

Lunar Phases Refutation Texts: Supplement Texts to Overcome Students' Misconceptions

Syuhendri Syuhendri, Sardianto M. Siahaan, and Abidin Pasaribu

ABSTRACT

The purpose of this research is to develop a set of refutation texts as supplement texts to overcome misconceptions and to improve conceptual understandings on the Lunar phases. The method used is research and development in education. Overall, the research consists of three stages, namely preliminary study, product development, and evaluation. The refutation text was developed based on Posner *et al.* (1982) conceptual change model. The results for the preliminary study stage obtained nine prototype of refutation texts, namely for the concepts of the Earth's natural satellite, the source of moonlight, the rotation and revolution of the earth, the rotation and revolution of the Moon, the direction of the daily motion of the Moon, Lunar phases, solar eclipses, Lunar eclipses, and causes of the tides. A set of refutation texts can be used in teaching the Lunar phase material in high school. Further research is needed to see the effectiveness of the Lunar phase refutation text in remediating students' misconceptions and increasing their concept understanding and the longevity of the substitute concepts.

Keywords: lunar phases, misconceptions, refutation texts.

Published Online: November 30, 2022

ISSN: 2736-4534

DOI : 10.24018/ejedu.2022.3.6.504

S. Syuhendri*

Department of Physics Education,
Universitas Sriwijaya, Indonesia.
(e-mail: syuhendri@fkip.unsri.ac.id)

S. M. Siahaan

Department of Physics Education,
Universitas Sriwijaya, Indonesia.
(e-mail: mr.sardi@unsri.ac.id)

A. Pasaribu

Department of Physics Education,
Universitas Sriwijaya, Indonesia.
(e-mail: pasaribuabidin@yahoo.com)

**Corresponding Author*

I. INTRODUCTION

Lunar Phases is one of the materials given in high schools in Indonesia. This material is included in the subject of natural science. As material to be taught by teachers, this material is also given to pre-service teachers in educational colleges. At the physics education department, faculty of teacher training and education in Universitas Sriwijaya, this material is included in the Earth and space science course. The aim of the lesson is that students are expected to have broader knowledge and insight about the concepts of Earth and space, including the motion and position of celestial bodies, the solar system, and the Earth-Moon-Sun system.

At the secondary school level, the competence for this material is included in the Basic Competence of analyzing the solar system, the rotation and revolution of the Earth, the rotation and revolution of the Moon, and their impact on life on the Earth (Kemdikbud, 2018). In the Indonesian latest curriculum, the Independent Curriculum, as one of the curricula that can be applied in schools, this material is in line with Learning Outcomes of students elaborate their understanding of the relative position of the Earth-Moon-Sun in the solar system and understand the structure of the Earth's layers to explain natural phenomena that occur in the context of disaster mitigation (Kemdikbudristek, 2022).

It is clear that this Lunar phase material is an important material in both high school and educational college. This material is included in the compulsory course. However, there are a lot of misconceptions found in this material, not only experienced by high school students but also by pre-service teacher in the Physics Education Department,

Universitas Sriwijaya. Based on a survey of misconceptions in the department, it was found that 33.85% of students experienced misconceptions on the Lunar phase material, especially for the period of the Lunar phase cycle.

The results of this survey are in line with research from various countries. For instance, Semercioglu and Kalkan (2021) conducted a project for teachers in Turkey saying that based on many studies in recent years it was found that the teachers still do not understand well the causes and scientific processes associated to the Lunar phases and the Lunar eclipse. This creates deep problems in teaching the subjects to students. Another study by Felicita (2021) on seventh grade students at Hyderabad, India, reported that many students understand very limited concepts about the phases of Moon and seasons. Ibrahim *et al.* (2021) also reported that pre-service teachers in a public Malaysian university have moderately (37.86%) conceptual understanding on space science with a number of misconceptions in basic astronomy.

The misconceptions experienced by students have a negative effect on the learning process (Syuhendri, 2019), especially those experienced by pre-service teachers who will teach the material later in school. Therefore, misconceptions must be eliminated and understanding of concepts must be improved. Posner *et al.* (1982) suggested the conditions of dissatisfaction, intelligent, plausible, and fruitful for conceptual change to occur, in addition to conceptual ecology. Based on this view, various strategies in teaching are derived (Syuhendri, 2010), one of which is considered effective is the use of refutation texts (Syuhendri, 2021).

