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Analysis of Readiness to Use the Metaverse Platform in Learning Activities

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Abstract

Metaverse technology is one of the many technological breakthroughs in education, notably in the teaching and learning process in the classroom, especially since the COVID-19 epidemic. This study aims to investigate, model, and assess the potential adoption of metaverse technology from the viewpoint of BINUS University students. The study methodology that is employed is quantitative descriptive analysis. This research used Mozilla Hub's SPOKE to create the classroom simulation. Students are asked to use a laptop web browser and a Virtual Reality (VR) headset to replicate two scenarios from the metaverse realm. The variables used are comfort, convenience, compatibility, interest, and efficacy. The findings of this research indicate that a more significant number of participants, as much as 80% than fewer respondents (20%) were interested in employing VR (the Metaverse) for online teaching and learning using headsets. The novelty in this research is that academics can find out student behavior that they prefer to study using a VR headset compared to a regular laptop by opening a web browser. This can be a special note that the use of VR headsets in learning can increase interest in learning so that it is more effective in providing teaching material. Future work for this study is the application of this metaverse technology, which still requires work and development, as it still necessitates careful planning and consideration of a few factors, including security, infrastructure availability, and user comfort.

Keywords:

Metaverse; Education; Simulation; Learning; Adoption; Technology; Virtual Reality.

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1- Introduction

Numerous industries, including healthcare, education, retail, and manufacturing, have been impacted by the term "metaverse." According to research done by Gartner, a few more industries will be impacted by the term by 2026. The term "metaverse," particularly in the context of education, emerged in the wake of the COVID-19 pandemic, which compelled people to reevaluate existing teaching and learning approaches [1]. This ecosphere is made up of the various technologies that allow for multimodal interactions, including Virtual Reality (VR) and Augmented Reality (AR), with people, the electronic library, and artificial environments [1, 2]. The training process will be improved, collaboration will likely increase, and most importantly, a happier workplace will result from the metaverse [3].

This is the sole explanation for why many corporate behemoths, including Nvidia, Facebook, Apple, Epic Games, and others, have migrated to this educational ecosystem [3]. With this technology, user conversations might be completely integrated in real-time, and engaging interactions with digital artifacts could be possible [4, 5]. This research discusses the metaverse in education and provides a thorough foundation for it in this study. It covers a comparison of

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traditional classroom instruction, online instruction, and metaverse instruction based on factors such as learning environment, resources utilized, teaching style, learning objective, learning experience, and learning evaluation. Education focused on competencies, students with a positive attitude toward learning, and engagement. Debatable are the different issues that the metaverse presents to the educational sector [4, 6, 7]. This publication will assist the community of researchers in gaining a clearer understanding of this ecology in education.

This study examines the theoretical underpinnings, development process, and application scenario of the educational Metaverse based on the notion [8, 9]. In the Information Systems courses, blended learning is implemented using the Metaverse idea [9, 10]. This involves designing the learning process, integrating the platform, creating materials, and determining the assessment technique [9, 10]. Our teaching plan is built around the idea of the Metaverse. It incorporates several elements, such as an online learning environment, the creation and distribution of resources, the design of assessments, and more. The Information Systems major received instruction, and it was discovered that this had a considerable positive impact on learning.

Nowadays, technological progress aligns with the fourth industrial revolution, while a pandemic that coincided with these advancements occurred between 2020 and 2022 [1, 4]. This pandemic has led to a change in the habits of people's daily activities who initially performed, typically in person or offline activities. The shift from offline to online has prompted changes in education, leading to adaptations in teaching and learning activities [7, 8]. This includes utilizing online media, such as meeting applications, as a method of teaching and learning [4, 6]. There is a breakthrough that uses the first-person perspective as if learning using the face-to-face method, namely the Metaverse [1]. Metaverse was initially created and introduced as a virtual new world [1]. Over time, the use of the Metaverse is adapted to the needs of its users, as used for teaching and learning activities in the Education field [1, 2].

Metaverse is a 3D virtual world concept that allows for two-way communication and unrestricted physical activity. It was then developed in 2003 called Second Life, which has the idea of a website-based 3D world where users can customize their avatar based on only one character [2, 3]. Second Life's virtual world development allows users to perform everyday activities such as shopping, socializing, and visualizing desires that could not be fulfilled in the real world. In many ways, Second Life is fundamental to thinking about what a metaverse is [11]. The current use of Metaverse has been implemented in games such as the Minecraft game introduced by Microsoft in 2014. In Minecraft, there is a feature that allows users to have their own metaverse world because the world in Minecraft is very open and customizable to the needs of each user [12]. The Metaverse in the game allows users to customize their world and interact with other players. The Metaverse can be used in the game world and educational settings for teaching and learning activities. Utilizing the Metaverse in education is akin to conducting a traditional classroom meeting in a virtual environment. This involves creating a virtual classroom within the Metaverse world and substituting the in-person meeting with a virtual conference.

The Metaverse is a digital space that exists as a 3D world. It combines Virtual Reality (VR), Augmented Reality (AR), internet advancements, and other semiconductor technologies [13]. This unique combination allows users of the Metaverse to have a personal and interactive experience. As technology advances, with the emergence of 5G internet networks and an increase in the production of VR devices, it will become more feasible to incorporate the Metaverse into education. This will enable the creation of courses and materials that offer instructors innovative ways to communicate with and engage with students. For example, suppose you are doing hands-on experiments that you would normally do on paper. In that case, the Metaverse will make it more visual and give you a clearer idea of how the investigation will be implemented.

Since the Metaverse technology is still relatively new, especially in Indonesia, many factors and components must be considered when implementing the Metaverse into the teaching and learning process at Bina Nusantara University. Factors to consider before implementing the Metaverse in the teaching and learning process include effectiveness, resource availability, user skills, and user interests. Therefore, adapting to a Metaverse implementation in teaching and learning at a university will take considerable time. This is because users are accustomed to face-to-face learning methods and online meeting applications. However, in this case, the researchers should always try to adapt and understand the perspective that users need when using the Metaverse in their teaching and learning processes. This research was conducted within the scope of Bina Nusantara University. Bina Nusantara University is one of Indonesia's most extensive private universities, established on July 1st, 1981. The location of the university that was used for this research is in West Jakarta, DKI Jakarta, Indonesia. To increase students' interest in learning and utilizing Metaverse technologies, it is crucial to employ the most effective teaching methods at Bina Nusantara University (BINUS) for undergraduate education. Several factors influence the readiness of BINUS University undergraduates to use Metaverse technology in their teaching and learning processes, including:

- Competence of BINUS University lecturers and students as users;
- Need for readiness, technology availability, and supporting resources to support the introduction of the Metaverse into university teaching and learning;
- Benefits received.

