3D MODEL'S ONLINE MODULES EFFECTIVENESS IN PRACTICING MASTERY OF SOLAR SYSTEM CONCEPTUAL KNOWLEDGE

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ABSTRACT

This study aims to describe the 3D model's online modules effectiveness in the practicing mastery of conceptual knowledge in solar system learning using an instrument which tested 58 7th-grade respondents from one of the junior high schools in Jombang, East Java, Indonesia. The respondents were then divided without randomization into 29 respondents for the experimental group (EG), which studied using 3D models online, and 29 respondents for the control group (CG), which studied using learning resources from student books and learning media in the form of 3D models from the NASA website. The effectiveness is assessed based on the results of the conceptual knowledge test instrument with the CRI method using a quantitative descriptive approach. Based on these results, the 3D models online module in solar system

learning cannot be fully effective in the practicing mastery of conceptual knowledge. When examined further, 3D model's online modules are effective in cognitive dimensions C3, learning indicators 1, 2, and 6, and conceptual knowledge sub-types 1. Furthermore, based on research results, learning the solar system using online modules with 3D models is better than using the official NASA website with student books.

Keywords: 3D models, conceptual knowledge, covid-19 pandemic, online module, solar system.

INTRODUCTION

Coronavirus Disease (Covid-19) has become a pandemic and has spread to various countries, including Indonesia (Morfi, 2020). Because of these problems, the Indonesian government immediately takes action to prevent a wider spread, including in the education field (Prodjomaroeto & Muhyidin, 2021). To comply with government policies related to the education system during the pandemic, most schools in Jombang Regency also conduct distance learning by utilizing various online learning services that are most suitable based on the ease and flexibility of the teachers and students (Sofrul, 2021).

New paragraph: use this style when you need to begin a new paragraph. Even during the Covid-19 pandemic, the learning and teaching process should run smoothly with the help of technology. Or even learning that utilizes technology is the new normal in the world of education (Tang et al., 2021). Conventional learning needs to be replaced with learning models related to technology (Marie, 2021). Several reports show the success of the flipped learning model (Birgili et al., 2021; Biyik Bayram et al., 2023; Shin et al., 2022) and blended learning (Marie, 2021; ozturk & Gunes, 2022). This learning will have a great chance of success if applied in urban areas where access to technology is so easy. However, a different story will occur if the model is applied in rural areas. No matter how sophisticated or modern the methods used in learning, it means nothing if learning resources are difficult to access due to various technical problems related to the availability of technological infrastructure, especially for synchronous learning.

The lack of even distribution of internet access in some areas and part of the population having middle to lower economic levels makes some students slow in responding to learning because their parents have not bought big internet quotas (Badan Pusat Statistik Kabupaten Jombang, 2020). In addition to the various challenges encountered in integrating technology, the learning process has accelerated during the Covid-19 pandemic. The use of technology in the world of education should have a positive impact on teachers and students. It is proven that teachers' essential digital and technology-related teaching skills are more important than digital technology resources (Sailer et al., 2021).

The entire world is going through challenging times, but that does not mean we can sit still. The ability to quickly adapt will be very much needed in uncertain conditions like now (Kasali, 2021). Based on this background, the researchers made a temporary conclusion that students in some areas required learning solutions in the form of innovative learning media adapted to students' conditions. This adaptability will appear in every teacher concerned for students and their innovations. Even in a situation like this, the education world should continue to be optimistic, move, adapt, and innovate to meet the ever-changing world (Kasali, 2021).

The dynamics of learning during the Covid-19 pandemic is a challenge to present solutions for teaching solar system material. The dynamics faced make researchers try to innovate with a module that can be accessed by every student quickly even though they cannot meet face to face. It can facilitate them to explore even in cyberspace and make the material studied not too abstract. Therefore, using 3D model's online modules should be tried to practice mastery of conceptual knowledge of the solar system during the Covid-19 pandemic.

Choosing a module as a solution offered for distance learning during the Covid-19 pandemic was the wisest choice because the module has characteristics that students can study independently. Modules can also be studied repeatedly regardless of the place and time of the study. Several studies support this statement by reporting that electronic modules can improve learning outcomes compared to those without electronic modules (Susanti et al., 2020).

The choice of solar system learning for this research is based on the characteristics of the material, which is classified as abstract (Isik-Ercan et al., 2014). Based on the theory of cognitive development, some experts argue that children have limited and qualitatively different reasoning skills and have little difficulty with abstract thinking (Isik-Ercan et al., 2014; Slavin, 2018).

The researchers also chose the solar system material because it was the last material to be taught in the seventh grade even semester in the 2013 curriculum (Peraturan Menteri Pendidikan Dan Kebudayaan Republik Indonesia, 2018). Due to the solar system material being the last material, science education practitioners often needed more time to discuss the material because there needed to be more time to teach all the material. It is unfortunate considering that the solar system material triggers students' curiosity because it is exciting and related to various phenomena that are close to students but challenging to examine the causes and consequences. Therefore, developing online modules with solar system materials that are flexible in terms of study time and can be used as independent learning resources with various limitations is very necessary to be developed.

On the other hand, the world of education is now dominated by Y, Z, and alpha generations who were born at a time when technology was developing rapidly. Research shows that using technology to complement teaching materials will positively impact learning outcomes (Li & Tsai, 2013; Susanti et al., 2020). Electronic-based games with the theme of environmental geoscience are also reported to be able to support the stimulation and effectiveness of student learning (Pringle, 2013). Several studies also said that education based on technology games on materials related to the solar system received positive responses from students (Kadosawa & Makino, 2018; Muntean et al., 2017; Pena & Tobias, 2014; Salazar et al., 2020; Sin et al., 2017).

When examined further, the average age of children at the junior high school level is 12-14. Based on the theory of cognitive development, children at that age are included in the formal operational category. They can start to think abstractly like adults (Slavin, 2018). However, this development is not a process that takes place as quickly as flipping the hand. They need a slow learning process so that this development can optimally run until they reach the adult stage. Therefore, assistance in the form of appropriate learning media is needed for the teaching and learning process to be meaningful for students. Thus, the selection of 3D models that can simulate events related to phenomena around students can provide them with a CL so that they can master abstract knowledge more smoothly, even in learning during the Covid-19 pandemic.

Several studies report that 3D visualization can improve student learning outcomes (Azhar et al., 2021; El Mawas et al., 2020; Merchant et al., 2014; Muntean et al., 2017; Sahin & Yilmaz, 2020; Salazar et al., 2020), can increase student activity in learning with questions, interest, and curiosity (Kadosawa & Makino, 2018; Muntean et al., 2017), as well as a deep understanding of the orbits of the planets in the solar system when introduced in 3D (Kadosawa & Makino, 2018). The existence of 3D models is also reported to be able to make students comfortable and feel immersed when students use virtual reality (Pena & Tobias, 2014) and suitable for junior high school (SMP) students (Azhar et al., 2021).

Motivation theory also plays a role in students' mastery of knowledge. The use of appropriate and sustainable learning media and learning resources in one complete module can help students be intrinsically motivated by presenting challenging activities with various 3D simulations, enabling students to gain control over their learning by taking advantage of the flexibility of online modules or triggering their curiosity about the solar system (Slavin, 2018). The higher the level of students' intrinsic motivation to continue learning will be directly proportional to the mastery of the knowledge they get (Bayoumy & Alsayed, 2021; Oose et al., 2019; Palittin et al., 2019; Tripathi et al., 2018).

