IJORER : International Journal of Recent Educational Research
Homepage : https://journal.ia-education.com/index.php/ijorer
Email : ijorer@ia-education.com

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 3, No. 2, March 2022
Page 162-181

The Effectiveness 3D Models Online Modules to Practice Mastery of Solar System Conceptual Knowledge

Dhanang Setyo Ervana[1]*, Raharjo[2], Munasir[3]
[1,2,3] State University of Surabaya, Surabaya, Indonesia

DOI : https://doi.org/10.46245/ijorer.v3i2.199

Sections Info
Article history:
Submitted: January 20, 2022
Final Revised: February 12, 2022
Accepted: February 17, 2022
Published: March 31, 2022

Keywords:
3D Models
Conceptual Knowledge
Covid-19 Pandemic
Online Module
Solar System

ABSTRACT

This study aims to describe the effectiveness of 3D models online modules to practice mastery of solar system conceptual knowledge. The effectiveness of the 3D models online modules was measured using a conceptual knowledge mastery test instrument which was tested on 15 7th grade junior high school students in Jombang district, East Jawa, Indonesia. The test instrument consisted of 30 questions with the addition of the Certainty of Response Index (CRI) which was divided into 3 meetings and each meeting tested 10 questions. The results showed that 48.67% of students had been able to master conceptual knowledge when given the 3D models online modules. However, 31.11% of students experienced misconceptions, 8.44% answered correctly because of luck and 11.78% had not been able to master conceptual knowledge. Because the resulting misconceptions fall into the moderate criteria, it can be concluded that the 3D models online modules in general has not been effective in practicing mastery of solar system conceptual knowledge. When examined further, this ineffectiveness is found in the cognitive dimensions of C4, learning indicators (LI) 1, 3 and 4, as well as conceptual knowledge sub-types (CKST) 1 and 3. While the effective 3D models online modules in cognitive dimensions C2 and C5, learning indicators (LI) 2 and 5, and conceptual knowledge sub-types (CKST) 2.

INTRODUCTION

The Coronavirus Disease (Covid-19) pandemic which has spread to various countries including Indonesia requires various sectors to immediately take a stand in preventing wider transmission, including the education sector. In this regard, the Ministry of Education and Culture of the Republic of Indonesia takes a stance to organize a distance learning process. The application of distance learning from the perspective of teachers and students is considered less than optimal. Even though the whole world is going through difficult times, that doesn't mean we can't do anything about it. In this condition of uncertainty, we really need adaptive capacity. This adaptability will appear in every teacher who cares for students along with the power of innovation. Therefore, in a difficult situation like this, this is no longer the time to maintain cynicism and pessimism. This is the time to cultivate optimism to keep moving, adapting, and innovating 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, especially for junior high school students. The dynamics faced make researchers try to innovate with a module that has the ability

to be accessed by every student easily even though they cannot meet face to face, and can facilitate them to explore even in cyberspace and make the material studied not too abstract. Therefore, the development of online learning modules containing 3D models should be tried to practice mastering the concept of the solar system during the Covid-19 pandemic. The selection of modules as a solution offered for distance learning during the Covid-19 pandemic is the wisest choice according to researchers because the module has characteristics that students can study independently. Modules can also be studied repeatedly regardless of place and time of study. Several studies support this statement by reporting that electronic modules can improve learning outcomes when compared to without the use of electronic modules (Susanti et al., 2020).

The choice of material for the solar system is based on the characteristics of the material which is classified as abstract. Based on the Indiana State Science Standards for Earth Sciences in Second Grade shows that if children just make simple observations of the sky it can potentially lead to misunderstandings such as "there are different Moons" and "Suns go up and down" without understanding the real dynamics between the Sun, Moon. and Earth (Isik-Ercan et al., 2014). Based on the theory of cognitive development, some experts argue that children have limited and qualitatively different reasoning skills, they have little difficulty with abstract thinking (Isik-Ercan et al., 2014; Slavin, 2018). The world of education is now dominated by generations Y, Z, and alpha who were born at a time when technology was developing rapidly. Based on research, the use of technology as a complement to teaching materials will have a positive impact on 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). On the other hand, learning based on technology games on materials related to the solar system received a positive response from students (Kadosawa & Makino, 2018; Muntean et al., 2017; Peña & Tobias, 2014; Salazar et al., 2020; Sin et al., 2017).

Based on research, 3D visualization can also 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 (Peña & Tobias, 2014) and suitable for junior high school students (Azhar et al., 2021). However, it should be noted that the addition of a virtual 3D model also has a negative impact that needs to be anticipated when implementing it in learning. It was reported that when tested 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. (Peña & Tobias, 2014).

Based on information processing theory which states that information that enters sensory memory must get the right attention and perception before it enters working memory (Slavin, 2018). This 3D model is expected to trigger the right attention and

perception by students to make it easier to understand the material provided by the online module. Teaching materials that utilize computer programs by adding 3D facilities can give students the freedom to repeat the material and make more in-depth observations, this can help students learn about difficult concepts more effectively. Information processing theory explains that the right repetition process can make the information obtained by students last longer by entering into long term memory (Slavin, 2018). The opportunity to be repeated as much as possible can be utilized by teachers or students who use 3D models online modules appropriately so that the information obtained can be more meaningful and last longer in long term memory.

