Forum for University Scholars in Interdisciplinary Opportunities and Networking
Graduate School, Universitas Terbuka
https://prosiding.ut.ac.id

Analyzing Students' Misconceptions, Incomprehension and Gender Differences in Understanding Earth's Rotation-Revolution Concept Using Two-Tier Diagnostic Test

Lidya Choirun Nisa[a*], Subuh Anggoro[b], Zidan Muhabib[c], Iga Dinata Zata Amani[d]
[a*]Universitas Muhammadiyah Purwokerto, Central Java, Indonesia, 2101100147@ump.ac.id
[b] Universitas Muhammadiyah Purwokerto, Central Java, Indonesia, subuhanggoro@ump.ac.id
[c] Universitas Muhammadiyah Purwokerto, Central Java, Indonesia, 2101100136@ump.ac.id
[d] Universitas Muhammadiyah Purwokerto, Central Java, Indonesia, 2101100158@ump.ac.id

Abstract
Earth's rotation and revolution is an important astronomy content in science learning at elementary school. The need for a good understanding of abstract concepts is often the cause of students' misconceptions and incomprehension due to the difficulty of visualizing the material through the explanation given. This study aims to analyze misconceptions, incomprehension and the influence of gender on students' concept understanding of the concept of rotation and revolution of the earth. The data collection method used is a survey with a *Two-tier diagnostic test* instrument assisted by *Certainty Response Index (CRI)* consisting of statement indicators with true-false answers and three categories of student confidence levels in the initial answer. The sample of this study was grade VI students totaling 133 students from seven elementary schools in the Banyumas and Cilacap regions with 66 male and 67 female students. The data obtained were then analyzed descriptively quantitatively using percentages with data presentation in the form of bar charts and tables. The results showed that most grade VI students experienced misconceptions and incomprehension of the concept of earth rotation and revolution, especially on the concept of the impact of the tilt of the earth's axis and the impact of the sun's movement on the earth. Then it was found that the percentage of female students' concept understanding was higher than that of male students. This finding indicates the need for the development of interactive learning media with appropriate and realistic visualizations so that it can help students understand abstract concepts more easily.

Article History:

Keywords:
Misconception, Incomprehension, Gender Differences, Two-Tier Diagnostic Test, Earth's rotation and revolution

1. Introduction

Earth's rotation and revolution are fundamental elements in basic astronomy learning that are covered in science learning at the elementary school level. This conception is important to understand as early as possible to build strong scientific knowledge because this material concept underlies students' personal experience with nature through their observations of everyday phenomena (Kanli, 2015). Earth's rotation and revolution are not only part of scientific material, but can also develop critical and analytical thinking skills and improve students' understanding of concepts about natural phenomena around them (Başpınar et al., 2024). Therefore, understanding the concept of earth rotation and revolution allows students to analyze and understand various physical phenomena in nature (Aktamis et al., 2015).

As part of the science subject in the context of the primary school education curriculum in Indonesia, the material on earth rotation and revolution is intended to build students' initial knowledge of celestial bodies and their relation to broad natural events. For example, such as describing how the day-night cycle occurs (Başpınar et al., 2024; Galano et al., 2018; Vosniadou & Skopeliti, 2017; Kanli, 2015), the cause of seasonal changes in various regions of the earth (Felicita, 2020; Galano et al., 2018; Aktamis et al., 2015; Kanli, 2015), differences in the length of daytime and nighttime (Dankenbring &

Capobianco, 2016), the impact of the tilt of the Earth's axis on the position of sunrise and sunset (Dankenbring & Capobianco, 2016), the different impacts of the earth's movement on its axis and on the sun, the direction of rotation and the time of rotation of the earth (Vosniadou & Skopeliti, 2017). It is important that these concepts are taught so that students' scientific knowledge can be formed by seeing the connection between the knowledge gained and the natural phenomena that occur around students (Aktamis et al., 2015).