When viewed, it is based on information processing theory which states that information entering sensory memory must get the proper attention and perception before it enters working memory (Slavin, 2018). This 3D model is expected to trigger students' good attention and perception to make it easier to understand the material provided by the online module. Teaching materials that utilize computer programs by adding 3D facilities can allow students to repeat the material and make more in-depth observations. This benefit can help students learn about complex concepts more effectively. Information processing theory explains that the proper repetition process can make the information contained by students last longer by entering long-term memory (Slavin, 2018).The opportunity to be repeated as much as possible can be utilized by teachers or students who use 3D model's online modules appropriately so that the information can be more meaningful and last longer in long-term memory.

It should be noted that adding a virtual 3D model also has a negative impact that needs to be anticipated when implementing it in learning. It was reported that when assessed on 5th-grade elementary school students, virtual reality-based learning media made it difficult for students to understand the information text in the game developed (Pena & Tobias, 2014).

Due to various dynamics and challenges faced by learning during the Covid-19 pandemic, the researchers limited the research results to only concluding 58 respondents who were divided into two groups at one of the schools in Jombang, East Java, Indonesia. Researchers also assume that students' study alone or are guided by their parents during the learning process.

METHOD

This study was conducted to determine the effectiveness of 3D model's online modules (Ervana et al., 2022). The fundamental difference from the research is the use of research design intact-group comparison design where respondents are divided into two groups. One group is treated using 3D models online modules, and the other uses learning resources from student books and solar system 3D models from the NASA official website. More concise research flow can be seen in Figure 1.

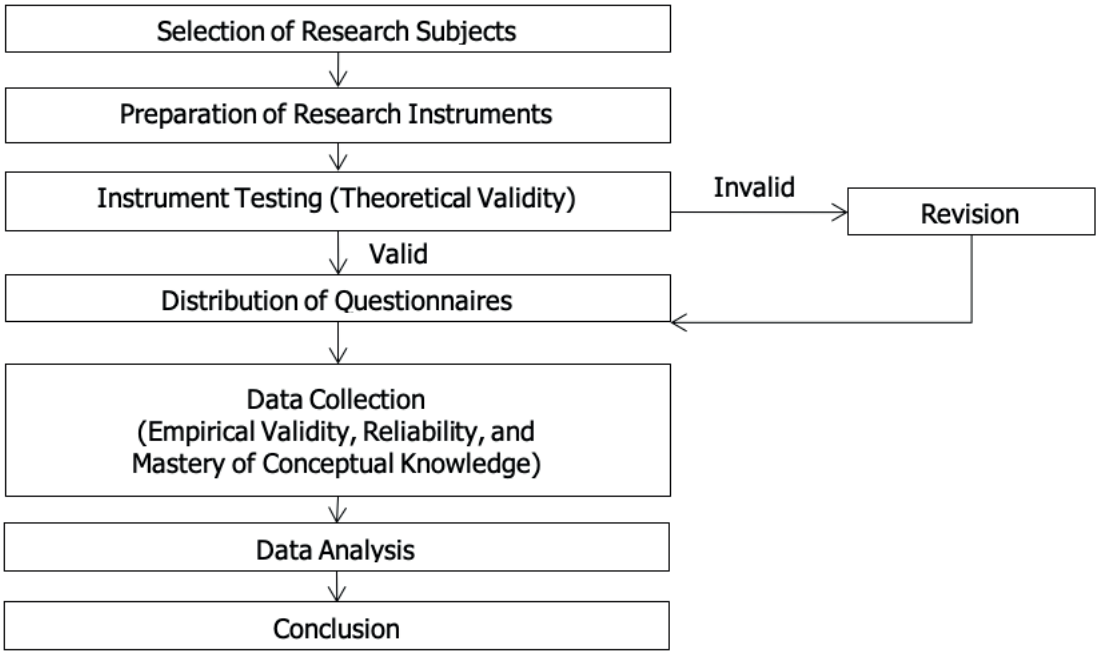

Figure 1. Research flowchart

Participants

The school used for this research is on the outskirts of Jombang Regency, East Java, Indonesia. Most students in the school can only access distance learning using smartphones during the Covid-19 pandemic. The uneven internet access in the area exacerbates the challenge of distance learning. The majority of residents have a lower-middle economic level, and the majority of them work as farmers, making some students relatively slow in responding to learning because their parents have not bought an internet quota (Badan Pusat Statistik Kabupaten Jombang, 2020). The learning conditions at that time were also exacerbated because students were forced to help their parents' economy at certain times, so learning by online meeting was not possible. Two culturally different tribes are participants in this study. The tribes are Javanese and Madurese. However, the distribution of the two tribes in each class the researchers used during the trial had been randomized by the school when determining the study group. So, cultural differences in the trial results can be assumed to have no significant effect.

The school has five study groups in 7th grade. The research trial began by taking two of the five classes with the most feasible learning schedule. The two classes were used as control group (CG) and experimental group

(EG) without randomizing students. As a result, 29 students were included in the EG, and 29 students were included in the EG. Determining students by randomization is not possible because it will interfere with the running of school administration and learning schedules for other subjects. Students' opportunity to get adequate education during the Covid-19 pandemic will also be disrupted and violate human rights.

During the experiment period, both groups were given the same learning method (direct instruction), the same test instrument, and the time and classroom conditions were not much different. Researchers always try to ensure that the results differ from the 3D model's online modules used in EG and student books and learning media in 3D models from the NASA official website used in CG.

Data Collection and Analysis

The instrument consists of 30 multiple-choice questions with the addition of a Certainty of Response Index (CRI). The questions point (QP) were divided into three meetings, each containing ten question points to be assessed. The test instrument used has specifications to measure the student's solar system conceptual knowledge. They are limited to the cognitive dimensions of understanding (C2), applying (C3), analyzing (C4), and evaluating (C5) because it adapts to conditions during the Covid-19 pandemic. Based on the researcher's experience, the cognitive dimension of remembering (C1) was not chosen because it is not suitable to be assessed during distance learning because students can easily search for information on search engines without needing to learn further. In contrast, the cognitive dimension makes (C6) not chosen because researchers find it difficult to supervise and guide students when working on a project during the Covid-19 pandemic lesson.

The cognitive dimension of Understanding (C2) is found in questions 1, 2, 25, 26, 27, 28, 29, and 30. The cognitive dimension of Applying (C3) cognitive dimension is seen in questions 21, 22, 23, and 24. The cognitive dimension of Analyzing (C4) is found in question items 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, and 17. Meanwhile, the Evaluating cognitive dimension (C5) is found in questions 11, 18, 19, and 20. So the total number of questions is 30 questions.

The researcher also used the test instrument's result to determine the competency indicators' achievement. The learning indicator of "Analyze the characteristics of the planets and components of the solar system" is found in question items 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10. The learning indicator "Evaluating information on the shape of the planet Earth" is only found in question 11. The learning indicator "Analyze the rotational motion and revolution of the Earth and Moon" are located in question numbers 12, 13, 14, 15, 16, and 17. The learning indicator "Evaluate information on the phases of the Moon" is found in questions 18, 19, and 20. The learning indicator "Explain the events caused by the movement of the Earth and the Moon" is seen in questions 25, 26, 27, 28, 29, and 30. While the learning indicators "Applying the impact of the movement of the Earth and Moon on everyday life" are found in question items 21, 22, 23, and 24. So overall, the number of item items is 30.