Various studies have recently reported the success of refutation texts in remediating misconceptions and improving concept understanding. For example, Weingartner and Masnick (2019) concluded that refutation texts have potential implications to optimize science texts in order to overcome misconceptions. Ferrero *et al.* (2020) reported that refutation texts can be an effective means to correct misconceptions, even for deep misconceptions, even though the effects may be short-lived. On the other hand, Schroeder and Kucera (2022) showed that refutation texts have positive, moderate effect ($g = 0.41$, $p < 0.001$) compared to other learning conditions. This effect was also consistent and robust for a wide variety of contexts. They support the implementation of refutation text to many fields.

Although refutation text has been reported on its effectiveness in various places, however it has not been widely used in Indonesia and does not yet exist in Indonesian language for Lunar phases topics. Therefore, this research in a wider project aims to develop valid and practical refutation texts for the Lunar phase to be used in the study of conceptual change learning.

II. METHODOLOGY

Overall the method used is research and development in education. The development research is carried out in three stages, namely preliminary studies, product development, and evaluation. In this article, authors report on the product development phase and the development of the prototype of refutation text to remediate misconceptions and improve conceptual understanding of the Lunar phase material.

In the preliminary study stage, it has been carried out material analysis, literature study, searching for standard instruments and translation to Indonesia, as well as identification of misconceptions in the Lunar phase material. The search for this standard instrument is considered better, because it will be easier to locate one and modify it than develop it for use in a study (Creswell, 2002). Furthermore, based on the existing misconceptions, a prototype of the Moon phase refutation text was developed.

Based on the dominant misconceptions experienced by students, a set of appropriate refutation text was developed. The refutation text facilitates the conditions for conceptual changes to occur as proposed by Posner *et al.* (1982). At the initial stage, it must be able to cause the reader's dissatisfaction with their thoughts, and then the explanation given must be reasonable, reliable, and useful for further investigation.

III. RESULTS AND DISCUSSION

Based on the analysis of misconceptions, there are nine refutation texts that have been developed. The design prototype of the refutation text that was decided to be made consists of three components, i.e., a statement of misconception, a statement stating that it is wrong, and an explanation of why the perception is wrong. The refutation text explicitly refutes the above misconceptions with an emphasis on currently accepted scientific explanations. The design of the refutation text is shown in Fig. 1.

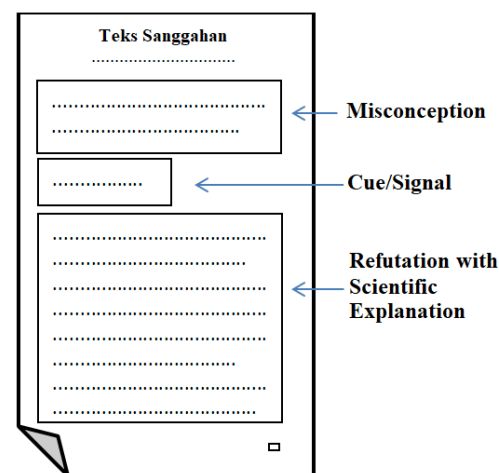


Fig. 1. The design of the prototype of the refutation text.

In the misconceptions space, it is written in the form of misconceptions with complete propositions, for example, many students think that the Moon is only in the sky at night. Furthermore, in the signal section it is stated that such a statement is wrong, for example with the sentence *that statement is wrong*. Finally, in the scientific explanation, an argument is put forward that it is a misconception, and if it is used it is not in accordance with reality or actual natural phenomena.

Nine refutation texts were developed according to this design. One of the refutation text prototypes is shown in Fig. 2.

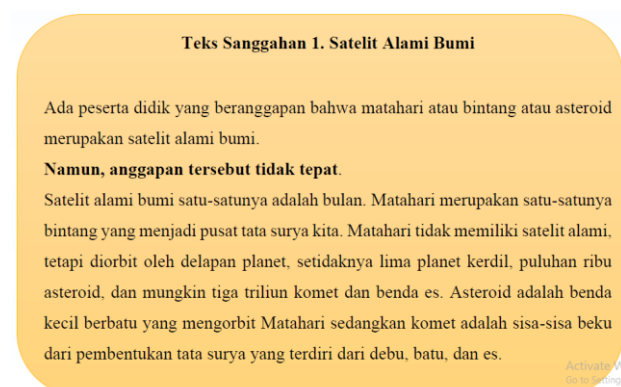


Fig. 2. The prototype of the refutation text with the title natural satellite of the Earth.

All refutation texts developed are spread over six Lunar phase modules. Each of them is explained as follows.