In this study, the authors discuss more about Metaverse technology in the teaching and learning process based on undergraduate students' perceptions at BINUS University. The authors create a classroom using Metaverse technology and investigate whether this Metaverse technology is suitable for the teaching and learning process of undergraduate students at BINUS University. In this paper, the focus is to find out how to prepare the students for adopting this Metaverse technology and dive deeper into the prospects and impact of Metaverse development. This research will observe the response of undergraduates in their technology classrooms to using this Metaverse by examining user interactions, usage customization, and user experiments. This metaverse could be the latest innovative technology in the teaching and learning process at BINUS University. Based on the above background, the purpose of this research is to compare using two tools to test the effectiveness of the Metaverse in the teaching and learning process.

2- Literature Review

Table 1 below shows the previous research related to metaverse adoption.

Table 1. The Previous Research Related Metaverse in Education

	Title	Year and Methods	The Research Focus
1	6G-Enabled Edge AI for Metaverse: Challenges, Methods, and Future Research Directions [14]	2022, Literature Review & Quantitative Method)	Focus on Technology Infrastructure (AI)
2	A conceptual framework for determining metaverse adoption in higher institutions of Gulf area: An empirical study using hybrid SEM-ANN approach [15]	2022, Qualitative Method	Focus on Technology Adoption (Human Behavior)
3	A Content Analysis of the Metaverse Articles [16]	2021, Literature Review	Focus on the Content
4	A critical evaluation, challenges, and Future Perspectives of using artificial intelligence and emerging technologies in Smart Classrooms [17]	2023, Descriptive Method	Focus on Technology Infrastructure (AI)
5	A study of college students' intention to use metaverse technology for basketball learning based on UTAUT2 [18]	2022, Quantitative Method	Focus on Technology Adoption (Human Behavior)
6	A study on the intention and experience of using the metaverse [19]	2022, Descriptive Method & Quantitative Method	
7	A Systematic Literature Review of the Metaverse for Software Engineering Education: Overview, Challenges, and Opportunities (Preprint) [20]	2022, Systematic Literature Review Method & Qualitative Method)	
8	A whole new world: Education meets the metaverse [21]	2022, Descriptive Method	
9	Advancing Education Through Extended Reality and Internet of Everything Enabled Metaverses: Applications, Challenges, and Open Issues [22]	2022, Comprehensive Review Method	Focus on Technology Infrastructure (XR)
10	An Investigation into The Utilization of Social Media to Foster Team Collaboration in a Higher Education Institution [23]	2022, Qualitative Approach & Interpretative Approach	Focus on Technology Adoption (Human Behavior)
11	Analyzing education based on metaverse technology [24]	2022, Mixed Method and Analytical Approach	
12	Augmented Reality: Increasing Engagement, Motivation, and Retention in Education [25]	2021, Descriptive Method and Conceptual Approach	Focus on Technology Infrastructure (AR)
13	Building a Smart Education Ecosystem from a Metaverse Perspective [26]	2022, Analytical Approach	Focus on Technology Adoption (Human Behavior)
14	D→K→I: Data-Knowledge-Driven Group Intelligence Framework for Smart Service in Education Metaverse [27]	2022, Literature Review Method	Focus on Technology Infrastructure (Architecture)
15	(From Immersive to Metaverse: Learning and Technology Gaps in Application in Agricultural Education) [28]	2022, Literature Review Method	Focus on Technology Adoption (Human Behavior) - Implementation
16	Definition, roles, and potential research issues of the metaverse in education: An artificial intelligence perspective [29]	2022, Definitive Approach	Focus on Technology Infrastructure (AI)
17	Development and Application of a Metaverse-Based Social Skills Training Program for Children with Autism Spectrum Disorder to Improve Social Interaction: Protocol for a Randomized Controlled Trial [30]	2022, Qualitative Method	Focus on Technology Infrastructure for special student-needs.
18	Educational applications of metaverse: possibilities and limitations [31]	2021, Descriptive Method and Analytical Approach	Focus on Technology Adoption (Human Behavior) - Challenges
19	Edu-Metaverse: Internet Education Form with Fusion of Virtual and Reality [32]	2022, Analytical Approach and Experimental Methods	Focus on Technology Infrastructure (simulation)
20	Enhancing Literacy Education with Narrative Richness in the Metaverse [33]	2022, Analytical Approach and Conceptual Approach	Focus on Technology Adoption (Human Behavior) - Challenges
21	Exploration of Educational Possibilities by Four Metaverse Types in Physical Education [34]	2022, Exploratory Method	Focus on Technology Infrastructure (Content Analysis)
22	Factors Affecting Learners' Adoption of an Educational Metaverse Platform: An Empirical Study Based on an Extended UTAUT Model [35]	2022, Quantitative Method	Focus on Technology Adoption (Human Behavior)
23	Hierarchical Deep Reinforcement Learning with Experience Sharing for Metaverse in Education [36]	2022, Descriptive Method	Focus on Technology Infrastructure (simulation)
24	Is Metaverse in education a blessing or a curse: a combined content and bibliometric analysis [37]	2022, Analytical Approach & Descriptive Method	Focus on Technology Adoption (Human Behavior)