The researcher divided the research instruments into three categories to measure mastery of conceptual knowledge based on sub-types of conceptual knowledge (Anderson et al., 2001). For the sub-type of conceptual understanding, "Knowledge of classifications and categories," the researcher uses question items 1, 2, 3, 5, 6, A7, 8, 9, and 1. The sub-type "Knowledge of principles and generalizations" uses items question number 21, 22, 23, 24, 25, 26, 27, 28, 29, and 30. As for the "Knowledge of theory, model, and structure" sub-type, use item numbers 4, 11, 12, 13, 14, 15, 16, 17, 18, 19, and 20. So overall, the number of item items is 30.

Before being assessed respondents, the validator tested the conceptual knowledge mastery test instrument for its theoretical validity using two expert lecturers and one science teacher. After being declared theoretically valid, Students tested the conceptual knowledge mastery test instrument. The result of instrument theoretical validity is analyzed quantitatively by using the value that often appears (mode) for the three validators. The mode score obtained is then interpreted based on the categories in Table 1.

Table 1. Category for Each Item of Theoretical Validityof Conceptual Knowledge Mastery Test Instruments (Sugiyono, 2018)

No.	Mode	Category
1	1	Not Good
2	2	Fairly Good
3	3	Fine
4	4	Very Good

The results obtained for each aspect are then calculated using the Equation 1.

$$Validity = \frac{the\ total\ score\ of\ results}{max\ score} \times 4 \quad (1)$$

Through this equation, the result of the validity calculation is then concluded based on the criteria in Table 2.

Table 2. Criteria of Theoretical Validity of Conceptual Knowledge Mastery Test Instruments (Budiarso, 2017)

No	Interval Score	Rating Category	Explanation
1	3,51≤P≤4,00	Very valid	Can be used without revision
2	2,51≤P≤3,50	Valid Enough	Usable but needs minor revision
3	1,51≤P≤3,50	Invalid	It is recommended not to use it because it needs major revisions
4	1,00≤P≤1,50	Invalid	Cannot be used

After the test instrument is considered theoretically valid, the instrument is given to the respondent. The results were analyzed using a quantitative descriptive approach. Furthermore, the results of the conceptual knowledge mastery test instrument tested on students are empirically analyzed. In contrast, in empirical validity, the question items in the conceptual knowledge mastery test instrument are said to have internal validity based on how far the grain results are consistent with the overall measuring results of the test. Therefore, the item's validity is reflected in the magnitude of the correlation coefficient between the item score and the total test score. The Pearson product-moment correlation test equation used Equation 2 (Chee, 2016).

$$r = \frac{(n\sum XY)-(\sum X)(\sum Y)}{\sqrt{\{(n\sum X^2)-(\sum X)^2\}\{(n\sum Y^2)-(\sum Y)^2\}}} \quad (2)$$

If this instrument is valid, it can be seen from the interpretation criteria regarding the correlation index (r) in Table 2. Furthermore, the test results are then compared to r_{table} *Pearson product-moment* using a significant level of 5% or 0.05 and the degree of freedom $df = n\text{-}2$ to find out the external validity (Sappaile, 2007). If $r_{result} > r_{table}$ then the item can be said to be valid and if $r_{result} < r_{table}$ then the item can be invalid.

Reliability shows that an instrument can be trusted to be used as a data collection tool because the instrument is already good. This study was conducted using Cronbach's Alpha testing to determine the instrument's reliability in the form of multiple-choice questions. An instrument in the form of reliability is declared reliable if Cronbach's Alpha value contained is at least 0.60. Cronbach Alpha equation show in Equation 3 (Streiner, 2003).

$$\alpha = \left[\frac{k}{k-1}\right]\left[1 - \frac{\sum s_i^2}{s_x^2}\right] \quad (3)$$

The test results are then interpreted with the criteria presented in Table 3. The results of the reliability test of a research instrument are said to be ideal if they get results more than 0.70 or fall into the criteria of good and very good (Wijaya & Darmayanti, 2019).

Table 3. Criteria for interpretation of conceptual knowledge mastery test instrument's reliability (Woollins, 1992)

No.	Score Interval	Interpretation
1	.90 – .00	Excellent
2	.80 – .89	Good
3	.70 – .79	Acceptable
4	.60 – .69	Questioned
5	.50 – .59	Poor
6	< .49	Unacceptable

The method used to identify students' conceptual knowledge mastery uses the Certainty of Response Index (CRI) method. The CRI method is a technique for measuring a person's concept mastery by measuring a person's level of confidence or certainty in answering each question given. The use of the CRI method is also intended to distinguish students who understand the concept, do not know the concept, and experience misconceptions. The scale used in the CRI ranges from 0-5, namely 0 = guessed answer, 1 = almost guess, 2 = not sure, 3 = sure, 4 = almost inevitable, and 5 = certain (Hasan et al., 1999).

The analysis results with CRI are used to distinguish students who know the concept, do not know the concept and those who have misconceptions. The matrix of CRI interpretation results can be seen in Table 4.

Table 4. CRI Criteria (Hasan et al., 1999).

Answer Criteria	Low CRI (<2,5)	High CRI (>2,5)
Correct answer	Correct answer but low CRI (CL) does not master conceptual knowledge. (Lucky Guess)	Correct answer and high CRI (CH) mean mastering the mastery of conceptual knowledge well
Wrong answer	Wrong answers and low CRI (WL) mean that they do not master conceptual knowledge.	Wrong answer but high CRI (WH) means there is a misconception

Identifying the mastery of conceptual knowledge is carried out individually and in groups. Identifying individual misconceptions is done by calculating the percentage of students who experience misconceptions. The percentage calculation is contained in Equation 4, 5, 6, and 7.

$$\%\, WL = \frac{number\ of\ WL\ students}{total\ number\ of\ students} \times 100\ \% \quad (4)$$

$$\%\, CL = \frac{number\ of\ CL\ students}{total\ number\ of\ students} \times 100\ \% \quad (5)$$

$$\%\, WH = \frac{number\ of\ WH\ students}{total\ number\ of\ students} \times 100\ \% \quad (6)$$

$$\%\, CH = \frac{number\ of\ CH\ students}{total\ number\ of\ students} \times 100\ \% \quad (7)$$

The percentage results contained are then grouped into the criteria presented in Table 5.

Table 5. CRI percentage interpretation criteria (Wola, 2020)

No.	Percentage	CRI Criteria
1	.00 – 30.00%	Low
2	30.01 – 60.00%	Medium
3	60.01 – 100.00%	High

From these results, the 3D model's online modules can be said to be effective for practicing the mastery of conceptual knowledge if the percentage results for each CRI identification of misconceptions, do not know the concept, and alleged debts get results of .00 – 30.00%. On the other hand, low criteria, and the identification of CRI master's conceptual knowledge of 30.01 – 100.00% or in the medium or high category (Wola, 2020).

FINDINGS AND DISCUSION

The Instruments Validity

The results of the theoretical validity processing are presented in tabular form in Table 6.