In understanding the concept of earth rotation and revolution, students often experience misconceptions. Misconception itself is a mismatch between students' personal ideas obtained from learning, experience and prior knowledge with scientific explanations approved by experts (Utami & Wulandari, 2016). Until now, various studies still highlight the number of misconceptions in science learning, especially in the field of astronomy, including the concept of rotation and revolution of the earth (Galano et al., 2018). Some sub-concepts of the earth's rotation and revolution are often misconceptions such as the day-night cycle is due to the earth's revolution around the sun (Başpınar et al., 2024; Galano et al., 2018; Vosniadou & Skopeliti, 2017; Kanli, 2015), seasonal changes occur because the earth is closer or farther from the sun throughout the year (Dankenbring & Capobianco, 2016; Kanli, 2015; Galano et al., 2018) and the clockwise direction of the earth's rotation (Felicita, 2020), and the tilt of the earth's axis (Kanli, 2015).

Basically, misconceptions are not unintentional but rather students' constructive efforts in linking initial ideas from their daily experiences with correct scientific concepts (Vosniadou & Skopeliti, 2017). The existence of these misconceptions has the potential to interfere with the acquisition of new understanding and integration of new knowledge because students will try to associate new knowledge with previously held concepts, leading to further misconceptions. (Felicita, 2020; Utami & Wulandari, 2016). Before learning the correct concept, students who are detected to have misconceptions need to eliminate their misconceptions first. Based on this, teachers must have good identification skills in distinguishing students who really lack knowledge from students who experience misconceptions and then adjust the right strategy in dealing with these problems. (Vosniadou & Skopeliti, 2017; Utami & Wulandari, 2016).

Research shows that students experience misconceptions in understanding astronomical phenomena because it contains many dynamic concepts, three-dimensional concepts and detailed abstract concepts, making it something that is difficult for students to understand (Aktamis et al., 2015). Another problem is adjusting students' daily experiences through observations of sunrise and sunset with abstract models shown by the teacher to explain the reasons and causes of the phenomenon (Felicita, 2020). Another study mentioned about an important reason misconceptions occur is the conflict between students' prior knowledge and the information presented in science texts, so students fail to infer the relevance between the two things in an effort to connect ideas in the text (Vosniadou & Skopeliti, 2017). In addition, visual representations with 2D images in textbooks used by teachers in learning activities to distinguish the movement between the Earth-Moon-Sun actually cause difficulties for students when understanding them. This is because the images concern specific astronomical phenomena with limited descriptions and students' reasoning varies when interpreting the visual representations, which exacerbates students' misconceptions (Galano et al., 2018). Even teachers and prospective primary education teachers still have misconceptions in various science topics that result in difficulties in guiding students to correct misconceptions (Kanli, 2015; Canada et al., 2012; Metin, 2022). If this is not addressed immediately, it will worsen the transfer of knowledge from teacher to student. Therefore, teachers need to identify their ability to misconceptions before teaching students on a topic (Canada et al., 2012).

The various factors that cause misconceptions indicate the need for early identification to reduce the adverse impact on the development of students' scientific thinking skills and concept understanding (Başpınar et al., 2024). Misconceptions and incomprehension that are left unchecked tend to make it difficult for students to accept scientific explanations because they contradict their initial understanding and intuition. From the difficulty of understanding this constructive concept causes cognitive distortion to affect student motivation because students feel that the concept of rotation and revolution of the earth is difficult to understand. (Vosniadou & Skopeliti, 2017). This problem becomes more complex if

teachers do not immediately find adequate tools to detect misconceptions and attempt to correct students' misconceptions.

