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Metaverse-Based Learning in the Digital Era

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Abstract

Digital disruption in the world of education refers to the impact of technology on traditional education systems and models, where the current education system is felt to need to be adjusted to the progress of the times and the needs of students. The business model of education in this digital era requires the innovation and creativity of teachers. After the Covid 19 pandemic, in addition to providing challenges in the world of education, it also provides an opportunity where students and educators are accustomed to *online* learning applications, *teleconference* applications, or collaboration applications that were previously not or rarely used by the world of Education. Many apps have been created to make online learning easier. Metaverse has been around since 2010, but due to the pandemic, the use of metaverse in learning is again being used with the development of Virtual reality, extended reality, and augmented reality technology. These three technologies can display a virtual environment just like the original environment. The method used to design metaverse-based learning is to use the ADDIE research and development model while learning development follows the stages of the Dick and Carey model. The results of field trials using survey methods and experiments on 20 junior high school students for one semester using the metaverse, resulted in a score of 4.82 with the conclusion of excellent learning material, students felt very happy, motivated to complete tasks, and always followed the learning stages designed in the form of games. Implementing the metaverse in learning can increase student engagement, creativity, technology skills, collaboration, and interaction as well as improve learning experiences that are more fun and engaging.

Keywords: metaverse, virtual education, metaverse in education, Avatar, Dick and Carey model

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INTRODUCTION

After the COVID-19 pandemic, the field of education has experienced rapid development in terms of technology. Online learning has explored various innovations in teaching and learning methods. One concept that is currently of concern is the concept of the metaverse. Mark Zuckerberg (Almahasees et al., 2021a) said that the metaverse is a virtual space where you can experience almost everything you can do in the physical world, but digitally. Metaverse is a virtual world that provides learning experiences, where students and educators can interact, collaborate, and learn in a digital environment (Wang et al., 2022). The

merging of the metaverse with the concept of education opens the door to different learning experiences. The metaverse is also creating new opportunities for collaborative learning, virtual experimentation, and learning approaches tailored to individual needs (Zhang et al., 2022). Metaverse allows users to interact in a digital world that mimics the real world with a high level of realism. In the metaverse, users can communicate with avatars, collaborate in virtual environments, and access different types of learning content.

As the pandemic subsided, some institutions urged students and teachers to return to school, and some schools used curvilinear learning as a learning paradigm that refers to a combination of face-to-face and online learning. (Heng, 2021; Hutchison & Mitchell, 2013; Jusuf et al., 2017; Khaerudin, 2011). Video-conferencing-based distance learning, such as Zoom, Google Meet, and Teams, became popular during the COVID-19 pandemic (Almahasees et al., 2021b). However, researchers have published several studies and found problems with learning on video conferencing platforms. These include fatigue, lack of motivation, lack of concentration, desocialization and depersonalization when using video conferencing. (Almahasees et al., 2021a). From 2021 to 2023, there have been many studies related to learning innovations using the metaverse, through the metaverse keyword on ScienceDirect produced 618 articles that have been published in various journals, but ethics searched using the keywords metaverse for education or metaverse in education only produced 17 articles from 2014 to 2023.

The metaverse is a convergence of virtually enhanced physical reality and physically persistent virtual space ; it allows users to experience both(Smart et al., 2007). Metaverse is a compound word of meta, which means transcendence and virtuality, and universe, which means the world and its contents (Tlili et al., 2022). Digital world refers to a new world expressed through digital media such as gadgets and the Internet. In 2021, Meta CEO Mark Zuckerberg updated and popularized the term again. (Kraus et al., 2022), Refers to a continuous virtual world or multi-user environment, a combination of physical reality and digital virtual reality. With the increasing use of various virtual, augmented and augmented reality technologies, the metaverse has come to the fore as an alternative to overcome the limitations of existing 2D-based online and remote classes. (Amanda et al., 2023).