Table 6. Grouping the theoretical validity of conceptual knowledge mastery test instruments based on categories

No.	Category	Amount	Percentage (%)
1	Very valid	5	8.33
2	Quite Valid	55	91.67
3	Less Valid	0	0
4	Invalid	0	0
Total		**60**	**100**

The Pearson Product Moment correlation test was used to determine the empirical validity of the conceptual knowledge instrument results. The results of the empirical validity of the conceptual knowledge mastery test instrument grouped based on the criteria and meetings conducted are presented in Table 7

Table 7. Grouping of Empirical Validity of Conceptual Knowledge Mastery Test Instruments Based on Criteria and Meetings

No.	**Criteria**	**EG**		**CG**	
		QP	**Total**	**QP**	**Total**
1	Valid	2, 7, 8, 9, 12, 18 and 30	7	3, 7, 14, and 15	4
2	Invalid	1, 3, 5, 9, 10, 13, 14, 15, 16, 17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, and 29	23	1, 2, 4, 5, 6, 8, 9, 10, 11, 12, 13, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, and 30	26
3	Undefined	4, and 11	2	-	0
Total			**30**		**30**

The reliability test has a relationship with the consistency of the score and is genuinely relevant when there is a consequence to the interpretation that will be contained (Henson, 2001). The results of the reliability test of a research instrument are said to be ideal if the results are more than .70 (Wijaya & Darmayanti, 2019). However, reliability refers to the evaluation instrument's results and not the instrument itself. So, it is correct to talk about the reliability of 'test scores' or 'measurements' rather than 'tests' or 'instruments' (Henson, 2001). The results of the conceptual knowledge mastery test instrument's reliability test, divided into three meetings in learning, are presented in Table 8.

The effectiveness of the 3D model's online modules is seen using a conceptual knowledge mastery test instrument with the addition of the CRI method. This CRI method has advantages and disadvantages. The advantage is that it is simple and can be used at various levels (high school to college), while the disadvantage is that this method depends on the student's honesty (Waluyo et al., 2019). Another area for improvement of the CRI method lies in categorizing the level of understanding of students who have a low level of confidence and the magnitude of the guess factor of students in answering questions because the form of questions used is a multiple-choice test. For example, if there are students who master conceptual knowledge but because they have a low level of confidence, they get a low CRI scale and are grouped in the category of not mastering conceptual knowledge or are considered guessing answers (Hakim et al., 2012). However, the CRI method is needed to determine the level of student mastery of learning material, especially in distance learning which is difficult to supervise. However, the CRI method is needed to determine the level of student mastery of learning material, especially in distance learning which is difficult to supervise.

Table 8. Reliability Grouping of Conceptual Knowledge Mastery Test Instruments

No.	QP	EG		CG	
		Reliability	Interpretation	Reliability	Interpretation
1	1, 2, 3, 4, 5, 6, 7, 8, 9, and 10	.66	Questioned	.49	Unacceptable
2	11, 12, 13, 14, 15, 16, 17, 18, 19, and 20	.08	Unacceptable	.25	Unacceptable
3	21, 22, 23, 24, 25, 26, 27, 28, 29, and 30	.24	Unacceptable	.54	Poor

The Percentage of CRI during Trials

The results of the answers from the conceptual knowledge mastery test instrument were further analyzed using the Certainty of Response Index (CRI) method. In the trial, two analytical results were contained because two treatments were conducted. The results of the analysis were divided based on the control class and the experimental class are presented in Figure 2.

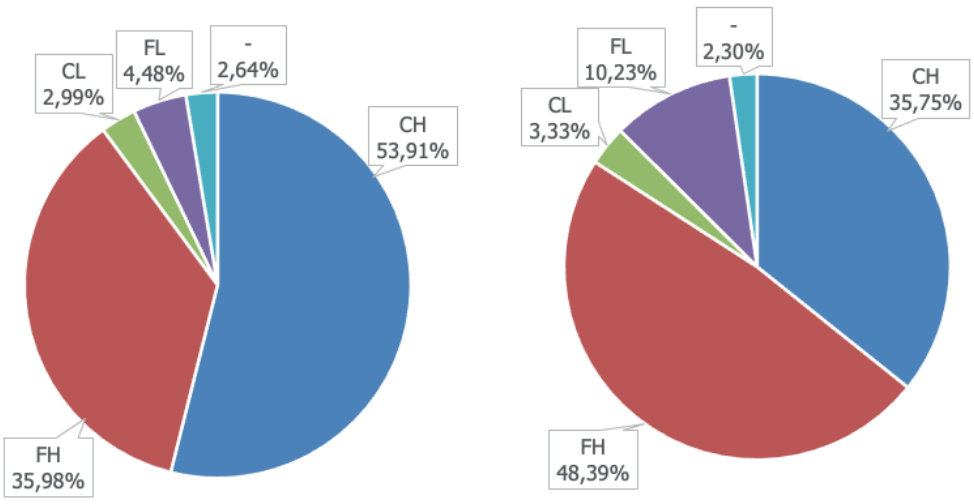

Figure 2. Percentage of CRI during trial on (a) EG and (b) CG

The results of trials in the EG are presented in Figure 2.a. Based on these results, and it is known that overall, 53.91% of students can master conceptual knowledge (CH) in the medium category. On the other hand, 35.98% of students experience misconceptions (FH) in the medium category, 2.99% answer correctly because of luck (CL) in the low category, and 4.48% of students have not been able to master conceptual knowledge (FL) in the low category. In addition to these results, it should also be remembered that 2.64% of students cannot be concluded. Based on these results, a temporary conclusion can be made that the learning conducted in the EG using 3D model's online modules also cannot be effective in practicing mastery of conceptual knowledge. That result is because even though 53.91% of students get the medium category in practicing conceptual mastery (CH). However, 35.98% of students in the moderate category need clarification.

The results of the trial in the CG are presented in Figure 2.b, containing information that overall, 35.75% of students can master conceptual knowledge (CH) in the medium category. On the other hand, 48.39% of students experience misconceptions (FH) in the medium category, 3.33% answered correctly because of luck (CL) in the low category, and 10.23% of students had not been able to master conceptual knowledge (FL) in the low category. In addition to these results, it should also be remembered that 2.30% of students cannot be concluded. Based on these results, learning in the CG cannot be said to be effective in practicing mastery of conceptual knowledge. Because although 35.75% of students fall into the medium category in practicing conceptual mastery (CH), 48.39% of students experience misconceptions and fall into the medium category.

Even looking at the overall treatment of EG and CG is ineffective. The result shows that the level of mastery of conceptual knowledge is in the medium category. That result is because technology-based learning resources that students can use to study at any time can be a solution during the Covid-19 pandemic (Jou et al., 2016; Sletten & Montebello, 2021). Several researchers report that learning by utilizing learning resources can train mastery of conceptual knowledge (Amir et al., 2020; Cai, 2021; Rittle-Johnson & Schneider, 2014).

Conversely, misconceptions are also included in the medium category for EG and CG. The occurrence of misconceptions during distance learning cannot be avoided, however. If students experience misconceptions or fail to master concepts correctly, they will have difficulty solving problems, resulting in low learning outcomes (Soeharto & Csapo, 2022). Many factors lead to misconceptions about distance learning, one of which is the passivity of students and the need for more social interaction (Darici et al., 2021). Researchers can reduce misconception potential by being even more careful in choosing each instruction so students get a better learning experience (Lapitan et al., 2023). Therefore, an online module containing 3D models results in lower misconceptions than learning that utilizes the official Nasa website and student books. However, this cannot be said to be effective because the results of misconceptions are still in the moderate category.