25	Learn-By-Doing Virtually: A Gamified and Metaverse Design for Group Projects Aiming at Exchanging Constructivist and Collaborative Learning [38]	2022, Correlation Method and Analytical Approach	Focus on Technology Infrastructure (Simulation)
26	Metaverse for Social Good: A University Campus Prototype [39]	2021, Literature Review Method	
27	Metaverse Framework: A Case Study on E-Learning Environment (ELEM) [40]	2022, Literature Review Method	Focus on Technology Adoption (Human Behavior)
28	Metaverse in a virtual education context [41]	2022, Explanatory Method and Qualitative Method	
29	Metaverse In Architectural Heritage Documentation & Education [42]	2021, Theoretical Approach & Practical Approach	
30	Metaverse in Education: A Systematic Review [43]	2023, Literature Review	
31	Metaverse in Education: Vision, Opportunities, and Challenges [44]	2022, Literature Review & Comprehensive Review	Focus on Technology Adoption (Human Behavior) - Feasibility
32	Metaverse system adoption in education: a systematic literature review [45]	2022, Descriptive and Explanatory Method	
33	Metaverse through the prism of power and addiction: what will happen when the virtual world becomes more attractive than reality? [46]	2022, Descriptive Method & Literature Review Method	
34	Metaverse, Metaversity, and the Future of Higher Education [47]	2022, Descriptive Method	
35	Perceptions of Teaching-Learning Force About Metaverse for Education: A Qualitative Study [48]	2022, Qualitative Method & Descriptive Study Method	
36	Possibility of Metaverse in Education: Opportunity and Threat [49]	2022, Descriptive Method	
37	Prediction of User's Intention to Use Metaverse System in Medical Education: A Hybrid SEM-ML Learning Approach [50]	2022, Quantitative Method	
38	Reflections of Metaverse-Based Education on E-Learning [51]	2022, Quantitative Method	
39	Students' Opinions about the Educational Use of the Metaverse [52]	2022, Mixed Method	
40	Systematic Literature Review on the Use of Metaverse in Education [53]	2022, Literature Review Method	
41	Teacher Perspectives on Mobile Augmented Reality: The Potential of Metaverse for Learning [54]	2018, Qualitative and Quantitative Method	Focus on Technology Infrastructure (AR)
42	Technology-Enhanced Education through VR-Making and Metaverse-Linking to Foster Teacher Readiness and Sustainable Learning [55]	2022, Analytical Approach	Focus on Technology Infrastructure (VR)
43	The Expanding Role of Immersive Media in Education [56]	2020, Literature Review Methods	Focus on Technology Adoption (Human Behavior) - Feasibility
44	The Formation, Development, and Research Prospect of Educational Metaverse [57]	2022, Literature Review & Quantitative Method	
45	The Importance of the Application of the Metaverse Education [58]	2022, Literature Review Method & Descriptive Method	
46	The Metaverse—An Alternative Education Space [59]	2022, Descriptive Method	
47	The Metaverse in Education: Definition, Framework, Features, Potential Application, Challenges, and Future Research Topic [60]	2022, Literature Review Method & Descriptive Method	
48	The Metaverse in mathematics education: The opinions of secondary school mathematics teachers [61]	2022, Mixed Method	
49	The Triple-S framework: Ensuring scalable, sustainable, and serviceable practices in educational technology [62]	2023, Analytical Approach & Synthesis Research Method	
50	The use of augmented reality in a gamified CLIL lesson and students' achievements and attitudes: a quasi-experimental study [63]	2022, Quasi-Experimental Research Design	Focus on Technology Infrastructure (AR)
51	Utilizing the Metaverse for Learner-Centered Constructivist Education in the Post-Pandemic Era: An Analysis of Elementary School Students [64]	2022, Mixed Method	Focus on Technology Adoption (Human Behavior) - Challenges
52	Virtual Reality Metaverse System Supplementing Remote Education Methods: Based on Aircraft Maintenance Simulation [65]	2022, Mixed Methods	Focus on Technology Infrastructure (VR)
53	Virtual World as a Resource for Hybrid Education [66]	2020, Quantitative Method	Focus on Technology Adoption (Human Behavior) - Challenges

This research paper concludes from previous research that most of the researchers focus on literacy and understanding related to metaverse technology and how metaverse technology is used in education. In this research, the authors create a class room learning metaverse technology-based so that the students can simulate learning in the classroom and experience immersive experiences directly. This simulation is to see interactions between users and provide direct experience to students in trying the Metaverse environmental space by the authors so that they can truly experience the Metaverse. After students do the simulation, then the authors give a questionnaire that must be filled out by students. The students become respondents ask to fill out questionnaires, and the researchers can get valid primary data to find out their understanding and the extent of their experience in conducting simulation trials. The findings from the previous studies can be used as research indicators for authors to find out more about the prospects for Metaverse technology in Indonesia. Researchers want to develop a Metaverse in education and see how the responses and interactions from the simulations have been carried out.

3- Methods

This case study was conducted to determine the effectiveness of using the Metaverse Technology in teaching and learning. The methodology used in this research is the quantitative-descriptive data collection method. Quantitative research methods broadly include questionnaires, structured observations, and experiments [67, 68]. Descriptive research can be quantitative, as it gathers quantifiable data to statistically analyze a population sample [67, 68]. These numbers can show patterns, connections, and trends over time and can be discovered using surveys, polls, and experiments. The respondents are BINUS lecturers and active students in the Information Systems Department for the 2023 academic year.

The research implementation in this study was a comparison of the use of a laptop web browser and virtual reality headset for learning in the Metaverse Classroom. BINUS students who are involved aim to discover the differences in the effectiveness of virtual teaching and learning with a laptop web browser or virtual reality headset. The Virtual Reality tool used is Oculus Quest, which is owned by BINUS University. The Oculus Quest itself is the newest VR device that is no longer wired and requires a high-quality PC. This VR tool is a technology that allows users to interact with the environment and avatars in a virtual world classroom simulated by the Mozilla Hub. With VR, users tend to feel exactly similar in that environment. In this study, this research used Mozilla Hubs Spoke since it's a collaboration platform in the formation of Metaverse, which can be accessed via an internet browser. Spoke is the platform's online-based 3D scene and environment editor. Within Spoke, users can compose assets, lights, images, videos, and more to create an environment that can be used in Hubs rooms or export as a glTF 3D model file. The users can interact with Mozilla Hubs through VR or a keyboard and mouse to perform various activities.

The Mozilla Hub platform is a great fit for the needs of the researchers involved in this study. Specifically, they need a platform for collaboration based on Metaverse that can incorporate elements of teaching and learning. The platform should facilitate user interaction to create authentic teaching and learning experiences that also provide comfort to platform users. The users can communicate with one and others via SMS or chat on the platform. The shared screen function in Mozilla Hub is used for educational activities where materials are shared, and chat is used for communication. Additionally, the researchers facilitate engagement with the materials offered and promote SMS usage. Information-sharing and interaction with other students are part of this research activities. The platform's feature, which allows for user involvement, takes the place of in-person interaction while using the Mozilla Hub.

In this study, this research uses quantitative descriptive methods to collect primary data by distributing the questionnaire (Appendix I). The dimensional sampling technique that this research uses is purposive sampling, since purposive sampling is one of the non-random sampling techniques where the researcher determines the sampling by determining specific characteristics that are in accordance with the research objectives so that it is expected to answer research problems. This research uses the purposive sampling method to get appropriate respondents to be able to follow the simulation. One hundred respondents participated in the metaverse class simulation. The simulation was conducted at the BINUS University Jakarta Campus. The respondents are active students starting from 2018 to 2022. The students filled out the questionnaire given on May 15th, 2023. The variables used in this study are as follows:

1. Comfort

The authors want to know users' comfort responses when using this Metaverse technology in teaching and learning.

