed based on the student's learning styles identified through the interview process with the teacher.

In its development process, M-VFTs refer to three main components shown in Fig. 2. (1) The 360 photoshoots; (2) Framework development (image rendering and layout M-VFTs); (3) Preparation of stop site scenes and content in M-VFTs (spots area, object information based on Geographical characteristics, and scientific infographics for student information literacy).

The 360 photoshoots were taken directly in the Baluran National Park area by taking scenes based on places representing geographical characteristics. Furthermore, the software used is Google Street View by utilizes the panoramic 360 feature. This feature

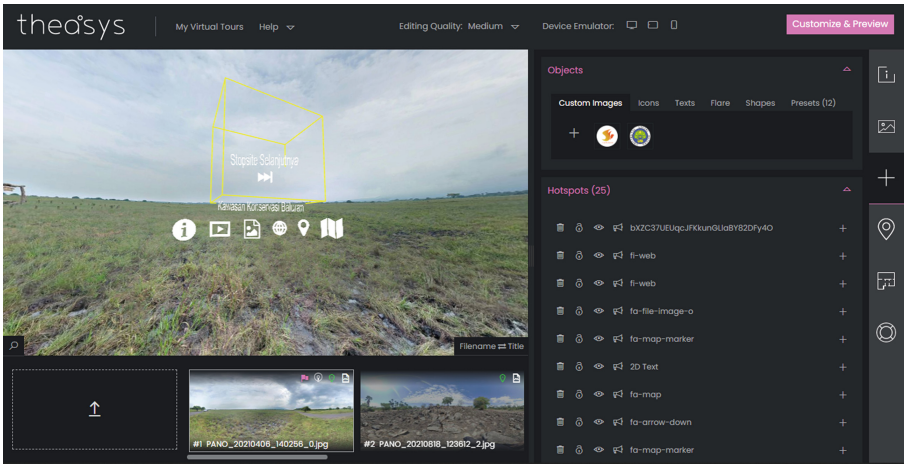

Fig. 3. Theasys.io site

lets researchers take 360 photos in the field, which can be stored directly via smartphone memory cards or Google Drive.

2.4 Framework Development

Design development framework for 360 Autostereoscopics Display M-VFTs through web-based applications. The development is based on the ease to use, performance, and accessibility of devices used by users. In addition, web application-based development makes it easy for users to interact freely through their hardware with an internet connection.

Development of 360 Autostereoscopics Display M-VFTs based on web applications assisted by virtual tours site developers on theasys.io site, shown in Fig. 3. This site facilitates developers to render 360 images quickly and create content by creating and compiling virtual tours. Besides that, this site is a virtual 360 compiler service provider suitable for beginners [36].

In the initial stage, the developer collects 360 photos at each stop site and arranges them according to the order in the study object. Furthermore, integrating content with student learning styles can be done by providing navigation and markings at each object point. Navigation and alerts are shown as buttons to open explanatory content of multimedia.

3 Findings and Discussion

3.1 Result

This research has produced M-VFTs with a web-based application that examines the objects of the Baluran National Park Conservation Area based on geographical characteristics. This development process goes through three phases based on the plomp model [35]. Furthermore, the following is a description of each phase of development activities.

Table 2. The Problems of MAN 2 Tulungagung in Geography Learning

No.	Problems
1	Class XI students still have difficulty studying flora and fauna conservation material because they still think the material is rote and abstract, so they need a Field Trip to facilitate their understanding of the material
2	Teachers have used media in the Geography learning process, but students think it is still monotonous, so they are less enthusiastic about participating in learning
3	Students need media that can help them visualize conservation material in real-life during online learning
4	Students have difficulty reading the information on the map, so it is necessary to add a description to the media

3.1.1 Preliminary Investigation Phase

There are several preliminary stages to determine the school's condition, the student's condition, and the conditions of learning Geography in the classroom.

First, to identify problems by conducting interviews with teachers and students of class XI MAN 2 Tulungagung about their difficulties in implementing Geography learning, especially on Flora and Fauna Conservation material. In identifying the problem, the researcher has some information as shown in Table 2.

Second, the implementation of a literature study to improve the media products of M-VFTs. In previous studies, developing M-VFTs or VR as learning media with conservation area objects only increased students' environmental awareness. Thus, this study focuses on developing pedagogical innovations in the media [37], especially organising material with geographical characteristics.

Third, the implementation of the needs analysis of teachers and students. The needs analysis includes teacher and student experiences using mobile-web-based learning media, student learning styles, and the availability of technology-based infrastructure in schools. Based on the observations, students prefer visual learning styles in this flora and fauna conservation material, so teachers also often present material using visual media such as videos, pictures, and maps. Furthermore, they have self-efficacy towards the use of technology, good computer laboratory facilities, and good wi-fi connection. However, in the use of M-VFTs, they have never been used in learning activities.