Because based on the results of the trials conducted, the two treatments did not get effective results due to the level of a misconception that was still above 30.00%. The researchers then conducted a more profound analysis by grouping based on the dimensions of cognitive processes, Learning Indicators (LI), and conceptual knowledge sub-types (SKST) (Anderson et al., 2001).

CRI for Cognitive-based Conceptual Knowledge

The grouping of the results of trials based on the dimensions of cognitive processes is intended to provide a comprehensive set of classifications for students' cognitive processes that are included in the learning objectives (Anderson et al., 2001). The dimensions of cognitive processes analysed in this study are C2 (understanding), C3 (applying), C4 (analysing), and C5 (evaluating). The analysis results based on the dimensions of cognitive processes are presented in Figure 3.

The results of the mastery of conceptual knowledge test in the EG showed that 53.88% of students had mastered conceptual knowledge of the C2 cognitive process dimensions with moderate criteria. The cognitive process dimension C2 is a learning objective to construct the meaning of instructional messages, including oral, written, and graphic communication (Anderson et al., 2001). Meanwhile, 38.79% of students experienced misconceptions with low criteria, 2.16% correctly answered because luck was in a low category, and 3.45% of students had yet to succeed in mastering conceptual knowledge on the C2 cognitive process

dimension. In the CG, the results were 47.84% of students mastered the cognitive process dimensions C2 with moderate criteria, 37.50% in the medium category, students answered correctly because of luck, 5.60% in the low category, and 8.62% of students have not mastered conceptual knowledge with low category on the cognitive process dimension C2. Using 3D models as learning media offers a deeper and more accurate understanding (Olivieri, 2019). 3D models should also minimize misconceptions about the material being studied (Grant & Olivieri, 2017). However, the result can conclude that the EG and CG cannot effectively practice mastery of conceptual knowledge of the cognitive process dimensions of C2 because both treatments contained misconceptions that fall within the moderate criteria. However, when viewed from the number of students who managed to master conceptual knowledge, the learning carried out in the EG using 3D model's online modules got higher results than CG. So, learning with 3D model's online modules is better than learning using the official NASA website.

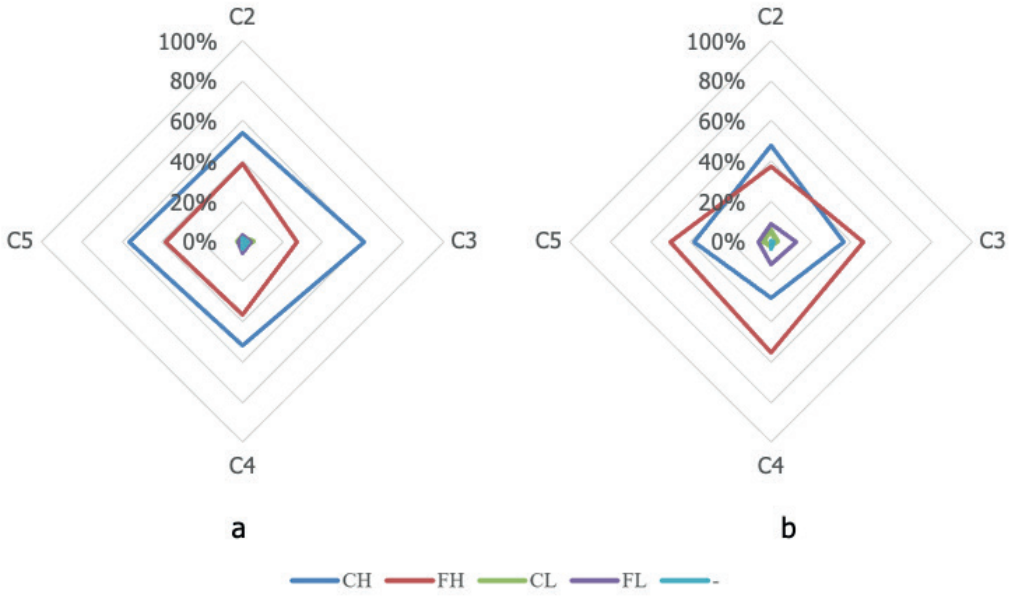

Figure 3. Recapitulation of CRI results on conceptual knowledge mastery test instruments based on cognitive dimensions during trial on (a) EG and (b) CG

In practice, the cognitive process dimension C3 is a learning goal that requires students to routinely carry out procedures when faced with unfamiliar tasks (Anderson et al., 2001). In the EG, information was contained that 60.34% of students had succeeded in mastering conceptual knowledge with moderate criteria. In contrast, 27.59% of students had misconceptions with low criteria, 5.17% answered correctly because of luck with low criteria, and 4,31% of students have not mastered the conceptual knowledge of the C3 cognitive process dimensions with low criteria. While in the CG, the results showed that 36.21% of students had mastered conceptual knowledge of the C3 cognitive process dimensions in the moderate category. On the other hand, 45.69% of students experienced misconceptions in the medium category, 2.45% of students answered correctly because of luck in the medium category, and 12.93% of students have not been able to master the conceptual knowledge of the C3 cognitive process dimensions. Based on these results, using 3D models in learning should help in mastery of the C3 cognitive dimension because several studies have reported that 3D models can provide visual simulations that can help with training (Bauch et al., 2019). Based on these results, in the trial, the mastery of conceptual knowledge of the C3 cognitive process dimensions carried out in the CG could not be practical because the level of misconceptions experienced by students was included in the moderate criteria. On the other hand, the EG using 3D model's online modules can be practical because the results of mastering conceptual knowledge of the C3 cognitive process dimensions fall into the medium criteria and the level of misconceptions falls into the low criteria.

The cognitive process dimension C4 is a learning goal to break down the material into its constituent parts and determine how the parts relate to each other and the overall structure or purpose (Anderson et al.,

2001). This cognitive dimension requires higher-order and complex thinking skills. The EG trial showed that 51.48% of students had mastered conceptual knowledge with moderate criteria. On the other hand, 36.21% of students experienced misconceptions with moderate criteria, 2.96% of students managed to answer correctly because of luck with low criteria, and 5.91% of students have not been able to master the conceptual knowledge of the cognitive process dimensions of C4 with low criteria. In the CG trial, information was contained that 28.08% of students succeeded in mastering conceptual knowledge of the C4 cognitive process dimensions with low criteria. On the other hand, 54.93% of students experienced misconceptions with moderate criteria, 1.97% of students answered correctly because of luck with criteria low, and 11.58% of students have not been able to master the conceptual knowledge of the cognitive process dimensions of C4 with low criteria. Based on these results, the learning in the EG and CG cannot be said to be effective in practicing mastery of conceptual knowledge of the C4 cognitive process dimensions. These results from the misconceptions that are included in the medium criteria. However, the CG and EG results cannot be effective. Learning in the EG is better than learning in the CG because the results of mastery of conceptual knowledge of the cognitive process dimensions of C4 learning in the EG are higher than learning in the CG.

