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DEVELOPMENT OF MILLEALAB VIRTUAL REALITY BASED ON DIGITAL MATHEMATICAL COMMUNICATION SKILLS FOR JUNIOR HIGH SCHOOL STUDENTS

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***Abstract*—The development of Millealab Virtual Reality (VR) for teaching algebra in junior high schools has shown promising potential in enhancing digital mathematical communication skills among students. This research aims to create an engaging and interactive learning environment through the use of VR, making algebraic concepts more accessible and comprehensible. The study involved validation tests by subject matter experts and mathematics teachers, revealing that the algebra content presented in VR aligns well with learning objectives. Practical tests across various demographics indicated that VR could significantly increase student interest and understanding of mathematical concepts. However, some students initially struggled to follow VR instructions, requiring proper guidance and support. Despite these challenges, the use of VR in mathematics education demonstrated a high level of student engagement and improved comprehension of algebraic concepts. This suggests the need for ongoing content development, tailored guidance, continuous evaluation, and adjustment of VR-based learning materials to match student capabilities and motivations, ensuring the effective integration of VR technology in mathematics education.**

Keywords— ***virtual reality; algebra; junior high school; digital mathematical communication; interactive learning; mathematics education.***

I. INTRODUCTION

Conducive learning environments are closely related to students' learning quality. Creating appropriate learning settings can reduce boredom and mental fatigue among students, while fostering interest and flexibility in learning [1]. In an active learning environment, students are not individually burdened with solving various cases that arise in the learning process; instead, they can ask questions and engage in discussions, thereby alleviating the heavy load of learning. By employing active learning strategies, it is hoped that students can achieve optimal learning outcomes.

However, the learning outcomes in mathematics education still fall short of expectations, as evidenced by the persistently low mathematics scores [2]. One area within mathematics where performance remains low in problem-solving is algebra [3]. Misconceptions among middle school students, particularly in algebraic operations, are still prevalent [4]. Students encounter difficulties in performing addition and subtraction of constants and coefficients. According to Kartika (2018), the difficulties students face in learning algebra include: a) Challenges in understanding the basic concepts of algebraic forms, b) Difficulties in applying algebraic concepts in word problems, and c) Challenges in substituting known equations [5]. Thus, it can be concluded that students fail to apply formulas in simple calculations, work systematically through calculations, and connect one concept to another. To address the low learning outcomes in algebra, innovation in mathematics education is needed.

One innovative approach that can be utilized is the use of media to facilitate learning, such as Virtual Reality (VR). Millealab is a creative platform within 3D and VR-based learning. It was launched in 2019 [6]. Millealab utilizes cloud technology for storage, making it easy for students to access the virtual world created by teachers [6]. Millealab provides features for both Millealab creators and viewers. Millealab creator is a VR content creation platform installed on computers or laptops, aimed at creating educational content based on 3D and VR technology without the need for coding. Millealab Viewer is a VR learning platform that allows users to access VR content easily. Millealab Viewer can be used in online, offline, or hybrid modes.

According to the research by Tsaaqib et al. (2022), VR is stated to be more effective in increasing students' learning interest compared to conventional learning [7]. Furthermore,

in Alfian's study (2022), 88% of students rated VR-based learning media as "excellent" for its practicality, thus making VR-based learning media both feasible and practical. VR can serve as digital mathematical communication for students [8].

Digital communication involves a two-way relationship between information providers and recipients through digital media [9]. Mathematical communication generally involves direct communication between teachers and students, or indirect interaction between students and textbooks. In this context, interaction between teachers and students does not have to be direct but can take place through technological spaces [10]. According to Baroody, there are two main reasons why communication is a major focus in the mathematics learning process [11]. First, mathematics is essentially its own language. Second, mathematics serves not only as a thinking tool for identifying patterns, solving problems, and drawing conclusions, but also as a means to organize our thoughts from different ideas to communicate accurately and concisely. Based on the research conducted by Khodijah et al. (2021), it was concluded that students' mathematical communication skills fall into the "moderate" category, and students still struggle with interpreting received mathematical information. Therefore, VR can be used in such learning environments [12].

Based on this background, this research aims to create and develop a learning environment through VR for mathematical digital communication abilities using the Millealab platform as a development tool, with the expectation that the results can be used as one of the learning media to explore students' experiences in mathematical learning communication. From these results, research will be conducted on "Developing Virtual Reality Millealab Based on Mathematical Digital Communication Skills for Middle School Students".

II. METHOD

This study is a Research and Development (R&D) study utilizing a qualitative approach. The R&D method was chosen because the aim of this research is to develop a product in the form of mathematics learning media based on Virtual Reality (VR).

