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VR360-INSPIRATION: Learning Media on Plant Structure and Function to Improve Student's Analytical Thinking

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Abstract

Analytical thinking is an ability that is really needed in facing the future challenges, including in the industrial era 4.0. The ability to think analytically is important for students to solve problems in a lesson, including the plant structure and function material which is commonly carried out through observation and practicum activities. Limited conditions during the Covid-19 pandemic require mastery of analytical thinking skills in students through innovative learning media. For this reason, the Virtual Reality 360 Interactive Spherical Panorama Slide Presentation (VR360-INSPIRATION) learning media was developed with a 4D research and development model which aims to improve students' analytical thinking skills. Based on the results of the media validation test, the average value was 3.53 in the valid category. The results of the parametric descriptive test and the effectiveness of the media showed that the use of VR360-INSPIRATION media was significantly different from the results of the control group and had high effectiveness in improving students' analytical thinking skills.

Keywords: virtual reality, analytical thinking, 4D, tour creator, 360, plant structure

INTRODUCTION

The industrial era 4.0 has had various impacts in various sectors of life, including in the fields of technology, social, economy, including education. According to the World Economic Forum (2018), there is a decreasing trend in the need for labor in the field of manual and routine work. On the other hand, there is a constant increase in non-routine jobs requiring analytical thinking skills and innovation, and these results are predicted to last until 2022 and four years thereafter, and even into the following years. However, the quality of Indonesia's young generation as human resources needed in the competitive world in the future is the opposite of what was expected. Based on the 2018 Program for International Student Assessment (PISA) report, the results of the average score of Indonesian students generally decreased from the achievement in 2015 and were still in the bottom ten rank of all PISA participating countries [22]. In scientific literacy, for example, Indonesian students have a major weakness in verifying whether or not information is logic based on scientific evidence. Based on that contradiction, it seems that the government and all education elements in Indonesia must do an evaluation.

One of the government's efforts to improve the quality of education in Indonesia is changing the format of the final assessment of students from the National Examination (Ujian Nasional) to the National Assessment (Asesmen Nasional) including Minimum Competency Assessment (Asesmen Kompetesi Minimum) and character surveys which purely assess the quality of learning in schools through sampling techniques. The AKM questions have also been designed in the types of questions that test higher-order thinking skills in students and resemble PISA questions which include assessing student achievement based on content, context, and cognitive processes [27]. This positive change should be an encouragement for teachers as implementers of education in schools to improve the quality of learning by using strategies,

models, media, and a form of learning assessment that can improve students' higher-order thinking skills (HOTS), because these abilities are cognitive competencies that students need to master in learning, including analytical thinking skills [46].

Analytical thinking is a component in higher order thinking [29]. The ability to think analytically is needed by students in the problem solving process in a lesson [31] so that when students answer cognitive questions of C4 type (analyze), students can apply their knowledge to solve these problems. According to [20], analytical thinking consists of five processes: matching, classifying, analyzing, generalizing, and detailing. Analytical thinking allows students to think logically about the relationship between the scientific concept and the contextual situation. Through the use of analytical thinking, one will involve the ability to (1) categorize the problem into its parts and understand the reading text, (2) explain the function of a system, the reason for something happening, or how to solve a problem, (3) compare and distinguish two or more phenomena, or (4) evaluate and test the characteristics of a phenomenon [16]. Analytical thinking is useful for adapting and modifying the information needed to overcome problems, especially those related to everyday life [24], including science subject matter regarding the structure and function of plant.

In the realm of knowledge and skills, according to basic competence (Kompetensi Dasar) in the for the structure and function of plant tissue material for eight grade students which has been set in Permendikbud number 37 of 2018, students are expected to be able to: (1) analyze the structure of plant tissue and their functions, as well as the technology used inspired by plant structures and (2) presents a creation which made from many resources about technology inspired by plant structures [18]. Based on these basic competency targets, students are required to have the ability to think analytically. According to the results of a questionnaire to 21 science teachers in Sukmajaya, Depok City, Indonesia, the answers from 15 teachers state that the structure and function of plant tissue in eight grade is material that is generally delivered by observation method on the plant morphology sub-material and by the practicum method of practicum in the plant anatomy sub-material using a microscope. Unfortunately, the Covid-19 pandemic required changes in the targets and implementation of the learning process. The process of learning activities cannot be carried out with the direct observation method, as well as practicum in the laboratory. Therefore, a media that can facilitate the delivery of learning material on the structure and function of plant is needed so that it can be carried out properly.

Virtual reality (VR) is defined as a computer-based technology that displays a replica of an environment and allows an activity to be carried out by the user so that it seems to be present and interacts in that environment [19]. Studies on the use of VR content in education have been going on for more than half a century. In general, the results of their use have shown positive findings ranging from increased time efficiency, interest, motivation [15], and retention in students [17]. According to [31], VR content has several characteristics that make it recommended for educational purposes. Its interactivity provides a more experiential learning process than the traditional or classical media and methods. Students will feel the atmosphere of the real environment, especially if coupled with the use of VR-head mounted displays (HMD) or VR glasses because the students will not be distracted by external visual disturbances and drift in a virtual environment that can bring deeper learning [9]. According to the research results of [35], VR simulation in biology learning can provide an interactive learning experience, increase students' interest in learning, and be more effective than two-dimensional media in increasing learning outcomes and understanding science-related concepts and phenomena.