Regarding 3D model simulation in the developed online module, researchers are trying very hard to make each object like the actual object. However, some adjustments need to be made (and cannot be avoided) to make it comfortable to use and display optimally on various devices and hardware specifications. These adjustments will affect the student's perspective on the 3D objects he observes. The limitation of the system that supports 3D models in the learning modules developed in displaying data is also a critical factor in the ineffectiveness of the 3D online modules developed in this study in practicing conceptual mastery of the C4 cognitive process dimension.

Finally, the trial results will be presented based on the conceptual mastery test for the C5 cognitive process dimension. The cognitive process dimension C5 is a learning goal to make judgments based on criteria and standards (Anderson et al., 2001). In the EG, information was contained that 56.03% of students had mastered conceptual knowledge of the C5 cognitive process dimensions with moderate criteria. On the other hand, 37.93% of students had misconceptions with moderate criteria, 2.59% of students could answer correctly because of luck, and 1.72% of students have not been able to master the conceptual knowledge of the C5 cognitive process dimensions with low criteria. Meanwhile, in the CG, 37.93% of students were able to master the conceptual knowledge of the C5 cognitive process dimensions with moderate criteria. On the other hand, 50.00% of students experienced misconceptions with moderate criteria, 3.45% of students managed to answer correctly because of luck with low criteria, and 6.03% of students have not been able to master conceptual knowledge with low criteria. Based on the results, it can be concluded that learning conducted in the EG and CG cannot be effective in mastering conceptual knowledge because it has a misconception rate of 50.00% of students for the CG and 37.93% of students with moderate criteria. However, based on these results, it can also be concluded that learning using 3D model's online modules is better than learning using the NASA official website and student books. These results were obtained from 56.03% of students who have mastered higher conceptual knowledge for EG and 37.93% for CG.

CRI for Learning Indicators

Competency Achievement Indicators (LI) are behaviors that can be measured and observed to be concluded in the fulfillment of essential competencies in core competencies (KI-3) and (KI-4) to be concluded. Both become a reference for the assessment of subjects (Peraturan Menteri Pendidikan Dan Kebudayaan Republik Indonesia, 2014). In the trial, six indicators were observed: (1) Analyzing the characteristics of the planets and components of the solar system; (2) Evaluating information on the shape of the planet Earth; (3) Analyzing the rotational motion and revolution of the Earth and the Moon; (4) Evaluating information on the phases of the Moon; (5) Explaining events due to the movement of the Earth and Moon; and (6) Applying the impact of the movement of the Earth and Moon on daily life. The results of the analysis based on LI are presented in Figure 4.

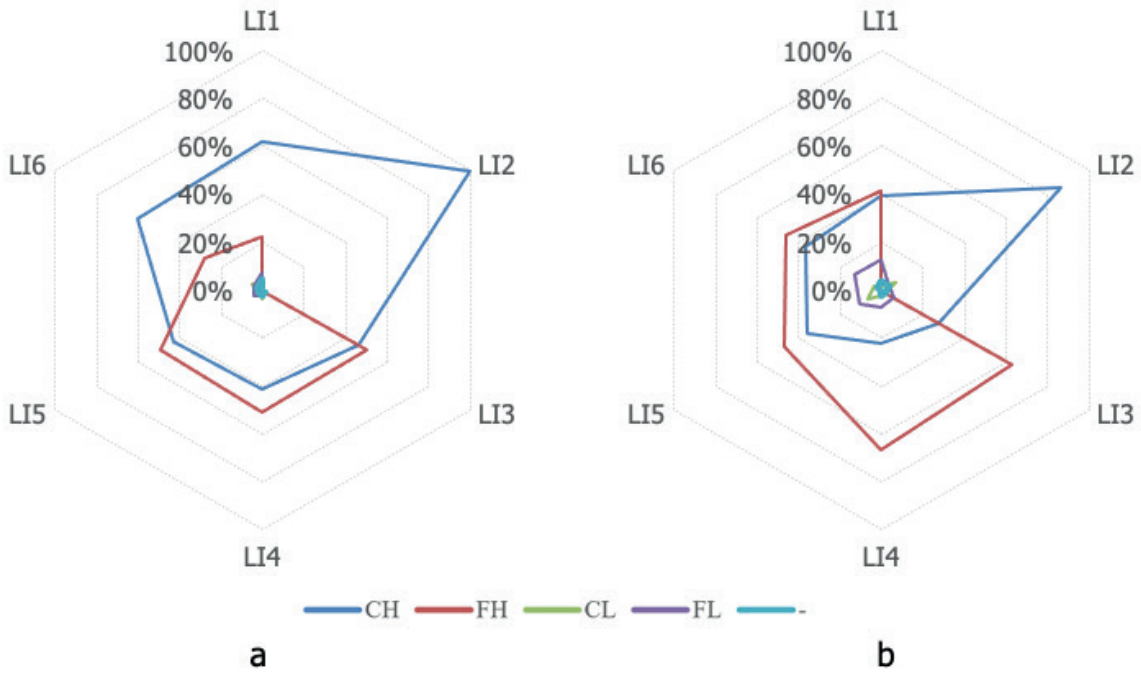

Figure 4. Recapitulation of CRI Results on Conceptual Knowledge Mastery Test Instruments Based on Learning Indicators (LI) during Trial on (a) EG and (b) CG

The results of the first learning indicator (LI1), which reads "analyzing the characteristics of the planets and components of the solar system" in the large group trial of the control class obtained results of 39.66% of students have successfully mastered conceptual knowledge (CH) with moderate criteria, 41.38% of students experienced misconceptions (FH) with moderate criteria, 2.07% of students managed to answer correctly due to luck (CL) with low criteria, and 13.10% of students have not been able to master conceptual knowledge (FL) with low criteria. The indicator's results "analyse the characteristics of the planets and components of the solar system" 61.72% of students had mastered conceptual knowledge (CH) with moderate criteria in the EG. On the other hand, 22.07% of students experienced misconceptions (FH) in the low criteria. However, 4.14% of students felt they did not understand the concept and answered lucky (CL) in the low category, and 7.59% did not master conceptual knowledge (FL) in the low category. Based on these results, the 3D model's online modules lesson are practical because it gets the results of mastering conceptual knowledge of LI1 in the medium category, and students who experience misconceptions are in a low category. On the other hand, learning using the NASA official website and student books in the CG cannot be said to be effective for practicing mastery of conceptual knowledge because the results of the level of misconception are in the moderate category.

For the second learning indicator (LI2), which reads "evaluating the information on the shape of the planet Earth," In the EG, it was found that 100.00% of students had mastered the concept (CH) with high criteria. No students had misconceptions (FH), answered correctly because of luck (CL), and had not mastered conceptual knowledge (FL). Meanwhile, in the CG, it was found that 86.21% of students had mastered the concept (CH) with high criteria. There are no students who have misconceptions (FH). However, 6.90% of students feel that they answered correctly because of luck (CL) with low criteria, and 3.45% of students have not been able to master conceptual knowledge correctly (FL) with low criteria. Based on these results, the two treatments, both the CG and EG as well as the CG, can be effective because the mastery of students' conceptual knowledge is included in the high criteria for the CG and EG. If the EG and the CG are compared, it can be concluded that learning using 3D model's online modules used in EG learning is better than learning using the NASA official website and student books in the CG at LI2.

