



The Development of Conceptual Change Theory-Based E-Modules Equipped with Conceptual Change Texts on the Solar System Topics

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Abstract: This study aims to develop a set of e-module teaching materials equipped with conceptual change text based on conceptual change theory on the Solar System materials. The research method used was Educational Design Research (EDR) with the Plomp model. The research consisted of three stages, namely the preliminary study, design development and product testing. At the initial stage, an analysis of competencies, essential materials, and misconceptions experienced by students in the Solar System material was carried out. There were major misconceptions such as the Sun as the biggest star, the motion of the planets that are always the same, the phases of the moon, revolution and rotation of the earth, Kepler's Laws II and III, solar eclipses, and Newton's gravity that occurs between the earth and the moon as well as the earth and the sun. These findings are the basis for developing the e-module. Based on the validation and practicality tests, the validation level was obtained at 3.85 which means very valid category and practicality at 93% means very practical category. Therefore, it can be concluded that the developed e-module teaching materials based on the conceptual change on the Solar System topics are valid and practical.

Keywords: E-module; Conceptual change text; Misconceptions; the solar system.

Introduction

The future of a nation depends on the education carried out in the nation. Education is a process that is expected to provide a change in a person's attitude and behavior (Sari, 2013). The process itself is an effort to mature the students through learning activity that is conducted in a systematic and planned manner. In the learning process students are expected to be actively involved in developing their potential to be able to have the spiritual, social, intellectual, and skills competencies that are needed for themselves, society, and the nation. One of the subjects included in the national curriculum in Indonesia is natural science.

The quality of science education is still a national problem. One of the main factors that cause the lack of quality educational outcomes is misconceptions experienced by students (Syuhendri, 2019). In general, the quality of science education including physics is influenced by five factors, namely process skills, creativity, attitude development, conceptual

understanding, and the use of concepts in everyday life (Kartika et al., 2020). In the process of science learning, understanding the concepts correctly is important for students to easily connect with new material (Syuhendri, 2019). The role of educators is very important in learning. Therefore, educators should also understand the concept according to the actual scientific so that students get an understanding of the concept that is also scientifically appropriate.

If students understand a concept correctly, then the students will be able to remember the lessons they have learned over a long period (Febriyanto et al., 2018). The same thing was expressed by Radiusman (2020), who stated that students who can find concepts on their own, will be able to understand and store concepts in memory for a long time. Understanding the concepts properly can make students' mindsets critical. Students will also be able to re-explain the material they understand in oral or written form to others and be able to make that person understand it.

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However, There are many students who experience errors in understanding the science concept. The source of the error in understanding the concept can be the wrong of initial perception. This false initial perception leads to misconception Syuhendri (2010) states that misconception is a term to state that something is understood differently from what is understood by scientists in certain fields of science, or someone's conception is different to or contrary with the conception of scientists. The difference between the initial conception that students have with the correct concept is what is called a misconception (Paramitha, 2021). Furthermore, according to Samara et al. (2020) misconception is a wrong explanation and an idea that is not following the scientific understanding accepted by experts.

SMP Negeri 1 Indralaya as one of the formal educational institutions continues to strive to improve the various abilities of its students so that they can compete globally. Based on the results of a preliminary study conducted at the school through observation, it was found out that the learning process carried out at the school had utilized technology in the learning process. In addition, internet facilities are also very adequate in this school. All students and teachers have the facilities so that the learning process can be carried out both on-line and off-line.

Based on the need analysis of learning process submitted to the science teachers through interviews, it was obtained the information that most of the learning media used by teachers were media with pdf format. Learning media with pdf format still has many shortcomings, including not being able to load moving illustrations or interesting learning videos so there are still many students who have difficulty understanding the science learning materials at the school. In line with this statement, the ability of students to understand the concept of the solar system material was only 41% and the remaining 59% of students stated that they had difficulty in understanding the material of the solar system or experienced misconceptions.

According to constructivist theories in education, misconceptions can emerge from every day experience (Coley & Tanner, 2012). Children have started to develop their concept of nature before entering school (Syuhendri, 2022). Misconceptions formed long before entering school will be firmly entrenched in students' minds. Therefore, the teacher must be serious if they want to overcome it. Overcoming misconceptions can be done by using various learning strategies oriented to conceptual change, such as analogies, bridging analogy, concept substitution, predict-observe-explain (POE), and conceptual change text (CCT). Syuhendri (2010). Conceptual change texts have the advantage that they can be used flexibly by students both in class and outside of the class. The CCT can be used as a supplement to

teaching materials that can be read over and over again at home. However, this kind of materials have not been developed for Indonesian students.

The learning strategies used should be based on conceptual change theory. Posner et al. (1982) proposed a model how to overcome misconception that called as conceptual change model. Based on the theory, conceptual change is a process in which individuals restructure their conceptual knowledge (Rodrigues & Thacker, 2019) with a radical accommodation process. Conditions for conceptual change to occur are students must feel dissatisfied with their old conceptions, and then the substitute concept must feel more intelligible, plausible, and fruitful (Syuhendri, 2017; Posner et al., 1982). In addition, identification of misconceptions needs to be done first in order to be able to prepare appropriate conceptual change learning tools and designs (Syuhendri, 2019).