Many studies have been conducted to identify misconceptions using questionnaires, multiple-choice tests, essay diagnostic tests, interviews and true-false questions as diagnostic tools for students' initial understanding, such as the *Certainty Response Index (CRI)* method and *two-tier diagnostic* test instruments. (Felicita, 2020; Yuberti et al., 2020; Galano et al., 2018; Kanli, 2015; Utami & Wulandari, 2016). However, the use of instruments with these methods is still limited in learning astronomy at the elementary school level because most studies have focused on high school students, university students, prospective teachers and teachers. (Elif Arıkurt & Şahin, 2020; Utami & Wulandari, 2016; Kanli, 2015; Canada et al., 2012; Bakas & Mikropoulos, 2003; Stover & Saunders, 2000). The use of *two-tier diagnostic test* instruments has been proven to be effective in detecting misconceptions, measuring the beliefs, experiences, and understanding of students, teachers, and college students regarding various science concepts. (Kanli, 2015). However, this instrument has weaknesses related to its accuracy to diagnose students who understand the concept, experience misconceptions, and students who do not understand the concept because students often hesitate and lack honesty in answering questions (A'yun & Nuswowati, 2018). For this reason, a method is needed to develop the instrument using the *Certainty Response Index (CRI)* which is useful in measuring the level of student confidence in the answers given so that student misconceptions can be more easily detected. (Yuberti et al., 2020; A'yun & Nuswowati, 2018; Potvin et al., 2015). This indicates the need for further research that examines the effectiveness of the *two-tier diagnostic test* instrument assisted by the *Certainty Response Index (CRI)* method on the concept of earth rotation and revolution at the elementary school level. In addition, not many studies have examined the use of this diagnostic instrument in analyzing the effect of gender differences on misconceptions and understanding of the concept of rotation and revolution of the earth in students. Although there are studies that show significance in the differences in concept understanding between male and female students, the focus of the concepts studied is different (Nti et al., 2023; Acar et al., 2015) and not astronomy concepts, especially the concept of rotation and revolution of the earth, so this can be a research gap that needs to be explored.

Based on this research gap, this study aims to analyze students' misconceptions and incomprehension as early as possible on the concept of earth rotation and revolution, especially at the primary school level using a *two-tier diagnostic test* instrument. This study was also conducted to identify and analyze the influence of gender on students' concept understanding, with a research focus on how effective this instrument can show different patterns of misconceptions and incomprehension between male and female students. Thus, it is hoped that this research can be useful by providing recommendations for teachers in developing teaching strategies and creating appropriate and effective learning media to improve concept understanding in students.

2. Method

This study used a survey research design with a *two-tier diagnostic test* instrument assisted by the *Certainty Response Index (CRI)* method through the distribution of questionnaires related to the concept of rotation and revolution of the earth. The population in this study were grade VI students from seven elementary schools in the Banyumas and Cilacap regions. The sample selected from the population was based on *purposive sampling* method with the criteria of students who learned about the concept of earth rotation and revolution. The total sample size was 133 students consisting of 66 male and 67 female students. All students voluntarily agreed to participate in this study.

The questionnaire given to the respondents was a two-level test containing 4 questions on the concepts of earth rotation and revolution. At the first level, statements and true or false choices of the 4 concepts were presented. Then at the second level, respondents were asked about how confident they were in the answers they gave at the first level. In this second level, respondents were given 3 choices of belief, namely "I'm Sure", "I'm Not Sure", and "I Don't Know". The use of this instrument is a development of the instrument used by (Potvin et al., 2015). The following is a table of the list of questions regarding the concept of rotation and revolutions of the earth using the *two-tier diagnostic test* instrument assisted by the *Certainty Response Index (CRI)* method.

Table 1. Questionnaire for Earth Rotation and Revolution Concept

Question	Correctness of Answer		Confidence Level		
	Correct	Wrong	Sure	Not Sure	Don't know
The cause of the day-night cycle is the Earth moving around the Sun.					
The Earth rotates and evolves, while the Sun does not.					
The direction of rotation of the earth is clockwise so that the sun appears to rise in the east and set in the west.					
The sun rises exactly in the east and sets exactly in the west every day					

The list of questions, then each item is tested for validity and reliability using SPSS. The validity test pays attention to the 5% significance level (2-tailed significance that is not> 0.01) where the data used amounted to (n = 133) indicating the minimum *r product moment* value is at 0.176. Then in the question reliability test, the Cronbach's Alpha coefficient measurement was used.