The results of the third learning indicator (LI3), which reads "analyze the rotational motion and revolution of the Earth and the Moon" in the EG, showed that 45.98% of students had succeeded in mastering the concept (CH) with moderate criteria. However, as many as 50.00% of students experienced misconceptions (FH)

with moderate criteria. In comparison, 1.72% of students responded correctly because of luck (CL) with low criteria, and 1.15% had not mastered the concept (FL) with low criteria. Meanwhile, in the CG, 27.59% of students had mastered the concept (CH) with low criteria, and 62.64% had misconceptions (FH) with high criteria. In comparison, 1.72% of students responded correctly because of luck (CL) with low criteria, and 5.75% had not mastered the concept (FL) with low criteria. Based on these results, learning in the CG and EG cannot be said to be effective in practicing LI3 conceptual knowledge. These results are obtained because the results of students who successfully master conceptual knowledge fall into the low criteria, and students who experience misconceptions fall into the moderate criteria in the CG. For learning in the EG, although students who have succeeded in mastering conceptual knowledge of LI1 are included in the moderate criteria, students experiencing misconceptions are also included in the moderate criteria. Based on these results, learning with 3D model's online modules is better than using the NASA official website and student books.

The fourth learning indicator (LI4), which reads "evaluating the information on the phases of the Moon," that the EG got a result of 41.38% of students had succeeded in mastering the concept (CH) with moderate criteria. Meanwhile, 50.57% of students experienced misconceptions (FH) with moderate criteria, 3.45% of students answered correctly because of luck (CL) with low criteria, and 2.30% of students did not understand the material (FL) with low criteria. Meanwhile, the CG received information that 21.84% of students had mastered the concept (CH) with low criteria. Meanwhile, 66.67% of students experienced misconceptions (FH) with high criteria, 2.30% of students answered correctly because of luck (CL) with low criteria, and 6.90% of students needed help understanding the material (FL) with low criteria. Based on these results, the learning in the CG and EG cannot be said to be effective in practicing mastery of conceptual knowledge. In the CG, the results of the mastery of conceptual knowledge with an LI4 were included in the moderate criteria. However, the level of misconceptions was also included in the moderate criteria. Meanwhile, even though the mastery of conceptual knowledge of LI4 also received moderate criteria in the EG. The resulting misconceptions are also included in the moderate criteria. However, based on these results, 3D model's online modules in the EG can be said to be better than learning using the official NASA website and student books in the CG.

The fifth learning indicator (LI5), which reads "explaining events due to the movement of the Earth and Moon," showed that 43.10% of students had succeeded in mastering the concept (CH) with moderate criteria in EG. On the other hand, 49.43% of students experienced misconceptions (FH) with moderate criteria, and 1.15% answered correctly because of luck (CL). With low criteria, and 4.60% of students need help understanding the material (FL) with low criteria. Meanwhile, the CG contained results of 35.63% of students having mastered the concept (CH) with moderate criteria. On the other hand, 46.55% of students experiencing misconceptions (FL) in the medium category, 6.90% of students answered lucky (CL) in the low category, and 10.92% of students have not mastered conceptual knowledge (FL) in the low category. Based on these results, the learning conducted in the CG and EG cannot be said to be effective in increasing students' mastery of conceptual knowledge. Although the level of mastery of students' knowledge is in the medium category, the level of students' misconceptions is also in the medium category. Based on these results, it can also be concluded that learning using 3D model's online modules models is better than NASA's official website and student books because of the higher mastery of conceptual knowledge and lower misconceptions.

The last one is the sixth learning indicator (LI6) which reads "applying the impact of the movement of the Earth and Moon in everyday life," where 60.34% of students had mastered conceptual knowledge (CH) with moderate criteria in EG. On the other hand, 27.59% of students experienced misconceptions (FH) with moderate criteria, 5.17% of students managed to answer correctly because of luck (CL) with low criteria, and 4.31% of students have not mastered conceptual knowledge (FL) with low criteria. While in the CG contained the results of 36.21% of students having mastered conceptual knowledge (CH) with moderate criteria. On the other hand, 45.69% of students experiencing misconceptions (FH) with moderate criteria, 3.45% of students successfully answered true because of luck (CL) with low criteria, and 12.93% of students have not mastered conceptual knowledge (FL) with low criteria. Based on these results, both the learning in the CG and EG cannot be said to be effective in practicing mastery of conceptual knowledge of LI6 because the misconceptions contained are included in the moderate criteria in the CG and EG. Based on these results, it can also be concluded that learning using the official NASA website and student books is better than 3D model's online modules in terms of practicing mastery of LI6 conceptual knowledge.

CRI for Conceptual Knowledge Mastery

Conceptual knowledge includes knowledge of categories, classifications, and relationships between and among them (a more complex and organized form of knowledge). Conceptual knowledge includes schemas, mental models, or theories implicit or explicit in different cognitive psychological models. These schemas, models, and theories represent an individual's knowledge about how a particular subject matter is organized and structured, how different pieces or bits of information related to each other more systematically, and how the parts function together (Anderson et al., 2001). The results of the analysis of the conceptual knowledge test instrument in the trial were also grouped into three subtypes are presented in Figure 5, namely: (1) Knowledge of classification and categories; (2) Knowledge of principles and generalizations; and (3) Knowledge of theory, model, and structure.

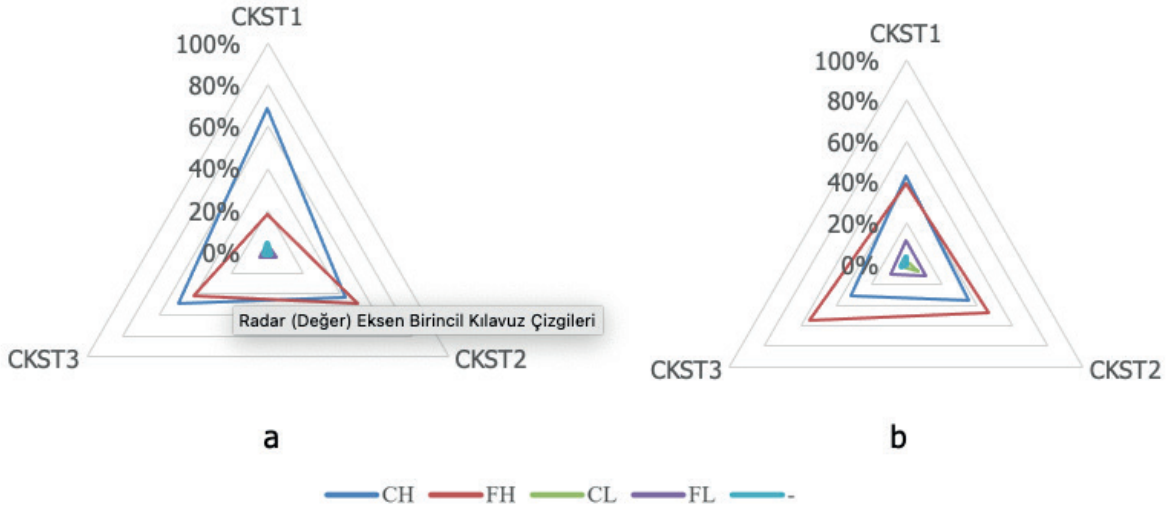

Figure 5. Recapitulation of CRI Results on Conceptual Knowledge Mastery Test Conceptual Knoledge Sub-Type (CKST) during Trial on (a) EG and (b) CG