RESEARCH METHOD

General Background

This study was conducted to determine the effectiveness of 3D models online modules. In a small group trial, the research used a one-shot case study design with a quantitative descriptive approach. In this research design, there is a group that is treated and the results are then observed (Sugiyono, 2018).

Participants

Participants in this study used a sample of 15 junior high school students in 7th grade junior high school in Jombang, East Java, Indonesia.

Instrument and Procedures

Before being tested on students, the conceptual knowledge mastery test instrument was tested for its theoretical validity using two expert lecturers and one science teacher. After being declared valid, the conceptual knowledge mastery test instrument was tested on students. The instrument as a whole consists of 30 multiple choice questions with the addition of a Certainty of Response Index (CRI). The questions were divided into three meetings and each meeting contained 10 questions to be tested. The flow of the research carried out can be seen in Figure 1.

The test instrument used has specifications to measure the student's solar system conceptual knowledge. The dimensions of conceptual knowledge measured are presented in Table 1 and are limited to the cognitive dimensions of understanding (C2), analyzing (C4), and evaluating (C5) because it adapts to conditions during the Covid-19 pandemic. Based on the experience of the researcher, the cognitive dimension of remembering (C1) was not chosen because it is not suitable to be tested during distance learning because students can easily search for information on search engines without the need to learn further. The cognitive dimension of applying (C3) was not chosen because of the limited learning time during the Covid-19 pandemic and it was not suitable for solar system material at the junior high school level. While the cognitive dimension makes (C6) not chosen because researchers find it difficult to supervise and guide students when working on a project. The concept mastery test instrument was also used to determine the achievement of the competency indicators which are summarized

in Table 2 and to determine the achievement of the sub-type of conceptual knowledge (Anderson et al., 2001) which is summarized in Table 3.

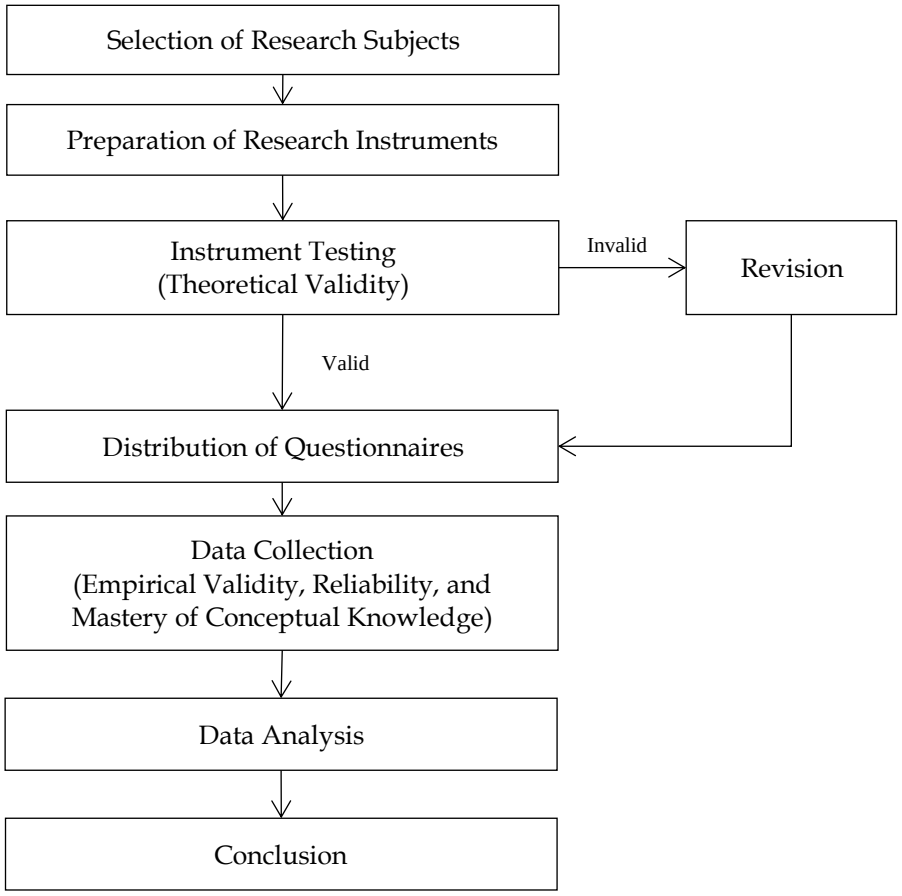

Figure 1. Research flowchart.

Table 1. Conceptual knowledge mastery test instruments based on cognitive dimensions.