Based on this description, the authors developed a set of valid and practical teaching materials in the form of an e-module based on conceptual change theory equipped with conceptual change texts on the solar system topics for junior high school students. This kind of learning materials not only can be used to master the materials according to the expected competencies but also can be used to overcome students' misconceptions and improve their conceptual understanding.

The objectives of this study are identifying forms of misconceptions on the matter of the solar system and produce valid and practical conceptual change theory-based e-module teaching materials to improve understanding of solar system material concepts.

Method

The type of research used in this research was Educational Design Research (EDR) with the Plomp development model. Plomp's research stages include preliminary research, prototype design, and evaluation (Plomp & Nieveen, 2013). The subjects of this study were the conceptual change theory-based e-modules and three lecturers and 7th-grade students of SMPN 1 Indralaya, Ogan Ilir Regency, South Sumatra, Indonesia.

In the preliminary study or research preparation stage, the study focuses on 1) literature study to analyze competencies, essential material, concept analysis, and misconceptions experienced by students on the subject of the solar system; 2) field studies to collect documents, materials, methods, media, evaluation techniques, and other activities in learning; and 3) describe the findings of misconceptions in the solar system topics so far.

At the development stage of the design of the conceptual change theory-based e-module, the materials comprise of conceptual changes texts and e-module on the solar system material was developed. The development begins with an analysis of the material and

concepts of the solar system material, followed by making a prototype of conceptual change text and e-module based on conceptual change theory and then taking the next steps to get a valid and practical test of the developed materials based on Tessmer's (1993) evaluation process.

The instruments used in this research are (1) expert validation: a sheet given to the expert in order to validate the product being developed. From this sheet will be obtained the results of assessment, suggestions and recommendations from experts to improve the conceptual change theory-based e-module, (2) questionnaire: The questionnaire is used to find out students' opinions about the conceptual change theory-based e-module. Furthermore, the data were analyzed to answer research questions related to the validation and practicality of the products developed.

The results of the walkthrough data analysis sourced from experts will be analyzed descriptively as suggestions for revising the developing teaching materials. The input is written on the validation sheet. The validation sheet given to the expert was then made in the form of a Likert scale. The Likert scale used is made in the form of a checklist with four categories of answers, namely very good, good, not good, and very bad.

The validation results from the validator will be explained in tabular form. Then it looks for the average value of the teaching material validation from the statement score with the average formula (Purwanto, 2012)

$$\bar{X} = \frac{\sum X_i}{n} \tag{1}$$

Where:

\bar{X} = average value of teaching material validation

X_i = total score obtained

n = number of statements

Then the average value of the assessment results from the validators obtained, adjusted into several categories as shown in Table 1.

Table 1. Category of Expert Validation Results (Wiyodoko, 2019)

Average Score	Category
3.26 - 4.00	Very Valid
2.51 - 3.25	Valid
1.76 - 2.50	Invalid
1.00 - 1.75	Very Invalid

The practicality questionnaire data were obtained from the one-to-one evaluation and small group evaluation stages on the prototype of the developed teaching materials. The results of the questionnaire were then analyzed using a Likert scale to measure students'

opinions on the use of teaching materials. The data from the questionnaire will be presented in tabular form and the percentage is calculated using the following formula 2.

$$\text{average score} = \frac{\text{number of scores}}{\text{maximum number of scores}} \times 100\% \tag{2}$$

The value of the questionnaire was then converted into percentage to find out the students' opinions about the teaching materials developed, according to the criteria set out in Table 2.

Table 2. Category of Expert Validation Results (Purwanto, 2012)

Average Score (X)	Category
81 - 100	Very Practical
61 - 80	Practical
41 - 60	Practical enough
21 - 40	Not practical
0 - 20	Very Impractical

At this stage, comments and suggestions from the students will also be obtained from the suggestion's column in the questionnaire sheet. These suggestions are also used as input to be able to improve the teaching materials in term of to make them more practical to use.

Result and Discussion

The study aims to develop a set of e-modules equipped with conceptual change texts materials based on conceptual change theory on the Solar System topics. The developed materials were examined their validity and practicality in order to improve students' conceptual understanding and to overcome misconceptions. This research used the Plomp development model which consists of preliminary research, prototype design stage, and evaluation stage. This section describes the results of each stage.

Preliminary Research

The indicators that have been developed consist of 13 indicators which are divided into 3 learning activities. The learning activity 1 about members of the solar system and their characteristics, consists of 3 indicators, namely: (1) name of the members of the solar system; (2) grouping of the solar system; (3) describing the characteristics of each member of the solar system. The learning activity 2 about the movement of the earth and the moon and their impact, consists of the following indicators: (1) describing the rotational motion of the earth (2) explaining the impact of the earth's rotation on life, (3) describing the motion of the earth's revolution, (4) explaining the impact of the motion earth's revolution for life, (5) describing the movement of the moon, (6) describing the phases of the moon, (7)

explaining the full moon and new tides, (8) explaining the synodic and sider moons. The learning activity 3 about the phenomenon of celestial bodies, consists of the following indicators (1) describing the Solar Eclipse, and (2) describing the Lunar Eclipse.

