

Development of Spatial.io-Based GeoRivers Learning Media in Sub-Material of Dynamics of Land Waters on River Surface

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Abstract

Learning media has an important role in the teaching and learning process in schools. Currently, teachers are expected to have skills in media literacy and the use of learning technology. Teachers need to adapt and utilize technology to create an effective learning process. This research aims to develop GeoRivers learning media based on the Spatial.io platform in the sub-material of Dynamics of Land Waters on the River Surface for grade X students. The research subjects for the media development trial were students of class XI IPS 2 MA Bilingual Batu which amounted to 26 students. The results of the needs analysis that have been carried out through observation, interviews, and questionnaires show that there is a need for innovation in learning media such as interactive digital media. The validation test involved media and material experts. The results of the media validation test showed that this media was very valid with scores of 87.59% and 89.11% in the material validation test. The results of the response by the students obtained a score of 90.38% (very good). The results of this study show that Spatial.io-based GeoRivers learning media is very feasible to be used in Geography learning. However, this study is still limited to the attractiveness and feasibility aspects, so further studies are needed to test its effectiveness thoroughly.

Keywords: Learning Media, Spatial.io, GeoRivers



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Introduction

Currently, the development of the educational curriculum continues to evolve according to the changes and demands of the times. This curriculum change is a transformational step that will have a significant impact on the development of the education curriculum in Indonesia in the future. The independent curriculum allows digital literacy to be implemented comprehensively in the learning process (Habibah, 2022). Through this curriculum, students have the opportunity to hone 21st-century technology skills, such as the ability to manage information and utilize trusted sources in daily life (Sari & Gumiandari, 2022). In today's digital era, learning media continues to develop with a strong tendency to utilize technology in every innovation. This condition poses challenges in optimally integrating technology into education, improving students' digital skills, and teaching digital literacy needed in this modern era (Yusuf & Sodik, 2023). Every innovation in the development of learning media must be easy for educators to understand, so that in the learning process, educators can guide students optimally towards achieving the learning goals that have been set (Patmanthara, 2023). Educators are also expected to be able to create an active, creative, innovative, and effective learning environment so that students can more easily understand the material, be creative, and actively involved in the classroom, so that the learning process has a more meaningful impact (Wirahayu dkk., 2024).

The metaverse is a technological innovation in the form of a three-dimensional virtual space that is currently being developed around the world. In today's digital era, if the metaverse is associated with learning media, many things will benefit from the learning and education process in Indonesia

(Hapidz dkk., 2022). The term metaverse first appeared in the novel *Snow Crash* by Neal Stephenson in 1992, who introduced it as a vast virtual world that can be accessed digitally (Li & Xiong, 2022). Today, the metaverse is also known as MUVE (Multi User Virtual Environments), which is a digital environment that allows multi-user interaction through avatars in 3D space. By utilizing AR, VR, and internet connectivity, this technology provides a realistic experience like being directly in a virtual world (Díaz dkk., 2020). In addition to entertainment or video games, the metaverse also has wider potential for use (Lee & Seowon, 2021). Spatial.io is a platform that utilizes virtual reality (VR) and augmented reality (AR) technology to create a three-dimensional collaborative and interactive space. This allows students to feel a physical presence in a realistic virtual learning space. Using this platform Spatial.io can create a more immersive spatial experience.

Geography has a broad field of study with the complexity of concepts in it (Putra dkk., 2021). Learning geography requires real evidence of the process of the occurrence of various natural phenomena. However, not all of these evidence can be seen directly in the surrounding environment due to sensory limitations, space, and time. In addition, geography is not limited to the study of physical or natural aspects only, but also includes social, economic, cultural, and population dimensions (Risnani & Astina, 2017). Therefore, more effort is needed so that students are able to understand the material thoroughly (Taufan dkk., 2023). Class X geography material on hydrosphere dynamics discusses everyday phenomena that are difficult to explain and observe directly by students due to space and time limitations. To meet the demands of actual and contextual learning, effective pedagogical practices and broad access to technology are needed (Gómez-Trigueros, 2020). As such, the material requires several types of media, such as images, animations, videos, and text. With this in mind, the study of geography needs to combine concrete forms that can be visualized into the media (Renggani et al., 2023).

