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Development of an Electronic Module Assisted by the Metaverse to Support Contextual Learning in the Geography Subject

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ABSTRACT

The type of research used was Research and Development (R&D), which aimed to produce and develop a metaverse-assisted electronic module that is feasible and practical to support contextual learning. The ADDIE development model was used in this study, consisting of five main steps: analysis, design, development, implementation, and evaluation. The results of the material expert validation showed an average percentage score of 90% with the criterion of very feasible, and the results of the media expert assessment produced an average percentage score of 75% with the criterion of feasible to be tested. The assessment results from students showed that the Electronic Module Assisted by the Metaverse achieved an average of 89.1% on the criterion of very practical, and the teacher assessment results showed an average of 89.5% on the criterion of very practical after testing. Based on the data obtained, the Electronic Module Assisted by the Metaverse met the criteria for validity and practicality to support contextual learning in the atmospheric dynamics material and can be used directly and independently by users.

Keywords: electronic module, metaverse technology, contextual learning

INTRODUCTION

Instructional materials are one of the learning tools used to achieve predetermined learning objectives. Ina Magdalena [1] in her study, explains instructional materials as learning resources used in teaching and learning activities to support the knowledge, abilities, and skills that have been established. In line with these points, M. Zaki [2] states that the material contained in learning resources needs to be organized in a structured and appropriate manner; moreover, the skill of developing instructional materials is essential for teachers to ensure that teaching and learning activities become efficient, practical, and aligned with the competencies to be achieved. However, in practice, there are still teachers who are not yet able to prepare instructional materials according to existing instructional elements that are based on learning needs [3].

In broad terms, teaching materials can be grouped into two categories, namely printed and non-printed. The printed category refers to materials with a physical form, such as books or modules, as its main examples. Meanwhile, non-printed teaching materials are digital in nature, such as visual media, audio, audiovisual, and interactive digital instructional materials [4]. According to Ginantara [5] Learning materials can be understood as a system with many interconnected components that, through a process, aim to form a unified whole that supports the achievement of optimal learning outcomes. The role of learning materials in supporting learning activities is significant when the materials are presented according to learners' needs. When learning materials are aligned with their needs, including their initial understanding and abilities, students can be encouraged to engage more actively in the learning process [6]. The quality of a learning material can be assessed from its ability to encourage students to be actively involved in the learning process when using it, as well as from its holistic, authentic, and engaging characteristics. An engaging and effective learning atmosphere can be created, among others, when the learning material is designed based on the needs of the students [7].

The study of geography has its own appeal and challenges to be learned [8]. Therefore, by applying contextual learning in the teaching materials, it is expected that students will be more active in examining atmospheric phenomena in their surrounding environment. The mastery of concepts and process skills that are relevant to the real world of students is the main focus in the implementation of contextual learning [9]. Contextual learning is incorporated to facilitate students' understanding of abstract materials. This is because the approach is considered highly suitable for implementation in the product that would be developed.

One of the most important components in developing learning materials is analyzing students' needs. Differences in students' learning styles, such as

visual, auditory, or kinesthetic, must be appropriately accommodated. Therefore, the results of the students' needs analysis significantly affect the selection of the learning components used to deliver the material [10]. Understanding students' characteristics and needs is essential to facilitating an optimal learning process [11]. Respondents' field notes indicated that the instructional materials used did not support contextual learning. In addition, the instructional materials used did not fully address students' needs. Thus, the use of these conventional instructional materials affected the learning process in the classroom.

The development of instructional materials in previous studies based on electronic modules has significantly improved learning quality. The study conducted by Salfia [12] stated that interactive electronic-module-based mathematics instructional materials on the integral topic for Grade XII senior high school using the 4D development model obtained a material expert validation score of 86.45% and a media expert validation score of 90.7%, both of which were in the "very good" category, and therefore declared feasible for use in learning. These findings were reinforced by another study, which stated that electronic modules are capable of facilitating more engaging and interactive learning, as well as improving students' understanding compared to conventional teaching materials [13]. These research results emphasize that innovation in technology-based teaching materials is essential for supporting an effective teaching and learning process.

Different from previous studies, the Electronic Module Assisted by the Metaverse, designed to support contextual learning in this research, was designed to meet students' learning needs. In addition, the development of the Electronic Module Assisted by the Metaverse was intended to facilitate students' contextual learning, grounded in real-life daily situations. Contextual learning was implemented through the arrangement of the material and the learning media included. Therefore, through the development of relevant learning materials, students can learn freely and flexibly anywhere [14]. Therefore, the utilization of metaverse technology in the field of education is very important to be carried out as a form of innovation that supports the development of learning in the present era [15]. Through the development of an electronic module, it is expected to facilitate students and teachers in delivering and receiving learning materials through the use of technology [16].

