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3D Interactive Virtual Reality Media to Improve Learning Outcomes in Thematic Subjects

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ABSTRAK

Di tingkat sekolah dasar, kegiatan pembelajaran didorong untuk mengutamakan partisipasi dan interaksi siswa dalam proses pembelajaran. Hal ini dilakukan untuk memaksimalkan pengalaman pendidikan secara keseluruhan. Memanfaatkan berbagai macam media pendidikan yang berbasis teknologi adalah salah satunya. Adalah dengan media yang berbasis virtual reality (VR) yang memberikan penggunanya kemampuan untuk berinteraksi dengan barang dalam setting virtual yang tidak hanya tampak nyata tetapi juga memiliki sensasi seperti nyata. Penelitian ini bertujuan untuk mengembangkan Media Interaktif 3D Virtual Reality untuk meningkatkan hasil belajar siswa di Sekolah Dasar. Pendekatan kuasi-eksperimental digunakan untuk metodologi penelitian ini, dan kelompok kontrol sebelum dan sesudah tes dimasukkan. Tes prestasi belajar merupakan alat yang digunakan dalam penelitian ini. Siswa di kelas empat dari sekolah dasar berpartisipasi dalam proyek penelitian. Berikut adalah beberapa temuan yang muncul dari penelitian ini: (1) pengembangan model multimedia interaktif virtual 3D; (2) pelaksanaan pembelajaran melalui media interaktif 3D virtual reality dengan perspektif sistem; (3) Ragam penilaian pembelajaran (assessment) yang memanfaatkan penilaian autentik; (4) Data menunjukkan respon yang baik dari siswa terhadap implementasi media interaktif 3D virtual reality. Terbukti bahwa penerapan media interaktif berupa virtual reality 3D telah berhasil meningkatkan hasil belajar siswa pada Mata Pelajaran Tematik, khususnya IPA di Sekolah Dasar.

ABSTRACT

At the elementary level of school, learning activities are encouraged to prioritise student participation and interaction in the learning process. This is done in order to maximise the overall educational experience. Utilising different kinds of educational media that are based on technology is one of them. It is with media that is based on virtual reality (VR), which gives users the ability to interact with goods in a virtual setting that not only appears real but also has the sensation of being real. This study aims to develop 3D Virtual Reality Interactive Media to improve student learning outcomes in elementary schools. A quasi-experimental approach was utilised for the methodology of this research, and pre- and post-test control groups were included. The learning achievement test is the tool that is being utilised in this research. Students in fourth grade from elementary schools participated in the research project. The following are some of the findings that emerged from this research: (1) the development of a model for 3D virtual interactive multimedia; (2) the implementation of learning through 3D virtual reality interactive media utilising a systems perspective; (3) Varieties of learning assessment (assessment) that make use of authentic assessment; (4) Data demonstrating a good response from students towards the implementation of 3D virtual reality interactive media. It has been demonstrated that the implementation of interactive media in the form of 3D virtual reality has been successful in enhancing the learning outcomes of students in Thematic Subjects, particularly Science in Elementary Schools.

1. INTRODUCTION

In today's world, learning must incorporate many forms of information and communication technologies into various subject areas. As a result of the growth of digital education, it is now feasible to assist students in the acquisition of knowledge and knowledge in a manner that is both swift and accurate