Based on the concept analysis, the key concepts that students have to master in the solar system material consist of 3 learning activities. In the Learning Activity 1 the key concepts are the solar system, members of the solar system consisting of the Sun, eight planets (including the earth) that revolve around the sun, satellites (including the moon) that orbit these planets, the Asteroid belt, Kuiper belt, planets dwarfs, meteoroids, and comets. The Learning Activity 2 consists of the rotation and revolution of the earth, the movement of the moon, and its impact on life on earth. The Learning activity 3 consists of the phenomena of the celestial bodies and discusses the solar eclipses and the lunar eclipses and their impact on human life.

Furthermore, based on the literature review from the previous research by Azizah (2022), Ananda (2021), and Rachmawati & Susanto (2017) by using CRI (Certainty Of Response Index) and PISA (Program For International Student Assessment) questions to identify science students' misconceptions on the Solar System Materials, and a preliminary study conducted by researchers using the standard instruments the Astronomy Misconception Survey (AMS) can be determined the form of misconceptions that students usually experience in the material of the solar system. The dominant misconceptions are 1) the sun is considered the largest star in the universe, 2) the movement of the planets is always the same, 3) the concept of the movement of the moon, 4) the concept of revolution and rotation of the earth, 5) Kepler's Laws II and III, 6) solar eclipse events, and 7) Newton's gravity that occur between the earth and the moon as well as the earth and the sun.

1. The sun is considered the largest star in the universe

In the concept of the sun as a star, the form of the misconception that occurs is that almost all students think that the sun is the biggest star in the universe. This is because the sun looks the largest and also the brightest from the earth. The correct explanation of the concept is that the sun is not the biggest star in the universe because there are still many stars in space that are much larger than the sun (1.3927 million km in diameter) such UY Scuti with a diameter of 2.38 billion km, KY Cygni with a diameter of 1.98 billion km, AH Scorpii with a diameter of 1.96 billion km, VV Cephei with a diameter of 1.85 billion km, V766 Centauri Aa with a diameter of 1.54 billion km and other stars (Rizaty, 2022). Judging from its diameter, we can compare that the sun is much smaller than other stars. The thing that causes students

to think the sun is the biggest star is because the sun is closer to Earth than other giant stars.

2. The motion of the planets is always the same

Students assume that the speed of a celestial body gets slower as it approaches the Sun and gets faster as it gets farther away because the influence of the Sun's gravity is getting smaller. On the other hand, there is also an assumption that the speed of the planet is getting bigger when it farther from the Sun because the influence of the Sun's gravitational force is getting smaller on the planet. Conceptions like this arise because students have experienced from various previous information that objects are freer to move in space when they are separated from Earth's gravity or that astronauts are easier to move on the Moon. After all, the Moon's gravity is smaller than Earth's gravity.

Another conception that was found was that the speed of the planets was the same because the area that it was swept was the same, and could not distinguish between the concepts of "time" and "speed". Each planet moves in such a way that an imaginary line drawn from the sun to the planet covers the same area in equal time (Rachmawati & Susanto, 2017). So, it can be concluded that a planet revolves around the Sun at different speeds along the path. The planet will change its speed every time along its path. These objects move in the form of uniform motion. When the celestial body is in a trajectory with a position closer to the Sun, the celestial body will move faster and the farther away from the Sun it will move slower. Planets have the greatest speed at perihelion and slowest at aphelion.

3. The concept of the movement of the moon

One form of the misconception that occurs in the movement of the moon is that many students assume that the New Moon occurs because the Moon is completely covered by the shadow of the Sun. This is wrong. After all, the new moon does not occur because the moon is covered by the sun, but occurs because the face of the moon that is exposed to the sun is not facing the earth. The position of the Earth, the Moon, and the Sun when the New Moon occurs is that the Moon is between the Earth and the Sun, therefore the Moon can't be covered by the sun's shadow, what happens is that the Moon is free to receive sunlight. At the time of the New Moon, all faces of the Moon facing the Earth do not get sunlight. Objects can be seen if they emit light or reflect light from other objects. Because the moon only reflects sunlight, at the time of the new moon the part of the Moon that faces the Earth is not exposed to sunlight so nothing is reflected on Earth. So that we do not get the impression of seeing the Moon.

4. The concept of revolution and rotation of the earth

Earth's revolution is the event of the earth around the sun. When the earth revolves around the sun its orbit is an ellipse. This happens because of the gravitational attraction between the Earth and the Sun. Therefore, the orbital paths of celestial bodies have the closest and farthest points from the Sun, namely Perihelion and Aphelion. Many students assume that the change of seasons is caused by the phenomenon of Aphelion and Perihelion. This is based on the idea that if its position is getting closer to the Sun (Perihelion) it means that the Earth is getting hotter and if its position is getting further away from the Sun (Aphelion) it means that the Earth is getting colder.