Based on the background that has been stated, researchers designed VR learning media in the form of a VR360 interactive spherical panorama presentation named VR360-INSPIRATION on the plant structure and function material using the Tour Creator application from Google. Tour Creator is an app that allows teachers to easily create their own VR tours using Google Street View or 360° photos taken with a spherical camera. With Tour Creator, users can produce a good quality VR content without requiring any coding knowledge, add interesting locations to their tours, and display 2D images to those locations so users can explore them further in more detail. The tour can be published on a Poly account (https://poly.google.com), Google's 3D content library, and can be viewed on computers or mobile devices with or without the use of Cardboard or VR glasses [1]. Published tours can be applied to learning by guiding students or directly sharing tour links to students through the website [42].

The learning media developed by the researcher can facilitate the learning process with discovery, inquiry, and observational learning methods virtually which aim to assess students' analytical thinking skills. According to [32], analytical thinking skill can be delivered by using inquiry and discovery learning.

VR360-INSPIRATION learning media is different from a typical media in the Tour Creator site, because the five processes in analytical thinking—matching, classifying, analyzing, generalizing, and detailing—are integrated into presentation slides through the images presented along with links to pretest, posttest questions, and exercises using the Quizizz application that is connected to the students' Google Classroom. VR360-INSPIRATION media can be used synchronously with the teacher's guide or asynchronously as assignments to students. The development of VR360-INSPIRATION media is expected to help deliver the plant structure and function material in accordance with the targeted learning objectives amid the limited conditions caused by the Covid-19 pandemic. In addition, the results of this development research aim to maximize the analytical thinking skills of students in accordance with the demands of 21st century learning.

LITERATURE REVIEW

Virtual Reality

The rapid development of technology offers various conveniences in human life, including in the field of education. Virtual reality (VR) is a technology product developed with the same goal. The term VR was first introduced by John Lanier, an American founder of a company called Virtual Programming Languages (VPL) in 1989 [1]. Virtual reality itself is defined as an immersive computer technology that replicates an environment and allows simulations as if the user can be present and interact in that environment [19]. Despite the many stigma associated VR with various hardware devices such as computers, VR glasses or head-mounted display (HMD), and haptic gloves as motion simulators, [37] separates the essence of VR from the existence of those devices and defines VR as a real or artificial environment that is made in such a way and make the users feel the telepresence or appear to be virtually experience in an actual location.

Initially, the VR industry produced products that were used in a limited manner in several special sectors such as flight simulations and military training devices [7]. Furthermore, VR technology began to expand into various fields, such as entertainment, marketing, advertising, gaming, including education. The use of VR in education is thought to support contextual learning and create immersive experiences [11], help visualize abstract concepts, explore content in various dimensions and from multiple perspectives [13], build collaborative learning, as well as making it easy to overcome time constraints, accessibility, security, and ethical issues in a practice that is difficult to implement in real life [33]. A number of studies on the effect of using VR media on science learning at various levels of education—from elementary to tertiary education—have also proven that VR media contributes positively to increasing learning outcomes, motivation, interest, and attitudes [2], sharpens practical skills, and helps implement complex experimental activities [43].

In order to feel the truly virtual reality experience, the use of VR glasses is very necessary. There are a wide variety of VR glasses on the market, from affordable Google Cardboard to more sophisticated but expensive head-mounted displays (HMDs) such as the Oculus Rift, Oculus Quest, and HTC Vive [1]. The more sophisticated the device, the more realistic the virtual experience the user will experience through motion tracking and simulating virtual environments using special controllers. However, the sophistication offered is also accompanied by various disadvantages, including expensive equipment costs, devices requiring large mobile space and special storage space, loss of practicality and portability, and complicated device settings. This makes Google Cardboard which was first released in 2014 by Google Inc. to be very popular with teachers because of its affordability, ease of assembly, and independence of use by students without special arrangements. However, it should be noted that VR content that can be enjoyed via Google Cardboard is only 360° videos or photos that are enjoyed via cellphones, so that users have limited interaction with the object being observed. Even so, with the teacher's guidance, this simpler VR experience is quite interesting and more importantly affordable for classroom use.

Analytical Thinking

Empowerment of analytical thinking skills is needed in the industrial era 4.0. Analytical thinking skills are one of the higher order thinking skills that must be trained and require special attention. It greatly affects the formation of conceptual systems in students. It is also indispensable in scientific reasoning to prove that the concept being built is really supported by parts of the concept [21]. Analytical thinking is a reasoning

in understanding a series of situations, which is defined as: (1) the ability to investigate and describe facts and analyze them based on strengths and weaknesses; (2) develop the ability to think wisely and intelligently in remembering and using information to analyze data and solve problems [5]. Analytical thinking skills are the basis of regular and systematic thinking. Through analytical thinking we can solve problems such as fix the tangled threads. Some of the characteristics of someone who has the ability to think analytically include (1) thinking systematically, (2) having high discipline, (3) appreciating facts that are presented logically, (4) liking things that are well organized, and (5) being careful and focus on problem details [36].

Analytical thinking is one of the most basic higher-order thinking skills to sharpen 21st century skills such as critical thinking, problem solving, creative thinking, and decision making [47]. That is why analytical thinking are very important for students. Based on the results of the analysis of the five indicators of analytical thinking skill conducted by Fakhrurrazi in [47] towards 90 students of twelve grade in Surakarta, it was proven that the achievement of students on the five indicators was still in the low category. It is assumed teachers have not accustomed their students to practicing analytical thinking, only memorizing formulas and doing exercises with closed answers.