2. Convenience

The users will try to do a simulation in a Metaverse classroom, and the researchers want to see how easy it is to use it in a classroom lesson.

3. Compatibility

The purpose to see how the user's reactions (the students, and lecturers) are in the compatibility adjustment using the Metaverse classroom.

4. Interest

The purpose wants to see users' enthusiasm in trying Metaverse technology for a teaching and learning process.

5. Effectiveness

The purpose wants to find out the effectiveness of learning that is different from usual/previous by implementing Metaverse technology in a classroom.

There are the steps to perform a quantitative analysis:

a. Each indicator in the questionnaire is divided into four alternative responses using an ordinal scale representing the ranking of responses. Responses to each hand are scored from 1 to 4.

b. Descriptive statistics were used to describe the user's responses and were produced in tabular or graphical form using Excel software.

c. This study utilized assessment criteria such as strongly disagree, disagree, agree, and strongly agree categories to provide descriptive answers about each variable dimension.

This study used descriptive method to analyse and describe the data on each variable, specifically to provide a general description of the respondent's responses. Table 2 shows the questions and indicators in the questionnaire that was carried out and filled out by the respondents.

Table 2. Measurement items table

Variables	Measurement Items	Answer
Comfort	CF1: I feel more comfortable taking the Metaverse class using a web browser laptop.	Likert Scale (4- Points)
	CF2: I feel more comfortable taking Metaverse classes using a VR Headset.	Likert Scale (4-Points)
	CF3: I am satisfied with Metaverse technology in classroom learning.	Likert Scale (4-Points)
Convenience	CN1: I find it easier to take Metaverse classes using a web browser on a laptop.	Likert Scale (4-Points)
	CN2: I find using a VR headset easier when taking Metaverse classes.	Likert Scale (4-Points)
	CN3: I think this Metaverse Technology is easy to understand quickly.	Likert Scale (4-Points)
Compatibility	CP1: I found a difference when using Metaverse Technology with Laptop Web Browser and VR Headset.	Likert Scale (4-Points)
	CP2: I've been having trouble taking Metaverse classes using VR for too long. Metaverse Technology is suitable for use in class.	Likert Scale (4-Points)
	CP3: Metaverse Technology is suitable for use in class.	Likert Scale (4-Points)
	CP4: Do you agree that the internet is the factor that most influences the use of Metaverse Technology?	Likert Scale (4-Points)
	CP5: I prefer to take online classes using:	Checkbox Option: • Zoom • Ms Teams. • Discord • Meta • Meta VR Others
	CP6: Suggestions or feedback for Metaverse technology	Free Text
Interest	IT1: I am interested in using Metaverse technology in classroom learning.	Likert Scale (4-Points)
	IT2: I feel more interested in joining the Metaverse class using a VR device than a laptop web browser.	Likert Scale (4-Points)
Effectiveness	EF1: I feel more productive when taking Metaverse classes using a web browser on my laptop.	Likert Scale (4-Points)
	EF2: I feel more productive when I take Metaverse classes using VR headsets.	Likert Scale (4-Points)
	EF3: Does the internet speed affect the use of Metaverse Technology?	Likert Scale (4-Points)
	EF4: It takes quite a long time to understand VR Headset.	Likert Scale (4-Points)

The authors used a list of questionnaires and asked respondents to answer on a scale based on their experience. The Figure 1 illustrates the stages carried out in this research:

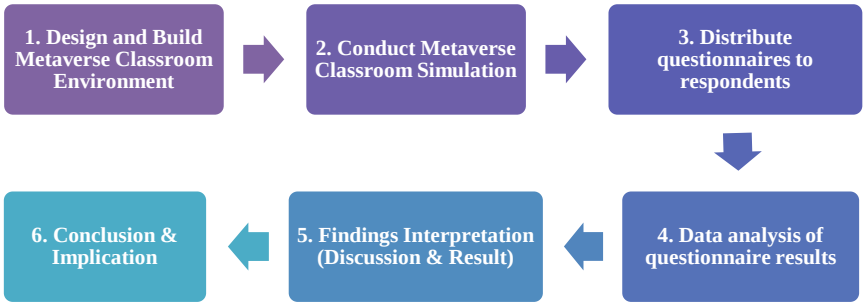

Figure 1. The Research Methods Stages

This study aims to identify comfort, convenience, suitability, interest, and effectiveness in using the Metaverse in teaching and learning activities, so that the respondents must clearly understand what the metaverse is and what their experience is when using it. After learning and understanding, the respondents can answer the survey based on their experiences and feelings when trying out the Metaverse learning platform. When conducting the Metaverse class simulation, this research uses two devices: a laptop web browser and a VR tool (Oculus Quest). This research wants to see how users interact with avatars in the virtual world and how these two devices work in the classroom Metaverse in the Mozilla Hub. The following are the specifications for the Oculus Quest 2 VR device used in this study when conducting trial simulations, as follows:

Table 3. Specification VR (Oculus Quest 2)

Specification VR	
VR Category:	All-in-one VR
Input:	Two Oculus Touch Controllers
Resolution:	3664 x 1920pzx
Processor:	Qualcomm Snapdragon XR2
Battery Power:	10000mAh (2 – 3 Hours)
LCD:	90Hz
USB Version:	3.2
Volume:	2783.45 cm^3
RAM:	6GB
Internal Storage:	256GB
Total Camera:	4
Weight:	503g
Thickness:	142.5mm
Wide:	191.5mm
Supported Usage Modes:	Seated, Standing, Room Scale
Glasses Friendly:	Comfortable to wear with glasses or RX insert

Below are the minimum requirements for using Mozilla Hub:

MacOS

- MacOS 10.12 or later.
- Mac Computer with an Intel x86 or Apple silicon processor.
- 512 MB of RAM.
- 200 MB hard drive space.

Windows

- Windows 7 or later operating system.
- Pentium 4 or newer processor that supports SSE2.
- 512MB of RAM / 2GB of RAM for the 64-bit version.
- 200MB of hard drive space.