The needs analysis carried out showed that students have a high interest in hydrosphere materials and prefer interesting and interactive digital formats. Where they can be actively involved in the learning process. However, currently, the learning methods that are still often used are PowerPoint presentations and printed teaching materials. Although this method is easily accessible, many learners feel that the approach is less interactive and incapable of providing an immersive visual experience. Therefore, the development of innovative learning media is needed to adjust to the needs and expectations of students, and to create a more enjoyable and optimal learning process. Research by (Nur'aini, 2024) showed that the Spatial.io-based Islamic cultural history learning media is suitable for use in grade VIII MTs Negeri 9 Sleman, with a very enthusiastic response from students. Furthermore, the research conducted by (Rasyida & Nurdin, 2023) shows that the application of metaverse-based learning and virtual reality through the Spatial.io platform and the Discovery Learning Model approach can increase students' interest and understanding in Informatics subjects. This increase can be seen from the higher average learning outcomes in the experimental group compared to the control group.

The use of 3D learning media is considered superior to 2D media because of its ability to present information in a more concrete, interactive, and in-depth manner (Ismunandar, 2020). Based on Edgar Dale's Cone of Experience theory, learning experiences that involve real simulations or three-dimensional representations help learners remember information more easily compared to flat visual media such as images or text (Khasanah & Fahmi, 2024). 3D media allows learners to see objects from various angles, understand spatial structures, and interact directly with the material, thereby improving conceptual understanding and learning motivation (Carolina, 2023). GeoRivers media is the development of geography learning media on the dynamics of inland waters on the river surface based on the Spatial.io platform. The use of Spatial.io technology can create an interactive 3D virtual space (Rasyida & Nurdin, 2023). The potential of Metaverse technology in the world of education provides a more immersive learning experience, allowing learners to interact in virtual environments, both realistic and imaginative created specifically for educational purposes, such as laboratory simulations and virtual historical tours. Thus, this potential can increase student engagement and understanding. In addition, the metaverse also facilitates collaborative learning by providing a platform for learners to collaborate in virtual spaces, honing their social and cooperative skills. The metaverse also supports

accessibility and inclusivity, allowing learners with physical or geographical limitations to be able to fully participate in learning through virtual avatars.

This research aims to develop and produce Spatial.io-based GeoRivers learning media in the sub-material of flat water dynamics on the river surface that is feasible to be applied. The resulting learning media is expected to meet the eligibility criteria to be applied in the educational environment, so as to increase students' understanding of concepts related to river water dynamics. In the research on the development of Spatial.io-based GeoRivers learning media, it was carried out at MA Bilingual Batu for grade XI students.

Method

The type of research used in this study is Research and Development (*Research and Development*). The purpose of this research is to produce a product through the stage of problem identification, designing and developing a product as an optimal solution. In this study, the ADDIE model is used which consists of 5 stages, namely *Analysis, Design, Development, Implementation, and Evaluation* (Branch, 2009). This model has the advantage of having systematic and effective work procedures. Therefore, the final product through a series of trial processes can determine that the developed product is suitable for use. The research subjects for the Spatial.io platform-based media development trial were 26 students in class XI IPS 2 MA Bilingual Batu.

Data collection in this study was carried out systematically through several steps. Student data was collected using Google Form for needs analysis, while geography teachers' needs were obtained through direct interviews. The information collected includes teaching methods, student learning styles, obstacles in teaching, and existing learning media. The researcher then conducted a validation test of the developed learning media, involving expert validators from the State University of Malang (UM) using a questionnaire sheet to assess the validity of the media and materials. After product revision based on the validation results, GeoRivers media was tested at MA Bilingual Batu with guidance and mentoring. Data from the trial was collected through a questionnaire to assess material comprehension, interactivity, and media appeal.