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with the assistance of assisting technology (Agustini et al., 2019; Suni Astini, 2020). The level of interest shown by those participating in the learning process is, in addition to the role that technology plays, a significant factor in determining how effectively the learning process is carried out. Therefore, the teacher must have also explored numerous approaches to develop the motivation of learners in the learning process by utilising educational technology to improve the quality of learning. Virtual reality is one of the media that can be utilised in an engaging learning process and can boost both the willingness and motivation of learners. It is one of the media that can be employed (Rusli et al., 2023; Shahroom & Hussin, 2018). The properties of virtual reality that make it so participatory, imaginative, and immersive also contribute to its growing popularity in the field of education. The implementation enables the learner to be placed in different surroundings with a level of realism that could never be accomplished with a textbook, while avoiding, at the same time, some characteristics that could block learning. Because of its application in the realm of education, pupils are able to be transported to an infinite number of locations and eras (Brown et al., 2020; Perez-Martínez, 2011). The term "virtual reality" (VR) refers to a technology that creates a sense of "virtual immersion" in a digital setting. This is accomplished through the use of a computer-generated graphic simulation that enables users to "immerse" themselves in an interactive three-dimensional environment. The use of virtual reality (VR) technology is becoming increasingly prevalent in a wide variety of areas and industries (Aznar et al., 2018; Everson et al., 2017). This is mostly attributable to recent developments in technology. For example, VR has been implemented in surgical education (Harrington et al., 2018; Yoganathan et al., 2018), sports training (Panchuk et al., 2018), language learning (Parmaxi, 2020), heritage education (Ibañez-Etxeberria et al., 2020) and even as a therapy to overcome stage fright (Bailey & Bailenson, 2017; Stupar-Rutenfrans et al., 2017). The potential of this technology for elementary students, as well as strategies for its implementation in the classroom (Pellas et al., 2021; Schmitz et al., 2020). Given the expected increase in children's use of this technology.

The rapid advancement of information and communication technology (ICT) or information communication technology (ICT), as well as the overall development of global information infrastructure, has changed the patterns and ways of activities carried out in industry, commerce, government and socio-politics. The development of an ICT-based economy and information society has given rise to a new dominant paradigm; the ability to engage effectively in the information technology revolution will determine the nation's future (Bhagwat et al., 2021; Klippel et al., 2020). The National Education Standards Agency explains that the demand for abilities that will stand out in the 21st century is the ability for connectivity, thanks to scientific technology that is increasingly converging, merging and even producing hybrids. This was pioneered by physicists who started speculating in search of a general theory that could explain the relationship of the existence of four forces (gravity, electromagnetism, strong and weak forces) into string theory or a theory that could explain all problems (Theory of Everything).

The world of life and education, especially in the 21st century, has been characterized by the presence of information technology, the impact of which has changed various fundamental aspects of life (Blume et al., 2019; Downes & Mcmillan, 2000). To the academic world, the science and technology mentioned above have opened up new insights about the reality of nature, humans (their abilities and limitations) and the meaning of social and cultural life, thus breaking the domination of the reductionistic philosophy of science at the ontological, epistemological and methodological levels (S. Chen et al., 2020; Kamińska et al., 2021). The utilization of high imaging technology (virtual reality) in Indonesia still needs to be developed. Learning, in general, is still conventional, namely learning that does not involve media technology to visualize material objects. This also happens at the basic education level, which should be more oriented to concrete principles according to its characteristics (Birt & Vasilevski, 2021; X. Chen et al., 2019). This study aims to develop 3D Virtual Reality Interactive Media to improve student learning outcomes in elementary schools. The increase in learning outcomes indicates the learning model's effectiveness (Chang et al., 2022; Checa & Bustillo, 2020; López Chávez et al., 2020). This research produce a form of innovative media in the form of high technology (virtual reality), which can increase the significance of students' understanding of the subject matter. The results of this study will be a reference for all parties related to learning, especially in elementary schools. The strength of this research product is in the media figure, which is interactive, involving students actively in learning through the use of interactive multimedia with visualization of real but virtual objects (Bodzin et al., 2021; Boedecker et al., 2021).