GNU/Linux

1. Firefox will not run at all without the following libraries or packages:
   - Glibc 2.17 or higher.
   - GTK+ 3.14 or higher.
   - Libstdc++ 4.8.1 or higher.
   - X.Org 1.0 or higher (1.7 or higher is recommended).
2. For optimal functionality, we recommend the following libraries or packages:
   - DBus 1.0 or higher.
   - GNOME 2.16 or higher.
   - Libxtst 1.2.3 or higher.
   - Network Manager 0.7 or higher

4- Results and Discussion

This section will explain and display the simulation results from the responses of respondents who have conducted a Metaverse technology trial simulation in the teaching and learning process at BINUS University using two trial tools: a web browser on a laptop and a VR Headset device. Then, see the results of the respondents who have responded by filling out the questionnaire.

4-1- Metaverse Simulation with Laptop Web Browser and VR Headset at Binus University

As explained above, this research conducted a class Metaverse simulation using a laptop web browser and a VR headset device. It was held on May 15th, 2023, at BINUS University and was attended by one hundred respondents. When carrying out this simulation, there are several stages, as illustrated below (Figure 2). The duration of the simulation for each student is around 25 minutes on average (including the setting of headset devices).

Figure 2. The Researcher Provides Direction

In the first step of the pilot simulation of this tool, the researcher provides directions or and actions that can be taken when conducting a classroom Metaverse trial on the Mozilla Hub. The researcher provides an overview of how to use and join a classroom with a laptop web browser and VR Headset (Figure 3).

Figure 3. The Simulation with the Web Browser on the laptop (Left) and the Simulation with VR (Right)

Furthermore, the first step of the simulation was to use a web browser on a laptop, and each respondent tried or came forward alternately to carry out the simulation using a laptop web browser. Respondents can go around the class using the W, A, S, and D buttons as the driving console and the Q and E buttons for camera rotation, or using the mouse left click to rotate the camera and right click to teleport. In the third picture, after the respondents tried the simulation using a laptop alternately, they carried out a trial using the VR tool the researcher had prepared. The VR tool is moved using the controller in the left hand and can also be teleported using a right or left click on the index finger. Before the respondent leaves the room, they must fill out a questionnaire and respond to the simulation and experience they had.

4-2- Metaverse Environment Simulation in Mozilla Hub

In this simulation room, there are three classrooms, and there are also five breakout rooms, which are helpful for group discussions by respondents, as illustrated below (Figure 4).

Figure 4 shows a classroom hallway, so when the respondent joins the classroom, they will see this hallway. Many posters and several classrooms are available in the hallway. The hallways of this classroom should be as interactive as possible so that students can get their first enthusiasm and picture when using this Metaverse technology. In Mozilla Hubs, many features are in appearance, namely invite (inviting friends), voice (talking to other avatars), share screen and camera, place (add several objects), react (give emotes and reactions), chat, leave, and more (drawing 3D space).

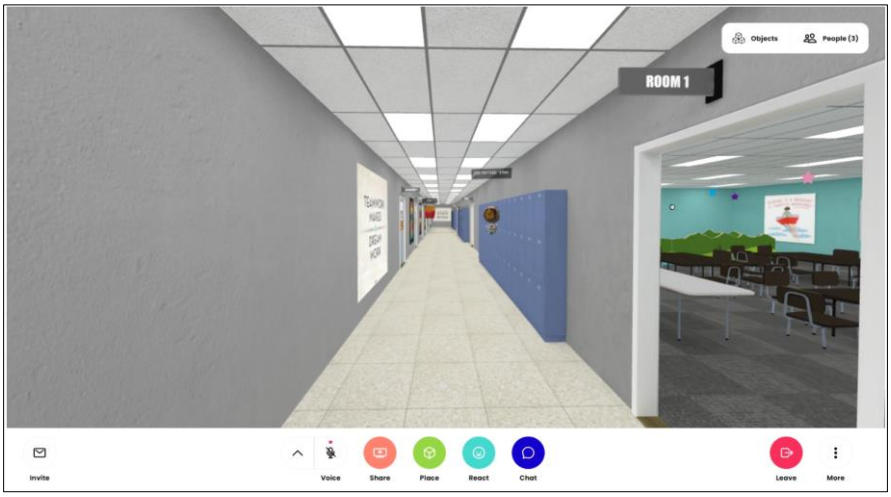

Figure 4. The Simulation Room: Classroom Hallway

This is the first classroom (Figure 5). The researchers had designed this space to be more open and to have grouped tables and chairs, creating a comfortable environment for students to interact with other avatars easily. Students can feel the sensation of the teaching and learning process in a virtual class. In this class, the user can choose the seat they want and see the video that has been displayed on the blackboard.

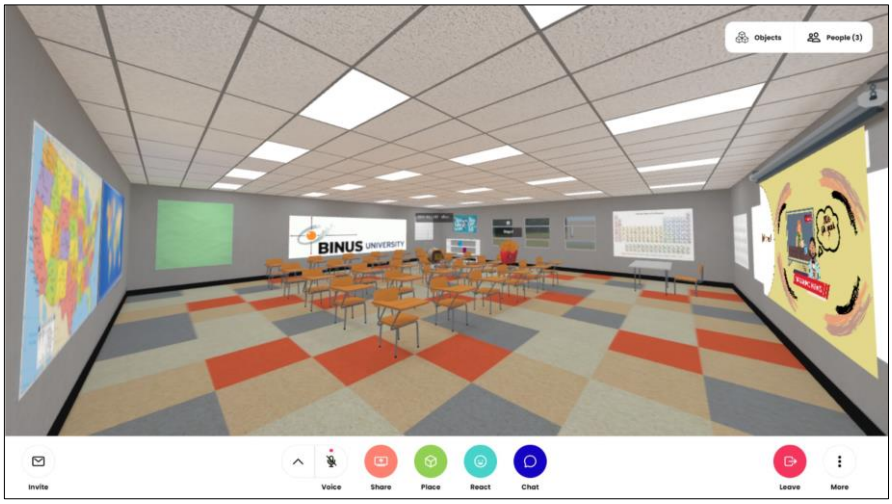

Figure 5. The Simulation Room: The First Classroom

In the following figure, there is a second classroom (Figure 6). This second classroom is more like a classroom in general at BINUS University. In this classroom, respondents also have the option to choose their seats. Additionally, this research uses a PowerPoint presentation that is displayed on the blackboard and can be easily viewed and navigated by the students.