No	Cognitive Dimension	Question Number
1	Understanding (C2)	A1, A2, C1, C2, C3, C4, C5, C6, C7, C8, C9, and C10
2	Analyzing (C4)	A3, A4, A5, A6, A7, A8, A9, A10, B2, B3, B4, B5, B6, and B7
3	Evaluating (C5)	B1, B8, B9, and B10
Total		30 Questions

Table 2. Conceptual knowledge mastery test instruments based on learning indicators.

No	Learning Indicators	Question Number
1	Analyze the characteristics of the planets and components of the solar system.	A1, A2, A3, A4, A5, A6, A7, A8, A9, and A10

No	Learning Indicators	Question Number
2	Evaluate information about the shape of the Earth.	B1
3	Analyze the rotational motion and revolution of the Earth and Moon.	B2, B3, B4, B5, B6, and B7
4	Evaluate information on the phases of the Moon.	B8, B9, and B10
5	Explain the events caused by the movement of the Earth and Moon.	C1, C2, C3, C4, C5, C6, C7, C8, C9, and C10
Total		30 Questions

Table 3. Conceptual knowledge mastery test instruments based on conceptual knowledge sub-types.

No	Conceptual Knowledge Sub-Type	Learned Conceptual Knowledge	Question Number
1	Knowledge of classifications and categories	• Knowledge of the characteristics of the planets in the solar system. • Knowledge of the characteristics of the components that make up the solar system. • Knowledge of the inner and outer planets in the solar system.	A1, A2, A3, A5, A6, A7, A8, A9, and A10
2	Knowledge of principles and generalizations	• Knowledge of eclipses. • Knowledge of tides. • Knowledge of the division of the month (sidereal and synodic). • Knowledge of the daily and annual apparent motion of the sun.	C1, C2, C3, C4, C5, C6, C7, C8, C9, and C10
3	Knowledge of theory, model and structure	• Knowledge of rotational and revolutionary motion. • Knowledge of viable and uninhabitable planet opportunities. • Knowledge of planetary models. • Knowledge of the model components that make up the solar system. • Knowledge of the shape of the moon that changes when viewed from the earth. • Knowledge of the structure of the Sun.	A4, B1, B2, B3, B4, B5, B6, B7, B8, B9, and B10.
Total			30 Questions

(Anderson et al., 2001)

Data Analysis

a. Instrument Validity

In order for the test instruments used in the study to have good quality, it is necessary to have an analysis of validity, reliability, objectivity, practicality, and economics (Arikunto, 2013). The results of the analysis of the validity of the conceptual knowledge mastery test instrument in this discussion are divided into theoretical and empirical

validity. A test instrument can be considered valid if it can provide appropriate information and can be used to achieve certain goals (Oktanin & Sukirno, 2015). Validity test is also needed in order to be able to find out which items resulted in low validity results for evaluation purposes (Utomo, 2018). Theoretical validity is obtained from the results before the trial or at the initial product development stage. Theoretical validity is obtained by collecting the validation results, which are then calculated from the experts cumulatively (Hidayati et al., 2017). After the validity results are collected, the mode value is then determined. The obtained mode scores are then interpreted based on the categories in Table 1.

Table 1. Conceptual knowledge mastery test instruments validity category.

No	Score Mode	Mode Category
1	1	Very bad
2	2	Bad
3	3	Good
4	4	Very good

The results obtained in each aspect are then calculated using the equation:

$$validity = \frac{the\ total\ score\ of\ the\ data\ collection\ results}{number\ of\ points \times number\ of\ validator \times maximum\ score} \times 4$$

Through these equations, the calculation results are further categorized based on Table 2.

Table 2. Criteria for validity of conceptual knowledge mastery test instruments.

No	Interval Score	Scoring Category	Description
1	$3.51 \leq P \leq 4.00$	Very valid	Can be used without revision
2	$2.51 \leq P \leq 3.50$	Quite Valid	Usable but needs minor revision
3	$1.51 \leq P \leq 2.50$	Less Valid	It is recommended not to use because it needs a major revision
4	$1.00 \leq P \leq 1.5$	Invalid	Cannot be used

(Budiarso, 2017)

Furthermore, the results of the conceptual knowledge mastery test instrument tested to students are empirically analyzed, while in empirical validity, the question items in the conceptual knowledge mastery test instrument are said to have internal validity based on how far the results of the grain are consistent with the overall measuring results of the test. Therefore, the validity of items is reflected in the magnitude of the correlation coefficient between the item score with a total test score. The Pearson product moment correlation test equation used is as follows (Chee, 2016):

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

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

b. Instrument Reliability

Reliability shows an understanding that an instrument can be trusted to be used as a data collection tool because the instrument is already good. To determine the reliability of the instrument in the form of multiple choice questions in this study, it was carried out using Cronbach's Alpha testing. For an instrument in the form of reliability, it is declared reliable if the Crobanch's Alpha value obtained is at least 0.60. To test the reliability of multiple choice items, the Cronbach Alpha equation is used as follows (Streiner, 2003):

$$\alpha = \left[\frac{k}{k-1}\right]\left[1 - \frac{\sum S_i^2}{S_x^2}\right]$$

The test results obtained 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 instruments reliability.