This study uses quantitative descriptive data analysis used to measure the feasibility of GeoRivers learning media. The data used consisted of qualitative data (criticism and suggestions from expert validators, geography teachers, and students) and quantitative data (questionnaires from expert validators, geography teachers, and students). The questionnaire was designed with a checklist method and a five-choice Likert scale, accompanied by responses to suggestions or recommendations for product development. The Likert scale can be seen in the following table:

Table 1.
Validation Assessment Criteria

Criterion	Score
Excellent	5
Good	4
Pretty Good	3
Not Good	2
Excellent	1

Source: (Oktaviara, 2019)

The quantitative data that has been collected is then processed and presented in the form of percentages using the following formula:

$$NP = \frac{\text{Nilai yang diperoleh}}{\text{Skor maksimal}} \times 100\%$$

Source: (Optiana, 2019)

The results of the calculation of quantitative data are then expressed in the following criteria:

Table 1.
Criteria for categorization of calculation results.

Average score (%)	Category	Results
85 – 100	Excellent	Considered so valid that it can be used without repair
70 – 85	Good	Considered valid so that it can be used with small-scale repairs
50 – 70	Not Good	Deemed invalid so it is recommended not to be used due to major repair both
0 – 50	Very Less	Considered invalid so it is not allowed to be used

Source: (Akbar, 2013)

The procedure of this study follows the ADDIE model which consists of several stages. The first stage is the analysis, which aims to identify the problems that exist in the school. During this phase, an analysis of the needs of teachers, students, curriculum, and learning media is carried out. This analysis includes the purpose of using the learning tools, the knowledge and skills needed to achieve the learning objectives, and the means and infrastructure needed. The analysis process is carried out through observation to identify needs in learning activities.

In the second stage, namely design, the product is designed as needed based on the results of the analysis. The design of learning media is systematically prepared starting with an analysis of learning materials that include learning outcomes, objectives, and desired knowledge and skills. The material to be included is the dynamics of inland waters on the river surface, and the design of the material is done using the Canva website which is then incorporated into the Spatial.io Platform. The third stage in this process is product development to produce a prototype. At this stage, validation is carried out by experts to evaluate the learning media in terms of attractiveness and feasibility. The learning media developed is first consulted with the supervisor, then validated by experts in the field of media and geography materials. The input from the validation results is used as a basis for further development. The implementation stage is carried out after revision of the validation results by media and material experts. Products that have been improved based on previous feedback will be tested on grade XI IPS 2 students and geography teachers to determine the response to the developed media.

Results and Discussions

1. Results

This research is a development study. The purpose of this study is to develop and produce Spatial.io-based GeoRivers learning media in the sub-material of flat water dynamics on the river surface that is feasible to be applied. The research model applied is the ADDIE model with development stages that are adjusted to the needs of researchers. The development research process includes:

a. Analysis Results

In this development, the initial stage carried out by the researcher is to conduct an analysis. At the needs analysis stage, this activity became the main foundation in media development. Based on the results of interviews and observations, it was found that geography learning at MA Bilingual

Batu is still conventional, with the main media in the form of PPT and textbooks. The teacher said that the use of media was quite helpful in delivering the material, but it was not able to attract students' interest. The needs analysis also shows that teachers need innovative, technology-based, and easy-to-use media in the classroom learning process.

Meanwhile, the results of the analysis of the students showed that their enthusiasm increased significantly when the learning process involved digital technology, such as the use of interactive videos, simulations, or VR-based applications. Students stated that it is easier to understand the concept of inland water dynamics if it is accompanied by real visualization, because they can see firsthand geographical phenomena that are difficult to observe in the surrounding environment. From the results of the curriculum analysis, it is known that the school uses the Independent Curriculum, which emphasizes project-based learning and hands-on experience. This is in line with the development of GeoRivers which is oriented towards active and contextual learning, where students are invited to explore natural phenomena through virtual experiences.

The results of the identification of the needs of teachers and students became the basis for the development of GeoRivers media which not only functions as a visual aid, but also as an exploratory and collaborative media. Through GeoRivers, students can learn independently or in groups in virtual spaces, discuss river flow dynamics, and understand the relationship between human activities and changes in the inland water environment.

b. Design results

At the design stage, the activity is focused on making an initial design of the media to be developed (Putri, 2016). This stage is a continuation of the needs analysis process that has been carried out previously. The design begins with the design of geography learning materials that are adjusted to the results of the analysis of the needs of teachers and students. The material developed refers to the Learning Outcomes (CP) Phase E and the Learning Objectives Flow (ATP) 10.6.3. Before compiling the material, the researcher first conducts a review of the content of CP and ATP so that the content included in the media is in accordance with the competencies that must be achieved.

