

Developing AtmoLearn: Mobile simulation learning media to enhance students understanding of atmospheric concepts

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Abstract

Background: The need for learning media continues to grow in accordance with students' learning needs, including in geography subjects. Geography material that still has difficulties in understanding is the phenomenon of the geosphere (Atmosphere). It is necessary to develop learning media that can solve problems in geography learning, namely media based on mobile learning simulation.

Purpose: The purpose of this study is to develop a geography learning media product for atmospheric material based on mobile learning simulation in the form of a website with the product name AtmoLearn.

Method: *The development method used is a modification of ADDIE, namely ADD. Researchers are aware of limitations in implementing it.*

Findings: *The results of this study are to produce learning media products that are ready to be implemented. Thus, AtmoLearn products can be applied to students to determine their effectiveness, usefulness, and can increase student motivation and learning outcomes.*

Keyword: learning media; simulation; mobile learning; geography

INTRODUCTION

Geography is a subject that has complex material characteristics. The complexity of geography material is seen from the study of very broad geographical material objects, geography becomes a field of science that is integrated with physical and social aspects packaged in the phenomenon of the geosphere (Aksa et al., 2019). The material of the geosphere phenomenon that still has difficulties in facilitating student understanding is the atmosphere. Teaching atmospheric material in class still uses textbooks, images, videos and materials in power points. Students' difficulties in understanding the material of the atmospheric layers in learning, because some teachers still use conventional media (Aristin et al., 2023). The impact is that there are still many students who do not understand the concept of learning material delivered by teachers using conventional media. (Darung et al., 2020). The need for atmospheric dynamics material which is concrete material must be presented in visual media. The increasingly complex scope of geography material is a major factor in the need for learning media that aims to achieve geography learning objectives (Sainul Fadlan et al., 2023). The need to develop mobile learning to improve existing learning media in helping students and teachers to carry out learning on atmospheric material.



Conventional learning methods are failing to adequately teach students about atmospheric layers, making the adoption of innovative digital learning media a necessity

Mobile learning has become a popular learning medium among students, especially those in the Generation Z (Gen Z) era. Generation Z students are characterized by a preoccupation with technology and gadgets, which are considered to make everything easier. This situation makes mobile learning highly sought after by students and makes it easier for them to access materials and learn independently (Pamungkas & Dwijoyo, 2020). The use of mobile learning has a positive impact on student learning development, as it can assist students and teachers in assigning assignments and quizzes during classroom learning (Rahmat et al., 2019). The use of mobile learning in geography subjects It is useful for meeting students' learning needs and facilitating teachers. Geographic learning content, which includes diverse geospheric phenomena (lithosphere, atmosphere, and hydrosphere) and their complex studies, can be implemented in mobile -based learning. (Putra et al., 2021). The form of mobile learning that can be developed is simulation mobile learning.

Mobile learning simulation combines mobile devices with digital simulation experiences in the learning process to create engaging and effective learning. Mobile learning simulations are similar to virtual laboratories. Simulators or virtual laboratories allow students to conduct experiments using simulated computers, thereby improving student learning, achievement, and attitudes in subjects (Juera, 2024). Many mobile learning simulation developments in the field are focused on exact science subjects such as biology, chemistry, physics, and other sciences. One interactive simulation medium developed is Phet Interactive Simulations, which supports the limitations of science subjects in conducting experiments (Wattimena & Batlolona, 2024).

Positively by integrating interactive simulations in learning can influence students' conceptual understanding (Arifin et al., 2023). Phet simulation is considered effective in helping students to build their understanding of abstract science material through interactive simulations, in addition Phet simulatin can help teachers and students who experience difficulties in the learning process (Fitriyawany et al., 2023). Not only science subjects that require digital simulations to meet the needs of experiments in schools, but geography subjects also require learning media based on digital simulations to build students' understanding of abstract geography materials. Many virtual geography laboratories or simulators are being developed to provide a learning environment that represents real conditions in the field to students, the need for virtual laboratory-based media or simulations in geography subjects is very

necessary, because geography has abstract material and geosphere phenomena that need visualization (Prasetya et al., 2024).

Mobile learning media to support geography learning has become an urgent need in this research to develop a mobile learning simulation media product for atmospheric phenomena material called AtmoLearn. The development of mobile learning media with digital simulation activities on the material of the air layer can support conscious, meaningful, and enjoyable learning activities. The purpose of this research is to produce a mobile learning simulation media product on atmospheric material as a variation of technology in education.

METHODS

This type of research uses the Research and Development (R&D) research model with the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). In this study, the ADDIE model was not fully implemented, only up to the Development stage. The following is a picture of the research steps using the ADDIE model.