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

(Woollins, 1992)

c. Observation Results Data Creative Thinking Skills

In this study, 3D models online modules are considered effective if students as respondents have mastery of conceptual knowledge on solar system material after using the developed online module. The method used to identify the mastery of students' conceptual knowledge 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 = totally guessed answer, 1 = almost guess, 2 = not sure, 3 = sure, 4 = almost certain, and 5 = certain (Hasan et al., 1999). The results of the analysis with CRI are used to distinguish students who know the concept, do not know the concept, and misconceptions. The matrix of CRI interpretation results can be seen in Table 4.

Table 4. Answer criteria.

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) means mastering the mastery of conceptual knowledge well
Wrong answer	Wrong answers and low CRI (WL) means that they do not master conceptual knowledge.	Wrong answer but high CRI (WH) means there is a misconception

(Hasan et al., 1999)

The process of identifying the mastery of conceptual knowledge is carried out individually and in groups. The identification of individual misconceptions is done by calculating the percentage of students who experience misconceptions. The percentage calculation is obtained from the equation:

$$\%\ WL = \frac{Number\ of\ students\ who\ do\ not\ master\ conceptual\ knowledge}{total\ number\ of\ students} x100\ \%$$

$$\%\ CL = \frac{Number\ of\ students\ who\ answered\ lucky}{total\ number\ of\ students} x100\ \%$$

$$\%\ WH = \frac{Number\ of\ students\ who\ have\ misconceptions}{total\ number\ of\ students} x100\ \%$$

$$\%\ CH = \frac{Number\ of\ students\ who\ master\ conceptual\ knowledge}{total\ number\ of\ students} x100\ \%$$

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

Table 5. CRI percentage interpretation criteria.

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

(Wola, 2020)

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

RESEARCH METHOD
RESULTS AND DISCUSSION

a. Instrument Validity

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

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

No	Category	Amount	Percentage (%)
1	Very bad	0	0
2	Bad	0	0
3	Good	55	91.67
4	Very good	5	8.33
	Total	**60**	**100**

To find out the results of the empirical validity of the conceptual knowledge mastery test instrument, it was obtained using the Pearson product moment correlation test. 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	Meeting	Amount
1	Valid	A	5
		B	5
		C	2
2	Invalid	A	5
		B	5
		C	8
	Total		**30**

Based on the results in Table 7, it can be seen that there are five questions that fall into the valid category and five items that fall into the invalid category at meetings A and B. However, at meeting C, there are two items that are categorized as valid and 8 questions that are included in the invalid category.

b. Instrument Reliability

Based on the results in Table 7, it can be seen that there are five questions that fall into the valid category and five items that fall into the invalid category at meetings A and B. However, at meeting C, there are two items that are as valid and 8 questions that are included in the invalid category.

Table 8. Reliability grouping of conceptual knowledge mastery test instruments.

No	Measurement of Learning Outcomes in the Area of Knowledge Reliability	Interpretation
1	.51	Poor
2	.68	Questioned
3	-.26	Unacceptable

The reliability test has a relationship with the consistency of the score and is very relevant when there is a consequence to the interpretation that will be obtained (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 results obtained with the evaluation instrument and not to the instrument itself. So, it is more correct to talk about the reliability of 'test scores' or 'measurements' rather than 'tests' or 'instruments'. (Henson, 2001).

Based on the reliability test of learning outcomes in the realm of knowledge, the results of the test instrument meeting A (items A1, A2, A3, A4, A5, A6, A7, A8, A9, and A10) obtained results of .51 with low interpretation, the test instrument meeting B (items B1, B2, B3, B4, B5, B6, B7, B8, B9, and B10) get a reliability result of .69 so it is in the doubtful category (it is doubtful to be in the low or good category). Based on these results, it can be concluded that there is a need for an evaluation both in terms of the conceptual knowledge mastery test instrument or the teaching and learning process carried out.

Sometimes, the variability of individual items exceeds their common variance, which may occur when items use different constructs to obtain a negative reliability result (Henson, 2001). In the results of the C meeting test instrument (items C1, C2, C3, C4, C5, C6, C7, C8, C9, and C10) it was found that the reliability of measuring learning outcomes in the realm of knowledge was -.26. Since negative values are theoretically impossible, it is recommended to report them as zero, but negative or zero having the same conclusion the item most likely did not measure what it intended (Henson, 2001). Based on these results, the test instrument and teaching and learning system at meeting C really need to be evaluated considering that there are also only two items in the assessment instrument for mastery of conceptual knowledge given at meeting C which are in the valid category.

c. Conceptual Knowledge Mastery Analysis

The effectiveness of the 3D models 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 is very dependent on the honesty of the student (Waluyo et al., 2019). Another weakness of the CRI method lies in the categorization of 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 existence of the CRI method is needed to determine the level of student mastery of a learning material, especially in distance learning which is difficult to supervise. However, the existence of the CRI method is needed to determine the level of student mastery of a learning material, especially in distance learning which is difficult to supervise.