The development model used in this study is the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation [14]. However, in this research, only the implementation stage is conducted to a limited extent because the goal is only to produce a prototype product.

The Analysis stage is conducted by identifying learning needs through literature studies and analyzing learning objectives, required skills, and teaching materials. The Design stage includes designing learning situations and VR learning media (content, interface, graphics). The Prototype Development stage develops a VR learning media prototype based on the design, then the prototype is validated by subject matter experts and media experts.

The research subjects involve seventh-grade junior high school students, mathematics teachers, lecturers, and the general public. Sugiyono (2016: 308) explains that data collection techniques are the primary activity in research because they aim to obtain data [14]. Data is collected through interviews with expert guidance (validation), observations with student observation sheets (practicality test), and online questionnaires/surveys for students, teachers, lecturers, and the public (practicality test).

Data analysis is conducted using analytical descriptive techniques, through stages of data reduction, data presentation, and drawing conclusions.

III. RESULTS AND DISCUSSION

In the analysis stage, the identification of the learning needs of junior high school students in understanding algebraic materials was conducted. The identification results indicate that students experience difficulties in identifying and addressing algebraic materials. To address this issue, learning strategies that provide real-world contexts and effective learning are required. Learning using VR is expected to assist students in understanding and applying algebraic concepts more effectively.

In the design stage, the learning module was designed using the Canva platform with an attractive layout that is easy for junior high school students to understand. This module serves as a guide for students to engage in VR-based learning, including how to download the application, join virtual classes, and navigate in VR mode. Once the module was designed, the virtual learning environment was created using Millealab Creator. This environment includes a virtual school building, additional assets, and supporting characters that provide guidance in the learning process.

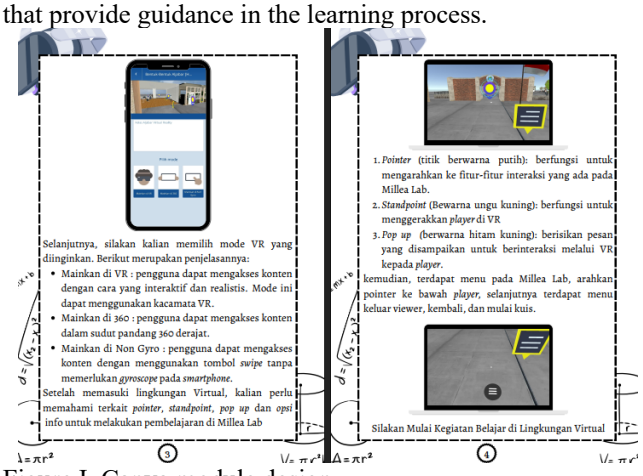

Figure I. Canva module design

Figure II. VR world design at Millealab

In the development stage, validation testing was conducted to ensure that the VR learning media designed is effective and meets the learning needs of students. Validation testing involved interviews with expert lecturers and junior high school mathematics teachers. They provided input regarding the structure of learning content and the effectiveness of VR learning media in assisting students to understand algebra.

TABLE I. VALIDATION RESULTS FROM LECTURERS AND JUNIOR HIGH SCHOOL TEACHERS

No.	Validation Aspect	Findings	Evaluation
1.	Content Presentation	Lack of detailed explanations and specific images for each interaction in the module.	Adding detailed explanations and images to aid student comprehension.
2.	Evaluation Questions	The need for story problems for AKM preparation.	Changing one of the application questions into a story problem.
3.	VR Usage	Interactive tutorials and a clear flow are necessary in VR.	Creating video tutorials and engaging pre-learning apperceptions.
4.	Backsound	A more cheerful backsound is required.	Choosing BGM that suits the learning atmosphere.
5.	Technology Engagement	VR attracts students' interest due to its audiovisual display and similarity to games.	Providing guidance and assistance in the use of VR.

The table above presents the conclusions of the development of VR learning media based on the findings and follow-up actions taken. The evaluation results indicate the need for improvements and adjustments in the aspects of content presentation, evaluation questions, VR usage, backsound, and technology engagement to ensure effective learning media that are suitable for the learning needs of junior high school students.

Limited implementation is conducted through practicality tests to evaluate the use of VR in learning. The following are activities for limited implementation, VR usage, and conducting evaluation questions.