The fact is that the position of the Earth in Perihelion and Aphelion is not enough to change the total temperature change for the Earth. Although it does not have a direct impact on temperature changes let alone seasons, Perihelion and Aphelion play a role in the duration of a season. When the Earth is at its closest, the Earth moves the fastest at a speed of almost 30.3 km/s or about 1 km/s faster than when the Earth is in the farthest position. Consequently, winter in the Northern Hemisphere and (at the same time) summer in the Southern Hemisphere take place more quickly. On the other hand, when Aphelion occurs, the Earth does not move faster, causing summer in the Northern Hemisphere and winter in the Southern Hemisphere to be almost 5 days longer (Anjar, 2018).

5. Kepler's Laws II and III

Some of the misconceptions that may occur due to a lack of understanding of the concept of Kepler's Third Law are (1) the orbital distance is directly proportional to the mass of the planet, (2) the orbital distance is directly proportional to the period and mass of the planet, (3) the distance of all orbits is the same, (4) more the closer the orbital distance the greater the speed of revolution of the planet. The correct explanation of the concept is that the orbital distance depends only on the period. This is following the concept of Kepler III's law which reads: " The square of the period of a planet is proportional to the rank of three of its average distance from the Sun."

6. The solar eclipse

In the event of a solar eclipse, the misconception that occurs is the assumption that a solar eclipse occurs during the full moon phase. The correct explanation of the concept is that a solar eclipse occurs when the sun is partially or completely covered by the moon. This solar eclipse occurs when the positions of the Earth, Moon, and Sun are in a line and plane, and the moon is between the earth and the sun. This position is the New Moon Position (The moon is completely dark). So, the solar

eclipse will only occur when the New Moon (New Moon).

7. Newton's gravity that occurs between the earth and the moon and the earth and the sun

Many people think that an object with a greater mass exerts a greater force on an object with a smaller mass. They believed that an object with a large mass would attract a small object with a greater force than an object with a small mass would attract a large mass object. In the case of the Sun-Earth system, the Sun is considered to exert a greater force on the Earth so that the Earth revolves around the Sun. In the case of the Earth-Moon system, the Earth is considered to exert a greater force on the Moon so that the Moon revolves around the Earth (Syuhendri, 2010). The correct explanation of the concept is that objects in nature will have a force of attraction (interaction force) between these objects. This force is known as the universal gravitational force and is formulated as Newton's Law of Universal Gravity: every particle of matter in the universe exerts an attraction on every other particle with a force that is directly proportional to the product of the masses of the particles and inversely proportional to the square of the distance between them, and the force acts in opposite directions along the line joining the two particles. So according to this law, object M attracts object m with a force

$$F_{mM} = \frac{G_{mM}}{r^2} \tag{3}$$

and object m attracts object M with a force

$$F_{Mm} = \frac{G_{Mm}}{r^2} \tag{4}$$

It is clear that the magnitudes of the two forces are the same, only in opposite directions, $F_{mM} = -F_{Mm}$. From this equation, it is clear that whatever the difference in the masses of the two objects, the force of attraction of the first object on the second object is equal to the force of attraction of the second object on the first object. In the case of the Sun-Earth, the Sun will pull the Earth with the same force that the Earth pulls on the Sun. because the mass of the Sun is much larger, the effect of the Earth's pull on the Sun is not observed.

The misconceptions found above are the basis for the development of the e-module based on conceptual change text (CCT) on the material of the solar system. At the design development stage, drafting/prototyping of e-modules based on CCT on the material of the solar system was carried out. The prototype was developed for the learning activity 1: members of the solar system and their characteristics, and the learning activity 2: the movement of the earth and moon and their impact on life. The learning activity 3: the phenomenon of celestial bodies.

Misconceptions can be eliminated by using the conceptual change texts. By reading the CCT, students will be aware of the form of misconceptions they have and then will understand the correct concepts. This is in accordance with Syuhendri (2016) research results that conceptual change texts help students pursue science concepts by actively involving them in filling out the conceptual change text sheets. Therefore, the CCT should be read carefully. The more the students reading the CCT the better their conceptual understanding.

The CCT is based on the explanation of Posner et al (1982) regarding the assimilation and accommodation of new knowledge according to Piaget's theory. Posner et al developed a general model of how a person's conceptual understanding can be shifted from a wrong conception to a correct one. The change in understanding from the old conception to a new conception is called a conceptual change. There are four conditions for a change in conception to occur, namely the old conception must be felt to be unsatisfactory for students, and then the substitute conception must be intelligible, plausible, and fruitful for them.

To fulfill these four requirements, the CCT can be made in this e-module in a format as stated by Syuhendri (2017) as follows:

- Situation
- Question
- Answers and Reasons
- Misconception
- Correct Concept Explanation

Conceptual Change Text-based e-module on solar system material was developed based on the above format.