Next, this development requires an analysis of basic competencies and learning materials for flora and fauna conservation in the M-VFTs. The curriculum analysis process is set out in Fig. 4.

3.1.2 Development or Prototyping Phase

The result of the development study is in the form of an improved product design. First, researchers develop the prototype according to the initial design and provide a gradual evaluation to produce a good product [38]. In general, prototype development is divided into 2, that is system and content. In developing the system, the researcher refers to the virtual tour web-based application theasys.io. Theasys.io is a service provider for creating

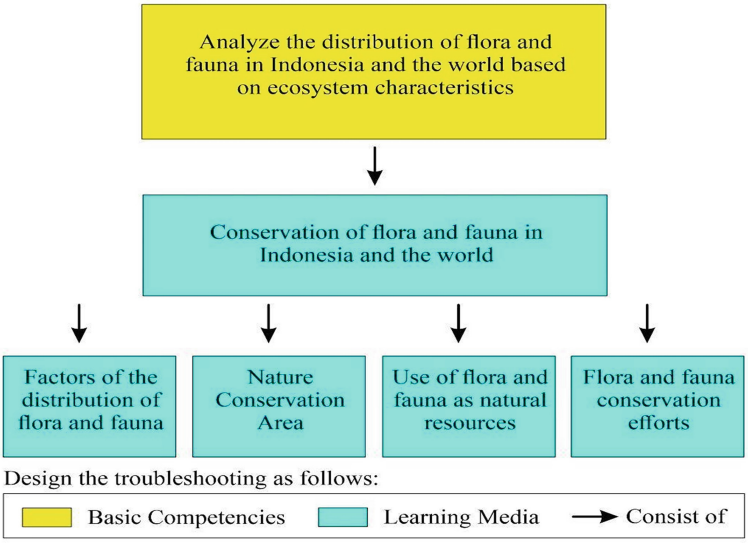

Fig. 4. Curriculum Analysis

Fig. 5. Framework Development of M-VFTs

360-based virtual tours that can be accessed through the website on a mobile basis. Elements in system development include the 360 photoshoots; Framework development in the form of content management in the form of visual (photos, satellite imagery, 360 photos, and maps), auditory (back sound), and kinesthetic (user control on smartphones and PCs) in Fig. 5; Then, the preparation of the media prototype, which can be shown in Fig. 2. Was developed based on the geographical characteristics shown in Table 3.

Table 3. Geographical Characteristics Scope

Characteristics	Sub-Characteristics
Physical	Geology and Geomorphology
	Climate and Weather
	Soil
	Water
	Vegetation and Flora
	Fauna
Non-Physical	Social
	Economy
	Culture

Development of content on 360 M-VFTs results from the derivation of Geographical Characteristics on research objects in Baluran National Park, shown in Table 4. The researcher divides the object of study according to the material, which includes Savanna Bekol (Introduction to the Baluran Conservation Area), Baluran Geological Zone (Physical characteristics of the Baluran Conservation Area), Residents around Lempuyang Beach (social characteristics of the Baluran Conservation Area), North Baluran Savanna (Distribution of Flora and Fauna). Baluran and Lempuyang Beach Mangrove Conservation (Conservation Efforts in Baluran).

3.1.3 Assessment Phase

In this study, the implementation of the assessment is in the form of a formative assessment and the results of a trial for MAN. Therefore, this assessment only aims to obtain the level of media feasibility. However, this assessment is very important to determine media feasibility when applied during learning activities.

The implementation of formative assessment involves material experts and media experts. The material expert gave an average score of 82 with excellent criteria, as shown in Table 5. Therefore, the material presented in it can be understood very easily. In addition, the selection of material is based on the appropriate curriculum currently in force in Indonesia. Furthermore, the media experts gave an average score of 86 with excellent criteria, as shown in Table 5. Besides that, 360 M-VFTs have outstanding Image clarity to display precise information.