After the preparation of the material, the researcher then creates a flow chart to describe the overall structure of GeoRivers media. This design includes the order of displays, user interactions, and placement of learning elements. In line with research conducted by Hamzah & Baalwi, (2022), this design stage includes the formulation of learning objectives and material delivery strategies so that the products produced are effective and in accordance with the needs of students.

Visually, the GeoRivers homepage features a cover themed "GeoRivers Classroom". In this virtual classroom, there are six learning rooms arranged based on learning objectives. Each space contains trigger questions related to the material being studied. The content presented is not only in the form of text or posters, but also videos, interactive maps, and 3D models that allow students to conduct visual exploration of the concept of inland water dynamics.

In addition, learners can interact in the form of avatars in Spatial.io virtual world, so they can communicate and collaborate just like in a real classroom. In the last room, an interactive quiz is provided as feedback that serves to measure students' understanding and provide reflection on the effectiveness of the learning media used.

c. Expert Validation

At this stage, a validation process by experts is needed which aims to obtain information about the feasibility of the media and the accuracy of the concepts presented, as well as to obtain suggestions and comments as a reference in product revisions (Anam et al., 2023). This research includes two types of validation tests, namely material validation tests and media validation tests, with the following results:

1) Material Validation Test Results

Table 3.
Results of the material validation test

Aspects	Average Score (%)	Category
Linguistik	93,33	Highly Valid
Content	84	Valid
Benefits	90	Highly Valid
Average	89,11	Highly Valid

Based on the table above, the results of the material validation test obtained an average score of 89.11%, which is included in the very valid category. The suggestions and comments from expert validators are presented in the following table:

Table 4.
Validator Advice Revision

Validator	Prior to Revision	After Revision
Material Validator	The content of the material needs to be adjusted to competence or CPL	Adjusted to competencies
	Each room in the learning media is given questions according to the material in the room	Questions have been added in each room

2) Media Validation Test Results

Table 5.
Media Validation Test Results

Aspects	Average Score (%)	Category
Linguistik	80	Valid
Attraction	88	Highly Valid
Benefits	86,66	Highly Valid
Comfort	90	Highly Valid
Relevance	93,33	Highly Valid
Average	87,59	Highly Valid

The results of the media validation test obtained an average score of 87.59% and were categorized as very valid. The suggestions and comments from expert validators are presented in the following table:

Table 6.
Validator Advice Revision

Validator	Prior to Revision	After Revision
Validator Media	Ahli Media covers need to include the developer's name	Developer identity added
	Clearer instructions for use are needed	Clear instructions for use have been added

The process of improving and improving the media is carried out based on the results of the validation, so that the resulting products can meet quality standards and feasibility for use in learning.

Figure 1 shows the initial media image of the final product developed by the researcher to be tested, based on the stage of development.