Virtual space platforms used in the Metaverse include Second Life, Roblox, Sandbox, horizon worlds, spatial, metanesia and others. The evolution of the metaverse development can affect the learning experience of students. The purpose of using virtual spaces in learning is to engage and motivate students of all ages to learn, especially in STEM subjects. In STEM subjects, you can take advantage of the metaverse for creative learning including reverse engineering, multisensory education, project-based learning, reading and solving puzzles, innovative e-learning, and many other ways in which virtual learning activities can be improved with the development of information technology and internet devices that are growing, the use of metaverse in the learning process can be more effective.

Based on literature studies that have been conducted, the use of the metaverse that has been studied previously is for the use of games (Park & Kim, 2022; Shin, 2022) or sales (Dwivedi, Hughes, Wang, et al., 2022; Kim, 2021; Shen et al., 2021), There are still few who use metaverse research for learning (Park et al., 2021; Zhang

et al., 2022). However, with the development of high-speed information technology and internet devices that can facilitate learning using the metaverse anytime and anywhere compared to the initial version of the metaverse, the use of the metaverse in the learning process will be liked by students, students will be very happy and motivated if learning using the metaverse because it can display 3D-based virtual reality where daily activities and economic life are carried out through avatars that can represent themselves (Tlili et al., 2022).

METHODS

This type of research to develop learning materials in the metaverse uses research and development methods, following the stages of the Dick and Carey model (Hokanson et al., 2014). The principles of the Dick and Carey model include: a learning model that views the learning process as a learning system, related components in this model include: learners, teachers, teaching materials, and learning environments, where this model is a detailed ADDIE model (Snell et al., 2018), namely Analyze (identify instructional goal, Conduct analysis instructional, Analyze learner and contexs, write performance objective), Develop (develop criterion reference test), Design (develop instructional strategy) Implement (Develop instructional material), Evaluate (conduct formative evaluation). The model skeleton steps are shown in figure 1 below

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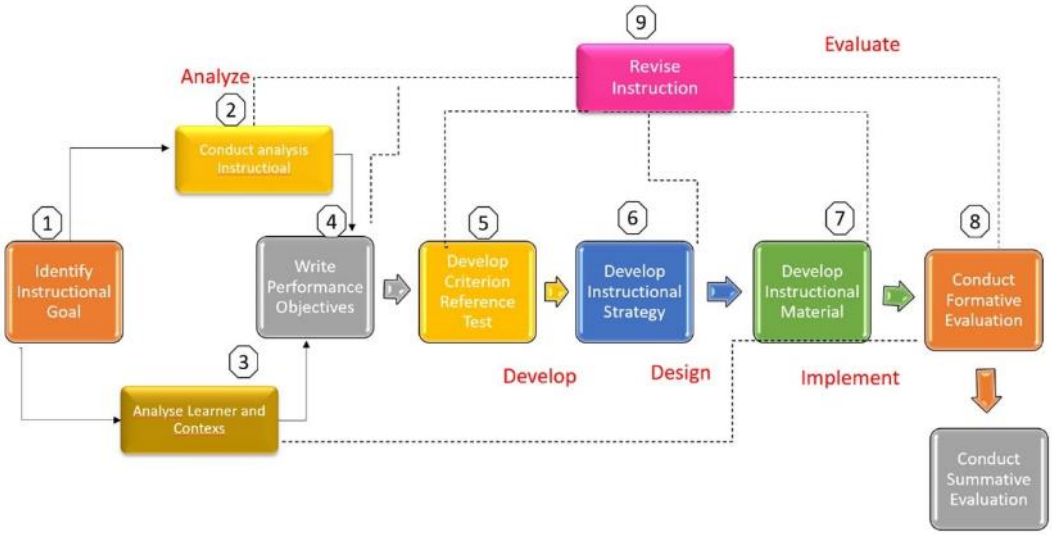

Figure 1. Stages of research and development of learning materials

This research was carried out by creating a metaverse learning environment developed using the firestorm application, the research time from September 2022 to September2023. The subjects of the study were junior high school (SMP) students who were interested in becoming respondents with natural science subjects.