Development stage / prototype

The second stage in Plomp's development is the prototype stage. At this stage, the design is carried out to develop the e-module based on the changing concept text of solar system materials. This stage produces four prototypes. The form of the e-module cover display can be seen in Figure 1 as prototype 1. Furthermore, based on self-evaluation, the researcher made improvements to prototype 1. Improvements in terms of content, language, and data layout. The result of this revision is referred to as prototype 2.

This e-module is also equipped with more complete material on the learning web and demonstration videos, as well as learning videos. The presence of videos can present information, explain processes, present information, explain complex concepts, teach skills, shorten the time, and help understand (Azhar, 2011). The form of learning web applications and demonstration videos can be seen in Figure 2.



Figure 1. The E-module Cover



Figure 2. The Learning Web and Video In E-module

The design of the e-module is also compiled based on the theory of concept change. The e-module is based on a conceptual change text that has an important role in helping students overcome the misunderstanding of concepts in solar system materials. The text of the conceptual change of the solar system matter can be seen in Figure 3.

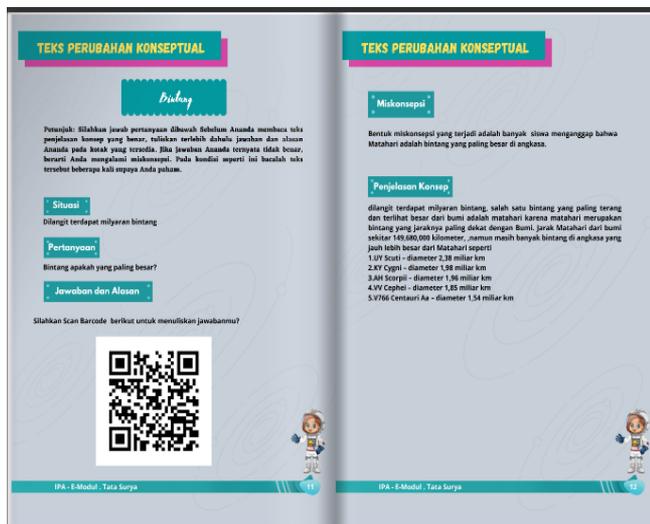


Figure 3. CCT in the Solar System E-module

This form of text is believed to be successful in increasing conceptual understanding to overcome the misconceptions experienced by students. The reasons are: first, CCT is a trusted source of information for students. CCT provides a variety of varied conceptions that may be the same as the views of students or conceptions that already exist in students' minds. The statement of alternative conceptions in the CCT reminds students that some of their conceptions are wrong. With the explanation of scientific concepts explained in the CCT, students realize that this is a new concept that is different from the conceptions possessed by students. So that it helps students to see the difference between their concepts and scientific concepts. Second, CCT is a powerful learning resource for classes with large numbers of students or large classes. The lecture method will not look at every problem that is on the mind of every student in large numbers with a limited time. This is in line with the results of research by Syuhendri (2017).

Prototype 2 was produced after conducting a self-evaluation of prototype 1. This evaluation focused more on the use of good and correct Indonesian spelling, selection of appropriate videos and images, completeness of e-modules, and completeness of CCT. Furthermore, the production of prototype 3 was carried out after formative evaluation and revision of prototype product 2. A formative evaluation was carried out in the form of expert reviews and One to One evaluation.

The expert review stage is the stage where the core components of prototype 2 which include the feasibility of content, suitability of teaching material needs, language, presentation, and graphics of text-based e-modules, and conceptual changes to the Solar System material are checked for validity. These components will be assessed correctly and appropriately so that the e-module prototype is suitable for use by students. Prototype 2 was assessed by three expert validators who are competent in their fields. Following are the results of

the recapitulation of the validation results of the e-module based on Conceptual Changes in the Solar System material.

Table 3. Validation results

Aspects of Assessment	Average Value	Category
Content feasibility aspect	3.86	Very valid
Aspects of the suitability of teaching material needs	3.85	Very valid
linguistic aspect	3.77	Very valid
Serving aspect	3.88	Very valid
Graphic aspect	3.92	Very valid

Based on the information in Table 3, it can be seen that all aspects are considered valid. This shows that each statement item in the developed e-module follows the syntax of the conceptual change text and follows the contents of the Solar System material. Based on the results of the analysis of the data obtained, this shows that the text-based e-module conceptual change in the solar system material developed has complied with the Basic Competence (KD) requirements, namely KD 3.11 and KD 4.11 contained in the 2013 curriculum syllabus and the learning objectives to be achieved. and the material provided is by the abilities of students. The formative test given at the end of the e-module activity is following the material being studied. Animated displays, practical videos, pictures, and material links provide information and help students understand the Solar System material. E-modules use video, audio, and animation to reduce the high verbal elements of the print module (Laili, 2019). Furthermore, a good e-module is equipped with video tutorials, animations, and audio to enrich the student learning experience (Kemendikbud, 2017).