The 3D models online modules is said to be effective if the percentage results of each CRI identification of misconceptions, not knowing the concept, and alleged debts get low criteria (0.00 – 30.00%) and the identification of CRI mastering conceptual knowledge is either in the medium category or high (30.01 – 100.00%) (Wola, 2020). The results of the recapitulation of the effectiveness of mastering conceptual knowledge from 3D models online modules can be seen in more detail in Appendix C.8. Based on the results of the recapitulation, it can be seen that overall, the online modules developed are less effective in practicing mastery of conceptual knowledge. Because the results of misconceptions experienced by students generally reach 31.11%, these results are included in the moderate criteria although in general 48.67% of students have mastered conceptual knowledge in the moderate category. Furthermore, in general 11.78% of students have not been able to master conceptual knowledge and fall into the low category. While 8.44% of students answered correctly because of luck with low criteria.

When examined further, there are misconceptions in the moderate category in which learning limitations during the Covid-19 pandemic are unavoidable and the most important thing is that students who answered that they were lucky and had not mastered conceptual knowledge were in the low category. To find out in more detail and facilitate evaluation, the effectiveness of the 3D models online modules will be further elaborated based on the dimensions of conceptual knowledge, achievement of competency indicators, and sub-types of conceptual knowledge.

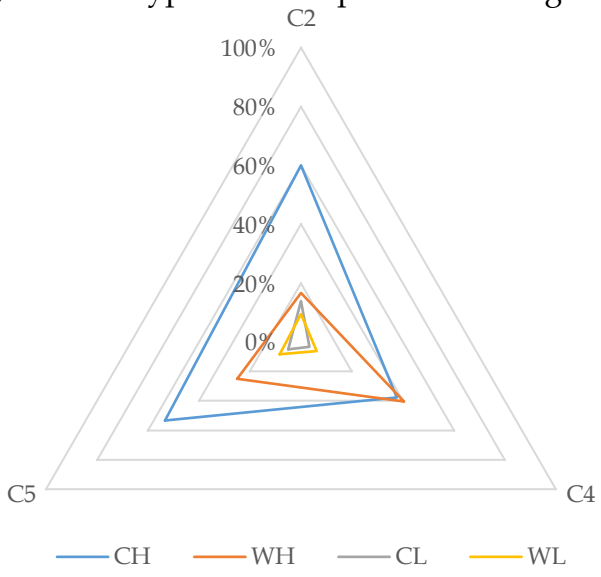

Figure 2. Recapitulation of CRI results on conceptual knowledge mastery test instruments based on cognitive dimensions.

The categories in the cognitive process dimension are intended to provide a comprehensive set of classifications for students' cognitive processes that are included in the learning objectives (Anderson et al., 2001). These categories include remembering, understanding, applying, analyzing, evaluating and creating. However, in the small group trial, it was only limited to the dimensions of cognitive processing categories C2 (understanding), C4 (analyzing), and C5 (evaluating). The results of research trials based on cognitive dimensions are presented in Figure 2. The results of the conceptual mastery test in the small group trial obtained the results that 60.00% of students mastered the conceptual knowledge (CH) of the C2 cognitive process dimension with moderate criteria. The cognitive process dimension C2 is a learning goal for constructing the meaning of instructional messages, including oral, written, and graphic communication (Anderson et al., 2001). Based on the results of the limited trial, it was also found that students who experienced misconceptions (WH) were 16.67% in the low category, students who answered correctly because of luck (CL) were 13.89% in the low category and 9.44% students did not master (SR) conceptual knowledge mastery test with a low category on the cognitive process dimension C2. These results are unavoidable, especially in the learning situation during the Covid-19 pandemic. Although the number is relatively small, it is still necessary to conduct an evaluation after the entire research process is completed. Based on these results, it can be concluded that an 3D models online modules is effective in practicing conceptual mastery on the C2 cognitive process dimension, which can be considered to be continued in large group trials.

The effectiveness of the 3D models online modules in practicing conceptual mastery on the dimensions of the C2 cognitive process can be related to the characteristics of the C2 cognitive process dimensions which are based on the ability to think that is not too complex and has a tendency to focus on visuals and memory. These results support reports where real objects that have three dimensions are more memorable than photos that actually have two dimensions, although in the same report there has not been further discussion regarding the differences between real 3D objects and virtual 3D objects (Snow et al., 2014). The cognitive process dimension C4 is a learning goal to break down material into its constituent parts and determine how the parts are related to each other and to the overall structure or purpose (Anderson et al., 2001). This cognitive dimension requires higher-order and complex thinking skills. In a small group trial, it was found that 37.62% of students mastered conceptual knowledge (CH) on the C4 cognitive dimension and entered the medium criteria. However, this result is lower than the level of misconception (WH) obtained, which is 40.48% of students or is included in the moderate criteria. Plus 3.33% of students who answered correctly because of luck (CL) and 6.19% of students had not been able to master conceptual knowledge (WL) on the cognitive dimension of C4 with low criteria. Because the results of the misconceptions obtained are too high, it can be concluded that the 3D models online modules are not very effective in practicing conceptual mastery on the cognitive process dimension C4 because the results of misconceptions (WH) are higher than the moderate criteria.