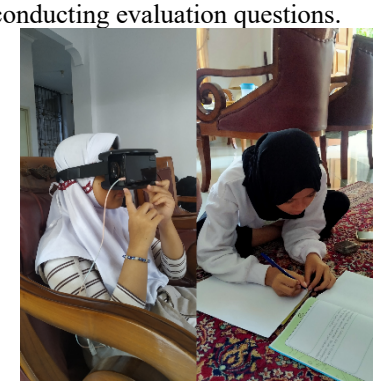
Figure III. Limited implementation activities

This test is conducted through observation and questionnaires involving students, teachers, lecturers, and the general public. Below are the number of respondents participating in the questionnaire:

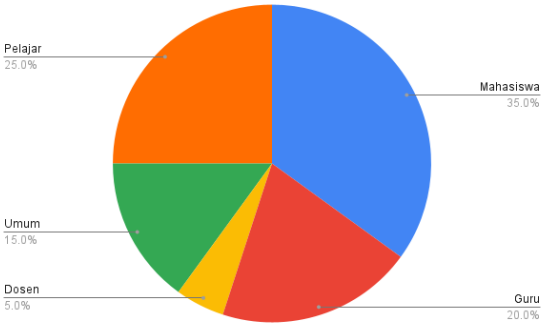

Figure IV. Number of respondents

Considering the respondents' feedback regarding the difficulties in using VR in algebra learning.

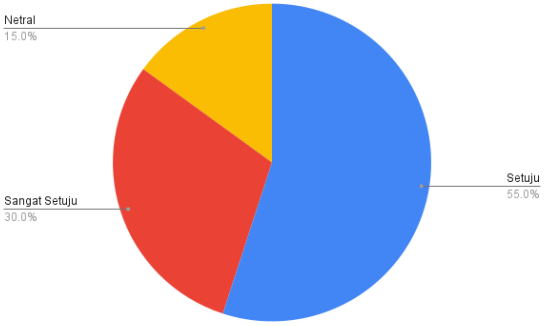

Figure V. The ease of virtual reality in assisting learning difficulties

Assessing the respondents' proficiency in using VR.

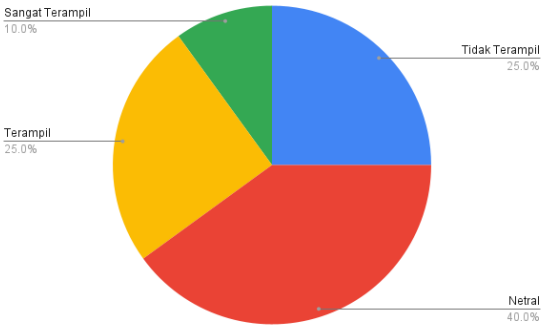

Figure VI. How skilled is the use of virtual reality

Observing the respondents' interest in using virtual reality for mathematics learning.

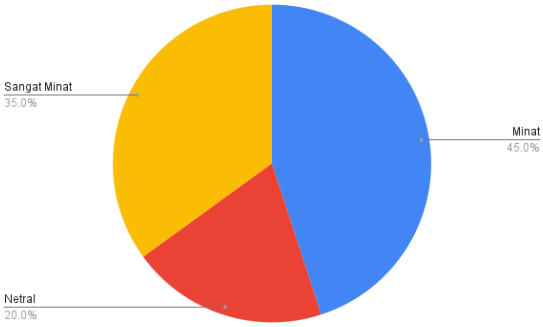

Figure VII Observing the interest in learning mathematics using virtual reality

Examining the respondents' feedback on how VR learning aids can assist in fostering mathematical communication skills in algebra.

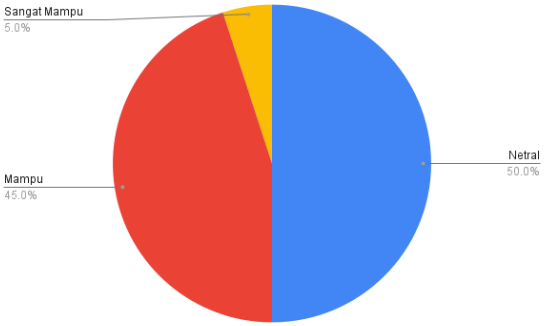

Figure VIII Observing the ability to communicate mathematically with the help of virtual reality

The observation results indicate that students demonstrate high interest and progress in mathematical digital communication skills, although some students still require additional guidance in operating VR technology.

The evaluation phase involves analyzing data from observations and questionnaires to assess the effectiveness of VR learning media. Based on the evaluation results, the VR learning modules and media have met the students' needs and have been able to increase students' interest and understanding of algebraic material. However, further assistance is still needed to ensure that all students can effectively utilize VR technology.

Thus, VR-based learning media focusing on mathematical digital communication skills can enhance students' understanding of algebraic material in junior high school. Further development and implementation are recommended to expand the use of this technology in school education.