2. METHOD

The experimental technique is being used for this investigation. Because it satisfies all of the prerequisites for investigating the connections between causes and effects, experimental research is considered to be the most comprehensive method for quantitative research. Experimental research

method is a research method that is used to look for the influence of specific treatments on others while the settings of the experiment are controlled (Sugiyono, 2012). This method of conducting experiments is a development of the traditional experimental design, which is notoriously challenging to put into practise. Although this design has a control group, it is not capable of controlling all of the external variables that could have an impact on the results of the experiment. However, its design derives more from pre-experimental design than from experimental design. A Quasi Experimental design was devised as a means of overcoming the challenges that were presented in the process of identifying the control group in research**.** Different methods of data collecting can be used in conjunction with one another, either directly or indirectly. In this research, the data were gathered through the use of several testing procedures. The test as an instrument, assessment consists of "the questions that are given to students in order to get answers from students in the form of oral expression (oral test), in the form of writing (written test), or in the form of action (action test) (Sudjana, 2006). In this research, the format of the test was a description test. The purpose of the selection of questions with the form of this description is to determine the extent to which students can understand the subject by utilising VR.

Subjects of research may be people, objects, or organisms, and they serve as a conduit for the collection of data necessary for research. When a researcher starts to construct a research design, it is the time when they should begin the process of selecting research subjects for their quantitative study. This study was carried out with students in fourth grade at an elementary school. The students in the fourth grade at Jatayu Bandung elementary school, which served as the class's control, and the students in the fourth grade at Cimahi Mandiri Elementary School, which served as the experimental class, accounted for the total of 120 participants in the study. The design used in this quasi-experimental research is a factorial design. In practice, the Research Team developed each learning device in two categories of time (duration), namely a 40-minute virtual reality (VR) device and a 30-minute device. Each device category was assigned to the experimental group treated, compared to the control group that did not receive the treatment. On this basis, the design used is a factorial design (Ali, 2011). The chart of this quasi-experimental design can be seen in Table 1.

Table 1. Quasi-experiment design table

Tool Group	Experiment group	Control group
Virtual Reality for 40 minutes	O_1 x O_2	O_1 O_2
Virtual Reality For 30 minutes	O_1 X O_2	O_1 O_2

The collected information is utilised to calculate how much of an effect or contribution virtual reality has on the students' comprehension of the course material. Pre- and post-tests administered before and after training provided the data. The pupils' pre- and post-test scores were evaluated according to established standards. Gain Score Normalisation Formulation The improvement score (real improvement) is calculated by subtracting the Pre-test from the Post-test results. The anticipated treatment effect is the change in test scores between before and after it (Sugiyono, 2012).

3. RESULT AND DISCUSSION

Result

Design of a 3D-based Interactive Multimedia Model

Creating a 3D Virtual reality Interactive Multimedia application program needs to be designed by considering various aspects so that it can provide significant changes to children's learning outcomes. Through a series of studies both on the existing literature and on existing media products, a 3D Virtual Reality Interactive Multimedia Model was developed, namely the Computer Assisted Learning (CBI) Model. This model consists of 4 layers of elements that must be present in the model, namely: (1) The outermost layer, namely the model assumptions that affect the optimization of the model, (2) The principle model layer (3) The layer which contains the stages in studying the material (4). The core layer, which is the core or target, is the mastery of aspects of student learning outcomes. As depicted in the following diagram as show in Figure 1.