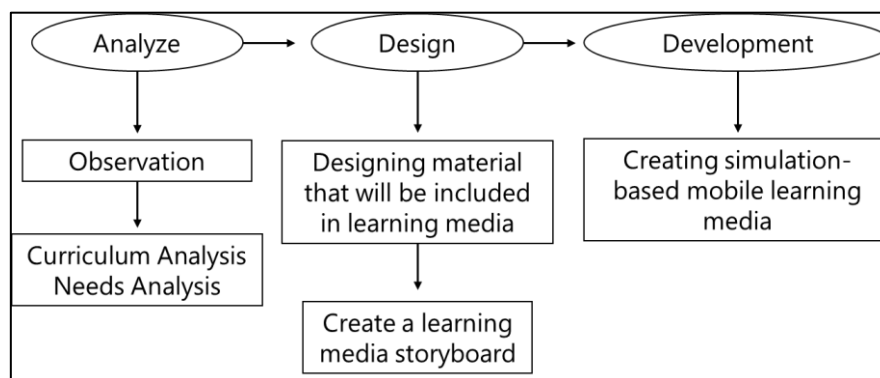


Figure 1. The Research Steps

The reason the researcher made modifications was due to limitations in carrying out the Implementation stage. The limitation in question is the time limitation in implementing the product development results. The product developed in this study is a mobile learning simulation media on Atmosphere concept for high school students with the product name AtmoLearn. The tool used in developing AtmoLearn is the Canva Application. The instrument used is a needs analysis. The instrument used was a needs analysis validated by lecturers. The needs analysis was conducted at SMA Islam Nusantara Malang City with 20 participants from grades 10 and 11. The needs analysis took the form of a 10-question questionnaire and interviews with students and teachers.

RESULT AND DISCUSSION

AtmoLearn learning media has been developed to meet the diverse needs of geography learning, particularly in the Atmosphere topic. The following is a presentation of the resulting product.

Analysis Stage in Developing AtmoLearn Media

At this stage, researchers conducted various forms of analysis, including curriculum analysis, material characteristics analysis, and student needs analysis as a basis for developing the Atmo Learn media. The curriculum analysis was conducted by reviewing documents related to the Independent Curriculum. In the Independent Curriculum, Geography is divided into two elements: process skills and conceptual understanding, packaged in the form of Learning Outcomes. Geography in high school is divided into two phases: Phase E (for grade 10) and Phase F (for grades 11 and 12). The following are the learning outcomes for the Geography subject.

Table 1. Geography Subject Learning Outcomes in Each Phase.

Element	Phase E	Phase F
Concept Understanding	At the end of the phase, students are able to identify, understand, think critically, and analyze spatially the Basic Concepts of Geography, Maps, Geographical Research and the Geosphere Environment, present ideas, and publish them in class or other media.	At the end of the phase, students are able to identify, understand, process and analyze, and evaluate spatially the Strategic Position, Biodiversity Patterns of Indonesia and the World, Disasters and the Environment, Regional and Development, and Cooperation between Regions, present ideas, and publish them.

Based on the presentation in Table 1, the CP contains materials to be achieved in each phase. Phase E in grade 10 includes material on geospheric phenomena that must be achieved through identification, understanding, critical thinking, and spatial analysis. One geospheric phenomenon that requires continued development of various learning media is atmospheric dynamics.

The results of a simple needs analysis were conducted to determine the urgency of developing geography learning media on atmospheric material for 10th grade high school. Based on the results of student needs, it was noted that 60% of students needed interactive and interesting learning media in understanding atmospheric material and the need for atmospheric layer visualization that could help them in learning. Overall, students use *smartphones* in learning to access lesson materials and 40% of students have used applications in the form of simulation-based games. Based

on the description of this analysis, it is the reason for researchers to develop *mobile learning simulation-based learning media* on atmospheric material.

Analysis need become base for create media that meets your needs with need Study students. The results of analysis very helpful needs in designing learning and appropriate learning media products with conditions in the field (Sainul Fadlan et al., 2023). Analysis main thing to do analysis curriculum and materials to be loaded in AtmoLearn media that is dynamics Atmosphere. Atmosphere material is presented in Phase E (Grade 10) in the even semester, with the main topic being the Geosphere phenomenon. The scope of atmospheric material achieved by students includes understanding the layers of air, weather and climate factors , and atmospheric phenomena. Atmosphere material is a learning material in schools that focuses on students to have critical thinking skills (Mukarromah et al., 2020).