In line with the problems described, the main objective of the research was to develop an Electronic Module Assisted by the Metaverse that is feasible and practical for supporting contextual learning. Contextual learning was achieved through learning activities supported by three-dimensional materials and media, enabling students to participate more effectively in the learning and teaching process. In addition, the electronic module was designed to support the learning process effectively. Through the materials and media provided in the electronic module, it was expected to offer real learning experiences so that sustainable learning could be created [17].

RESEARCH METHODS

The teaching materials in this research were designed and developed through a Research and Development (R&D) approach. The development process adopted the ADDIE model, which aims to create a product and to assess the feasibility and practicality of the electronic module. The development flow in this research adopted the ADDIE model, which includes five systematic steps, namely analysis, design, development, implementation, and finally evaluation [18]. The advantage of this model lies in the implementation of each stage being carried out systematically, allowing it to be used in the product development process [19]. The stages conducted included needs analysis, product design, expert validation, product revision, and limited trials. These stages aimed to produce a learning module that is feasible and practical to be applied in the classroom learning process.

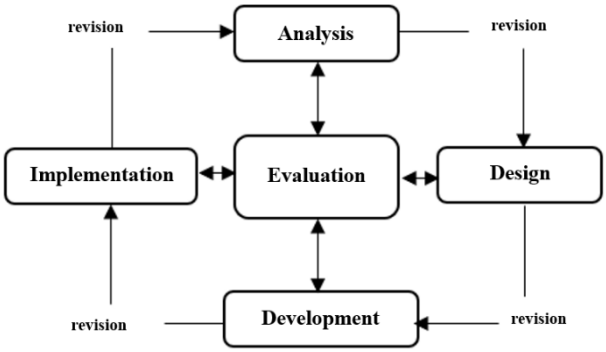

Figure 1. Flow of the ADDIE Development Model [20]

Tenth-grade students of Madrasah Aliyah Negeri 3 Jember in the 2024/2025 academic year and one geography teacher were selected as subjects in this study using purposive sampling techniques. The module was evaluated for feasibility by media and materials experts, then tested in learning activities to assess its practicality. Primary data sources included student and teacher questionnaires and validator assessments, while secondary data consisted of supporting documents, such as relevant literature. The instrument used in this research consisted of a closed questionnaire to analyze students' needs as the basis for developing the learning materials, an expert validation instrument to assess product feasibility before revision and testing, and a practicality test instrument used to evaluate the module by users. A quantitative and qualitative approach was used to analyze the research findings, in which quantitative data were used to calculate the average scores of feasibility and practicality assessments, while qualitative data were used to process suggestions, criticisms, and responses from validators, teachers, and students as the basis for product refinement, so that the module developed is expected to become feasible and practical to support contextual learning at Madrasah Aliyah Negeri 3 Jember.

The results of the validator assessment were then used to determine the product's feasibility level. The

validator assessment served as the basis for evaluation and product revision. After conducting descriptive quantitative analysis, the data results were processed into percentage form using the formula [21] as follows:

$$\text{Percentage of Feasibility} = \frac{Score\ Obtained}{Maximum\ Score} x\ 100\%$$

The final results of processing the media expert and material expert validation data were then described using the percentage technique. The product feasibility criteria were based on the results shown in Table 1 below.

Table 1. Feasibility Criteria

Percentage (%)	Criteria
81-100	Very Feasible
61-80	Feasible
41-60	Fairly Feasible
21-40	Less Feasible

Source: Mada Raharja [22]

The responses collected from the questionnaire need further processing. In order for the obtained scores to be interpreted and concluded, the data must first be quantified to determine the percentage of achievement using the formula [23] as follows:

$$\text{Percentage of Feasibility} = \frac{Score\ Obtained}{Maximum\ Score} x\ 100\%$$

After processing the module practicality data, an analysis was conducted using a descriptive percentage approach to define the results. The criteria for module practicality can be seen in Table 2 below:

Table 2. Module Practicality Criteria

Percentage (%)	Criteria
85.01- 100	Very Practical
70.01- 85	Practical
50.01-70	Fairly Practical
1-50	Not Practical

Source: Hidayati Rais [24]

RESULT AND DISCUSSION

1. Analysis Stage

The curriculum used at Madrasah Aliyah Negeri 3 Jember adopted the Merdeka Curriculum. However, in its implementation, the Merdeka Curriculum used was still in a transitional phase from the previous curriculum. Therefore, adjustments to the learning process were needed in accordance with the applied curriculum. In the context of implementing the Merdeka Curriculum for Phase E at Madrasah Aliyah Negeri 3 Jember, the Atmospheric Dynamics material was positioned as a foundation for developing students' critical reasoning skills. The focus shifts from mere factual knowledge to strengthening students' abilities to examine, review, and evaluate atmospheric processes. Methodologically, students are guided not only to memorize weather and climate elements such as temperature, pressure, wind, humidity, and precipitation, but also to analyze their interconnections. The objective is for them to be able to formulate logical explanations regarding the formation of various climate patterns in Indonesia. This learning also requires students to analyze larger atmospheric phenomena.