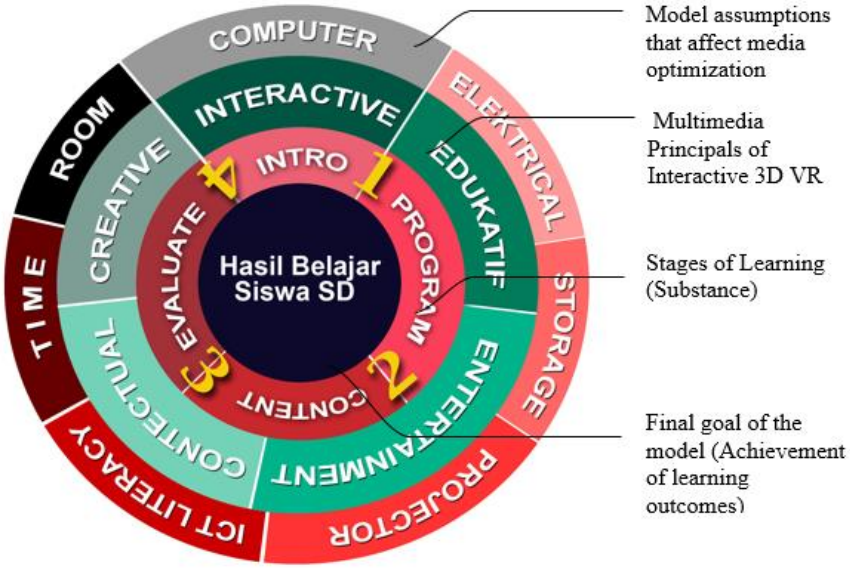

Figure 1. 3D Virtual Reality Interactive Multimedia Model

Layer 1. Model Assumption

This model can be used optimally in student learning using thematic models for elementary grades I-6, depending on the availability of the following aspects: (1) the computer: the main facility that can run programs. The devices used can be personal computers, laptops, tablet PCs and others. (2) Electrical Elements. This program depends on the use of electricity following the computer's supply capacity; this program cannot function in locations that do not have adequate electricity availability. (3) Storage. This program application requires at least 486 MB of data storage space for data files. Thus an empty storage resource is needed for data storage, which can be in the form of a CD/DVD, hard disk, or flash disk. (4) Projectors. In using classical learning, the teacher needs to provide an LCD projector device that can display program files in large sizes so that all students in the class can see them. (5) ICT Literacy, what is meant is the initial ability of both students and teachers to use the program. Students and teachers who cannot operate a computer need help to learn optimally from this application. (6) Time. Sufficient time is needed to use the application. It can be converted according to the available time allocation of 30-40 minutes for each use. (7) The room in question is the need for a room or place that is conducive to learning, the program is equipped with supporting devices such as sound

Layer 2: Basic Principles of Multimedia Interactive 3D

Realizing innovative media that can change children's behaviour takes much work. However, it needs to be designed considering various things, one of which is the principle. Researchers determine there are 5 basic principles: Informative, educative, entertainment, contextual, and Creative. 1.) Informative means that the 3D VR Multimedia presented contains more cognitive information, namely knowledge that students must know. The knowledge in question is both knowledge and understanding. 2.) Educative. This principle is a characteristic of 3D VR Multimedia compared to other media, which are more of an entertainment nature. The educational element refers to the value principles carried, such as honesty, commitment, semantar, empathy and others. Through this film, significant changes will likely occur in students. 3.) Entertainment referred to in this principle is that Multimedia 3D VR must also have an element of entertainment, making the children who watch it entertained, cheerful, and enthusiastic. The entertainment elements displayed can be packaged with jokes (upholstery) and funny object movements. This principle is an attraction so that animated films do not seem boring. 4.) Contextual. The material and substance of the film elevate the existing social reality. The world corresponds to reality, not just imagination and fantasy that have no form in reality. The goal is for students to have knowledge and experience in accordance with everyday life. 5.) Creative. This is in accordance with the world of children, they are still happy with imagination, therefore 3D VR Multimedia must inspire students to think creatively.

Layer 3: Multimedia Interactive 3D Procedure

The flow in this 3D VR Multimedia is designed according to existing standards through several main stages, namely (1) Intro: the display at the beginning of the 3D VR Multimedia, which explains the program identity, program title, target users, and the manufacturing institution. (2) Program Menu: contains several buttons/links that complement the program in the form of materials, exercises and games. Students click on each button for a complete study accompanied by writing, pictures, animations, videos and others. (3) Content contains subject matter that is presented interactively, students learn not only to listen to the lesson but to be actively involved. (4) Evaluate an assessment of student learning outcomes in mastering the material presented in the program.