Questionnaire about data collection method. Quiz for validation of research equipment, expert assessment by instructional design experts, material experts,

specialists, design and media experts, individual assessment by a total of 3 students, a total of 9 students Small group evaluations, and large group experiments with a total of 20 students. Questions about the gamified Metaverse Platform, which are run to follow all learning processes, are run to test the effectiveness of the Metaverse Platform and the developed learning materials. Problems developed by analyzing, evaluating, and creating using the high-level Bloom taxonomy can be performed in the metaverse through group work, survey-based learning, and even virtual experiential learning.

The data obtained from this survey can be divided into two parts: qualitative data and quantitative data. Qualitative data is obtained by testing the validity of questions and inputs during the evaluation process to improve the product under development.

Quantitative data analysis techniques use questionnaire data in the form of statements using Likert scales. Learning outcome data were collected in a large group experiment with gamified questions. Metaverse platform questions were first tested by him on 5 students before using to know the difficulty of the questions to use.

RESULTS & DISCUSSION

Result

1. Analyze

Prior to the development of the Metaverse, by first involving a research team to seek input on the design of the learning materials to be developed, and then formulating overall educational goals and determining the competencies that students need to master. , adjustments are made. It determines the requirements that students must have to take science courses and sets specific educational goals as indicators of learning achievement. Here is the result of the formulation: 1) Technical learning outcomes using high-level taxonomies bloom. 2) Competency Map; 3) Student Characteristics 4) Learning Partial Results .

2. Develop

In the traditional learning process, teachers assess students based on summative assessments based on test-based learning outcomes. In this case, test result are the only indicator of learning, with side effects such as uneven scores. Support for learning records and learning analytics in the Metaverse allows teachers to use formative assessment information and summative assessments to assess student performance more comprehensively. It focuses on the learning process that students carry out rather than relying solely on test results .

Based on the objectives of learning outcomes that have been set, assessment question types are built to measure student learning outcomes compared to predetermined learning objectives. The questions to be used must be checked for validity. The validity of the questions is checked through the validity of the content, which is a question that is considered valid by subject experts according to learning outcomes based on learning objectives

3. Design

In developing the Metaverse platform, researchers will use Firestorm applications and learning materials developed in the form of everyday life-like environments. According to Davis in (Jusuf et al., 2021) Choosing an appropriate learning strategy is a matter of educational effectiveness. This includes her five management methods: Manage your time, decide what to say, know where and how to use energy most efficiently, prioritize appropriately, and coordinate components to produce effective results. .

Metaverse emerged precisely because of technological advancements (Dwivedi, Hughes, Baabdullah, et al., 2022; Lee & Hwang, 2022; Zhang et al., 2022), The realization of the metaverse in education will depend heavily on the latest technology and capabilities of educational institutions. . Figure 2 below is the metaverse infrastructure developed from Xinli Zhang's research (Zhang et al., 2022).