A. Earth's Natural Satellite

In the first refutation text, it is stated that there are students who think that the Sun or stars or asteroids are natural satellites of the Earth. This misconception is countered by the explanation that the Earth's only natural satellite is the Moon. The Sun is the star at the center of our solar system. The Sun has no natural satellites, but is orbited by eight planets, ten dwarf planets, tens of thousands of asteroids, and perhaps three trillion comets and icy bodies. In fact, it is the Earth that orbits the Sun and is known as a planet of the Sun.

B. Source of Moonlight

In this second refutation text, there are students who think that the Moon emits its own light and only shines at night.

The scientific explanation for this is that the Moon does not produce its own light. Moonlight is a reflection of sunlight shining on the Moon. The Moon shines at night and in the morning because the Moon gets its light from the Sun. If we pay close attention, sometimes we can also see the Moon during the day.

C. Earth's Rotation and Revolution

It was stated that there are students who have the assumption that the Earth faces the Moon during the day due to the rotation and revolution of the Earth. It is a wrong conception. The scientific explanation is that during the day, the position of the Earth facing the Sun is caused by the rotation of the Earth. During the 24 hours it takes the Earth to rotate once on its axis, every point on its surface faces the Sun for some of the time and away from it for the other.

D. Moon Rotation and Revolution

There are students who think that the Moon evolves in one year because the Moon and the Earth revolve around the Sun at the same time. This statement certainly makes sense but it is not true. It takes the Moon to rotate on its axis the same time it takes the Moon to circle the Earth once in one month, or 27.3 days to complete one revolution, but 29.5 days to change from New Moon to the next. As the Moon moves around the Earth, the Earth also moves around the Sun. The Moon will have to travel a little further on its path to make up for the extra distance and complete its phase cycle. This causes the phases of the Moon to repeat every 29.5 days.

E. Moon Daily Motion Direction

Here the concept of the Moon's daily pseudo motion is presented. The student's misconception is that the Moon moves relatively from east to west. Based on everyday experience, the Moon, the Sun and other celestial bodies appear to move from east to west across our sky. However, when viewed from above, the Moon orbits Earth in the same direction as our planet's rotation. So, the Moon is actually moving from west to east through our sky. This happens all the time and we hardly ever notice it.

F. The Lunar Phases

In the sixth refutation text, there is a misconception that the full Moon occurs when the Sun's rays on the Moon are covered by the Earth, making the Moon look like a waning Moon. The scientific explanation is that during a full Moon, the positions of the Moon, Earth, and Sun are almost parallel or form an angle of 180 degrees. The Moon is on the opposite side of the Earth, so the entire face of the Moon that gets sunlight is facing the Earth and the part that is shadowed is completely hidden from the view of observers on the Earth. This is different from the new Moon phase, where the side of the Moon that is illuminated by the Sun faces the Sun and the dark side that is not illuminated by the Sun faces the Earth.

G. Solar Eclipse

The misconception that arises for this topic is the idea that a solar eclipse occurs when the Moon, the Earth, and the Sun are in a straight line. To refute this opinion, an argument was put forward that a solar eclipse occurs when

the Moon is directly between the Earth and the Sun which forms a straight line. As the Moon moves between the Earth and the Sun, it blocks out the Sun's light so darkness falls on a small part of the Earth.

H. Lunar Eclipse

Another idea that is often put forward is that a Lunar eclipse occurs because the Moon is blocked by sunlight. A rebuttal is given that the statement is false. Furthermore, it is explained that a Lunar eclipse occurs when the Earth is right between the Sun and the Moon. The Earth blocked the sunlight from reaching the Moon, leaving it in complete darkness. For observers on the Earth, a shadow appears on the Moon, causing it to darken. As the Earth moves out from between the Sun and the Moon, the Moon is gradually illuminated until the entire full Moon is visible again.

I. Causes of Tides

In the last refutation text, it is described that there are students who think that the rotation of the Moon affects the tides of sea water. The scientific explanation given is the balance theory which states that the rise and fall of sea levels is proportional to the tidal generating force. The system of movement between the Earth-Moon-Sun is separated into two systems, namely the Moon-Sun and the Earth-Moon. This theory states that the tides are related to the sea, rising water masses, the Moon and the Sun. Therefore, there are three main factors in this equilibrium theory, including the rotation of the Earth on its axis, the revolution of the Moon with respect to the Sun, and the revolution of the Earth with respect to the Sun.

The nine refutation texts were finally inserted into the teaching materials as a supplement to the teaching materials. Thus, the teaching materials developed not only contain material normatively but also contain emphasis on mastering the right concepts. Since the misconception is still a serious educational problem in Indonesia (Syuhendri, 2019), the refutation text in Indonesian needs to be developed continuously as an innovation in concept learning (Syuhendri *et al.*, 2019).