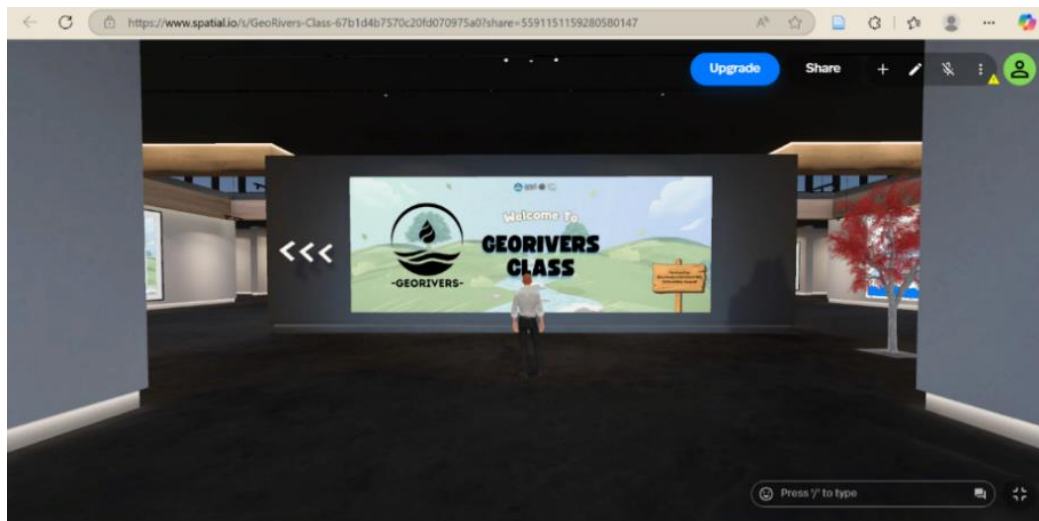


Figure 1. GeoRivers Media Display

d. Implementation Results

At this stage, a trial was carried out for students of class XI IPS 2 at MA Bilingual Batu. The selection of this class is based on the criteria that students have received material about the hydrosphere before. In the implementation of the trial, the Problem Based Learning (PBL) learning model was used which emphasized real problem solving to build students' knowledge and skills. This model was chosen because it is compatible with the characteristics of GeoRivers' interactive and exploration-oriented media. The results of the trial are presented in the following table:

Table 7.
Results of the Student Trial.

Yes	Question	Score					NP%	Category
		1	2	3	4	5		
1	The attractiveness of GoeRivers learning media				7	19	94,61	Excellent
2	Ease of understanding the material on GeoRivers media				17	9	86,92	Excellent
3	Quality and interest of the images presented on GeoRivers media				8	16	93,84	Excellent

4	Color selection and design on GeoRivers media	6	16	84,61	Excellent
5	Font type and size selection on GeoRivers media	14	12	89,23	Excellent
6	Completeness of presentation of material on the dynamics of inland waters on the river surface	14	12	89,23	Excellent
7	Language selection used in GeoRivers media	10	16	92,30	Excellent
8	Can GeoRivers media that contains material on the dynamics of inland waters on the river surface make it easier for you to learn the material?	10	12	86,15	Excellent
9	Has the GeoRivers media created interactive learning between students?	8	16	93,84	Excellent
10	Do you find it useful to learn material on the dynamics of inland waters at the river surface using GeoRivers media?	9	19	93,07	Excellent
sum				90,38	Excellent

Based on the results of observations and questionnaires, the average response of students was 90.38%, which is included in the very good category. Students showed high enthusiasm during learning activities, as seen from their activeness in asking questions, answering, discussing, and paying attention to the material presented. Learning also becomes more interactive and interesting, and is able to keep students focused and not easily bored during the learning process.

e. Evaluation Stage Results

The fifth stage in this study is the evaluation stage, which is carried out after the final refinement process of the GeoRivers learning media product based on Spatial.io. The media that has been developed can be accessed online through various devices, such as computers, tablets, and Android and iOS-based mobile phones, making it easier for teachers and students to use them. The purpose of this evaluation stage is to determine the suitability of learning media with development goals (Priangga, 2021). The evaluation carried out is formative, namely the evaluation is carried out at the end of each stage of development of the ADDIE model. The purpose of formative evaluation is so that improvements can be made directly and continuously during the development process (Sugihartini & Yudiana, 2018). The formative evaluation in this study includes input and suggestions from supervisors and media and material expert validators, which are used to correct product shortcomings before the media is widely implemented. Based on the results of the evaluation, GeoRivers products are declared feasible and practical to be used in technology-based geography learning activities.

2. Discussion

The development of Spatial.io-based GeoRivers learning media is an innovation in geography learning that is oriented towards 21st century skill development. This media leverages an interactive three-dimensional (3D) virtual environment to create an immersive and contextual learning experience. The results of the study show that the development of this media is in line with the needs of modern learning that demand integration between digital technology and active learning approaches. Based on the results of the needs analysis, teachers and students showed a high interest in technology-based media because the conventional media used previously was still

less interactive and unable to motivate students to learn independently. This finding strengthens the opinion of Priangga (2021) that the use of digital media in learning plays an important role in increasing the effectiveness of material delivery and student involvement. In addition, the conformity with the Independent Curriculum emphasizes that this media is designed to support learning outcomes that are oriented towards concept understanding, critical thinking skills, and collaboration.