The high level of misconception in practicing conceptual mastery on the cognitive process dimension C4, the researchers indicated it was caused by students who were not so familiar with the data and how to process information from the data presented. Considering that the students who were sampled in the small group trial had only come from the elementary school level and during the past year (from the first time they studied at junior high school to the small group trial) carried out independent learning. Moreover, the learning process during the pandemic which involves very minimal scientific process activities and learning is carried out with a teacher-centered orientation to reduce physical interaction between students.

In terms of 3D model simulation in the developed online module, researchers are trying very hard to make each object have a similarity to the real object, but some adjustments need to be made (and cannot be avoided) to make it comfortable to use and can be displayed optimally on devices that have a variety of features. hardware specifications. These adjustments will affect the student's perspective on the 3D objects he observes. The limitations of the system that supports 3D models in the learning modules developed in displaying data are also a key factor in the ineffectiveness of the 3D models online modules in this study in practicing conceptual mastery on the C4 cognitive process dimension.

Finally, the results based on the results of the conceptual mastery test for the cognitive process dimension C5 obtained results of 53.33% of students successfully mastering conceptual knowledge (CH) with moderate criteria. The cognitive process dimension C5 is a learning goal for making judgments based on criteria and/or standards (Anderson et al., 2001). However, 25.00% of students experienced misconceptions (WH) with low criteria. As many as 5.00% of students answered correctly because of luck (CL) in the low category and 8.33% of students were unable to master conceptual knowledge (WL) on the C5 cognitive process dimension with low criteria. Based on the results obtained, it can be concluded that the 3D models online modules is effective in practicing conceptual mastery for the C5 cognitive process dimension. However, these results need to be examined further in large group trials, considering that the percentage of students who experience misconceptions is still relatively high.

Learning indicators are behaviors that can be measured and/or observed to be concluded in the fulfillment of basic competencies (KD) in core competencies (KI-3) and (KI-4) to be concluded, both of which become a reference for assessment of subjects (Peraturan Menteri Pendidikan dan Kebudayaan Tentang Pembelajaran pada Pendidikan Dasar dan Pendidikan Menengah, 2014). In this study, five indicators were observed: (1) Analyzing the characteristics of the planets and components of the solar system; (2) Evaluating information on the shape of the Earth; (3) Analyzing the rotational motion and revolution of the Earth and the Moon; (4) Evaluating information on the phases of the Moon; and (5) Describe events due to the movement of the Earth and Moon. The results of research trials based on learning indicator are presented in Figure 3.

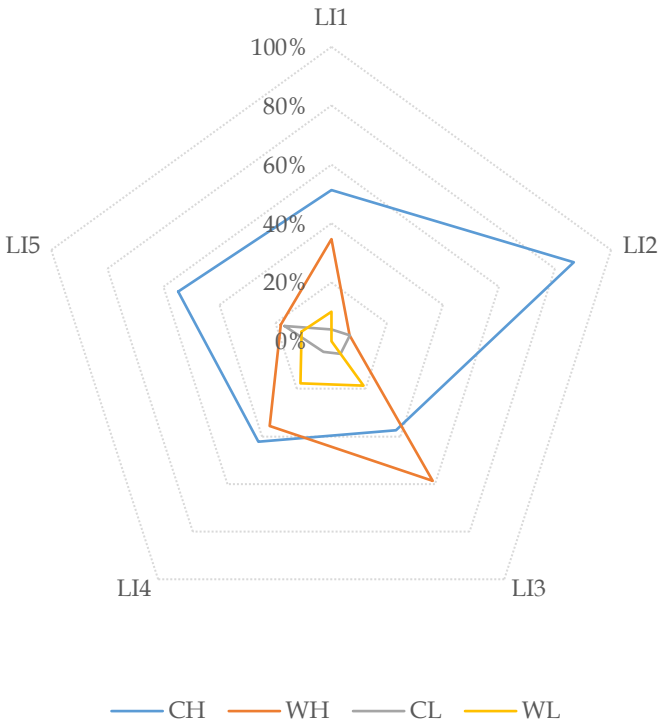

Figure 3. Recapitulation of CRI results on conceptual knowledge mastery test instruments based on learning indicators (LI).

The result of the indicator "analyzing the characteristics of the planets and components of the solar system" in the small group trial showed that 51.33% of students had mastered conceptual knowledge (CH) with moderate criteria. On the other hand, 34.67% of students experienced misconceptions (WH), this result was in the medium category. However, 4.00% of students felt they did not understand the concept and answered lucky (CL) in the low category and 10.00% of students did not master conceptual knowledge (WL) in the low category. Based on these results, it can be concluded that the 3D models online modules is not effective enough in training indicators to analyze the characteristics of planets and components of the solar system. This is because the level of mastery of conceptual knowledge is in the medium category, but the results of misconceptions are also in the moderate category so that 3D models online modules need to be evaluated on these indicators.