IV. CONCLUSIONS

The use of VR in mathematics education shows great potential. Validation testing results from expert lecturers and mathematics subject teachers indicate that the algebraic material presented in VR aligns with the learning objectives. Practicality tests involving various stakeholders also show that the use of VR can enhance students' interest and understanding of mathematical concepts. Students demonstrate high interest in learning mathematics through VR due to its engaging and interactive learning experience. In some cases, students who initially hesitated and struggled to follow VR instructions were able to overcome these challenges after receiving proper guidance and assistance. However, some students still face difficulties in expressing mathematical understanding digitally through VR.

Based on the evaluation results, there are several recommendations for the development and improvement of VR usage in mathematics education. First, there is a need to develop more varied and engaging VR content, with diverse learning approaches to reach students at different levels of understanding. Second, students experiencing difficulties in using VR technology need further guidance and support. Third, the questions presented in VR need to be tailored to students' understanding and abilities so that they can better tackle challenges and feel motivated to solve problems. Fourth, continuous evaluation of VR implementation in mathematics education is needed to continuously enhance and improve the learning process. The use of VR in mathematics education not only increases students' interest but also opens up new opportunities for more innovative and effective teaching approaches. With proper implementation and ongoing evaluation, VR can become a highly useful tool in mathematics education.

REFERENCES

[1] J. Jumrawarsi and N. Suhaili, "Peran Seorang Guru dalam Menciptakan Lingkungan Belajar yang Kondusif," *Ensiklopedia Education Review*, vol. 2, no. 3, pp. 50–54, 2021.

[2] F. K. Sari, R. Rakimahwati, and Y. Fitria, "Hubungan Minat Dengan Hasil Belajar Peserta Didik pada Pembelajaran Matematika Kelas VI SDN 25 Jati Tanah Tinggi," *Jurnal Basicedu*, vol. 3, no. 2, pp. 397-405, 2019.
[3] H. M. Sari and E. A. Afriansyah, "Analisis Miskonsepsi Siswa SMP pada Materi Operasi Hitung Bentuk Aljabar," *Mosharafa: Jurnal Pendidikan Matematika*, vol. 9, no. 3, pp. 439-450, 2020.
[4] Mulyani, E. K. N. Indah, and A. P. Satria, "Analisis Kemampuan Pemahaman Matematis Siswa SMP pada Materi Bentuk Aljabar," *Mosharafa: Jurnal Pendidikan Matematika*, vol. 7, no. 2, pp. 251-262, 2018.
[5] Y. Kartika, "Analisis Kemampuan Pemahaman Konsep Matematis Peserta Didik Kelas VII SMP pada Materi Bentuk Aljabar," *Jurnal Pendidikan Tambusai*, vol. 2, no. 2, pp. 777-785, 2018.
[6] MilleaLab, "MilleaLab," *Millealab.com*, 2019. [Online]. Available: https://www.millealab.com/about-us. [Accessed: May 23, 2023].
[7] Tsaaqib, A. Buchori, and D. Endahwuri, "Efektivitas Penggunaan Media Pembelajaran Virtual Reality (VR) pada Materi Trigonometri terhadap Motivasi dan Hasil Belajar Matematika Siswa SMA," *JIPMat*, vol. 7, no. 1, pp. 11–19, 2022.
[8] M. Alfian, "Pengembangan Media Pembelajaran Berbasis Virtual Reality Millealab pada Materi Sel Elektrolisis," Doctoral dissertation, Universitas Sultan Ageng Tirtayasa, 2022.
[9] S. A. Pramuditya, Wahyudin, and E. Nurlaelah, "Kemampuan Komunikasi Digital Matematis," *Media Sains Indonesia*, 2021.
[10] E. Wahyuni, D. Hidayati, and R. Romanto, "Kesiapan Guru terhadap Pembelajaran Berbasis Teknologi," *Jurnal Pendidikan dan Konseling*, vol. 4, pp. 2556–2560, 2022.
[11] Kadir, "Kemampuan Komunikasi Matematik dan Keterampilan Sosial Siswa dalam Pembelajaran Matematika," *SEMNAS Matematika dan Pendidikan Matematika 2008*, vol. 2, pp. 339–350, 2008.
[12] S. Khodijah, S. A. Pramuditya, and S. Asnawati, "Kemampuan Komunikasi Matematis Siswa pada Materi Sistem Persamaan Linear Dua Variabel," *Pedagogy: Jurnal Pendidikan Matematika*, vol. 6, no. 1, pp. 139–146, 2021.
[13] R. M. Branch, *Instructional Design: The ADDIE Approach*, vol. 722. New York: Springer, 2009.
[14] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. Bandung: PT Alfabet, 2016.