METHODS

Participant

This research was held from August to December 2020. The research method used is research & development which aims to produce a product and test its effectiveness [38] with the 4D model. The researcher chose to use the 4D development research model which consists of four stages of implementation, namely conducting literature studies (define), design the products (design), develop the products (develop) and distribute the products (disseminate) [40]. The product effectiveness test was carried out using a quasi-experimental qualitative non-equivalent group design method, which is a research design with two groups that were selected non-randomly [37].

The population in this study were all students of Budi Cendekia Islamic Junior High School, Depok, Indonesia. We use purposive sampling to eight grade level where the plant structure and function materials exist. Furthermore, random sampling was carried out on five parallel classes of eight grade to obtain two trial classes with a total of 27 students per class, so that the total sample was 54 students. Granada class was selected to be the control class, while Istanbul class was the experimental class given VR360-INSPIRATION learning media.

Measuring tools

The instrument used in this study was an instrument of analytical thinking. The instrument consists of questions that test the ability to think analytically based on the indicators according to Marzano (2007), whose explanation is detailed by [8]. The analytical thinking ability instrument consists of 50 multiple choice questions which are validated before being used as pretest and posttest questions. The instrument validation was carried out to a small class of 15 students of 8th grade students in Budi Cendekia Islamic Junior High School, Depok, Indonesia. After validation, it is obtained 5 invalid items. The validity test of the analytical thinking instrument uses the anates version 4.1 application.

Table 1 Analytical thinking ability instrument

Indicator of analytical thinking ability	Description	Question number
Matching	Identify similarities and differences between the components of knowledge (concepts, theories, etc.) and group them accordingly	1 *, 2, 3, 4, 17, 18, 19, 33, 34, 35, 36, 37
Classifying	Organizing knowledge into meaningful categories (whether subordinate or superordinate) and identifying the hierarchical structure of information.	5, 6, 7, 2 *, 21, 22, 23, 38, 39, 40
Analyzing errors	Identify concept mismatches and errors in a process	8, 9, 10, 24, 25, 26, 41, 42, 43, 44 *
Generalizing	Build a generalization, conclusion, or principle based on known or observed information	11, 12, 13, 27, 28, 29, 45 *, 46, 47
Specifying	Make an estimate / prediction about what will happen next in a certain situation / scenario	14, 15, 16, 30, 31, 32, 48, 49 *, 50 *

* invalid item

Experiment procedure

The research and development model used is the 4D model which consists of 4 stages. The first stage is literature study (define) through teacher interviews regarding an overview of students' analytical thinking skill seen from their answers in previous subject matter. In addition, researchers also collected information from junior high school science teachers in Sukmajaya Village, Depok, Indonesia regarding materials that require supporting learning media, especially in the Covid-19 pandemic conditions which did not allow students to carry out field observations and practice in the laboratory.

The next stage in the development of VR360-INSPIRATION media is the design stage. At this stage the researchers collected learning material about the plant structure and function along with plant-inspired technology from various sources, including textbooks, electronic books, and material from trusted internet page sources. Then the researchers designed the material plots to be displayed on the media from the beginning to the end. Some 360° images (for example the description of types of plant tissue) are edited with the CorelDraw X7 application, while the slides that show various types of plants are taken using the Xiaomi Mi Sphere 4K Panorama Action Camera. The entire material needed is then designed into the Google Tour Creator website via the page https://arvr.google.com/tourcreator/. On that page, a template material for the structure and function of plant tissue was created, which was inserted with an introductory narrative and points of interest on several objects on the slide.

The third stage is development. The VR360-INSPIRATION media that has been compiled are then tested for its feasibility by two competent validators, seen from the ownership of a educator certificate, more than 10 years of teaching experience, and experience in making science learning media based on interactive technology. The results of the validation instruments filled in by the two expert validators were then used to revise and improve the quality of the VR360-INSPIRATION media. In addition to media development, at this stage the validity and reliability of the analytical thinking ability instrument was also carried out on 15 students of eight grade in Budi Cendekia Islamic Junior High School, Depok, Indonesia.

The last stage is disseminating or the stage of media distribution or publication to students. As an initial activity, at this stage students in the control class and experimental class worked on validated pretest questions. VR360-INSPIRATION learning media was then delivered to the experimental class through synchronous and asynchronous learning. The final activity is to provide posttest to both control and experimental class. At the end of the material, besides filling out the attendance form, there is also a student testimonial column regarding the use of VR360-INSPIRATION media in learning.

Data Analysis

The media that had been compiled were then assessed by two expert validators, namely Mr. Nugraha Sofyan, S.Pd from SMPIT Harjamukti and Mrs. Nurul Awalin, M.Pd from SMPIT Bina Insan Kamil,

Depok, Indonesia. Both of them have more than 10 years of teaching experience, have educator certificates, and experience in training and making learning media, including being members of SEAMEO QITEP. VR360-INSPIRATION was assessed using a descriptive questionnaire with an assessment score from 1-4. After assessing and providing suggestions and input on aspects of the accuracy of the material concept, language, display, and usefulness, the results of the average assessment are then adjusted to the validation criteria for learning media as shown in Table 2.