3D Interactive Multimedia Implementation Model

The learning model referred to in this study is the procedure or steps for using Animation media in the integrity of learning carried out by teachers and students at school. In general, learning is carried out through a systems approach consisting of three main stages, namely: (1) Input, (2) Process, and (3) Output. Systemically it can be described as show in Figure 2.

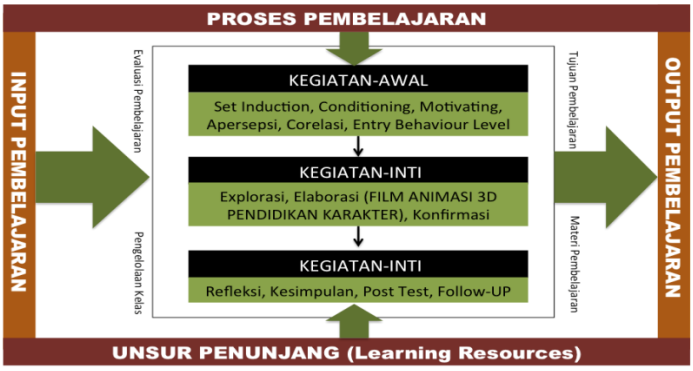

Figure 2. Animation media learning procedure/ steps

Learning input is elementary school students in low grades (grades 1-3) with their characteristics. These characteristics include: 1.) One of the characteristics of low-grade elementary school students is learning from concrete things and gradually moving towards the abstract. 2.) Integrative, that is, at the stage of elementary school children, children still perceive something as a whole, they have not been able to separate a concept into parts by parts. More specific matters. 3.) Hierarchical is a child's learning method that develops gradually from simple to more complex things. Therefore social studies learning material or knowledge that is taught must be logical or make sense so that students easily understand it. 4.) Likes to play and prefers to be happy/happy; low-grade elementary school children still like to play and have fun because they are in the transitional stage from kindergarten, which is full of games. 5.) Expressive. They are usually thrilled and driven to achieve as they do not like to experience dissatisfaction and resist failure 6.) Doing. The characteristics of low-grade elementary school children are that they like to feel or do/demonstrate something directly in terms of the cognitive development theory of elementary school children entering the concrete operational stage. 7.) Groups. Students still like to study with friends or in groups because of their association with peer groups. 8.) Curiosity. Curiosity is high; elementary school children at this age are very critical and often ask random questions to become a learning environment.

The learning process includes 3 main stages, namely (1) Initial Activities, (2) Core Activities and (3) Closing Activities. In the initial activities, the teacher did: opening the lesson by greeting and greeting (set induction). Provide positive motivation and encouragement to students to be enthusiastic about learning. Conditioning students to be ready to learn by sitting neatly, praying, singing or yelling. The teacher links the material to be conveyed with students' knowledge (apperception). Connecting the material presented with the material given at the previous meeting (correlation). Exploring the knowledge possessed by students and connecting with new material based on existing levels. The main activities the teacher carries out: exploring student knowledge (Exploration), and the most important, according to this model, is the teacher carrying out Elaboration by displaying 3D Virtual Reality Interactive Multimedia, which closes with Confirmation activities. The closing activity is filled with: Reflection, Conclusion, Post Test, and Follow-UP. The last stage in this learning activity is output, which means the output in the form of learning targets expected to be achieved by students. The output emphasizes the dimensions of knowledge, skills and attitudes. Changes in behaviour that are

apprehensive become a greater focus and attention because this is at the core of this learning model. The success of this learning cannot be separated from the supporting elements, which are learning resources. Learning resources are all sources in the form of data, people and certain forms that can be used by students in learning, both separately and in combination so that it makes it easier for students to achieve learning goals or achieve certain competencies. Learning resources in this study are in the form of (1) messages: information, teaching materials, folklore, fairy tales, saga, and so on, (2) people: teachers, instructors, students, experts, resource persons, community leaders, institutional leaders, career figures and so on; (3) materials: books, transparencies, films, slides, pictures, graphics designed for learning, reliefs, temples, statues, comics, and so on; (4) tools/equipment: hardware, computers, radio, television, VCD/DVD, cameras, blackboards, generators, machines, cars, motorcycles, electric tools, screwdrivers and so on; (5) approaches/methods/techniques: discussions, seminars, problem-solving, simulations, games, workshops, ordinary conversations, discussions, debates, talk shows and the like; and (6) environment: classrooms, studios, libraries, halls, friends, gardens, markets, shops, museums, offices and so on.