At the design stage, the media structure developed is in the form of a virtual learning room consisting of six main rooms. Each space has different learning functions, from concept introduction to problem-solving and evaluation. This design approach shows that the integration of metaverse technology through Spatial.io can be effectively utilized to support problem-based learning. This is in line with the opinion of Utomo & Handoyo (2024) who affirm that innovative and experience-based learning models are able to optimize the learning process of students. The results of the validation test by experts show that GeoRivers media meets the criteria for feasibility of content, display, and usefulness with a very valid category. This means that the content presented is in accordance with learning needs and can be used effectively in teaching and learning activities. The suggestions given by the validators focused on improving the visual appearance, making navigation more informative, and adjusting the instruction sentences to be more communicative. These results reinforce the findings of Sugihartini & Yudianta (2018) that the repeated validation process can improve the quality of the learning media developed.

At the implementation stage, the results of the trial by the Geography teacher showed that the GeoRivers media obtained a very good assessment with a score of 98%. Teachers consider that this media is able to foster curiosity, increase learning engagement, and support the mastery of 21st century skills such as critical and collaborative thinking. Meanwhile, the results of the students' responses showed an average of 90.38% with the very good category. Students become more active in asking questions, discussing, and showing high enthusiasm during the learning process. These findings show that Spatial.io-based media is able to increase students' motivation and interest in learning through engaging visual presentations and interactive learning experiences.

Learning with the Problem Based Learning model integrated into GeoRivers media has also proven to be effective. Students are invited to explore the learning space, observe a 3D map of the Brantas River area, and solve the environmental problems presented. This activity helps students understand the concept of inland water dynamics in a more contextual way. These findings are consistent with the research of Rasyida & Nurdin (2023) and Nur'aini (2024), who stated that the use of Spatial.io as a learning medium improves conceptual understanding and learning outcomes because it facilitates active interaction and exploration.

Furthermore, the evaluation stage is carried out to ensure the suitability of the media with the learning objectives. Formative evaluations conducted at each stage of development serve as continuous feedback so that improvements can be made immediately. The results of the evaluation show that GeoRivers is not only substantially valid but also practically used by teachers and students. This is in line with the results of research by Putra, Islam, et al. (2021) which affirm that formative evaluation at each stage of development is able to produce learning products that are feasible and relevant to the development of educational technology.

Overall, this discussion shows that the development of Spatial.io-based GeoRivers learning media has succeeded in meeting the principles of developing effective, innovative, and contextual educational media. This media is able to increase students' learning motivation, interactivity, and understanding of concepts, and is relevant to the direction of technology-based education policies and the Independent Curriculum. Thus, GeoRivers has the potential to become an alternative learning medium that supports the transformation of geography learning towards digitalization and experiential learning.

Conclusion

The Spatial.io-based GeoRivers learning media in the sub-material of inland water dynamics on the river surface has been completed. Based on the results and discussions that have been submitted previously, it can be concluded that the use of Spatial.io-based GeoRivers learning media in Geography learning has very valid results. This is known from the results of the validation of media experts, which is 87.59% and the results of material validation, which is 89.11% with a very valid category. Then the response results by students were 90.38% with the category of very good. The product developed has a positive response, so that it can be applied in Geography learning, especially in the material of Dynamics of Land Waters on the River Surface in class X MA Bilingual Batu.

This research has only reached the stage of developing Spatial.io-based GeoRivers learning media in terms of attractiveness and feasibility. However, it does not include the evaluation of its effectiveness in learning activities. Therefore, further research is needed that focuses on testing the effectiveness of the use of GeoRivers learning media. In the implementation of this study, there are still obstacles in terms of internet access for several students, so the next researcher is expected to better prepare all needs for media that require internet access. In addition, this GeoRivers learning media also has the opportunity to be further developed with other subject matter. This GeoRivers media product is also disseminated to Geography teachers at MA Ya-Ikhsan Andonosari, Tukur District, Pasuruan Regency to be used as a supporting media for geography learning.

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