As part of the effort to develop instructional materials, a needs analysis was conducted to explore in greater depth students' preferences and interests, both toward the subject matter and the instructional materials used. Based on the needs analysis, 70.4% of students showed interest in the Geography subject. Among all topics taught, atmospheric dynamics was the most preferred, with an interest level of 87%. These data are in line with students' assessments of the instructional materials used, in which 68% considered the Student Worksheet (LKS) to be less effective, and other data showed that 54.8% of students preferred digital-based instructional materials as a learning tool.

The interview conducted with the geography teacher produced information that students were less enthusiastic about learning using the Student Worksheet (LKS). This affected the delivery of material and the classroom situation, which did not run optimally. On the other hand, the LKS used had not been equipped with contextual examples, so the learning process could not be comprehensively understood. This condition caused the teacher to rely more dominantly on the lecture method, resulting in a learning process that was less varied and unable to fully capture students' attention [25]. Thus, the classroom learning process requires adequate teaching materials to facilitate learning activities optimally. In addition, the selection of approaches, methods, and learning models needs to be adjusted to the needs of the students so that a more varied and engaging learning atmosphere can be created [26].

The findings revealed that tenth–grade students had a high interest in the atmospheric dynamics material, yet their understanding was not optimal because the teaching materials used still needed to be developed, particularly in the areas of contextual learning and more engaging visual presentations. In line with these findings, Sutomo [27] stated that limitations in teaching materials may reduce

students' opportunities to develop critical thinking skills and conduct analyses for problem-solving.

2. Design Stage

The next stage was product design, carried out to systematically plan the objectives and material strategies, considering the findings from the analysis stage. The product design played an important role in planning all components so that they could support one another, and this aimed to deliver the intended message clearly [28]. The material and the structure of the module were designed to support contextual learning by integrating three-dimensional metaverse technology, thereby enabling students to learn interactively and immersively, with ease in understanding the material. This aligns with Suhartoyo [29], in his study, stating that contextual learning aims to connect the material with real-life situations so that students' knowledge becomes more diverse and easier to understand.

The product design stage included determining the structure, content, and materials in the three-dimensional media. The module structure included a cover, author identity, table of contents, list of important terms, concept map, module description, basic competencies, material summary, user guide, main materials, and learning activities. The learning activities were organized into three sections, corresponding to the chapters studied, each containing learning objectives, explanations of the material, summaries, exploration activities, independent tasks, practice questions, and self-reflection. This design was arranged to ensure the module could provide a systematic, interactive learning flow that aligns with students' characteristics.

The design stage of the electronic module was carried out using the Canva application and the Spatial.io software to design each required element. Spatial.io is a metaverse software that provides an immersive and multisensory three-dimensional environment for users in the field of education [30]. Canva has the advantage of practical use in realizing a creative idea visually, allowing concepts to be presented clearly [31]. The selection of these tools was based on their ability to facilitate the integration of text, visuals, and interactive media that students need. The module structure was designed to simplify navigation, with the table of contents serving as the main guide so students and teachers can locate topics quickly. This indicates that the module structure design does not merely serve as an administrative complement but also plays an important role in providing an overview of a systematic learning flow, thereby helping students understand the scope of the material comprehensively [32].

In the developed metaverse, students can freely take virtual trips to learn about and analyze atmospheric phenomena. This enables students not only to obtain conceptual understanding theoretically but also to connect it with concrete visual representations, allowing the learning process to become more in-depth and interactive. This view aligns with Siregar [33], who in his study stated that to support learning motivation, students require learning resources that are engaging and interactive so that their involvement and enthusiasm for learning can increase. In line with Iswanto [34] in his study, the use of metaverse technology can provide new and highly immersive experiences through learning visualization. In this regard, the use of technology in learning becomes an essential point for offering an innovation that can enhance a more engaging learning experience [35].