Students' Learning Results Analysis

Based on the research method that has been determined, namely quasi-experimental, this research was conducted in two schools, SD Saluyu Bandung and SD Cimahi Mandiri Cimahi. In each school 2 classes were taken, one as a control class and one as an experimental class. A learning assessment was carried out in each of these classes through the pre and post-test stages. The following results describe the recapitulation of scores for each stage in each school.

Cimahi Mandiri Elementary School

Learning has been carried out for students in grades IV, A and B at Cimahi Mandiri Elementary School in Thematic learning using interactive 3D Animation multimedia. Students involved in the learning were as many as 30 people. In this study, pre and post-tests were carried out in each class. The pre-test aims to determine students' initial abilities (entry behaviour) from students before learning is carried out. At the same time, the post-test aims to measure students' abilities after learning is carried out. The test given is in the form of a written test (pencil and paper test) with 10 items of questions. For the experimental class, it was found that the average pre-test was 55.13, and the post-test was 82.13. The summary of the results of the learning tests is show in Table 2.

Table 2. Cimahi Mandiri Learning Results Recapitulation

School	Class	Average		Gain
		Pre-Test	Post Test	
SD CIMAHI MANDIRI	EXPERIMENT	55.13	82.13	27
	CONTROL	50.53	68.06	17.53

Based on Table 2, there are differences in learning outcomes between the Experiment and Control classes. This can be seen from the average difference between the pre-test and post-test in each class. Furthermore, the difference in learning outcomes can also be seen from the greater gain of the experimental class compared to the control class. As explained in the following graph as show in Figure 3.

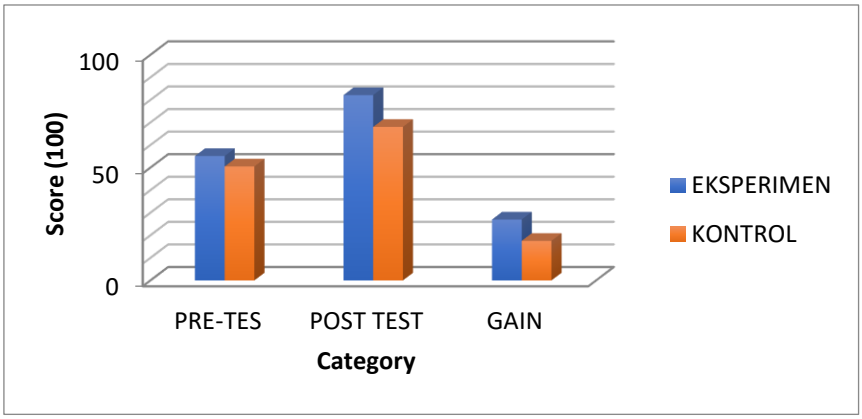

Figure 3. The average difference between the pre-test and post-test in each class

Jatayu Bandung Elementary School

SD Negeri Jatayu is located on Jl. Supadio 39-A Air Complex, Husein Sastranegara, Cicendo Bandung City. At this location, learning activities are carried out as a place to collect data on the use of Multimedia 3D Animation. The number of students involved was 30 people. Class IV was as many as two classes, one class as the experimental class and one as the control class. After the learning evaluation was carried out, the data recapitulation was obtained as show in Table 3.