The one-to-one evaluation stage is carried out after the teaching materials have been declared valid at the expert review stage. This one-on-one evaluation stage was carried out to see the practicality of the text-based e-module conceptual changes in the Solar System material that had been developed. The one-to-one evaluation stage is also not only to see the level of practicality of the prototype 1 teaching material but also to find out the lack of teaching materials that have been developed from the user side, namely students. At this stage, the e-module was tested on 3 students who had studied the material on the Solar System. With this, it is intended that they can provide appropriate and useful suggestions for the improvement of CCT-based e-modules. The results of the student response questionnaire assessment at this one-to-one evaluation stage can be seen in the Figure 4.

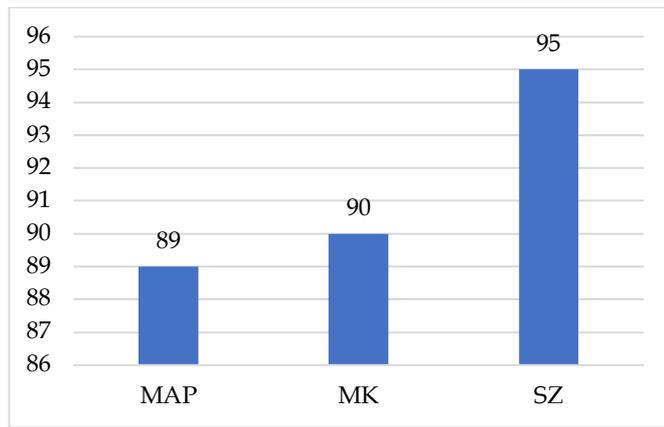


Figure 4. One to one evaluation

From the graph in Figure 4, it is found that the average result of the student response questionnaire assessment is 91%. Based on Table 2, it can be concluded that the text-based e-module on the conceptual change of the Solar System material is practical in the very practical category. This proves that learning using text-based e-modules makes conceptual changes easier for students to understand the concept of Solar System material, this follows one of the characteristics of e-modules which are user-friendly (Kemendikbud, 2017).

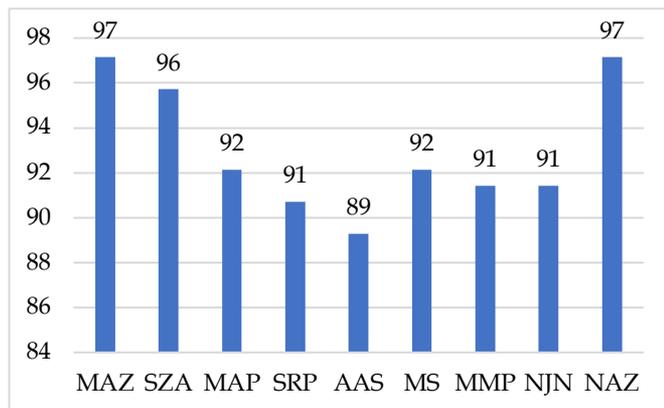


Figure 5. The small group evaluation

The small group evaluation stage is the final stage in the evaluation stage of research on the development of text-based e-module teaching materials on conceptual changes in solar system material. Prototype 3 has been produced and then tested on students who are divided into 3 groups. The implementation of this small group evaluation is almost the same as the one-to-one evaluation stage where students are given time to understand and briefly discuss the suitability of the content, display design, and the benefits of this teaching material for them. Then after that students were given a questionnaire about prototype 3 that they had read and understood before. The results of the student response questionnaire assessment.

Based on the diagram in Figure 5, it can be seen that the average assessment of student response

questionnaires is 93.01 so based on Table 3 regarding the practicality criteria for teaching materials, it can be concluded that prototype 3 e-module teaching materials based on text conceptual changes in solar system materials are included in the practicality criteria very practical form. This shows that the developed e-module allows students to learn according to their respective abilities and learning speed.

Conclusion

The development of a set of the conceptual change theory-based e-module teaching materials equipped with the conceptual change texts on the Solar System material has been successfully carried out with the stages of planning, development and evaluation. The preliminary stage consists of competency analysis activities, essential materials, and dominant misconceptions experienced by students in the solar system material. This stage is the basis for developing CCT-based e-modules on solar system materials. The CCT topic for the Solar System e-module material has begun to be developed with the following formats: situations, questions, answers and reasons, types of misconceptions, and correct concept explanations. The CCT can eventually be used to improve conceptual understanding and remediation of misconceptions about the solar system. The development of conceptual change theory-based e-modules on the solar system matter has been valid and practical and can be used in the learning process. In the future it needs also to be tested for effectiveness of the developed materials in the learning process.