Table 2 The criteria for the validation of the media and material eligibility by expert validators

Interval category	Criteria	Description
3.25 <x <4.00	Very Valid	Can be used without revision
2.50 ≤ x ≤ 3.25	Valid	Can be used with minor revisions
1.75 <x <2.50	Less Valid	Can be used with multiple revisions
1.00 <x <1.75	Invalid	Cannot be used

adaptation of Ratumanan & Laurens (2011)

After the media goes through the final validation stage, then its effectiveness is tested at the disseminate stage. The data obtained from the participants' pretest-posttest scores in the control class and the experimental class were analyzed using the application of The Statistical Product and Service Solution (SPSS) version 25 through the normality, homogeneity and difference test of the two sample means t-test or independent t test. The t test results will show the difference between the results before and after using VR360-INSPIRATION media in the experimental class compared to the control class that does not use the same media.

The next step is to test the effectiveness to determine the difference in pretest and posttest values based on each indicator of analytical thinking , then calculate it using the Normalized Gain formula (1) as follows:

$$\textit{Normalized Gain} = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Maximum score} - \text{Pretest score}} \quad (1)$$

The results of the Normalized Gain mean of the experimental class were compared to the control class which was then translated into how much the students' analytical thinking skills increased based on the criteria in Table 3.

Table 3 The criteria for obtaining Normalized Gain are analytical thinking skills

Interval category	Criteria	Description
Normalized Gain > 0.7	High	Increased higher analytical thinking skills
0.7 ≥ Normalized Gain ≥ 0.3	Moderate	Improved analytical thinking skills are sufficient
Normalized Gain <0.3	Low	Improved analytical thinking skills are low

adaptation of [12]

RESULTS AND DISCUSSION

Define: student and teacher's need analysis

Based on a search on the results of working on daily assessment questions on the previous subject matter, namely "Work and Simple Plane in Everyday Life", out of 130 students of 8th grade, on average only 47% answered correctly on 4 items in the essay category. C4 or the ability to analyze. This shows that the ability to think analytically in students is low. Furthermore, based on the results of a questionnaire on teacher needs analysis regarding the names of science 8th grade materials which are generally carried out through field observation methods and laboratory practices, 15 junior high school science teachers in Sukmajaya, Depok, Indonesia or 71% of the total respondents chose network structure and function materials. plants (Figure 1).

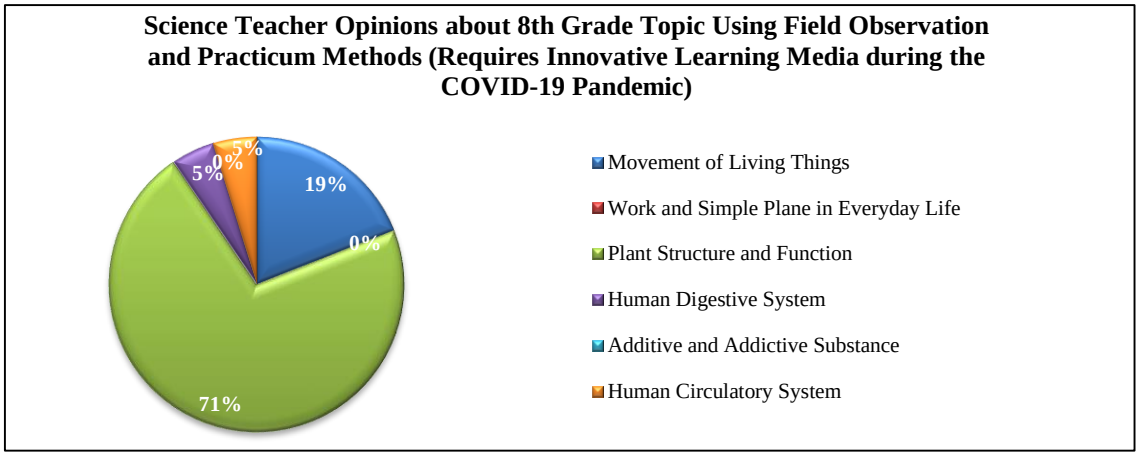


Figure 1 Results of the teacher needs analysis

Design: VR360-INSPIRATION

VR360-INSPIRATION learning media is a learning media consisting of 17 presentation slides that use a spherical or circular view that can be shifted as far as 360°. In the preparation and production, the presentation slides were sorted based on the content of the plant structure and function for 8th grade according to the 2013 revised curriculum in Indonesia. On the presentation slide there is a link to the google form page for the implementation of the pretest and posttest at the end of the meeting. In addition to showing spherical 360 images in several parts, the VR360-INSPIRATION presentation slide also displays a chart / scheme that includes point of interest in the form of images and text narrative (Figure 2).

