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Comprehensive Teaching Materials Based on Cognitive Conflict Strategies to Reduce Misconception of Calories for Junior High School Students

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Abstract *– Heat is a material that is close to everyday life. However, most students still have misconceptions about this material. Thus, teachers need to develop teaching materials that can reduce the misconception of heat material. One alternative is to use teaching materials with cognitive conflict strategies. The research aims to develop teaching materials that are able to reduce students' misconceptions about heat material. The development model used is the 4D model which consists of four stages, namely defining, designing, developing, and distributing. The teaching materials developed include lesson plans, textbooks, student worksheets, and tests. The subjects of the study were seventh-grade students in Lamongan regency which consisted of 10 state junior high schools and private junior high schools. The research instrument was a feasibility test sheet for teaching materials and a questionnaire to see students' responses. Data collection techniques used the feasibility sheet of teaching materials and questionnaires. Therefore, the result shows that cognitive conflict-based teaching materials are appropriate to be used classroom with a score between 3.0 and 3.9 and a reliability coefficient value of more than 90%. and can reduce misconceptions with a percentage reduction in misunderstandings from 10 junior high schools in the Lamongan regency ranging from 30.3 to 47.8 percent.*

Keywords: *cognitive conflict; heat; misconceptions; teaching materials*

I. INTRODUCTION

Physics is a fundamental science and relates to human behavior and the structure of objects (Giancoli, 2001). Learning physics requires more understanding than memorization, so the key to success in learning physics is the ability to use three main things in physics, namely, concepts, laws or principles, and theories (Sakti, 2012). Heat material is material that is close to everyday life so it can be ascertained that students already have an initial conception (preconception) of heat material. However, it is often found that students have not shown optimal and enjoyable learning outcomes. Students giving answers from a test are felt to be different from concepts that have been understood by scientists. This shows that

students have not understood the concept well or it is not in accordance with the actual concept (misconceptions) which causes students to have difficulty in using the concepts they have to explain various natural phenomena (Haryono, 2020). Heat is an abstract material because heat material involves a medium to know in more detail. Heat material requires a lot of conceptual understanding so that misconceptions in understanding the concept of heat do not occur (Pathare, 2010). In fact, students still encounter misconceptions about heat material. This fact was found by researchers through pre-research activities. The pre-research was conducted on students, where it was identified that 29% understood the concept, 54% had misconceptions, 17% did not know the concept in answering questions (Haryono, 2018). States that when the ice cubes melt, many students think that the temperature of the ice cubes changes, while the correct concept is that the temperature of the ice does not change but causes the ice to melt due to latent heat.

David Hammer in Tayubi (2005) defines misconceptions as "strongly held cognitive structures that are different from the accepted understanding in a field and that are presumed to interfere with the acquisition of new knowledge," so that misconceptions can be viewed as students' different concept or a cognitive structure from concept generated by experts, which can make students misunderstand natural phenomena and scientific explanations. Misconceptions occur when students' understanding of a concept is different from what is meant by the scientific community or students provide a different understanding of a concept from what the curriculum or reference books mean (Nana, 2018). Hammer in (Pesman & Eryilmaz, 2010) said that misconceptions have an impact on students' understanding of the scientific concept that must be solved so that they learn the scientific concept effectively.

According to the findings of the student learning outcomes indicated above, it is required to refocus physics instruction, particularly on the subject of heat and changes in the state of matter, in order to reduce student misconceptions. Good and proper physics learning will be achieved by selecting the appropriate model, technique, and strategy for the content being taught, hence reducing student misconceptions. As a result, teachers must provide teaching resources that can help students overcome their preconceptions about heat material. Thus, teaching materials with cognitive conflict strategies are one alternate form that meets the above criteria.

Teaching materials are instruments that aid and accelerate learning activities in order to attain objectives. Syllabi, lesson plans, student activity sheets, evaluation instruments or learning outcomes examinations, and textbooks are all forms of teaching materials that can be used to manage the learning process. Good teaching materials

meet multiple requirements, including Validity, Practicality, and Effectiveness.

A cognitive conflict approach is defined by Drefus in (Wiradana, 2012) as a conceptual transformation strategy used to shift students' preconceptions to the proper concept. There are three key phases in learning employing cognitive conflict strategies. According to Sadia in (Adnyani, 2013), first, identifying which students have misconceptions and what is causing them. Second, challenging students' beliefs (preconceptions) with scientific conceptions in order to shock students' misconceptions and make them doubt their preconceptions' accuracy. The third, step is known as the conflict phase, and it is where students' preconceptions are transformed into scientific knowledge. Students will wish to understand and rearrange and restructure their misconceptions throughout this conflict period.