For the first conceptual knowledge sub-type (CKST1), which reads "knowledge of classifications and categories," the materials observed are (1) Knowledge of the characteristics of planets in the solar system, (2) Knowledge of the characteristics of the components that make up the solar system; and (3) Knowledge of the inner and outer planets in the solar system. The EG showed that 68.58% of students had mastered the first conceptual knowledge sub-type (CKST1) (CH) with moderate criteria. On the other hand, 18.39% of students experienced misconceptions (FH) with low criteria, 4.60% felt they did not understand the concept and answered correctly because of luck (CL) with low criteria, and 4.21% of students did not master the sub-type. Conceptual knowledge (CKST1) (FL) with low criteria. In the CG, 43.31% of students have mastered the first conceptual knowledge sub-type (CH), which reads "knowledge from classification and categories" with moderate criteria. On the other hand, 39.46% of students experienced misconceptions (FH) with moderate criteria, 2.30% of students felt that they answered correctly because of luck (CL) with low criteria, and 11.88% of students did not master the first conceptual knowledge sub-type (FL) with low criteria. Based on these results, both the learning in the CG using the official NASA website and student books cannot be said to be effective because the level of students' misconceptions is in the medium category. Meanwhile, learning using 3D model's online modules is effective for training the first conceptual knowledge sub-type because it has successfully trained mastery of conceptual knowledge to the medium category and misconceptions to the low category. These results are because the virtual 3D model applied to learn can increase student learning motivation so they can enjoy the teaching and learning process more (Afnan et al., 2021; Akcayir et al., 2016; Akcayir & Akcayir, 2017; Zhang et al., 2014).

In the second conceptual knowledge sub-type (CKST2), which reads "knowledge of principles and generalizations," the materials observed are (1) Knowledge of eclipses, (2) Knowledge of tides, (3) Knowledge

of the division of the moon (sidereal and synodic); and (4) Knowledge of the daily and annual apparent motion of the Sun. The EG showed that as many as 43.10% of students had mastered the sub-type (CH) with moderate criteria. However, as many as 49.43% of students experienced misconceptions (FH) with moderate criteria, 1.15% of students felt that they answered correctly because of luck (CL) with low criteria, and 4.60% of students had not mastered the second conceptual knowledge sub-type (FL) with low criteria. Meanwhile, 35.63% of students in the CG have mastered the conceptual knowledge sub-type (CH) with moderate criteria. However, 46.55% of students experienced misconceptions (FH) with moderate criteria, and 6.90% felt that they answered correctly because of luck (CL) with low criteria. Meanwhile, 10.92% of students have not mastered the second conceptual knowledge sub-type (FL) with low criteria. Based on these results, both the CG and EG cannot be effective because students who experience misconceptions fall into the moderate criteria for students in the CG and the EG. Based on these results, learning 3D model's online modules developed in the EG is better than learning the official NASA website and student books in the CG. Based on these results, it is an evaluation material that one of the drawbacks of implementing virtual 3D models is that the design process is quite tricky so that the working principle resembles the original object (H. Y. Chang et al., 2022; K. E. Chang et al., 2014).

The last is the third sub-type (CKST3) which reads "knowledge of theory, model and structure" the material observed in that sub-type is: (1) Knowledge of rotational and revolutionary motion; (2) Knowledge of viable and uninhabitable planet opportunities; (3) Knowledge of planetary models; (4) Knowledge of the model components that make up the solar system; (5) Knowledge of the changing shape of the moon when viewed from the earth; and (6) Knowledge of the structure of the Sun. From the EG, 49.43% of students mastered the third conceptual knowledge sub-type with moderate criteria. On the other hand, 41.15% of students experienced misconceptions with moderate criteria, 2.76% of students answered correctly because of luck with low criteria, and 4.60% of students had not been able to master the conceptual knowledge sub-type with low criteria. Meanwhile, in the CG, 31.26% of students have mastered conceptual knowledge (CH) with moderate criteria, and 54.48% have misconceptions (FH) with moderate criteria. Meanwhile, 2.53% of students answered correctly because of luck (CL) with low criteria, and 8.97% of students had not mastered the third conceptual knowledge sub-type related to knowledge of theory, model, and structure (FL) with low criteria.Based on these results, learning in the CG and EG cannot be said to be effective in practicing mastery of conceptual knowledge sub-types because the level of misconceptions experienced by students is in the medium category. However, if we look further, it can be concluded that learning 3D model's online modules used in the CG is better than learning the official NASA website and student. These results are obtained because the level of students who have mastered the third conceptual knowledge sub-type in the EG is higher than CG. he use of 3D models in learning does have many positive impacts, but virtual 3D model media developers should do development more carefully during the design and evaluation process. (H. Y. Chang et al., 2022) as well as pay attention to the impact and level of efficiency (Akpan & Shanker, 2017).

Based on observations, the presence of 3D Model's online modules can slightly support learning during the Covid-19 pandemic, especially in rural areas where technological and economic limitations are not sufficient for the continuity of synchronous learning. Although more complex than using learning resources from the official NASA website, 3D Model's online modules are adequate and adapted to the conditions of rural students so that they can be considered alternative learning resources during the Covid-19 pandemic because they have better performance.

CONCLUSION

Based on the results of the study, it can be concluded that in general 3D model's online modules are less effective in practicing mastery of conceptual knowledge. In general, of 3D model's online modules still cannot be said to be effective in practicing mastery of conceptual knowledge because 53.91% of students can master conceptual knowledge in the medium category, 35.98% of students experience misconceptions in the medium category, 2.99% answer correctly because luck is in the low category, and 4.48% of students have not been able to master conceptual knowledge in the low category. In addition to these results, it should also be remembered that 2.64% of students cannot be concluded. Based on these results, a temporary conclusion can be made that the learning carried out in the experimental class using of 3D model's online modules

cannot be said to be effective in practicing mastery of conceptual knowledge because even though students' mastery of conceptual knowledge is in the medium category, the level of misconceptions that occurs is also included in the medium category.

Although the of 3D model's online modules cannot be said to be effective in practicing mastery of conceptual knowledge, the results are still better than learning in the control class where 35.75% of students can master conceptual knowledge in the medium category, 48.39% of students experience misconceptions in the medium category, 3.33% answered correctly because of luck in the low category, and 10.23% students have not been able to master conceptual knowledge in the low category. In addition to these results, it should also be remembered that 2.30% of students cannot be concluded. Based on these results, it can be concluded that learning in the control class using the NASA website cannot be said to be effective in practicing mastery of conceptual knowledge because even though students' mastery of conceptual knowledge is in the medium category, the level of misconceptions that occurs is also in the medium category.

Limitations and Suggestions for Future Studies

The effectiveness of the online module with 3D models was tested using a conceptual knowledge mastery test instrument. In the large group trial, the online module with 3D models cannot effectively practice mastery of conceptual knowledge. No one drug can treat all diseases; the online module with 3D models developed also has advantages and disadvantages that need to be observed when used in learning. The researcher has conducted a sub-analysis to determine the strengths and weaknesses of the developed online module. With the sub-analysis, the development of this online module or similar modules can be more easily done.

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