In practice, students still find it difficult to understand the concept of the atmosphere, due to the complex material and requiring good communication, so it requires more interactive learning media (Budiman et al., 2023). This is in accordance with the results of a needs analysis conducted on 10th grade students at SMA Islam Nusantara, that 50% of students admitted that atmospheric material was difficult to understand by only reading from textbooks and 60% of students needed learning media that could help understand atmospheric material interactively and interestingly, and digitally based. The positive impact felt by students, when teachers use digital learning media in the form of increased enthusiasm and motivation to learn and provide a more interactive learning experience to students (Firmansyah, 2024).

AtmoLearn Media Design Stage.

At this stage, researchers designed the learning materials to be included in the AtmoLearn learning media. The materials used included components of air layers, air temperature, and air pressure. Afterward, researchers also created a design for the AtmoLearn learning media website. The table 2 is the material mapped for inclusion in the AtmoLearn learning media.

The AtmoLearn learning media is designed with three segments: material, simulation, and quizzes, packaged in an interactive *website* . In the material segment, students will be presented with a description of the layers of air along with the color gradations of each layer. Then, in the simulation segment, students will be given a calculator to calculate air temperature and pressure. In the quiz segment, students will work on questions to check their understanding and can see their achievements directly in the form of a percentage score.

Table 2. Material Design for AtmoLearn Learning Media

Material	Sub-Material
Geosphere - Atmospheric Phenomena	1. The layers of air: troposphere, stratosphere, mesosphere, ionosphere, and exosphere. Includes the characteristics and thickness or height of each layer. 2. Air temperature in the troposphere has a thermal gradient, a relationship between altitude and air temperature. The law of thermal gradient states that for every 100 m increase in altitude, the air temperature drops by 0.6 °C. 3. Air pressure is the force exerted by air per unit area. Air pressure decreases by 12% for every 100 m increase in altitude.

The visual design of AtmoLearn media utilizes the Canva app to make it more engaging and interactive, with the website designed to be adaptable to students' learning needs. Tabel 3 is a *storyboard* of the AtmoLearn media developed.

Mapping of materials and curriculum as well as students' needs in learning geography on atmospheric material is used as the basis for designing AtmoLearn media. Design activities can also be a follow-up step from the analysis results (Sainul Fadlan et al., 2023). The design material used as content in AtmoLearn media is atmospheric dynamics, specifically the air layers, air temperature, and air pressure. The selection of this material is adjusted to students' learning needs in understanding the air layers material, so that learning objectives and mastery of concepts can be achieved well. Students need to have the ability to master the concepts of material in geography learning to get optimal learning outcomes (Aristin et al., 2023).

Student interest in learning media is also seen from its visuals. AtmoLearn media is designed with attractive visuals for use in learning. Researchers used the Canva application to design the visuals for AtmoLearn media. Canva has become a widely used application for developing interactive learning media. The Canva application is a type of online-based graphic design application that can be accessed via gadgets or PCs and its advantage is that it can make it easier for teachers to convey material to students (Kharissidqi & Firmansyah, 2022). In the next stage, after designing the material and UI (*user interface*) display, the next step is to develop it into AtmoLearn learning media.

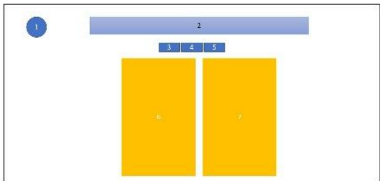
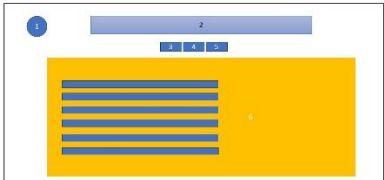
AtmoLearn Media Develop Stage.

AtmoLearn's learning media is developed based on analysis and planning. The development process utilizes the design application Canva. The AtmoLearn product specifications are as follows:

- 1. Format : application in the form of a website
- 2. Platform : Canva design app
- 3. Compatibility : Laptops and gadgets
- 4. User interface : interactive and numeric input
- 5. Media Access Link : <https://bit.ly/AtmoLearn>

The following are the parts of the AtmoLearn application that have been developed.

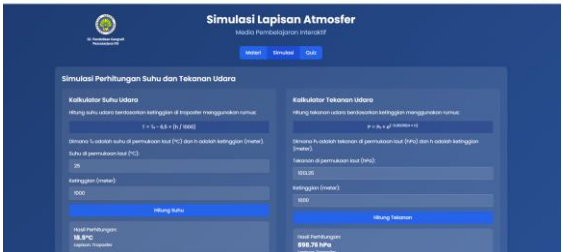
Table 3. AtmoLearn Media *Storyboard*

No.	Picture	Information
1.		Main page view 1 = "Start" button
2.		Material page view 1 = logo 2 = title "Air Layer Simulation" 3 = "material" button 4 = "simulate" button 5 = "Quiz" button 6 = interactive air layer material box
3.		Simulation page view 1 = logo 2 = title "Air Layer Simulation" 3 = "material" button 4 = "simulate" button 5 = "Quiz" button 6 = air temperature simulation box 7 = air pressure simulation box
4.		Quiz page view 1 = logo 2 = title "Air Layer Simulation" 3 = "material" button 4 = "simulate" button 5 = "Quiz" button 6 = Quiz question box