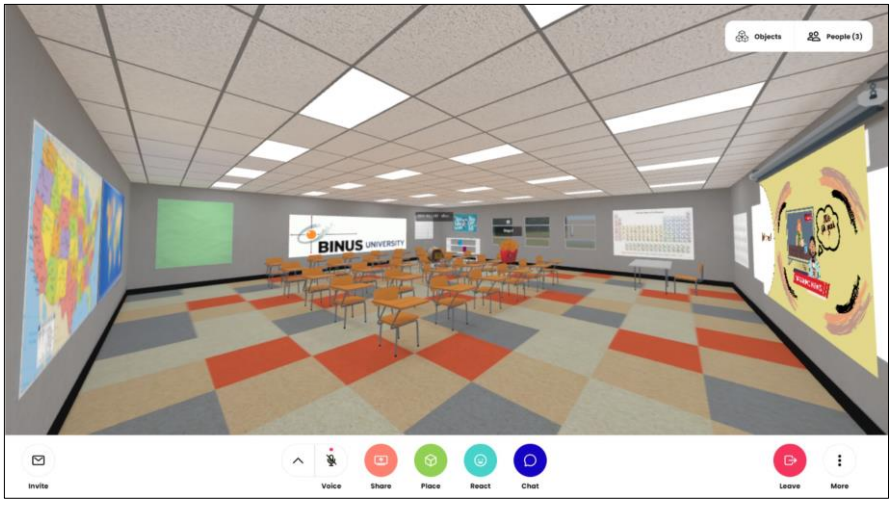

Figure 6. The Simulation Room: The Second Classroom

Figure 7 shows the third and final classroom, resembling a large, ample studio space with an upward or increasing shape. In this classroom, respondents can also choose the seat they want and interact with each other among other avatars. So, the goals in each class are different in shape so that respondents can feel the sensations of various kinds of classrooms.

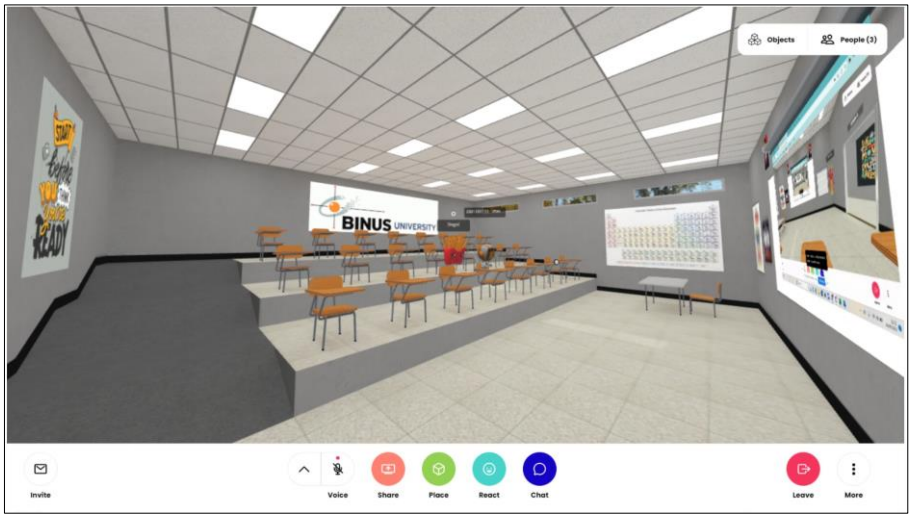

Figure 7. The Simulation Room: The Third Classroom

Figure 8 shows the last room, which is a breakout room. The breakout room is a group workspace or meeting room containing approximately five chairs. This breakout room is used for discussion if there are group assignments or those completed in groups. There are five rooms in the virtual world that the researchers created. In this breakout room, participants can engage in discussions with one another and freely communicate their thoughts and ideas.

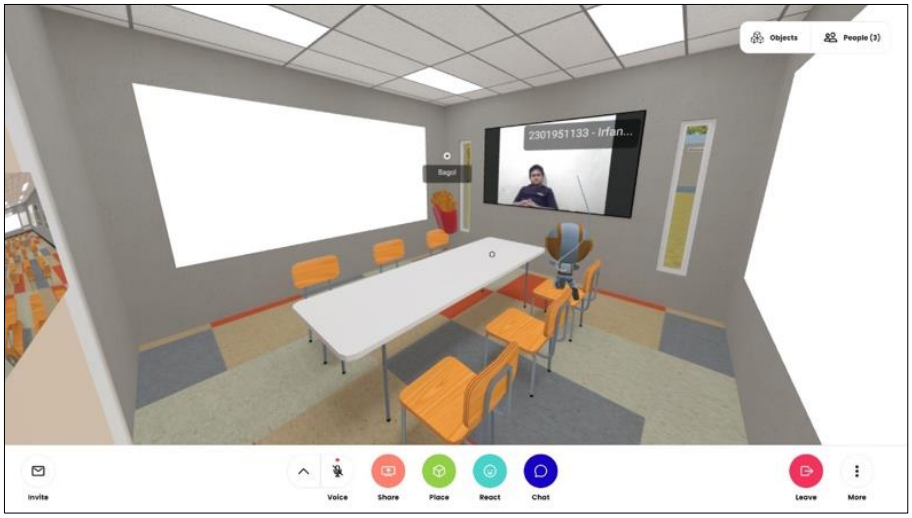

Figure 8. The Simulation Room: The Breakout Room

4-3- Questionnaire Results

The respondents will be required to simulate and test the Metaverse technology using their laptop web browser and VR Headset tools, and then complete and provide an answer summarizing the simulations performed. Respondents completed a survey provided by the researchers and shared their thoughts on the Metaverse based on their own experiences. The researcher processed the outcome data from the results of all questionnaire responses received and further analyzed it using Microsoft Excel with descriptive data processing techniques. Descriptive data processing techniques collect, process, analyze, and present descriptive quantitative data. Description techniques involve presenting data in its original form or providing detailed descriptions of the data. In descriptive methods, data can be displayed in graphical formats, such as tables and graphs, or numerically to calculate mean values and standard deviations. In this descriptive data processing technique, researchers collect and simplify the data they receive. Then, transform that data into more attractive, understandable, and helpful information. Information obtained from descriptive data processing includes data concentration (mean, median, mode), data distribution (standard deviation, variance, range), data group bias, and so on. From the processing of descriptive data, this study obtained the results of five variables, as follows (Tables 4 to 8):

Table 4. Descriptive Data Processing from Comfort

Comfort	
Mean	2.933333333
Standard Error	0.172429118
Median	3
Mode	3
Standard Deviation	0.944433176
Sample Variance	0.891954023
Kurtosis	-0.279045139
Skewness	-0.649882137
Range	3
Minimum	1
Maximum	4
Sum	88
Count	30
Confidence Level (95,0%)	0.352657143