The concept map contained in the module functions as a visual guide. This role is designed to help students more easily identify the interconnections among various material concepts. A deeper, more structured understanding can be developed because this module presents the material not only linearly but also in an integrated way. The scope of the Basic Competencies (KD) and the learning objectives was arranged to ensure that the direction of learning remained aligned with the curriculum achievements. This indicates that the presence of the concept map and the KD was not merely a formality but served as instruments that ensured the relevance of the module to meaningful learning needs [36].

The design stage showed that the product's design process became the main determinant of its development. The design ensured a coherent connection among the learning objectives, the material structure, and the technology used. The product design process was carried out systematically, from the initial analysis and content organization to the integration of interactive media. The use of spatial.io and Canva enabled the material to be presented in a more visual, contextual, and in-depth manner, so it is expected to increase student engagement. This structured and interactive learning trajectory is achieved through a consistent module structure, clear concept mapping, and a variety of learning activities.

3. Development Stage

The Electronic Module that had been developed then underwent validation testing by material and media experts. According to Rahmawati [37] in her study, validation testing was conducted to assess the suitability and to explain the level of feasibility of the product being developed. The product that had passed the validation stage was then revised based on the validators' suggestions. This step was taken to ensure that the Electronic Module being developed truly aligned with the learning needs. Thus, the module developed was not only feasible to use but also relevant to the expected learning outcomes.

Table 3. Results of Media and Material Expert Validation

Media			Material		
Aspect	Total Score	Percentage (%)	Aspect	Total Score	Percentage (%)
Self-Instruction Aspect	21	75	Module Size Aspect	7	87.5
Self-Contained Aspect	6	75	Module Cover Design Aspect	56	87.5
Stand-Alone Aspect	6	75	Book Content Design Aspect	99	91.6
Adaptive Aspect	3	75			
User-Friendly Aspect	3	75			
Total Percentage		**75**	**Total Percentage**		**90**
Feasible			**Very Feasible**		

Source: (Researcher's Processed Data, 2025)

The results of the media expert assessment in Table 3 produced an average percentage of 75%. The percentage of media expert validation results, based on Table 1, met the criterion for feasibility of use. The validator also provided input on the arrangement and clarity of media descriptions, the importance of aligning the cover design with meteorological and climatological phenomena, the balance of the image layout, the selection of illustrations that are more meaningful to the material, and the use of sharper colors. Based on the media expert validation results, improvements were made to these aspects to refine the product. These findings indicate that, overall, the Electronic Module Assisted by the Metaverse has met the criteria for media feasibility well, although refinement of visual details is still required to make the product not only feasible to use but also more attractive, representative, and effective in supporting learning.

The assessment by the material expert in Table 3 showed an average of 90% with the criterion of very feasible, based on Table 1 as the reference. Based on the results of the material expert validation, the product underwent revisions in several aspects that still required improvement in order to enhance the quality of the module content. These findings indicate that the metaverse-assisted electronic module developed has met the standards of content feasibility; however, it still requires refinement of certain details to be more optimal in supporting the learning process. These results also show that the material presented is aligned with the curriculum, relevant to students' needs, and capable of providing a more contextual, systematic, and interactive learning experience. When students are able to observe, listen to, and directly interact with the material through contextual learning, their understanding and retention of information become stronger.

Figure 2. (a) electronic module cover; (b) metaverse media display

4. Implementation Stage

After the validation stage, the research continued to the implementation stage involving teachers and students. The developed product was tested at Madrasah Aliyah Negeri 3 Jember, involving 42 students from 2 different classes and one Grade X Geography teacher. After implementation, the teacher and students were asked to complete an assessment questionnaire to evaluate the practicality of the module based on the learning experience they had gained. The results of this assessment served as a reference for analyzing the product's practicality and as a consideration in improving the module during subsequent development. The practicality assessment conducted by students and teachers aimed to determine whether the teaching material was practical as a support for learning activities [22].

The findings from the trial stage showed that students actively asked questions, engaged in discussions, and appeared highly enthusiastic when given tasks aligned with the learning activities in the Electronic Module. The teacher and the researcher also provided intensive assistance throughout the learning process. This was done to ensure that students could learn easily through the Electronic Module. The results during the process and at the

end of the learning activities showed that students' learning activity exceeded that in the previous learning process using conventional teaching materials, and students' understanding also strengthened through the materials and media provided in the developed Electronic Module.

5. Evaluation Stage

In this study, the evaluation stage was conducted to review the entire product development process and ensure the quality and effectiveness of the developed electronic module. The evaluation included teacher and student assessments to provide a comprehensive overview of the product's practicality. This process also focused on identifying the product's strengths and weaknesses; thus, improvements could be made to meet the needs. Therefore, the evaluation played an important role in ensuring that the developed electronic module truly met the expected feasibility criteria and could effectively support the learning process.