Table 2. Validity Test Results using SPSS

Correlations

		Q1	Q2	Q3	Q4	TOTAL
Q1	Pearson Correlation	1	.027	.508**	.554**	.743**
	Sig. (2-tailed)		.754	.000	.000	.000
	N	133	133	133	133	133
Q2	Pearson Correlation	.027	1	.267**	.105	.485**
	Sig. (2-tailed)	.754		.002	.230	.000
	N	133	133	133	133	133
Q3	Pearson Correlation	.508**	.267**	1	.484**	.797**
	Sig. (2-tailed)	.000	.002		.000	.000
	N	133	133	133	133	133
Q4	Pearson Correlation	.554**	.105	.484**	1	.783**
	Sig. (2-tailed)	.000	.230	.000		.000
	N	133	133	133	133	133
TOTAL	Pearson Correlation	.743**	.485**	.797**	.783**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	133	133	133	133	133

**. Correlation is significant at the 0.01 level (2-tailed).

Judging from **Table 2**, the *Pearson Correlation (r product moment)* value of all questions has met the criteria, namely > 0.176. Likewise, in the Sig. (2-tailed), each question is not >0.01. This shows that the questions used are valid.

Table 3. Reliability Test Results of Questionnaire Instruments using *Cronbach's Alpha* coefficient

Reliability Statistics

Cronbach's Alpha	N of Items
.659	4

Table 3. shows the *Cronbach's Alpha* coefficient value of 0.659 which means that the questions used are reliable. This can be seen based on the analysis of the *Cronbach's Alpha* value in **Table 5** below.

Table 4. Analysis of *Cronbach's Alpha* Value

Reliability Index	Category
0,00-0,199	Very low reliability
0,20-0,399	Low reliability
0,40-0,599	Average reliability
0,60-0,799	Strong reliability
0,80-1.000	Very strong reliability

(Sumintono & Widhiarso, 2015 in (Safira & Harun, 2024))

After the data were collected through the *two-tier diagnostic test* instrument assisted by the CRI method, the data were then analyzed descriptively quantitatively. Data analysis was carried out using Microsoft Excel with data presentation in the form of bar charts and tables to show the percentage of three categories of conceptions, namely concept understanding, misconceptions, and incomprehension of concepts in students. The percentage data was then described in general and specifically. The percentage of data showing differences in students' concept understanding ability based on gender is also displayed in the form of bar charts and tables.

Equations

The equation to calculate students who understand the concept, do not understand the concept, and misconceptions can use the following formula:

$$P = \frac{F}{N} \times 100\%$$

Description:
P = Percentage of students who understand the concept, misconceptions, and do not understand the concept
F = Frequency of students who understand the concept, misconceptions, and do not understand the concept
N = Total number of students

3. Results and Discussion

3.1 Results

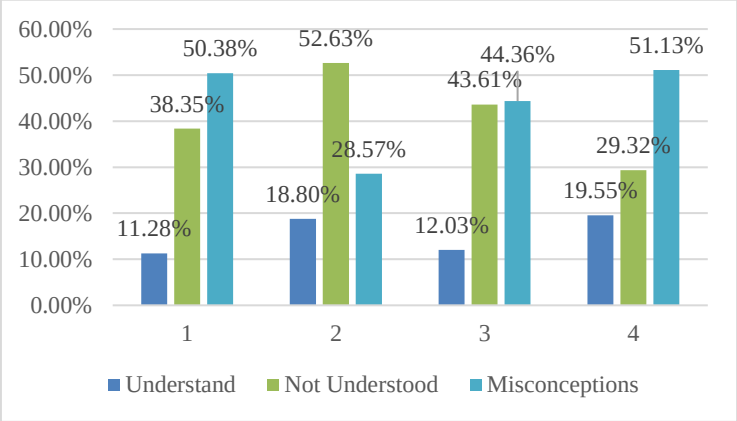
The results of data analysis of grade VI students with a total of 133 students in the form of percentages for students who understand the concept, do not understand the concept, and misconceptions can be seen in **Table 5.**

Table 5. Percentage of Student Conception Categories

Student Conception Level	Percentage (%)
Concept Understanding	15,42%
Do not understand the concept	40,98%
Misconception	43,61%

The data above shows the average percentage of students' level of understanding of the concept of rotation and revolution of the earth in particular. Only 15.42% of students understand the concept and this is a fairly low value. On the other hand, students who do not understand the concept are quite high, namely 40.98%. Meanwhile, students who experienced misconceptions were 43.61%. This shows that the dominance of the percentage is in misconceptions and students' incomprehension of the concept of earth rotation and revolution. The highest percentage level is misconception which means that most students are in that condition and more than a third of the other students experience incomprehension of the concept of earth rotation and revolution.