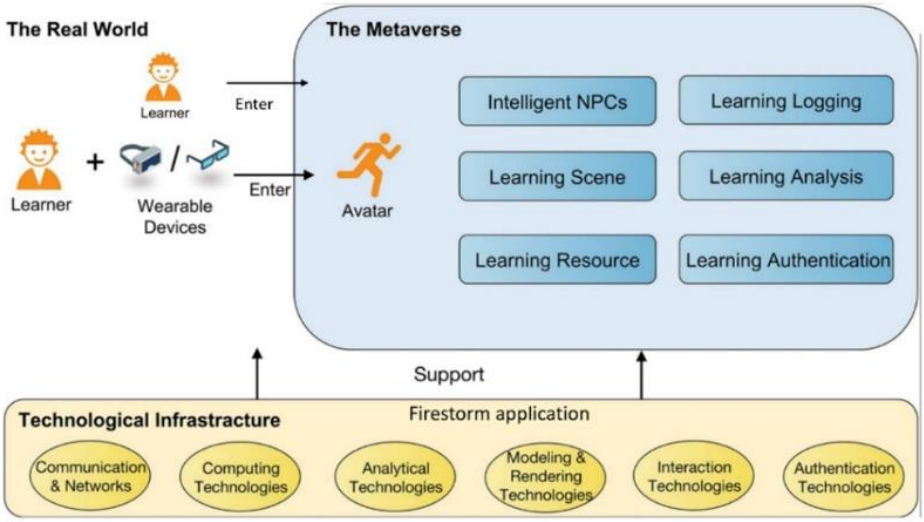

Figure 2. Metaverse framework in education

The results of the design of the virtual learning room form as shown in figure 3 below.

Figure 3. Learning spaces in the metaverse

4. Implement

In this step, learning materials are developed in a metaverse environment that contains material descriptions equipped with explanatory videos of each material and in each material there are questions that must be done by students both independently and in groups.

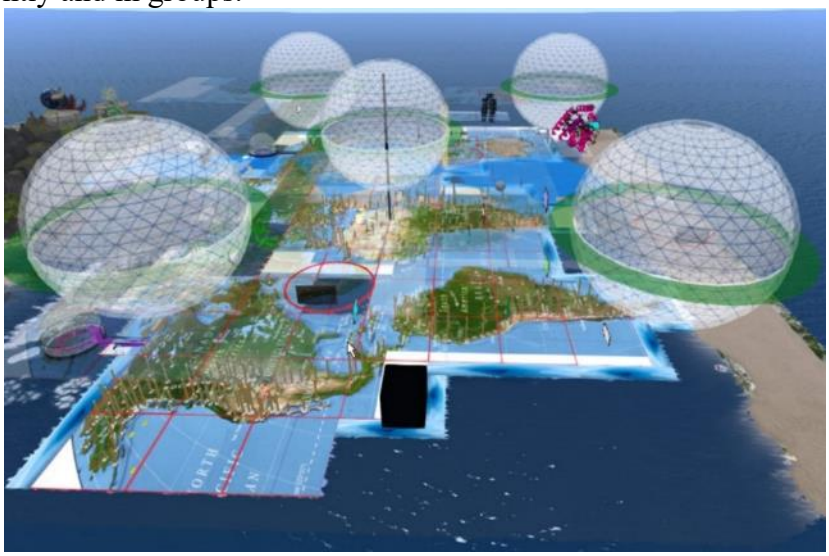

Figure 4. Explanation of the earth map

In figure 4 is a subject matter about maps and explanations about the area. Students / avatars can explore the island and can enter a circular room, inside each circle will contain an explanation of the earth map of which continent the circle is located. After listening to the explanation, students are required to solve the mystery box in a circle, if the answer is correct the participant will be safe, but if the answer is wrong, then the circle will collapse and the participant will fall into the island or fall into the ocean.

Figure 5. Outdoor study room

In figure 5 the subject matter is about the brain. If each section is clicked, the section will change color and provide info about the section clicked. The brain is like a very large cloud, so the avatar or student can fly in it and if one part is clicked it will come out a lightning-like beam that describes the nerve flow from which it is clicked. In figure 5 there is also a presentation board that can display explanation videos and questions that must be done by avatars, there are also chairs for avatars to sit to hear explanations from mentors.