Table 4. Practicality Assessment Results of the Electronic Module by Students and the Subject Teacher

Students			Subject Teacher		
Aspect	**Total Score**	**Percentage (%)**	**Aspect**	**Total Score**	**Percentage (%)**
The instructional guidelines for the teaching material are easy to understand.	145	87.5	This teaching material has clear usage guidelines	3	75
The material in the electronic module is easy to understand	143	85	This teaching material uses language that is easy to understand and has an attractive appearance	4	100
The electronic module helps you understand the atmospheric dynamics material	144	87.5	This teaching material is easy to access and use	3	75
The teaching material has an attractive design	154	92.5	The three-dimensional learning media inside it can support contextual learning	4	100
The use of text and language in the teaching material is easy to understand	141	85	It contains new and interesting features	4	100
The material in the teaching material helps you think critically	147	87.5	The suitability of the material in the teaching material	4	100
The three-dimensional illustrations in the metaverse learning space are clear and easy to understand	147	87.5	Completeness of the material	3	75
Learning material and three-dimensional illustrations in the metaverse space can help you observe phenomena in everyday life	145	87.5	The use of three-dimensional technology as a learning medium is effective in this teaching material	4	100
The teaching material can encourage students' learning interest in geography learning	150	90	Usefulness in delivering atmospheric dynamics material to students	4	100
The material presented can broaden your insights related to atmospheric dynamics	146	87.5	Learning is not monotonous and becomes more interesting with the use of this module	3	75
This teaching material is feasible to be used in school learning	147	87.5	It provides smoothness in the learning process	4	100
			Utilizing gadgets properly as a learning resource	4	100
Total Percentage		89.1	Total Percentage		89.5
		Very Practical			**Very Practical**

Source: (Processed Research Data, 2025)

Referring to the practicality assessment of the module tested on students in Table 4, the module obtained an average practicality score of 89.1%. Based on Table 2 as a reference, the students' assessment of the electronic module product falls into the very practical category. The students provided positive responses in learning using the electronic module. Classroom conditions became enjoyable and not monotonous. A pleasant learning atmosphere can motivate students, encourage them to think critically, express their opinions, and ask questions [38]. During the trial activity, the students engaged in contextual learning with high enthusiasm, demonstrated ease in understanding the material, and the learning process, supported by the electronic module, fostered the development of critical thinking skills.

Subsequently, the teacher assessment results in Table 4 showed an average percentage score of 89.5% for the criterion of very practical after data processing. These results indicate that the developed module was not only easy to use but also relevant to students' needs, thereby functioning effectively as a learning support in the classroom. The teacher assessed that the structure of the material presentation, the clarity of the instructions, and the integration of three-dimensional media in the module facilitated a more systematic and efficient learning process. In addition, aligning the content with students' characteristics contributed to their active engagement and deeper understanding of concepts.

In the trial activity, the students learned contextually with enthusiasm, understood the material more easily, and experienced a learning process using the electronic module that effectively fostered the development of critical thinking skills. During the trial activity, the students engaged in contextual learning with enthusiasm, demonstrated ease in understanding the material, and the use of the electronic module successfully fostered the development of critical thinking skills [39].

The electronic module developed had several limitations, as indicated by trial results involving students and teachers. Several students had difficulty downloading the Spatial.io application for 3D learning because the Android devices they used did not meet the required specifications. In addition, unstable internet access caused the process of opening and operating the three-dimensional learning media to take a longer time. The findings of this study also indicate that the use of an Electronic Module Assisted by the Metaverse can enhance students' understanding, in line with the function of teaching materials that are designed to guide students through learning activities in accordance with the substance and competencies being taught [40].

CONCLUSION

Based on the stages of research and development, the Electronic Module Assisted by the Metaverse was declared feasible and practical to use, with a material validation result of 90% under the criterion of very feasible, a media expert assessment of 75% under the criterion of feasible, as well as student and teacher assessments of 89.1% and 89.5%, respectively, both under the criterion of very practical. The electronic module offers advantages: it can be accessed anywhere, is relevant to students' needs, presents material systematically and interactively, and can enhance conceptual understanding through meaningful, contextual geography learning. In addition to providing students with convenience in learning, this module also offers an immersive experience that positively affects students' engagement and learning motivation. Nevertheless, limitations in device access and personal internet connectivity remain obstacles in the use of the module at school. Therefore, the researcher suggests that future studies provide more adequate device and network support and examine the module's effectiveness through experimental research, thereby enabling a more comprehensive test of its contribution to student learning outcomes.

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