Product Educational technology in the form of AtmoLearn media combine activity packaged online simulation in mobile learning. The learning media developed with existence activity simulation more interesting caring and helpful difficulty student

in learning activities simulation designed with goals, students can understand draft more material interactive and meaningful than method traditional (Natifa et al., 2024). Activity simulation in AtmoLearn media that is student can do simulation calculation temperature air and pressure air, so that moment There is studies student cases requested for count temperature air and pressure air, students with easy know it and analyze it. Activities simulation give possibility to student for do experiment virtually, manipulate variable data, and manage the result (Natifa et al., 2024).

Table 4. Segments of the AtmoLearn Application

No.	Picture	Information
1.	 The home screen of the AtmoLearn application. It features a sunset background with the text 'MEDIA PEMBELAJARAN ATMOLearn' in large, bold letters. Below it, in smaller text, is 'Simulation Mobile Learning - Materi Atmosfer'. A yellow 'START' button is centered at the bottom.	AtmoLearn Home Screen
2.	 A screenshot of the 'Simulasi Lapisan Atmosfer' (Atmosphere Layer Simulation) screen. It shows a vertical cross-section of the atmosphere with layers labeled: Troposfer, Stratosfer, Mesosfer, and Termosfer. A 'START' button is visible at the bottom.	Display of Material Segments in the AtmoLearn Application
3.	 A screenshot of the 'Simulasi Lapisan Atmosfer' screen showing two calculation segments. The left segment is 'Simulasi Perhitungan Suhu dan Tekanan Udara' (Simulation of Air Temperature and Pressure Calculation) and the right segment is 'Simulasi Perhitungan Tekanan Udara' (Simulation of Air Pressure Calculation). Both segments contain input fields and a 'Hitung' (Calculate) button.	Simulation Segment View in AtmoLearn App
4.	 A screenshot of the 'Quiz Lapisan Atmosfer' (Atmosphere Layer Quiz) screen. It displays a multiple-choice question: 'Lapisan atmosfer yang paling dekat dengan permukaan Bumi adalah?' (The atmospheric layer closest to the Earth's surface is?). The options are A. Stratosfer, B. Troposfer, C. Mesosfer, and D. Termosfer. A 'Jawab' (Answer) button is at the bottom.	Quiz Segment View in AtmoLearn App

AtmoLearn, a simulation-based mobile learning product, aligns well with constructivist learning theory. Designed according to these principles, the app fosters a more interactive learning process (Casfian et al., 2024). In the classroom, AtmoLearn facilitates dynamic and interactive geography lessons, giving students opportunities to collaborate, discuss, and engage in practical exercises. Consequently, it not only

helps teachers explain atmospheric dynamics more effectively but also aids in preventing common student misconceptions on the topic.

Creating AtmoLearn media in the Canva application, researchers utilise feature Canva AI Code for produce learning media that has a simulation basis digital. In official, developer from Canva app releases A its novelty namely Visual Suite 2.0 with use intelligence AI- generated software, one of which is Canva Code. This Canva Code feature help users in write code for make application simpler interactive, and projects that have been finished can direct shared through link.

Currently in its development stage, AtmoLearn is expected to face several implementation challenges, including limited internet access among students and the prevalence of inadequate devices. A more significant weakness, however, lies in its long-term sustainability. Because the application is built using Canva Code—a non-cloud-based platform—it cannot be easily updated or patched once deployed. Therefore, any errors or issues identified during testing will require a complete regeneration of the product, rather than a simple incremental update.

CONCLUSION

AtmoLearn is a simulation-based mobile learning tool designed for geography education on the topic of the atmosphere. It was developed to help students understand atmospheric concepts and to increase their learning motivation. A key benefit is that students can use it to review material anywhere and anytime. For educators, AtmoLearn serves as a valuable resource for classroom instruction and simplifies the process of explaining complex atmospheric topics. The potential use of AtmoLearn can create more meaningful, mindful, and enjoyable learning activities for students. However, the application has only reached the development stage and now requires implementation. Therefore, the author suggests that further research should involve a trial implementation of AtmoLearn in 10th-grade geography classes. This would determine the media's effectiveness and compare student learning outcomes using AtmoLearn versus other teaching methods.

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