IV. CONCLUSION

The developed refutation text is a potential material in science teaching, including for basic astronomy. Science discusses natural phenomena experienced by humans since childhood. The imperfection of the senses in capturing natural phenomena can lead to various misconceptions. The refutation text that was developed is a supplement material to other materials in learning to deal with these misconceptions. Further research is needed to test the effectiveness of the Lunar phase refutation texts in remediating misconception and increasing conceptual understanding. Further research is also needed to see the duration of the persistence of the new concept suggested in the students' minds.

ACKNOWLEDGMENT

Authors gratefully acknowledge the support from Institution of Research and Community Service Universitas

Sriwijaya, and Dean of Faculty of Teacher Training and Education. Authors also thank all participants involved in the research.

FUNDING

The research/publication of this article was funded by DIPA of Public Service Agency of Universitas Sriwijaya 2022. SP DIPA-023.17.2.677515 /2022, on Desember 13, 2021. In accordance with the Rector's Decree 0017/UN9.3.1/SK.LP2M.PT/2022, on Juni 15, 2022.

CONFLICT OF INTEREST

Authors declare there is no conflict of interest.

REFERENCES

- Creswell, J. W. (2002). *Educational research: Planning, conducting, and evaluating quantitative* (Vol. 7). Prentice Hall Upper Saddle River, NJ.
- Felicitia, G. A. (2021). Alternative conceptions of elementary school students in astronomy. *EPRA International Journal of Multidisciplinary Research (IJMR)*, 7(1), 25–31.
- Ferrero, M., Hardwicke, T. E., Konstantinidis, E., & Vaddillo, M. A. (2020). The effectiveness of refutation texts to correct misconceptions among educators. *Journal of experimental psychology: applied*, 26(3), 411.
- Ibrahim, N., Yusof, M. M. M., Zulkipli, Z. A., & Dalim, S. F. (2021). Pre-service teachers conceptual understanding in space science. *International Journal of Asian Social Science*, 11(3), 177–187.
- Kemdikbud. (2018). *Peraturan menteri pendidikan dan kebudayaan Republik Indonesia Nomor 37 Tahun 2018* [Regulation of the minister of education and culture of the Republic of Indonesia Number 37 Year 2018]. In Kemendikbud. Indonesian.
- Kemdikbudristek. (2022). *Capaian pembelajaran mata pelajaran ilmu pengetahuan alam (IPA) Fase D Untuk Jenjang SMP/MTs/ Program Paket B* [Learning Outcomes of Natural Science Subjects in Phase D for Junior high schools of Package B Program]. Indonesian.
- Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Toward a theory of conceptual change. *Science education*, 66(2), 211–227.
- Schroeder, N. L., & Kucera, A. C. (2022). Refutation text facilitates learning: a meta-analysis of between-subjects experiments. *Educational Psychology Review*, 34(2), 1–31.
- Semercioglu, M. G., & Kalkan, H. (2021). Understanding of teachers on phases of the Moon and the Lunar Eclipse. *Online Submission*, 8(2), 102–131.
- Syuhendri, S. (2019). Student teachers' misconceptions about gravity. In *Journal of Physics: Conference Series* (Vol. 1185, No. 1, p. 012047). IOP Publishing.
- Syuhendri, S. (2010). Pembelajaran perubahan konseptual: pilihan penulisan skripsi mahasiswa [Conceptual change learning: choices for students' thesis writing]. In *Forum MIPA* (Vol. 13, No. 2, pp. 133–140). Jurusan Pendidikan MIPA FKIP Universitas Sriwijaya. Indonesian.
- Syuhendri, S. (2021, April). Effect of conceptual change texts on physics education students' conceptual understanding in kinematics. In *Journal of Physics: Conference Series* (Vol. 1876, No. 1, p. 012090). IOP Publishing.
- Syuhendri, S., Andriani, N., & Saparini, S. (2019). Understanding the Concept and Misconception of Student Teacher in Kepler's Laws. *Jurnal Kependidikan*, 3(2), 261–275.
- Weingartner, K. M., & Masnick, A. M. (2019). Refutation texts: Implying the refutation of a scientific misconception can facilitate knowledge revision. *Contemporary educational psychology*, 58, 138–148.



Syuhendri Syuhendri is a senior lecturer in the Department of Physice Education, Faculty of Teacher Training and Education, Universitas Sriwijaya, Indonesia. His research focuses on Physics Education, Conceptual Change Learning, as well as studying misconception and conceptual understanding in physics.