Table 5. Descriptive Data Processing from Convenience

Convenience	
Mean	3.166666667
Standard Error	0.144503377
Median	3
Mode	4
Standard Deviation	0.791477594
Sample Variance	0.626436782
Kurtosis	-1.309004774
Skewness	-0.314622979
Range	2
Minimum	2
Maximum	4
Sum	950
Count	300
Confidence Level (95,0%)	0.295542591

Table 6. Descriptive Data Processing from Compatibility

Compatibility	
Mean	3.275
Standard Error	0.143167017
Median	4
Mode	4
Standard Deviation	0.905467722
Sample Variance	0.819871795
Kurtosis	0.104801144
Skewness	-1.025687819
Range	3
Minimum	1
Maximum	4
Sum	1310
Count	400
Confidence Level (95,0%)	0.289582626

Table 7. Descriptive Data Processing from Interest

Interest	
Mean	3.55
Standard Error	0.198348444
Median	4
Mode	4
Standard Deviation	0.887041208
Sample Variance	0.786842105
Kurtosis	2.834424583
Skewness	-1.926663704
Range	3
Minimum	1
Maximum	4
Sum	710
Count	200
Confidence Level (95,0%)	0.415148065

Table 8. Descriptive Data Processing from Effectiveness

Effectiveness	
Mean	3.1
Standard Error	0.137747446
Median	3
Mode	3
Standard Deviation	0.871191345
Sample Variance	0.758974359
Kurtosis	-0.182684535
Skewness	-0.690671428
Range	3
Minimum	1
Maximum	4
Sum	1240
Count	400
Confidence Level (95,0%)	0.278620509

Tables 9 to 13 show the comparison between the VR headset and website access via a browser on the laptop for all variables.

Table 9. Comparison of Tool Preferences (Comfort)

	Comfort	
	Virtual Reality Headset	**Website Browser Laptop**
Total Point	53%	47%

Table 10. Comparison of Tool Preferences (Convenience)

	Convenience	
	Virtual Reality Headset	**Website Browser Laptop**
Total Point	52%	48%

Table 11. Comparison of Tool Preferences (Compatibility)

	Compatibility	
	Virtual Reality Headset	**Website Browser Laptop**
Total Point	53%	47%

Table 12. Comparison of Tool Preferences (Interest)

	Interest	
	Virtual Reality Headset	**Website Browser Laptop**
Total Point	80%	20%

Table 13. Comparison of Tool Preferences (Effectiveness)

	Effectiveness	
	Virtual Reality Headset	**Website Browser Laptop**
Total Point	46%	54%

4-4- Statistical Analysis

Below is a statistical table (Table 14) of the results obtained for each indicator:

Table 14. Descriptive Statistics for Five Criteria

	Mean	Min	Max	St Dev	Kurt	Skew
Comfort	2.933	1	4	0.928	-0.279	-0.649
Convenience	3.166	2	4	0.778	-1.309	-0.314
Compatibility	3.275	1	4	0.894	0.104	-1.025
Interest	3.550	1	4	0.864	2.834	-1.926
Effectiveness	3.100	1	4	0.860	-0.182	-0.690

According to the descriptive statistical data shown above, the average of each indicator ranges from (2.933 – 3.550) and has a standard deviation ranging from (0.778– 0.928). Each hand has a varying average value but a different minimum value, namely scales 1 and 2. The questionnaire used in this study uses a Likert scale, which is given a minimum score of 1 (Strongly disagree) and a maximum value of 4 (Strongly agree), with most respondents giving Agree or Strongly Agree answers. However, some respondents answered Disagree or Strongly Disagree.

The maximum average value obtained in this study is owned by users' interest in Metaverse, which is equal to 3.550, and the minimum average value obtained in this study is owned by the convenience of using Metaverse, which is to like (2.933). Based on users' experience in trying the Metaverse in Education, they feel interested in the use of Metaverse in Education and want to experience better development in implementing the Metaverse into teaching and learning activities. Based on user experience, some individuals may feel more comfortable using Metaverse for teaching and learning activities if they have experience using a web browser on a laptop or VR headset. This is because they may experience dizziness or discomfort 40% when using these tools for the first time, causing them to feel unused.

From Table 15, the indicators' results still have low values and are pretty good. The current results are good enough, but some respondents must still be satisfied with this Metaverse technology. On a scale of 1-4, the results above are good because there are only five out of 16 question indicators with scores below 3. The values that are not good from the CF1 and CN1 indicators are the contents of the indicator questions, which are questions about using the Metaverse using a web browser on a laptop. It can be concluded that users prefer Metaverse technology to using VR tools. However, in the CP3 indicator (I think this Metaverse Technology is easy to understand quickly), users feel it still needs to be more suitable for using Metaverse in class. This was triggered by limited access and information to use Metaverse, evident from the low results of the indicators EF2 and EF4, so respondents wondered whether Metaverse could increase their productivity. This value can be improved if this Metaverse technology can be developed even better and easier to access because most of the low scores are in internet problems and VR tools, which, if used for a long time, will be heavy and dizzy. The problem is that they must get used to it; it is their first time trying the VR tool. In addition, in the questionnaire, the researcher also asked for suggestions from respondents for this Metaverse technology (CP6). Let’s look at Table 16 below from their feedback:

Table 15. Descriptive statistics for indicators

	Mean	Median	Min	Max
CF1	2.7	3	1	4
CF2	3	3	1	4
CF3	3.1	3	1	4
CN1	2.9	3	2	4
CN2	3.1	3	2	4
CN3	3.5	4	2	4
CP1	3.5	4	2	4
CP2	3.2	3.5	1	4
CP3	2.8	3	1	4
CP4	3.6	4	2	4
IT1	3.6	4	2	4
IT2	3.5	4	1	4
EF1	3.3	3	2	4
EF2	2.8	3	1	4
EF3	3.7	4	3	4
EF4	2.6	2.5	1	4

Table 16. Suggestions and feedback user

	Answer
User Feedback	The use of the metaverse with a virtual reality headset is interesting
	The use of metaverse provides a new and exciting experience
User Recommendation	Internet constraints affect the use of the metaverse.
	Using VR for a long time causes discomfort to the user.