Table 3. Cimahi Mandiri Learning Results Recapitulation

School	Class	Average		Gain
		Pre-Test	Post Test	
SD CIMAHI JATAYU BANDUNG	EXPERIMENT	53.33	72.26	18.93
	CONTROL	50.53	68.06	17.53

Based on Table 3 it is explained that there are differences in learning outcomes between the Experiment and Control classes. The experimental class has a higher pre and post-test average than the control class. As shown in Figure 4.

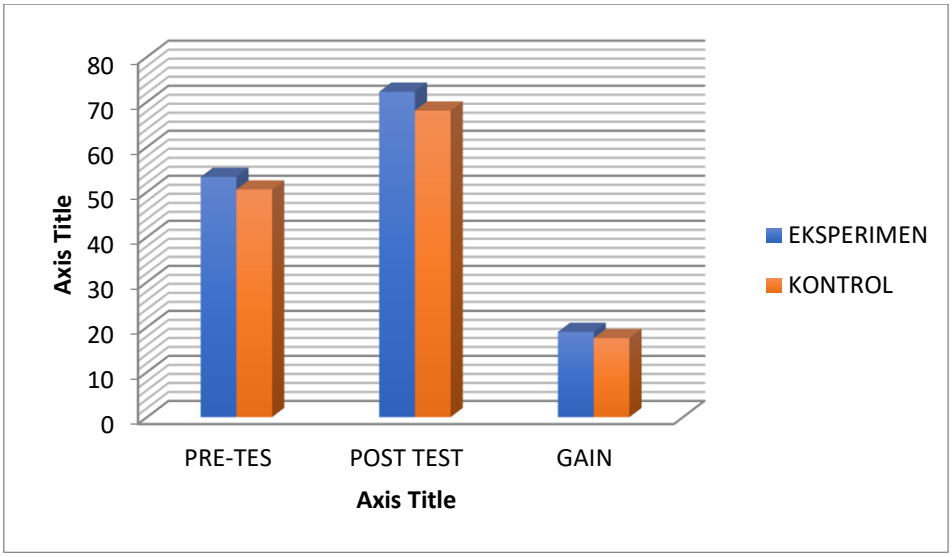

Figure 4. The average difference between the pre-test and post-test in each class

Discussion

As virtual reality (VR) technology continue to evolve, there is reason to be optimistic about their ability to deliver an engaging educational experience. Furthermore, the rapid development of VR features has opened up an almost infinite number of opportunities for teachers of foreign languages. Recent research made use of spherical video-based virtual reality (SVVR) applications. These apps make use of movies or photographs that have been captured in 360 degrees to depict the virtual environment. This environment can be viewed using a head-mounted display (Jensen & Konradsen, 2018; Lan et al., 2018; Wang et al., 2017). For instance previous study shown that the utilisation of SVVR systems for English-speaking instruction in conjunction with the peer assessment method can improve English-speaking ability, motivation, and critical thinking (Chien et al., 2020). In a similar vein other study revealed that higher order thinking was improved in students when they were exposed to SVVR environments (Sun et al., 2018).

In general, the VR corpus demonstrates instances in which the use of VR has brought about a significant increase not only in student learning but also in the development of twenty-first century skills. For instance, the utilisation of a collaborative virtual learning environment in which students were required to communicate in the target language in order to solve a problem led to language gains as well as increased critical thinking abilities for the participants (Campbell et al., 2016; Sourmelis et al., 2017; Sun et al., 2018). The capacity of virtual reality to transport users to locations and experiences that would be difficult or impossible to replicate in a conventional learning environment has also been investigated (Mangina, 2017; Mangina et al., 2018; Yamazaki, 2018). For example, previous study studied the use of VR as a method for evaluating aviation English (Park, 2018). The results of this study showed that virtual

reality (VR) had a good impact, as it demonstrated that performing virtual interactive activities within a virtual world made it easier to apply a variety of strategy types. Additionally, the study found a positive association between the test scores of the participants and the number of cognitive and metacognitive strategies they used. On the other hand, the papers present instances in which the utilisation of VR has not resulted in any appreciable improvement in the level of student learning, as can be shown in research focusing on certain circumstances. For instance, the research conducted brings up the question of the relative efficacy of three-dimensional virtual worlds for the teaching and learning (Tan et al., 2016). It points out the necessity of addressing the complexity of multimodal learning environments as well as the numerous difficulties that come along with them.