Figure 1. Percentage of Conceptual Understanding, Incomprehension, and Misconception on Each Question Item



When described in general, the percentage category of students' misconceptions on the concept of rotation and revolution of the earth which has the highest level of misconception for grade VI students is in question number 4 with a percentage of 51.13% where students are sure about the statement "The sun rises exactly in the east and sets exactly in the west". The high level of misconception towards this statement means that students are still wrong in knowing the impact of the tilt of the earth's axis. Meanwhile, the lowest level of misconception experienced by students is in question number 2 with a percentage value of 28.57%. This question states that "The earth rotates and evolves while the sun does not".

Based on the percentage category of students' incomprehension, question number 2 occupies the highest level with a value of 52.36%. Although only a few students had misconceptions in question number 2, more students did not understand it. The percentage results show that more than half of the students do not understand the concept of the movement of the sun and its impact on the earth. Then, the question with the lowest incomprehension was number 4, which amounted to 29.32%.

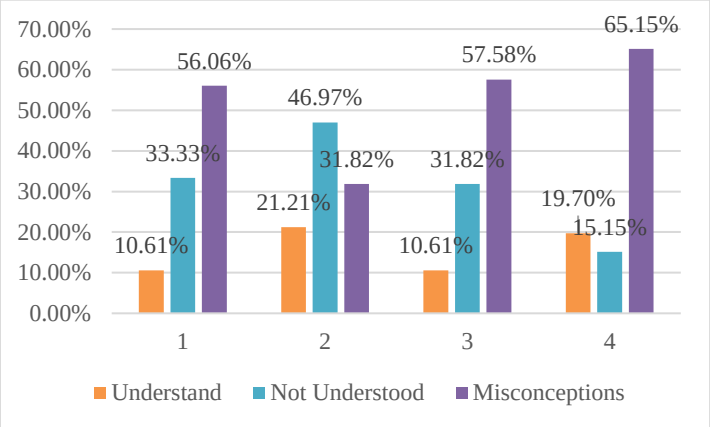
The results of data analysis of the percentage of conceptual understanding, not understanding the concept, and misconceptions of male students in class VI with a total of 66 students can be seen in **Table 6**.

Table 6. Percentage of Conceptual Understanding, Incomprehension, and Misconception of Male Students

Student Conception Level	Percentage (%)
Concept Understanding	15,53%
Do not understand the concept (TP)	31,82%
Misconception	52,65%

The data above shows the average percentage of male students' understanding of the concept of earth rotation and revolution in particular. Only 15.53% of students understand the concept and this is a fairly low value. On the other hand, male students who do not understand are at 31.82%. Meanwhile, students who experienced misconceptions were 52.65%. This shows that the dominance of the percentage is in the misconceptions and incomprehension of students about the concept of rotation and revolution of the earth. The highest percentage level is misconception which means that most students are in that condition where more than half of the students have misconceptions and more than a third of the students have incomprehension of the concept of rotation and revolution of the earth.

Figure 2. Percentage of Conceptual Understanding, Incomprehension, and Misconception on Each Item for Male Students



In general, the percentage category of misconceptions of male students in grade VI on the concept of rotation and revolution of the earth with the highest level of misconception is question number 4 which has a percentage of 65.15%. This value is very high because most male students experience misconceptions on the concept of the impact of the tilt of the earth's axis. Meanwhile, the lowest level of misconception experienced by male students is in question number 2 with a percentage value of 31.82%.

Based on the percentage category of male students' incomprehension in grade VI, question number 2 occupies the highest level with a value of 46.97%. The percentage results show that almost half of the students did not understand the concept of the movement of the sun and its impact on the earth. Then, the question with the lowest incomprehension was number 4, which amounted to 15.15%.