5. Evaluation

In this phase, researchers create research tools to evaluate the process of developing learning materials. The research tools created are validated by experts based on their expertise. Validated tools include tools for documentation specialists, language specialists, instructional designers, design and communication professionals, tools for individual student assessment, tools for small group assessment, and tools for field research. increase. Questionnaires with a Likert scale of 1 to 5 were used for tools with expert, small group, and field testing. The Guttmann scale was used for individual assessment by students and knew yes and no. Tool validation was performed by device experts. So all devices are suitable for use .

a. One-to-one evaluation with an expert

Learning materials are then evaluated by selected experts who have access to the metaverse as well as assessment tools. After the data is collected, it will be processed using simple statistics, namely using the average of the total values. This average score is used as a basis for providing the extent to which teaching materials are developed using assessment criteria (Widjoyoko & Qudsy, 2009, p. 263)

A summary of the results of verification by all experts on learning material is very well shown in Table 1 below:

Table 1. The results of verification by all experts on learning material

No	Expert	Average rating
1	Material	4.90
2	Indonesian	4.83
3	Instructional Design	4.95
4	Design and Media	4.85
Overall average		4.88
Conclusion		Excellent

b. One-to-one evaluation with students

Summary of *one-to-one* evaluation results with 3 students as shown in table 2 below.

Table 2. summary of *One-to-One* evaluation results

No	Aspects	Respond
1	Material	100%
2	Indonesian	100%
3	Instructional Design	100%
4	Design and Media	100%
Overall average		100%
Conclusion		Excellent

The respondents' conclusions answered that 100% of learning materials are suitable for use without revision.

Evaluate small groups with students Recapitulation of small *group* evaluation results with 9 respondents as table 3 below

Table 3. Recapitulation of small *group* evaluation results

Student	Average rating
Responden 1	4.90
Responden 2	4.95
Responden 3	4.92
Responden 4	4.98
Responden 5	4.99
Responden 6	4.90
Responden 7	4.88
Responden 8	4.96
Responden 9	4.88
Overall Average	4,92
Conclusion	Excellent

c. Field trial with 20 Students

In the field test, the respondents were 20 students who had never learned to use the metaverse. Participants were selected from junior high schools (SMP) located in the BSD area. The trial is led by mentors and students receive instruction to access subject matter in the metaverse. A week later, mentors and students were given access to the metaverse, after which students were asked if there were any obstacles or difficulties in accessing the metaverse, students answered no. At the beginning of their studies, students are required to participate in all learning activities available in the metaverse assisted by mentors. At the end of learning, respondents are asked to provide an assessment of the learning material that has been developed as a benchmark for improving the learning material before it becomes the final product, as in Table 4 below.

Table 4. *Field Trial* results.

No	Aspects	Statement	Result
1	Instructional Design	I understand and understand science better because the learning objectives are clearly explained	4.5
2		I have an easier time understanding science because the presentation techniques in the metaverse are very structured	4.6
3		In my opinion, learning materials are easier to understand because in the metaverse the presentation is structured, easy to understand, and has multimedia explanations in the form of videos.	4.65
4	Material	Illustrations on Videos make understanding easy	4.82
5		I can understand the learning material because the content given are easy to understand	4.73
6		I like the science material because the material presented in the metaverse is clear and interesting	4.76

No	Aspects	Statement	Result
7	Motivation	I like the subject matter because the questions motivate me to study more	4.85
8		These questions really helped me to understand scientific concepts	4.50
9		By using the metaverse, I can chat with friends more easily because there is a chat menu	4.60
10		The questions given motivate me to learn new things	4.65
11		With the use of learning materials in the metaverse, I have fun learning	4.50
12		Learning materials in the metaverse help me individually/actively group answer questions	4.75
13		With these study materials, I can study anytime, anywhere	4.6
14	Language	The sentences used are easy to understand	5
15	Design and Media	The illustrations displayed are very interesting, true to the original	5
16		Existing writing, clearly legible	5
17		The presentation of the layout of the object is appropriate and very interesting	5
18		Letters make it easy for material to read clearly	4.76
19		Coloring is very appropriate	5
20	Proper	I totally agree if learning materials in the metaverse can be applied	5

As shown in Table 5, field test results of the learning materials administered to 20 students achieved an average overall score of 4.82. This means that the Metaverse learning materials are considered very good