There are certain advantages to using VR as a teaching tool in a language school, but there are also some disadvantages. Virtual reality (VR) is seen by both academics and industry professionals as an incredible tool that has the potential to improve the educational experience for students and teachers alike (Mroz, 2015; Spolaôr & Benitti, 2017). However, researchers and practitioners alike need to be aware of what virtual reality (VR) has to offer, as well as its limitations and delimitations. To put it another way, prior to venturing into new educational programmes, we need to have a solid understanding of precisely what virtual reality (VR) has to offer instructors. The primary contribution that this study makes is to demonstrate that virtual reality (VR) has an increasing potential for use in language classrooms. Future researchers and practitioners should focus their attention on the following areas: the alignment of the features of virtual reality (VR) with a solid pedagogical foundation; the alignment of VR features with the learners' strategies, cognitive processes, and practises; the investigation of less-researched skills such as writing, reading, cultural awareness, and critical thinking; and the employment of fully immersive, affordable virtual technologies.

Through a series of research activities carried out as described in the previous chapter, and referring to the formulation of the problem and research objectives. In general, 3D Virtual Reality interactive Multimedia has proven effective in increasing student learning outcomes in Thematic Subjects in Grade IV Elementary Schools. In particular, this study produced some specific conclusions as follows: The design of the 3D Virtual Reality interactive Multimedia model is a computer-assisted learning model/computer-based instruction (CBI) based on 3D Animation Virtual Reality technology. This model consists of four layers of elements, namely: (1) The outermost layer, namely the model assumptions that affect the optimization of the model, (2) The principle model layer (3) The layer which contains the stages in studying the material (4). The core layer which is the core or target is the mastery of aspects of student learning outcomes. Implementation of learning using 3D Virtual Reality Interactive Media to improve student learning outcomes in Science Subjects in Elementary Schools uses a systems approach consisting of three main stages, namely: (1) Input, (2) Process, (3) Output. The focus of using 3D Virtual Reality Interactive Media is in the elaboration phase of knowledge and learning content; students actively use the media facilitated by the teacher (Kersting et al., 2021; Kim et al., 2020).

The form of learning assessment (assessment learning) using 3D Virtual Reality Interactive Media in improving student learning outcomes in Thematic Subjects in Elementary Schools uses authentic assessment, relevant to the objectives of interactive multimedia characteristics. The type of assessment used is a pencil and paper test with objective test techniques and an assessment of student activity and responses. Data obtained showed a positive response from students towards using 3D Virtual Reality Interactive Media in Elementary Thematic Subjects. In general, students are active, creative, enthusiastic, and willing to do the exercises well and there is an increase in student learning motivation (Kittel et al., 2020; Klippel et al., 2019). 3D Virtual Reality Interactive Media has effectively increased student learning outcomes in Thematic Subjects, especially Science in Elementary Schools. This can be proven by increased learning outcomes between the pre-test and post-test in two school locations, SD Jatayu Bandung and SD Cimahi Mandiri. The score of learning outcomes in the experimental class at each school proved to be higher than in the control class.

4. CONCLUSION

The impact that virtual reality (VR) has on the topic mastery and learning outcomes of elementary school pupils highlights the importance of continuing this line of research. Some studies have indicated that some users can feel symptoms of physical pain when using immersive technologies. This is the case despite the benefits that immersive technologies provide in terms of learning. In point of fact, this condition was referred to as cybersickness when it was first identified in the nineties. In this light, the results of future studies that take into account both positive and negative effects on learning will constitute a significant step forward for the educational community worldwide as they attempt to

evaluate the possibilities of using virtual reality (VR) more frequently in educational settings for longer periods of time.

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