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References

Agustina, L. (2016). Upaya meningkatkan kemampuan pemahaman konsep dan pemecahan masalah matematika siswa SMP Negeri 4 Sipirok kelas VII melalui pendekatan matematika realistik (PMR). *EKSAKTA: Jurnal Penelitian Dan Pembelajaran MIPA*, 1(1), 1-7. <http://dx.doi.org/10.31604/eksakta.v1i1.%25p>

Ananda, L. dan Syuhendri, S. (2021). *Miskonsepsi Mahasiswa Calon Guru Fisika Pada Mata Kuliah Ipa*

- Materi Periode Orbit Bulan Mengelilingi Bumi.* (Unpublished skripsi). Universitas Sriwijaya. Indonesia.
- Anjar, R. (2018). Apa Jadinya Ketika Bumi Mendekat dan Menjauh dari Matahari?. Retrieved from <https://www.zenius.net/blog/dampak-aphelion-perihelion-suhu-bumi>
- Azhar, A. (2011). *Media pembelajaran* (i). Jakarta: PT. Raja Grafindo Aksara.
- Azizah, S. N., Akhsan, H., Muslim, M., & Ariska, M. (2022). Analysis of college students misconceptions in astronomy using four-tier test. *Journal of Physics: Conference Series*, 2165(1). <https://doi.org/10.1088/1742-6596/2165/1/012004>
- Badiro, D., Syuhendri, S., & Fathurohman, A. (2019). Pengembangan Media Pembelajaran Aplikasi Android Berbasis Teori Perubahan Konseptual Materi Tata Surya dan Listrik dinamis Mata Kuliah IPBA. *Jurnal Inovasi Dan Pembelajaran Fisika*, 6(1), 103-112.
- Coley, J. D., & Tanner, K. D. (2012). Common origins of diverse misconceptions: Cognitive principles and the development of biology thinking. *CBE Life Sciences Education*, 11(3), 209-215. <https://doi.org/10.1187/cbe.12-06-0074>
- Dirman, H. M., Mufti, F., & Festiyed, F. (2022). Review and Comparison of Four-Tier Multiple Choice and Five-Tier Multiple Choice Diagnostic Tests to Identify Mastery of Physics Concepts. *Jurnal Penelitian Pendidikan IPA*, 8(1), 1-12. <https://doi.org/10.29303/jppipa.v8i1.838>
- Fahrudin, A. G., Zuliana, E., & Bintoro, H. S. (2018). Peningkatan Pemahaman Konsep Matematika melalui Realistic Mathematic Education Berbantu Alat Peraga Bongpas. *ANARGYA: Jurnal Ilmiah Pendidikan Matematika*, 1(1), 14-20. <https://doi.org/10.24176/anargya.v1i1.2280>
- Fitriza, Z., & Gazali, F. (2017). Pengembangan Modul Pembelajaran Kimia Berbasis Model Perubahan Konseptual Ed3u (Explore, Diagnose, Design, Discuss, Use) Terintegrasi Multi Representasi Pada Materi Struktur Atom. *Jurnal Eksakta Pendidikan (Jep)*, 1(2), 64-71. <https://doi.org/10.24036/jep.v1i2.51>
- Handayani, N. D., Astutik, S., & Lesmono, A. D. (2018). Identifikasi Miskonsepsi Siswa Menggunakan Four-Tier Diagnostic Test pada Materi Hukum Termodinamika di SMA Bondowoso. *Jurnal Pembelajaran Fisika*, 7(2), 189-195. <https://doi.org/10.19184/jpf.v7i2.7927>
- Kartika, D., Maming, R., & Tawil, M. (2020). Identifikasi Miskonsepsi Mata Pelajaran Ipa Siswa Kelas Viii Smp Terakreditasi a Di Kabupaten Gowa. *Jurnal IPA Terpadu*, 3(2), 10-23. <https://doi.org/10.35580/ipaterpadu.v3i2.12035>
- Kemendikbud. (2017). *Panduan Praktis Penyusunan E-Modul*. Jakarta: Direktorat Pembina SMA. 1-57.
- Laili, I. (2019). Efektivitas Pengembangan E-Modul Project Based Learning Pada Mata Pelajaran Instalasi. *Jurnal Ilmiah Pendidikan Dan Pembelajaran*, 3, 306-315. <https://ejournal.undiksha.ac.id/index.php/JIPP/article/download/21840/13513>
- Nadelson, L. S., Heddy, B. C., Jones, S., Taasoobshirazi, G., & Johnson, M. (2018). Conceptual change in science teaching and learning: Introducing the dynamic model of conceptual change. *International Journal of Educational Psychology*, 7(2), 151-195. <https://doi.org/10.17583/ijep.2018.3349>
- Nirahua, J., Taihuttu, J., & Sopacua, V. (2020). Pengembangan Bahan Ajar Berbasis Blended Learning Dan Critical Thinking Skill Pada Mata Kuliah Astrofisika Dalam Menyongsong Era Revolusi Industri 4.0. *Jambura Physics Journal*, 2(1), 24-36. <https://doi.org/10.34312/jpj.v2i1.6869>
- Paramitha, D. (2021). *Tes Diagnostik Four-Tier untuk Mengidentifikasi Miskonsepsi pada Materi Fisika Four-Tier Diagnostic Test to Identify Misconceptions in Physics Concepts*. 6(2). <https://doi.org/10.36709/jipfi.v6i2.17366>
- Permendikbud. (2018). Peraturan Menteri Pendidikan No. 37 tahun 2018 perubahan permen 24 tahun 2016 tentang Kompetensi Inti dan Kompetensi Dasar Pelajaran pada Kurikulum 2013 pada Pendidikan Dasar dan Pendidikan Menengah. Jakarta: Kementerian Pendidikan Dan Kebudayaan Republik Indonesia, 62-63.
- Plomp, T. (2013). Educational design research: An introduction. *Educational design research*, 11-50.
- Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science education*, 66(2), 211-227.
- Prastowo, A. (2015). *Panduan Kreatif Membuat Bahan Ajar Inovatif* (Cetakan VI). Diva Press.
- Purwanto, M. ngalim. (2012). Prinsip-prinsip dan Teknik Evaluasi Pengajaran. PT Remaja Rosdakarya Offse
- Radiusman, R. (2020). Studi literasi: pemahaman konsep siswa pada pembelajaran matematika. *FIBONACCI: Jurnal Pendidikan Matematika Dan Matematika*, 6(1), 1-8.
- Rizaty, M.A. (2022). 5 Bintang Terbesar di Alam Semesta, Ukurannya Seribu Kali Matahari. Retrieved from <https://databoks.katadata.co.id/datapublish/2022/02/18/>
- Rodrigues, J., & Thacker, I. (2019). Refuting a Fraction Misconception: A Brief Intervention Promotes Teachers Conceptual Change. Proceedings of the forty-first annual meeting of the North American