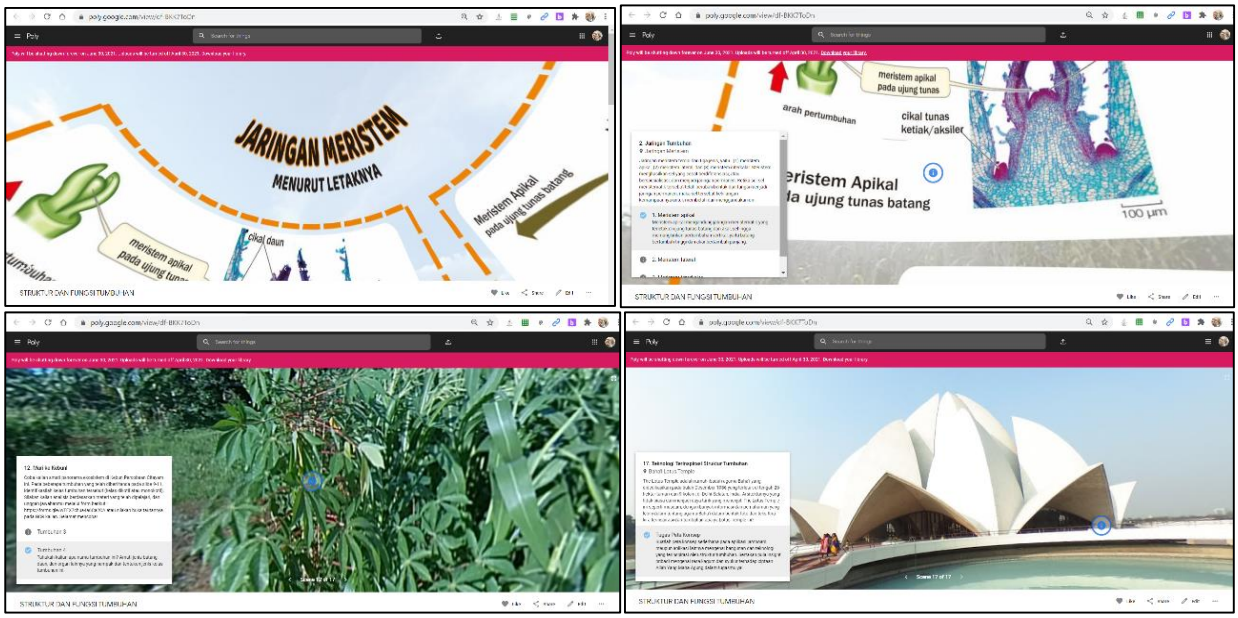


Figure 2 VR360-INSPIRATION media display

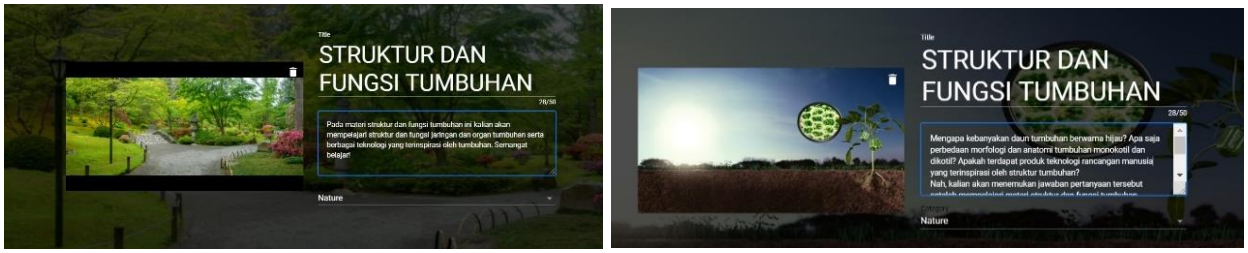
Develop: suggestions and improvements

After the media has been designed, the next stage is development based on assessments, suggestions, and input from expert validators in terms of the accuracy of the material content, language, display, and usefulness of the media. Based on the results of the final validation by two material experts as well as media experts, the final average score is 3.53 for this VR360-INSPIRATION media, which is described in Table 4.

Table 4 The final result of expert validation on VR360-INSPIRATION learning media

Rated aspect	Indicator	Validator 1	Validator 2	Average	Average per aspect
The accuracy of the material concept	Conformity of content with SK, KD, indicators, and learning objectives	4.00	4.00	4.00	3.60
	The order of the material presentation	4.00	4.00	4.00	
	Selection of examples of challenging questions that fulfill aspects of analytical thinking	3.00	4.00	4.00	
	Completeness of the material	3.00	3.00	3.00	
	The actuality and contextuality of the material	3.00	4.00	3.50	
Language	The effectiveness of sentence formation	4.00	4.00	4.00	3.63
	The accuracy of choosing words and terms according to the cognitive level of students	4.00	3.00	3.50	
	The accuracy of using grammar according to PUEBI	3.00	4.00	3.50	
	Use of polite, interesting, and motivating language	3.00	4.00	3.50	
Display	Selection of narration and background image on an attractive introduction page	4.00	4.00	4.00	3.29
	Image selection and layout accuracy	3.00	3.00	3.00	
	Image quality for media content	3.00	3.00	3.00	
	The accuracy of selecting the font type and size	3.00	3.00	3.00	
	The suitability of the narration with the slide being displayed	4.00	4.00	4.00	
	Audio quality	3.00	3.00	3.00	
	Ease of use of media	3.00	3.00	3.00	
Benefit	The ability of the media to facilitate mastery of the material for students	4.00	4.00	4.00	3.63
	The ability of the media in developing students' analytical thinking skills	4.00	4.00	4.00	
	The ability of the media in growing students' motivation to learn	3.00	3.00	3.00	
	The ability of the media to increase the learning independence of students	3.00	4.00	3.50	
Total score		70.00	71.00	70.50	
Average score		3.50	3.55	3.53	