For the second learning indicators which reads "evaluating information on the shape of the Earth", as many as 86.67% of students have mastered conceptual knowledge with a high category. However, as many as 6.67% of students experienced misconceptions, the same results, namely 6.67% of students felt that they answered correctly because of luck (CL) and there were no students who lacked conceptual knowledge (WL) these results were in the low category. Based on these results, it can be temporarily concluded that the 3D models online modules are effective in practicing mastery of conceptual knowledge on these indicators.

The results of the third learning indicators (LI3) which reads "analyze the rotational motion and revolution of the Earth and the Moon" get results of 37.33% of students having successfully mastered conceptual knowledge (CH) in the medium category. However, as many as 58.67% of students experienced a moderate category of misconceptions (WH). Meanwhile, 5.33% of students felt that they answered correctly because luck (CL) was in the low category and 18.67% had not mastered conceptual knowledge, both results were in the low category. Based on these results, it can be concluded that for the time being 3D models online modules are less effective in training conceptual knowledge on indicators of analyzing rotational motion and revolution of the Earth and Moon. This is because the level of mastery of conceptual knowledge is in the medium category, but the results of misconceptions are also in the moderate category so that 3D models online modules need to be evaluated on these indicators.

The fourth learning indicators (LI4) which reads "evaluating information on the phases of the Moon" obtained information that 42.22% of students have successfully mastered (CH) conceptual knowledge in the moderate category. Meanwhile, 35.56% of students experienced misconceptions (WH) in the medium category, 4.44% of students answered correctly because of luck (CL) in the low category, and 17.78% students did not understand (WL) conceptual knowledge in the low category. Based on these results, it can be concluded that the 3D models online modules have not been effective enough in training indicators to evaluate information on the phases of the Moon. This is because the level of mastery of conceptual knowledge is in the medium category, but the results of misconceptions are also in the moderate category so that 3D models online modules need to be evaluated on these indicators.

The last is the fifth learning indicators (LI5) which reads "explaining events due to the movement of the Earth and Moon" obtained results of 54.67% of students have mastered conceptual knowledge (CH) in the high category, 18.00% of students have misconceptions in the low category, 16.67% of students answered lucky (CL) in the low category and 10.67% of students did not master (WL) conceptual knowledge in the low category. Based on these results, it can be concluded that the learning module developed is effective in training indicators to analyze the rotational motion and revolution of the Earth and the Moon. This is because the level of mastery of conceptual knowledge is in the medium category and the results of misconceptions, answered lucky and have not mastered conceptual knowledge are in the low category.

Conceptual knowledge includes knowledge of categories, classifications, and relationships between and among them 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 the knowledge that an individual has about how a particular subject matter is organized and structured, how different pieces or bits of information are interconnected and interrelated in a more systematic way, and how these parts function together (Anderson et al., 2001). In this discussion, the results of the analysis of the conceptual knowledge test instrument are grouped into three sub-types, namely: (1) Knowledge of classifications and categories; (2) Knowledge of principles and

generalizations; and (3) Knowledge of theory, model, and structure. The results of research trials based on conceptual knowledge sub-type are presented in Figure 4.

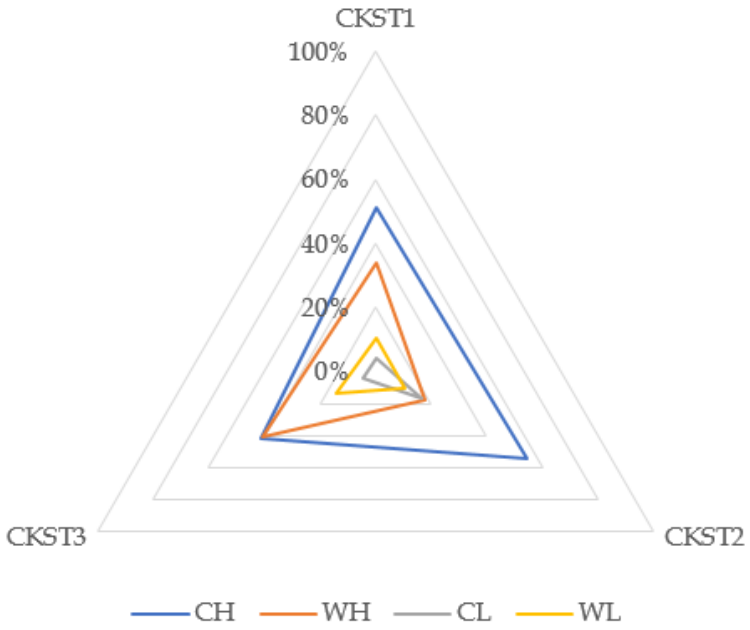

Figure 4. Recapitulation of CRI results on conceptual knowledge mastery test instruments based on Conceptual Knowledge Sub-Types (CKST).