- Chapter of the International Group for the Psychology of Mathematics Education. St Louis, MO: University of Missouri.
- Samara, R. A., Syuhendri, S., & Muslim, M. (2020). Pengembangan Teks Perubahan Konseptual Handout Untuk Remediasi Miskonsepsi Materi Dinamika Sma/Ma. *Jurnal Inovasi Dan Pembelajaran Fisika*, 7(1), 55–63. <https://doi.org/10.36706/jipf.v7i1.10993>
- Sari, I. P. T. P. (2013). Pendidikan Kesehatan Sekolah Sebagai Proses Perubahan Perilaku Siswa. *Jurnal Pendidikan Jasmani Indonesia*, 9(2), 141–147. <https://journal.uny.ac.id/index.php/jpji/article/viewFile/3017/2510>
- Setyadi, E., & Komalasari, A. (2013). Miskonsepsi Tentang Suhu Dan Kalor Pada Siswa Kelas 1 Di Sma Muhammadiyah Purworejo, Jawa Tengah. *Berkala Fisika Indonesia*, 4(1 & 2), 46–49.
- Sriyanti, I., Almafie, M. R., Marlina, L., & Jauhari, J. (2021). The effect of Using Flipbook-Based E-modules on Student Learning Outcomes. *Kasuari: Physics Education Journal (KPEJ)*, 3(2), 69–75. <https://doi.org/10.37891/kpej.v3i2.156>
- Syuhendri. (2010). Pembelajaran Perubahan Konseptual: Pilihan Penulisan Skripsi Mahasiswa. *Forum MIPA*, 13(2), 133–140.
- Syuhendri. (2014). Konsepsi Alternatif Mahasiswa Pada Ranah Mekanika: Analisis Untuk Konsep Impetus Dan Kecepatan Benda Jatuh. *Jurnal Inovasi Dan Pembelajaran Fisika*, 1(1), 56–67. <http://ejournal.unsri.ac.id/index.php/jipf/article/view/1265>
- Syuhendri, S. (2016). Developing of Conceptual Change Texts (CCTs) Based on Conceptual Change Model to Increase Students' Conceptual Understanding and Remediate Misconceptions in Kinematics. *The 2nd Sriwijaya University Learning and Education-International Conference (SULE-IC)*, 1191–1205.
- Syuhendri, S. (2017). Pengembangan Teks Perubahan Konseptual (TPK) untuk Pengajaran Perubahan Konseptual. In Seminar Nasional Pendidikan IPA (Vol. 1, No. 1, pp. 682-691).
- Syuhendri, S. (2019). Student teachers' misconceptions about gravity. *Journal of Physics: Conference Series*, 1185(1), 0–6. <https://doi.org/10.1088/1742-6596/1185/1/012047>
- Syuhendri, S. (2022). Teaching for conceptual change on Newton's First Law. *Journal of Physics: Conference Series*, 2165(1), 6–12. <https://doi.org/10.1088/1742-6596/2165/1/012036>
- Syuhendri, S., Sania, L., & Akhsan, H. (2021). Pengembangan Bahan Ajar Teks Perubahan Konseptual Materi Fisika Dasar Topik Kinematika. *Jurnal Kumparan Fisika*, 4(1), 43–50. <https://doi.org/10.33369/jkf.4.1.43-50>
- Tessmer, M. (1993). Planning and conducting formative evaluations: Improving the quality of education and training. Psychology Press.
- Widoyoko, E.P. (2012). Teknik penyusunan instrumen penelitian. Yogyakarta: pustaka pelajar.
- Yani, Y. P., Hardeli, H., Oktavia, B., & Kurniawati, D. (2020). Development of an Integrated E-Module of Scientific Literacy and Video Demonstration Using a Problem-Based Learning Model for High School Students on Acids and Bases. *Jurnal Penelitian Pendidikan IPA*, 8(2), 452–462. <https://doi.org/10.29303/jppipa.v8i2.1306>