Table 4. Media Stop Site 360 Arrangement

Stop site	Location	Coordinate	Altitude Range (masl)	Learning Content
Bekol Savanna	Sumberwaru, Banyuputih, Situbondo	7°50′32″ S–114°26′33″ E	34	Introduction to Baluran Conservation Area
Baluran Geological Zone	Sumberwaru, Banyuputih, Situbondo	7°45′35″ S–114°20′35″ E	4	Physical characteristics of Baluran Conservation Area
Residents around Lempuyang Beach	Sumberwaru, Banyuputih, Situbondo	7°47′35″ S–114°25′57″ E	1	Social characteristics of Baluran Conservation Area
North Baluran Savanna	Sumberwaru, Banyuputih, Situbondo	7°45′28″ S–114°21′23″ E	13	Distribution of Baluran Flora Fauna
Lempuyang Beach Mangrove Conservation	Sumberwaru, Banyuputih, Situbondo	7°47′24″ S–114°26′14″ E	1	Conservation Efforts in Baluran

Table 5. Validation results from material and media experts

The Expert	Aspects	Score (%)	Criteria
Material	Material suitability	85	Excellent
	Presentation of material based on the Geographical Characteristics	75	Good
	Ease in understanding the content	87	Excellent
	Average	**82**	**Excellent**
Media	Media compatibility	90	Excellent
	Design	80	Excellent
	Image clarity	87	Excellent
	Easy to use	83	Excellent
	Flexibility	90	Excellent
	Average	**86**	**Excellent**

After going through the validation process from material and media experts, 360 M-VFTs were tested to get responses from teachers and students. Based on the teacher's response, 360 M-VFTs have an average score of 85 with excellent criteria, as shown in Table 6. The teacher thinks that this media is a learning innovation that can help

Table 6. Teacher and Students response results

Subject	Aspects	Score (%)	Criteria
Teacher	Media is easy to operate	75	Good
	Easy to learn media	82	Excellent
	Media according to a student-centered approach	90	Excellent
	Media helps the delivery of material to be more interesting	94	Excellent
	Average	**85**	**Excellent**
Students	Media can be accessed flexibly	86	Excellent
	Media according to the student learning style	82	Excellent
	Media helps to learn	87	Excellent
	Media increases learning motivation	92	Excellent
	Average	**87**	**Excellent**

students understand the material with more fun concepts. While the student response questionnaire was given during a large group trial consisting of 34 students at MAN 2 Tulungagung, producing an average score of 87 with excellent criteria, as seen in Table 7. Students assumed that this media increased their motivation to study material for flora and fauna conservation areas, especially in Baluran.

Based on the validation results of material experts, media experts, teachers, and students' responses, these M-VFTs need revision. Revisions that need to be improved include: The description of each stop site needs to be clarified, and the buttons and navigation need to be changed to be more attractive.

3.2 Discussion

M-VFTs with web-based applications attract students' interest in learning Geography. Based on the test results, teachers and students responded positively to 360 M-VFTs. This media follows the student's learning style, namely visual. In addition, teachers and students assume that this media can direct students to learn independently (student-centred approach). In line with in Refs. [39–41] student-centred approach can improve students' collaborative skills in understanding the material and problem solving. Selain itu, kemandirian belajar dalam penggunaan M-VFTs juga mampu meningkatkan motivasi belajar [42, 43].

In contrast to previous developments, these M-VFTs describe a region object by geographical characterstics. The development of M-VFTs media with geographical characteristics has positively contributed to the study of Geography, especially on flora and fauna conservation material. For example, discussion of the Baluran conservation area based on geographical characteristics leads students to think spatially complexly [44–46]. M-VFTs present material through virtual scenes spatially with descriptions of objects at each stopsite. This can improve students' critical thinking skills [42, 47], so students can analyze the physical and social phenomena [48, 49].

Image quality on M-VFTs affects display clarity of science. In addition, good visual quality also supports students' understanding of the material in this media [50]. In addition, the high image quality also enhances the immersion of the M-VFTs [51]. Students' interest in the phenomena that appear in the Baluran conservation area provokes students to ask questions about the material and follow up by looking for additional material independently through the internet. These results align with as stated in Refs. [52, 53] that M-VFTs can increase students' curiosity to explore a material.

M-VFTs still have shortcomings in their development. Stop sites on these M-VFTs already represent the geographical characteristics of the Baluran Conservation Area but are still not comprehensive. So, future research needs to add stop sites in several corners of the area. In addition, further development can add several stop sites related to tourism and the savanna as a characteristic of the area. In addition, this media is more optimal if its implementation uses a learning model. However, the learning model can be student-centred, so the teacher can only act as a guide.

4 Conclusion

Based on the assessment of material and media experts, M-VFTs have excellent feasibility so that they can be tested in schools. Furthermore, based on the teacher's and students' assessment of MAN 2 Tulungagung, M-VFTs have excellent criteria. So, based on the validation results, M-VFTs are suitable for learning Geography in schools, especially on the material for the Conservation of Flora and Fauna. This media can increase students' learning motivation and curiosity about flora and fauna conservation material. However, this media still requires content design and instruction optimization in the future. M-VFTs require integration with appropriate learning models. The suggested learning model is student-centred, so the teacher only functions as a guide. In addition, in optimizing the content design, it is possible to add stop sites from increasing student options in virtual visits to recognize the geographical characteristic of Baluran better.

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