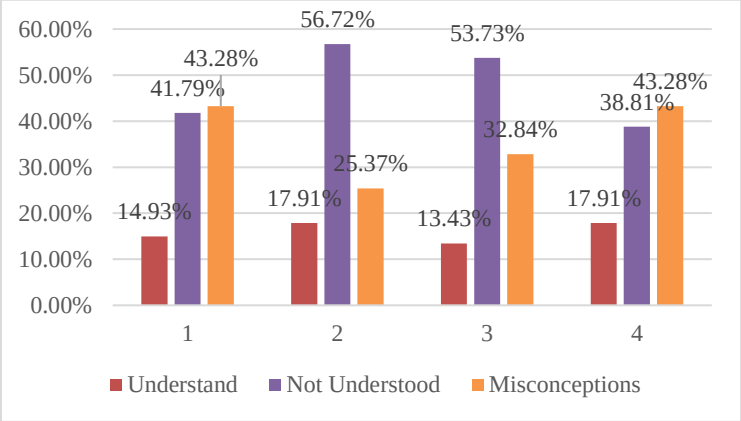
The results of data analysis of the percentage of conceptual understanding, not understanding the concept, and misconceptions of female students in class VI with a total of 67 students can be seen in **Table 7**.

Table 7. Percentage of Conceptual Understanding, Incomprehension, and Misconception of Female Students

Student Conception Level	Percentage (%)
Concept Understanding	16,05%
Do not understand the concept	47,76%
Misconception	36,19%

The data in the table above shows the average percentage of female students' understanding of the concept of earth rotation and revolution in particular. Only 16.05% of students understand the concept and this is still considered a low value. On the other hand, female students who do not understand the concept are at 47.76%. While students who experienced misconceptions were 36.19%. This shows that the dominance of the percentage is in misconceptions and students' incomprehension of the concept of rotation and revolution of the earth. The highest percentage level is incomprehension which means that almost most female students experience this condition and more than a third of students of the concept of rotation and revolution of the earth.

Figure 3. Percentage of Conceptual Understanding, Incomprehension, and Misconception on Each Question Item for Female Students



Based on the bar chart above, the percentage category of misconceptions of female students in grade VI in general on the concept of rotation and revolution of the earth with the highest level of misconception is questions number 1 and 4 which both have a percentage of 43.28%. This value is moderate because almost most female students experience misconceptions on the concept of differences in the impact of earth rotation and revolution and the impact of the tilt of the earth's axis. Meanwhile, the lowest level of misconceptions experienced by female students is in question number 2 with a percentage value of 25.37%.

From the category of the percentage of incomprehension of female students in grade VI, question number 2 occupies the highest level with a value of 56.72%. The percentage result is relatively high because more than half of the students do not understand the concept of the movement of the sun and its impact on the earth. Then, the question with the lowest incomprehension was number 4, which amounted to 38.81%.

After comparing the percentage results between male and female students, a gap was found in the difference in students' concept understanding. Female students have a slightly higher percentage of concept understanding than male students with a percentage value of 16.05%. Although in fact this figure is still relatively low for understanding the concept of rotation and revolution of the earth in grade VI students. Indeed, female students have a slightly higher concept understanding than male students, but the percentage of female students' incomprehension is actually higher than their concept understanding because the percentage value shows a figure of 47.76%. This figure is also greater than the percentage of concept misconceptions experienced by male students. In addition, when viewed from the percentage, male students' misconceptions have a higher average percentage than female students, amounting to 52.65%.

3.2 Discussion

The results of the research that has been carried out are in accordance with the initial objectives of the research to analyze misconceptions, incomprehension of concepts and gender differences in students' concept understanding using a two-tier diagnostic test assisted by Certainty Response Index (CRI). The use of this diagnostic test instrument proved to be effective in analyzing three categories of student conceptions consisting of conceptual understanding, non-conceptual understanding, and misconceptions because the accuracy of the CRI uses the level of confidence of the answer. Analysis of the results with the instrument shows the low understanding of students' concepts in the range of 15.42%. This indicates the need for appropriate interventions such as interactive learning models or media with audio and visualization to correct misconceptions and improve student understanding. There are various factors behind this, especially the mismatch between students' personal ideas based on their previous experiences or learning with scientific concepts and abstract concepts that make it difficult for students to understand the concept of rotation and revolution of the earth. Not a few of the teachers who have a wrong basic understanding then do not correct their misconceptions first and continue to teach students. This distorted transfer of knowledge leads to continued misconceptions.