For the sub-type "knowledge of classification and category", the observed materials 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. Getting the results of 51.11% of students have mastered (CH) the first sub-type of conceptual knowledge and is included in the medium criteria. On the other hand, 34.07% of students experienced misconceptions (WH) and were included in the moderate criteria. Furthermore, 4.44% of students felt they lacked conceptual knowledge (CL) and answered that they were lucky (WL) in the low criteria. Finally, 10.37% of students lack conceptual knowledge in the low category. Based on these results, it can be concluded that the learning modules developed are not effective enough in training the sub-types of knowledge from classification and categories. This is because the level of mastery of conceptual knowledge is in the medium category, but the results of misconceptions are also in the moderate category so that 3D models online modules need to be evaluated on these indicators too.

In the sub-type "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. From the small group trial, it was found that 54.67% of students had

mastered conceptual knowledge (CH) with moderate criteria. However, 18.00% of students experienced misconceptions (WH) with low criteria. 16.67% of students felt that they answered correctly because of luck (CL) in the low category. Meanwhile, 10.67% of students have not mastered (WL) learning well. Both results are included in the low criteria. Based on these results, it can be concluded that the 3D models online modules is effective in training sub-types of knowledge from principles and generalizations. This is because the level of mastery of conceptual knowledge is in the medium category and the results of misconceptions, answered lucky and have not mastered conceptual knowledge are in the low category.

The last is the sub-type "knowledge of theory, model and structure", the material observed in this 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 small group trial, it was found that 41.21% of students had mastered conceptual knowledge (CH) in the medium category, and 40.61% of students experienced misconceptions (WH) in the medium category. Meanwhile, 4.24% of students answered correctly because of luck (CL) in the low category and 13.94% students did not master well (WL) related to knowledge of theories, models, and structures in the low category as well. Based on these results, it can be concluded that the learning modules developed are not effective enough in training the sub-types of knowledge from theory, model, and structure. This is because the level of mastery of conceptual knowledge is in the medium category, but the results of misconceptions are also in the moderate category so that 3D models online modules need to be evaluated on these indicators. This result contradicts research (Azhar et al., 2021; El Mawas et al., 2020; Kadosawa & Makino, 2018; Merchant et al., 2014; Muntean et al., 2017; Peña & Tobias, 2014; Sahin & Yilmaz, 2020; Salazar et al., 2020), considering the 3D models online modules because one of the A reliable advantage of 3D models is the ability to load both models and structures. Researchers suspect that these results are because students are too focused on 3D objects and lack focus in absorbing knowledge or theory information attached to the 3D models presented and the learning situation during the pandemic that had not occurred during the research period. Perhaps the same case occurred in the study of (Peña & Tobias, 2014) and needs to be anticipated and improved for the purposes of large group trials or further research.

CONCLUSION

In general 3D models online modules are less effective in practicing mastery of conceptual knowledge. Because the resulting misconceptions fall into the moderate criteria, it can be concluded that the 3D models online modules in general has not been effective in practicing mastery of solar system conceptual knowledge. However, it needs to be observed further, because the distance learning situation during the Covid-19 pandemic resulted in misconceptions that were unavoidable and the most important thing was that all aspects were categorized as moderate to high in mastering conceptual

knowledge and students who answered lucky and had not mastered conceptual knowledge were included in the category low in all aspects. When examined further and based on the dimensions of cognitive processes, learning indicators, and sub-types of conceptual knowledge, the modules developed are effective on the dimensions of cognitive processes C2 and C5, but are less effective in the dimensions of cognitive processes C4. Based on learning indicators, the online module developed is effective in indicators of "evaluating information on the shape of the Earth" and "explaining events due to the movement of the Earth and the Moon", but less effective in indicators of "analyzing the characteristics of planets and components of the solar system", "analyzing rotational motion and revolutions of the Earth and Moon", and "evaluating information on the phases of the Moon". Based on the conceptual knowledge sub-type, the online module was effective on the "knowledge of principles and generalizations" sub-type, but was less effective on the "knowledge of classifications and categories" and "knowledge of theory, model and structure" sub-types. Based on all this information, the 3D models online modules will then be refined and used for large group trials to further ensure the effectiveness of the module.

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***Dhanang Setyo Ervana, S.Pd. (Corresponding Author)**
Postgraduate Programe, Continuing Program Development
State University of Surabaya,
Jl. Lidah Wetan, Surabaya, East Java, 60213, Indonesia
Email: dhanang.19039@mhs.unesa.ac.id

Dr. Raharjo, M.Si.
Postgraduate Programe, Continuing Program Development
State University of Surabaya,
Jl. Lidah Wetan, Surabaya, East Java, 60213, Indonesia
Email: raharjo@unesa.ac.id

Prof. Dr. Munasir, S.Si., M.Si.
Postgraduate Programe, Continuing Program Development
State University of Surabaya,
Jl. Lidah Wetan, Surabaya, East Java, 60213, Indonesia
Email: munasir_physics@unesa.ac.id