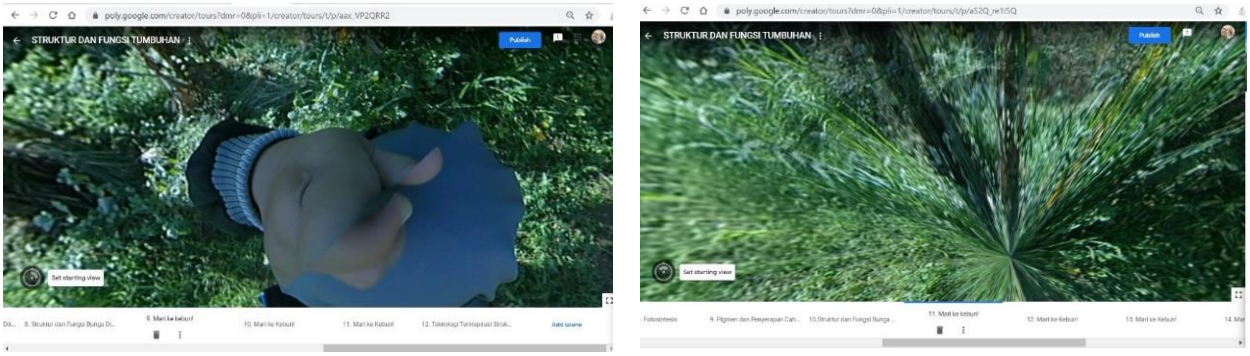
In the aspect of material content, the average score on the first validation was 3.40 and increased to 3.60 in the final result, because the researcher followed the suggestions from validator 1 to perfect the contextuality of the practice questions into a type of National Assessment question using a stimulus in the form of news or issues in everyday life. According to [25], there are several criteria for good stimulus questions, including (1) factual, (2) substantive and interesting to read, (3) challenging but not necessarily too difficult, (4) the narrative is comprehensive and intact, and (5) functions to deliver questions tailored to the indicators of competency achievement. However, not all questions, both in training and evaluation on the VR360-INSPIRATION media, were changed by adding a stimulus in the form of a narrative on contextual issues, because the basic character of HOTS questions (one of which is about the ability to think analytically), does not lie in the presence or absence of a stimulus, but on the level or level of thinking students use in answering these questions [39].



(a) (b)

Figure 3 Opening page display before (a) and after (b) revision with the addition of apperception.

The validator does not give too much note on the linguistic aspect. The average score at the first validation stage has reached 3.50 then increased to 3.63 in the final validation results. Revisions made include the introductory sentence on the opening page being changed to a sentence that not only contains a description of the material (Figure 3a) but added perceptions and questions that arouse the curiosity and motivation of learning of students (Figure 3b). According to [3], apperception is a process in which a set of thoughts or ideas (Vorstellungsmasse) is systematized by the addition of new elements of knowledge. When a new idea about an object enters the mind, it will generate or recall previous memories that refer to the same object. Giving apperception at the beginning of each lesson is important to ensure students are ready to absorb the knowledge being learned [14]. A correct apperception must be able to create conflict or cognitive problems [41] in this case against students. One of the perceptions that can be in the form of questions that are relevant to the content of the material to be studied and related to previous learning will create a cognitive conflict in students, causing a sense of curiosity in them so that the interest and motivation of students to be involved in the learning process will increase [28].



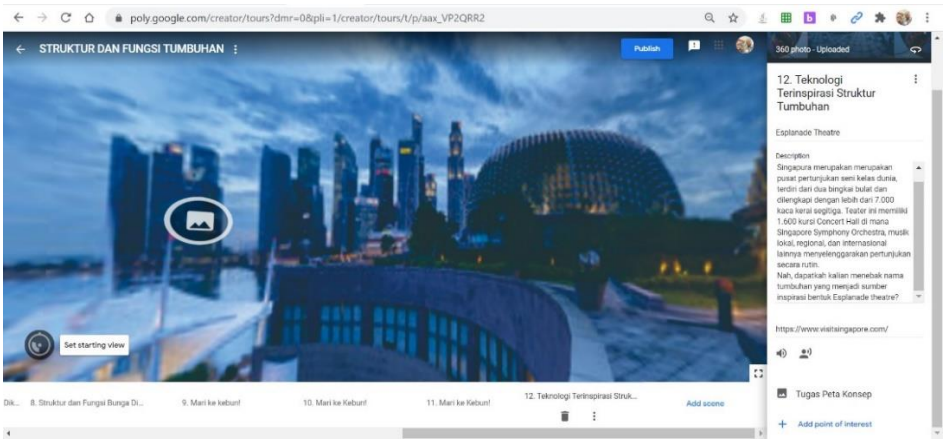
(a)

(b)

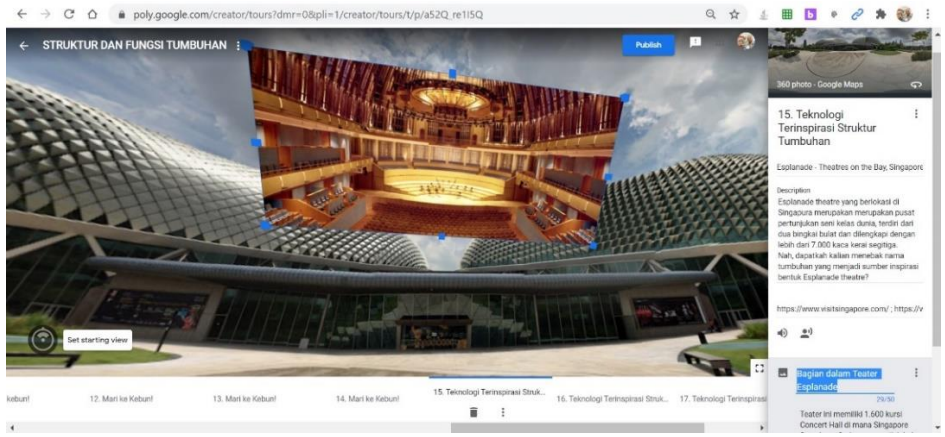
Figure 4 Nadir angle on a 360° photo taken using Xiaomi Mi Sphere 4K Panorama Action Camera before (a) and after revision (b) by removing the less aesthetic parts.