Several respondents provided suggestions and responses saying they were interested in using the Metaverse, primarily virtual reality headset tools. Respondents like Metaverse technology because it offers new experiences that have never been done before. Users can interact with each other and adapt to the latest technology they are currently using. However, some respondents complained about their discomfort when using virtual reality headset tools to simulate Metaverse technology in teaching and learning. This is because if the virtual reality headset tool is used for too long, it will make the user feel dizzy and uncomfortable. This is because the users had never used or tried the tool before. So, it is necessary to adapt to the use of this tool. Users like and are also interested in the previously tried Metaverse technology. However, they provide some suggestions and responses, primarily related to the virtual reality headset tools they use. Therefore, adaptation by users is needed, and according to the researchers, this is a good suggestion and response for the future development of the Metaverse.

In Figure 9, most respondents choose to use the Metaverse (Virtual Reality), which has a percentage of up to 60%. This percentage far outperforms the second option. This second option (Discord) gets a rate of 20% and is followed by Zoom and Metaverse (laptops), each of which has a percentage of 10%. In this case, the respondents were interested in using the Metaverse or virtual reality headsets, during online teaching and learning. This test shows how enthusiastic the respondents or users are about using the Metaverse technology they have tried before.

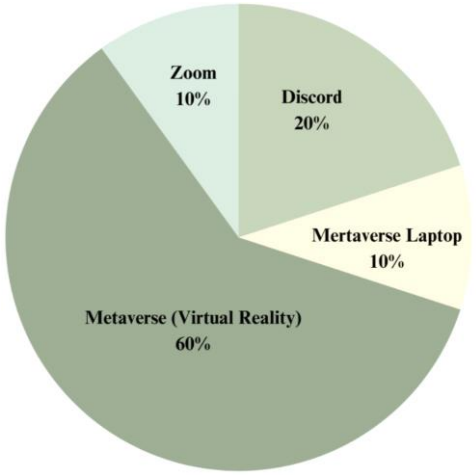

Figure 9. Respondents prefer online classes

5- Conclusion

The Metaverse was initially created and introduced as a virtual new world. Over time, the use of the Metaverse has been adapted to the needs of its users, as used for teaching and learning activities in the Education World. Mozilla Hubs were used in this research. It is very suitable for the needs of researchers in this study, namely a collaboration platform based on Metaverse to implement teaching and learning activities. When using the Mozilla Hub, researchers aim for interaction between respondents or users. Most respondents choose to use the Metaverse (Virtual Reality), which has a percentage of up to 60%. This percentage far outperforms the second option. This second option (Discord) gets a rate of 20% and is followed by Zoom and Metaverse (laptops), each of which has a percentage of 10%. Respondents were very interested in using the Metaverse, or virtual reality headset, during online classes' teaching and learning processes. However, it is necessary to increase and develop in implementing this Metaverse technology because it still requires careful preparation and several aspects such as security, infrastructure availability like internet capabilities (bandwidth capacity), etc. During the meta-version technology simulation, researchers were limited by time and tools, which resulted in a limited number of respondents being included. Therefore, adequate equipment is needed to adjust it to the next target respondent, and there is also more time to explore further the implementation of Metaverse technology in the learning process. The researchers suggest the journal will develop even better to attract readers' interest. This journal is very suitable for new research work for students and lecturers.

6- Declarations

6-1- Author Contributions

Conceptualization, Y.K.; methodology, Y.K. and A.E.S.; software, I.A.K. and R.S.; validation, S.E.H., Y.K., and G.B.; formal analysis, Y.K.; investigation, A.E.S., I.A.K., and R.S.; resources, A.E.S.; data curation, Y.K.; writing—original draft preparation, Y.K.; writing—review and editing, G.B.; visualization, R.S.; supervision, Y.K.; project administration, S.E.H.; funding acquisition, Y.K. All authors have read and agreed to the published version of the manuscript.

6-2- Data Availability Statement

The data presented in this study are available on request from the corresponding author.

6-3- Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

6-4- Institutional Review Board Statement

Not applicable.

6-5- Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

6-6- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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Appendix I: Questionnaire From

The Use of Metaverse in Teaching and Learning Activities for Undergraduate Students at Bina Nusantara University

Good morning/afternoon/evening ladies and gentlemen and friends.

Introducing, we are BINUS University students from the Information Systems Department, Aldino Eka Susandyoga, Raditya Sismandrajaya, and Irfan Ahmad Kamal.

At this time, we are conducting research for the Final Project with the title "The Use of Metaverse in Teaching and Learning Activities for Undergraduate Students at Bina Nusantara University".

In this research, we will try to learn more deeply about metaverse technology in the teaching and learning process based on the perceptions of undergraduate students at Bina Nusantara University. Where, we will create a classroom using metaverse technology to try and find out whether this metaverse technology is suitable in the teaching and learning process for undergraduate students at Bina Nusantara University.

We will examine what we need to prepare to increase students' readiness to adopt this Metaverse technology, and dig deeper into the prospects, implications, and sustainability of Metaverse development. We will also see how undergraduate students respond to using the classroom with this metaverse technology by looking at the interactions between users, adjustments when using it, and also experiments given by users. Where, this metaverse can become the latest innovation technology in the teaching and learning process at Bina Nusantara University.

* *Indicates required question*

Name *

your answer

NIM *

your answer

Email address *

your answer

Comment on your experience:

Give your opinion regarding the following statement with the following measurement scale:

1 : Strongly Disagree
2: Disagree
3: Agree
4 : Strongly Agree

I am interested in using Metaverse technology in classroom learning *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

I found a difference when using Metaverse Technology with Laptop and VR *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

I find it easier to take Metaverse classes using a laptop *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

I find it easier when taking Metaverse classes using VR tools *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

I feel more comfortable when I take the Metaverse class using a laptop *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

I feel more comfortable when I take Metaverse classes using VR *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

I'm having trouble taking Metaverse classes using VR for too long *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

In my opinion, the Metaverse Technology is suitable for use in the classroom *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

I feel more productive when I take Metaverse classes using a laptop *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

I feel more productive when I take Metaverse classes using VR tools *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

I feel more interested in joining the Metaverse class using a VR device than a laptop *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

Does the speed of the internet really affect the use of Metaverse Technology ? *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

Do you agree that the internet is the factor that most influences the use of Metaverse Technology *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

I think this Metaverse Technology is easy to understand quickly *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

I feel it takes quite a long time to understand the use of VR tools *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

I am satisfied with Metaverse technology in classroom learning *

	1	2	3	4	
Strongly Disagree	○	○	○	○	Strongly agree

I prefer to take online classes using: *

- ○ Zoom
- ○ Microsoft Teams
- ○ Discord
- ○ Metaverse (Laptops)
- ○ Metaverse (Virtual Reality)
- ○ Other