The sub-concept that has the highest level of misconception at 51.13% is in the statement "The sun rises exactly in the east and sets exactly in the west every day". This indicates the strength of students' assumptions that they think make sense based on observations of natural phenomena in everyday life. In fact, sunrise and sunset are not always exactly in the east and in the west every day due to the tilt of the earth's axis which causes the sunrise and sunset points to always change by a fraction of a degree. The findings of this study indicate a difference from previous research that is interesting to understand. In contrast to the results of the study by Kanli (2015) where the highest percentage of misconceptions in secondary students and teachers about the movement of celestial bodies such as stars, the moon, and the sun, the findings in this study highlighted the highest misconceptions of primary school students regarding the effect of the earth's tilt on the sunrise point. The disparity in findings could be due to differences in students' level of understanding, differences in the standard curriculum applied, students' learning styles, students' learning resources and learning approaches used. In addition, this study also highlighted the influence of gender differences on students' concept understanding. Female students have better concept understanding (16.05%) than male students (15.53%). Although it is fairly low with a thin difference for grade VI students' concept understanding related to earth rotation and revolution.

This research can help teachers to detect misconceptions that exist in students before implementing learning. By identifying and analyzing students' misconceptions and incomprehension from the beginning using a CRI-assisted two-level diagnostic test, it allows teachers to design appropriate learning strategies, models, or media to correct students' misconceptions. For example, such as the preparation of learning media for the concept of rotation and revolution of the earth can use Augmented Reality (AR) which presents 3D visualization so that it helps teachers more easily explain abstract concepts in a material.

4. Conclusion

Based on the results of the study, it can be concluded that the level of understanding of the concept of rotation and revolution of the earth of grade VI students is still very low because it only ranges from 15.42%. The percentage of students' misconceptions and incomprehension of concepts took a large portion, namely 43.61% and 40.98%. The influence of gender on students' concept understanding shows that male and female students have significant gaps in three categories of conception. The gap includes the categories of conceptual understanding, incomprehension, and misconception for male students (15.53%, 31.82%, and 52.65%) and female students (16.05%, 47.76%, and 36.19%). Female students can be said to have a better understanding of the concept than male students, but female students also have a higher incomprehension of the concept. Identification and analysis of misconceptions and incomprehension in students using *Two-Tier Diagnostic Test* instrument questions assisted by the CRI method which allows higher accuracy with a level of confidence in the answer. This CRI method-assisted instrument can only identify misconceptions but cannot eliminate misconceptions. To be able to eliminate and correct misconceptions in students, teachers need to design appropriate strategies, models, or learning media that support 3D visualization so that abstract concepts in the material can be well visualized and easily understood by students.

REFERENCES:

Acar, Ö., Büber, A., & Tola, Z. (2015). The Effect of Gender and Socio-economic Status of Students on Their Physics Conceptual Knowledge, Scientific Reasoning, and Nature of Science Understanding. *Procedia - Social and Behavioral Sciences*, *174*, 2753-2756. https://doi.org/10.1016/j.sbspro.2015.01.962

Aktamis, H., Acar, E., & Unal Coban, G. (2015). A summer camp experience of primary students: Let's learn astronomy, explore the space summer camp. *Asia-Pacific Forum on Science Learning and Teaching*, *16*(1), 1-24.

A'yun, Q., & Nuswowati, D. M. (2018). Analysis of Student Misconceptions Using Cri (Certainty of Response Index) Assisted Multiple Choice Diagnostic Test. *Journal of Chemical Education Innovation*, *12*(1), 2108-2117.