The suggestions for improvement given by the validator on the presentation aspect became the important notes for researchers. The initial validation score for the presentation aspect was 2.86, so that many revisions had to be made to this aspect. Initially, the selection of the background image on the media was only a plain basic colour, namely white with the aim of focusing the eye on the sliced plant tissue image displayed. However, the validator suggested that the background colour of the image should not be too plain and validator 1 suggested a blurry image as the background of the microscopic plant tissue images. In the indicators of image selection, layout, and image quality, there are many notes of improvement from the validator, among them are the existence of a hand holding the camera at the bottom spot of the garden panoramic slide (Figure 4a). The bottom or south spot of the panoramic object where the bottom of the camera usually appears is called the nadir angle [34]. Nadir angle is an angle that is difficult to capture properly when shooting 360 images or videos which are spherical because they are blocked by the presence of a tripod or the camera itself [10]. The existence of this nadir angle is indeed very disturbing in terms of aesthetics, especially if the photos or videos taken will be used as a VR tour object using a head mounted display (HMD) or VR glasses. Researchers have tried to minimize the appearance of the appearance of the hand and camera on the lower side or nadir angle; however, the captured image is still imperfect. As a follow-up to the validator's suggestion, the researcher tries to find a trick to improve the nadir angle by

making photo corrections or editing with the COREL PHOTO PAINT application. As a result, with a patching technique, the nadir angle can be corrected (Figure 4b).



(a)



(b)

Figure 5 Improved image resolution by utilizing Google Street View before (a) and after (b) revisions to the technology slide inspired by plant structures.

Beside the suggestions about background photos and nadir angles, the validator also criticized the image quality on the slides regarding plant-inspired technology. On the slide, researchers took a 360° image of the Esplanade Theater in Singapore. The theater has a shape and is indeed inspired by the shape of the durian fruit. Initially, the researchers downloaded 360° photos with the best resolution that were free to download from the internet, but it turned out that when they were exposed as a slide background on the Tour Creator, the low resolution and free downloads photo did not match the size of the computer screen so they appeared blur and low-pixeled (Figure 5a). As a solution, the researchers replaced the downloaded images with spherical 360° images from Google Street View. After getting the best viewpoint from the Esplanade Theater's 360° panoramic view, then the panorama is added to the slide background for this VR360-INSPIRATION media. Through the Google Street application researchers can added not only Esplanade Theater, but also The Taipei 101 building in Taiwan and The Baha'i Lotus Temple in India as a form of building construction and technology inspired by plant structures (Figure 5b).

The last aspect of the assessment is media usefulness. Based on the results of the validator's final assessment, this aspect obtained a score that was included in the very good category, namely 3.63. Before the revision, the score for the usefulness aspect was 3.38. The increase of 0.25 points was due to the improvement of the question of analytical thinking skill, so that the VR360-INSPIRATION media is considered very valid in facilitating mastery of material, developing analytical thinking skill, fostering learning motivation, and increasing students' learning independence.

Disseminate: impact on student's analytical thinking

At the disseminate stage, the VR360-INSPIRATION media was tested on the experimental class, namely 27 students from 8th Istanbul class in Budi Cendekia Islamic Junior High School, Depok, Indonesia. Before and after learning activities, both the experimental and control classes were given the same pretest and posttest questions, namely a total of 15 pretest questions and 30 posttest questions given in three meetings using VR360-INSPIRATION as a learning medium for students.

The pretest and posttest questions on the plant structure and function which measure the analytical thinking have gone through the validity and reliability tests. As described in the research instrument, from the results of the validity test, there are 5 invalid questions because the t-count value is below the t-table value (t-table = 0.35). After that, to measure the consistency of the instrument in measuring students' analytical thinking, a reliability test was conducted with a result of 0.79 in the high category.

After the data for the students' pretest and posttest scores were collected, the analysis was carried out using statistical tests, namely the normality, homogeneity, and independent t test with the SPSS application. The results of the normality test using the Kolmogorov-Smirnov show that the data came from a normally distributed population. Furthermore, the results of the variance equality test or homogeneity test state that the data are homogeneous. Because the data were normally distributed and homogeneous at the significance level $\alpha = 0.05$, then the two independent t-test sample mean differences were tested.

The number of samples in each experimental and control class was 27 students, so that the t table = 2.007 was obtained. Based on the calculation results, obtained t count equal to 2.020, which means that the pretest and posttest mean results of the experimental class differed significantly from the control class mean, because the t value> t table. Furthermore, to test the effectiveness of media use and see the comparison of the increase in students' analytical thinking skills between the experimental and control classes, the normalized gain calculation was carried out based on the analytical thinking ability indicator, the results can be seen in table 5

Table 5 Calculation Results of Normalized Gain Based on Indicators of Analytical Thinking Ability