Table 5. Summary of Field Trial Results

No	Aspects	Result
1	Instructional Design	4.58
2	Material	4.77
3	Motivation	4.63
4	Language	5
5	Design and Media	4.95
6	Proper	5
Overall Average		4. 82
Criterion		Excellent

Discussion

Learning resources for students in schools are usually printed textbooks, printed worksheets, e-books, picture guides, videos, and multimedia. Students tend to interact less with these learning resources. Albert Bandura in (Loon, 2017, p. 59) Saying that one's environment is in, can shape one's behavior and one's behavior can shape one's environment, that is, the process by which the world and one's behavior influence each other. According to Gartner (Zhang et al., 2022) By 2026, approximately 30% of people are expected to spend two hours a day in the Metaverse for working, entertaining, education and socializing. This is an opportunity to use the Metaverse in education, as it can overcome obstacles

encountered in traditional learning processes and, more importantly, it can indicate trends towards future education. (Jovanović & Milosavljević, 2022). In the metaverse, various learning materials can be reconstructed virtually based on real learning environments or can be simulated in a virtual way. The use of increasingly sophisticated and affordable smart wearable devices will greatly help to better experience the world of the metaverse, especially for students with special needs, they can learn without barriers.

Virtual learning developed using the Firestorm application. Learning materials developed in virtual learning are in the form of virtual worlds, all learning materials are contained in objects that have previously been designed including also designing question shapes for each learning activity. As a result of field trials, students feel very happy and motivated to complete exercises in the metaverse, while still following the learning steps in the metaverse.

Based on the metaverse framework, learning with the metaverse will not be the same as synchronous online or asynchronous online learning. The difference is as in the following table 6 below:

Table 6. Online Learning VS Metaverse

Aspects	Online learning	Metaverse
When and where learners attend class	Only available when a teacher has opened the meeting via video conferencing	No time or place restrictions
Learner identity	Real identity	Customized, dynamic digital identity with avatars
Learning resource	Learning resources that are primarily multimedia or online with which learners cannot normally interact	Primarily visual or decentralized learning resources that allow learners to interact
Learning acitivity	Lectures are the focus of lectures. Learners cannot easily participate in complex learning activities.	Mainly a set of contextualized learning activities in a 3D learning scene. Allow learners to participate virtually in various learning activities. It can support remote collaboration. Initiate more inquiry-based activities and problem-solving tasks to facilitate creative learning activities .
Learning experience	Mainly based on online communication with video and audio	Mainly based on multi-sensory engagement and expression
Learning objective	Aimed mainly for low-level cognitive development	Easy to develop higher-order cognition
Learning assesment	Focus on learning results	Combine with formative and summative data.

CONCLUSION

The development of Metaverse virtual learning has been completed and as a result the students are very happy and motivated to continue exploring every object contained in the metaverse. The results of the assessment with experts gave an average result of 4.88 with the conclusion that the learning material in the metaverse was very good. The results of individual assessments with 3 respondents showed that 100% of learning materials could be used. The assessment value of Small Group Teaching Materials of 4.92 means that teaching materials can be used without modification. The results of field trials using survey methods and experiments on 20 junior high school students for one semester using the metaverse, resulted in a score of 4.82 with the conclusion of excellent learning material, students felt very happy, motivated to complete tasks, and always followed the learning stages designed in the form of games.

Implementing the metaverse in learning can increase student engagement, creativity, technology skills, collaboration, and interaction as well as improve learning experiences that are more fun and engaging.

Along with the rapid advancement of technology and the speed of internet access, the metaverse has great potential today and in the future as an innovative and creative new learning environment to make students get an extraordinary learning experience so that they are motivated and excited in learning. Metaverse can help students with special needs to be able to learn without barriers, metaverse can also help educational institutions that have problems with laboratory facilities and teaching aids.

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