Bakas, C., & Mikropoulos, T. A. (2003). Design of virtual environments for the comprehension of planetary phenomena based on students' ideas. *International Journal of Science Education*, *25*(8), 949-967. https://doi.org/10.1080/09500690305027

Başpınar, P., Çakıroğlu, J., & Karahan, E. (n.d.). *The Effect of Engineering Design-Based Science Instruction on 6th-Grade Students' Astronomy Understandings*. *24*(2024), 3835-3857. https://doi.org/10.15354/sief.24.or628

Canada, F., Santos, M. I., Arevalo, M. J., Gil, M. V, Cubero, J., & Mora, F. (2012). Evolution of Alternative Conceptions About the Sun-Earth System in Students of the Third Cycle of Primary School. *5Th International Conference of Education, Research and Innovation (Iceri 2012)*, *January*, 4623-4632.

Dankenbring, C., & Capobianco, B. M. (2016). Examining Elementary School Students' Mental Models of Sun-Earth Relationships as a Result of Engaging in Engineering Design. *International Journal of Science and Mathematics Education*, *14*(5), 825-845. https://doi.org/10.1007/s10763-015-9626-5

Elif Arıkurt, Ü. G., & Şahin, ülsüm D. ve Ç. (2020). *Examination of Students' Ideas in Different Grades about the Astronomy Developmentally Gelişimsel Olarak İncelenmesi ** Elif Arıkurt, Ümmü Gülsüm Durukan ve Çiğdem Şahin*. *June 2015*.

Felicita, G. A. (2020). Alternative Conceptions of Elementary Scholl Students in Astronomy. *EPRA International Journal of Multidisciplinary Research (IJMR)-Peer Reviewed Journal*, *2*, 198-210. https://doi.org/10.36713/epra2013

Galano, S., Colantonio, A., Leccia, S., Marzoli, I., Puddu, E., & Testa, I. (2018). Developing the use of visual representations to explain basic astronomy phenomena. *Physical Review Physics Education Research*, *14*(1), 10145. https://doi.org/10.1103/PhysRevPhysEducRes.14.010145

Kanli, U. (2015). Using a Two-tier Test to Analyze Students' and Teachers' Alternative Concepts in Astronomy. *Science Education International*, *26*(2), 148-165.

Metin, D. (2022). *Preservice Science Teachers Misconceptions in Basic Astronomy 2 nd INTERNATIONAL EDUCATIONAL RESEARCH*. *January 2021*.

Nti, D., Appiah-twumasi, E., & Ameyaw, F. (2023). Analyzing Gender Differences in Misconception in Linear Momentum Using Two-tier Diagnostic Test Instrument. *Journal of Education and Practice*, *January*. https://doi.org/10.7176/jep/14-1-10

Potvin, P., Skelling-Desmeules, Y., & Sy, O. (2015). Exploring Secondary Students' Conceptions about Fire Using a Two-Tier, True/False, Easy-to-Use Diagnostic Test. *Journal of Education in Science, Environment and Health*, *1*(2), 63. https://doi.org/10.21891/jeseh.99647

Safira, A. F., & Harun. (2024). *Development of Three-Tier Diagnostic Test to Measure Misconcpetions of Grade 5 Students about Fractions*. *9*(2), 82-88.

Stover, S., & Saunders, G. (2000). Astronomical misconceptions and the effectiveness of science museums in promoting conceptual change. *Journal of Elementary Science Education*, *12*(1), 41-51. https://doi.org/10.1007/bf03176897

Utami, D. N., & Wulandari, H. R. T. (2016). The use of astronomy questions as an instrument to detect student's misconceptions regarding physics concepts at high school level by using CRI (Certainty of Response Index) as identification method. *Journal of Physics: Conference Series*, *771*(1). https://doi.org/10.1088/1742-6596/771/1/012027

Vosniadou, S., & Skopeliti, I. (2017). Is it the Earth that turns or the Sun that goes behind the mountains? students' misconceptions about the day/night cycle after reading a science text. *International Journal of Science Education*, *39*(15), 2027-2051. https://doi.org/10.1080/09500693.2017.1361557

Yuberti, Y., Suryani, Y., & Kurniawati, I. (2020). Four-Tier Diagnostic Test with Certainty of Response Index to Identify Misconception in Physics. *Indonesian Journal of Science and Mathematics Education*, *3*(2), 245-253. https://doi.org/10.24042/ijsme.v3i2.6061