Indicator of analytical thinking ability	Class	Pretest Average	Posttest Average	*Normalized Gain*	Criteria
Matching	Experiment	60.40	83.50	0.58	moderate
	Control	61.20	75.20	0.36	moderate
Classifying	Experiment	65.50	84.60	0.55	moderate
	Control	60.30	79.00	0.47	moderate
Analyzing errors	Experiment	61.80	82.50	0.54	moderate
	Control	53.10	59.40	0.13	low
Generalizing	Experiment	55.30	79.20	0.53	moderate
	Control	43.40	54.70	0.20	low
Specifying	Experiment	52.50	73.40	0.44	moderate
	Control	54.40	59.10	0.10	low

DISCUSSION AND LIMITATIONS

The descriptive test results prove that the value of t count>t table which means that the VR360-INSPIRATION media significantly improves the students' analytical thinking skills. In addition, normalized gain for each indicator of analytical thinking skill in the experimental class as a whole has a higher value than the control class. The difference between the normalized gain value is clear, especially in the indicators of analysing, generalizing, and specifying which criteria for the description of the results differ between the experimental class (moderate) versus the control class (low). This may be due to the VR360-INSPIRATION media inserted questions that direct students to think analytically adjusted to a dynamic and attractive spherical 360 slide view so as to facilitate the memory storage process of the material presented. This result is in line with the principle of " Cone of Experience " proposed by Edgar Dale (1969)

in [26], where the position of the learning experience by looking at dynamic images such as on a spherical slide in VR360-INSPIRATION is in the cone area under the learning experience by means of view still or static images. That is, by using learning media in the form of dynamic images, it will further improve the retention or absorption of knowledge in students compared to learning using static image / slide media, for example in learning with simple power point media. The results of this study are also in line with [48] research regarding the Virtual Learning Environment (VLE), that learning with VLE media can improve analytical and synthesis abilities in students.

In addition to the 360° spherical slide along with the point of interest and the explanation, the VR360-INSPIRATION media is also inserted with a link that leads to the virtual lab and also learning videos from Rumah Belajar website from The Ministry of Education and Culture's, so that the VR360-INSPIRATION media can still present material that is usually conveyed by teacher through power point, but with the added advantage of a dynamic display that resembles a real environment, it makes the learning experience more real. The VR360-INSPIRATION media can also be used and explored independently by students so that it supports student-centered learning and enables independent learning. This is in accordance with the study of [45] which states that analytical thinking skills can be improved through learner-centered learning.

Learning with VR media has many benefits for students, including building students' skills, increasing involvement in the topics being studied, and time and cost efficiency [6]. VR media can also enhance 21st century skills, have the potential to increase learners' imaginations towards new discoveries, and increase motivation and enthusiasm due to real-world modeling effects that produce new interactions and experiences [23]. This is reinforced by the student testimonial questionnaire in the experimental class on the impression at the end of the lesson that 96% students stated that the VR360-INSPIRATION media was interesting and increased their learning motivation. In addition, there are also other benefits during the Covid-19 pandemic, namely VR media can be a way to fulfill one's visual desire to visit a location without direct contact with people or objects that can cause the transmission of the SARS-CoV-2 virus that causes Covid-19 [4].

However, in addition to the advantages offered, VR360-INSPIRATION media also has weaknesses and limitations. Unfortunately, in Tour Creator we cannot insert 360° videos on the same page and does not have a zoom in-zoom out feature. The absence of a display magnification feature causes the researcher to make many slides with large image content so that the captions of the image can still be read quite well. The font format provided by Tour Creator is static or the type and size cannot be adjusted as desired, so the researcher cannot fulfill the validator's suggestion to enlarge the image display and change the font appearance. In addition, due to the limited ability of researchers, creating background and content on VR360-INSPIRATION slides is still very simple without using 3D effects. Some of the content in the photosynthesis sub-material still modifies the available templates, so that with various limitations, other learning media such as learning video links are still needed to clarify and enrich the delivery of the material. Researchers hope that Google inc can improve its Tour Creator product so that it can provide more comfort and satisfaction to its users. Given that the implementation of learning during the disseminate stage was an online mode in the Covid-19 pandemic, due to time and cost limitations students do not use VR glasses to explore this VR360-INSPIRATION media.

CONCLUSION

This research conducted is the development of learning media in the form of virual reality 360- interactive spherical panorama presentation named VR360-INSPIRATION with the concept of simple virtual reality on the plant structure and function in 8th grade student. This learning media aims to improve students' analytical thinking skill. The results of this study indicate that compared to the control class that uses learning media in the form of power points, VR360-INSPIRATION media has significantly better results in improving students' analytical thinking skills, especially on indicators of analyzing, generalizing, and specifying.

The application of VR360-INSPIRATION media and the like is indeed very useful, especially in learning materials that require observation or exploration methods to various locations in its lesson. Therefore, VR360-INSPIRATION media is likely to be suitable for application to other science materials such as interactions in ecosystems, layers of the earth and natural disasters, etc. Not only limited to junior

high school science material, VR360-INSPIRATION media seems to be suitable to be applied to various subjects at various levels of education, from early childhood until tertiary education stage. Even more interesting, if the teacher is mastery on content editing, especially converting it into three-dimensional form, not only material that requires field observation, but various materials including the structure and function of human organ systems and other materials can also be supported by this form of media.

Moreover, based on the results of the testimonials at the end of the lesson, 96% of students stated that the VR360-INSPIRATION media is interesting and can increase learning motivation. It is hoped that with an increase in learning motivation, the absorption of knowledge, formation and retention of memory regarding the material presented will be better. However, further studies need to be carried out to see the accuracy of the effect of VR360-INSPIRATION media in increasing learning motivation and other indicators.

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