The cognitive conflict approach is a teaching method that involves students with something contradictory in order to acquire a greater level of knowledge balance (Kristianti, 2011). The initial stimulus for achieving a new equilibrium is cognitive conflict, with the new equilibrium becoming higher in position than the old equilibrium (Ismaimuza, 2013; Wahyuni, 2018). There are two types of cognitive conflict associated with different forms of equilibration in Piaget's theory, according to (Hewson, 1988) (Stavy & Berkovitz, 1980), namely the conflict between the learner's conception and experience, and the conflict between two different cognitive structures related to the same phenomenon.

Teaching materials that use cognitive conflict strategies allow students to develop assumptions or hypotheses, organize experiments, collect and analyze data, and make decisions or come to conclusions on their own. The description above demonstrates that cognitive conflict-based learning may be implemented because students not only develop abilities that they can apply in everyday life, but they can also gain hope in understanding the concept of natural science subjects through the use of independent discovery learning more deeply that will result in a more meaningful learning process

Referring to the previous background, this study aims to develop teaching materials based on the cognitive conflict in order to eliminate the heat misperception among seventh-grade students of junior high school in the Lamongan regency.

II. METHODS

This research is classified as a research context because it develops teaching materials such as lesson plans, textbooks, student worksheets, and tests. The subjects in this study were comprehensive teaching materials based on cognitive conflict strategies. The test subjects were grade VII junior high school students in Lamongan Regency consisting of SMP Negeri 1 Lamongan, SMP Negeri 3 Lamongan, SMP Negeri 1 Sukodadi, SMP Negeri 2 Sukodadi, SMP Negeri 1 Pucuk, SMP

Terpadu Nurul Ummah, SMP Al Ikhlash, Maarif Darul Hidayah. SMP NU SIMO, and SMP Muhammadiyah 11. This research was conducted in the even semester of the 2020-2021 school year. The 4D model was used in the developmental process, which consists of four stages: defining, designing, developing, and distributing (Haryono, 2018). A feasibility test sheet for teaching materials and a questionnaire for user responses to teaching materials as the research instrument. The feasibility sheet of teaching materials and user response surveys were used to collect data. Technique for data analysis:

1. Feasibility Materials for teaching materials

The findings of the quantitative and qualitative data analysis are utilized as a guide in establishing the viability of the teaching materials generated. A Likert scale was utilized in this quantitative data analysis questionnaire. Table 1 shows the score requirements using a Likert scale as given by Riduwan (2013).

Table 1. Guidelines for Assessment of Likert Scale Categories

Assessment	Value
Very Valid / feasible	4
Valid / feasible	3
Less valid / feasible	2
Invalid / feasible	1

The data collected is analyzed by adding up, compared with the expected amount so that a percentage is obtained, or it can be written with the following formula:

$$Percentage\ eligibility\ (\%) = \frac{observed\ score}{expected\ score}\ x100\%$$

The quantitative descriptive analysis techniques were used to examine the acquired data, which were represented as a distribution of scores and percentages against specified rating scale categories. The next stage is to describe and draw conclusions about each indicator after it has been presented in percentage form. To conclude the findings of the validation of teaching materials, apply the qualification level of the eligibility criteria as indicated in Table 2 below:

Tabel 2. Achievement Rate Conversion

Achievement Level	Qualification	Information
90% - 100%	Very Worth it	No need for revision
75% - 89%	Well worth it	Revised
65% - 74%	Decent enough	Revised
55% - 64%	Not worth it	Revised
0% - 54%	Not feasible	Revised

1. Usage Response

To analyze data about user responses using a percentage in this study. The data is analyzed by adding it up and comparing it to the expected amount to get a percentage (Riduwan, 2013), or it can be written using the formula:

$$\text{Persentase user's response} = \frac{observed\ score}{expected\ score}x100\%$$

After the percentage is obtained then it fits into the assessment guideline criteria that have been made in accordance with Table 3.

Table 3. User Response Criteria

Percentage	Letter grade	Quality	Predicate
86% - 100%	A	4	Very good
76% - 85%	B	3	Good
60% - 75%	C	2	Pretty good
55% - 59%	D	1	Not good
0% - 54%	E	0	Not good

(Purwanto, 2000)

III. RESULTS AND DISCUSSION

The following are the findings of a study using the 4D model to generate comprehensive teaching materials based on cognitive conflict strategies to reduce heat misunderstandings in junior high school students:

1. Define

The purpose of this stage is to define learning conditions. The stage aims to analyze the objectives and limitations of the learning material. There are five main steps in this stage, namely needs analysis, student analysis, task analysis, concept analysis, and formulation of learning objectives.

According to the results of the needs analysis questionnaire, learning was restricted to using existing teaching materials at school without attention for students' cognitive conflicts. Students have difficulty utilizing the concepts they have to explain various natural phenomena due to a lack of understanding or a conception that is not in harmony with the actual concept (misconception). Task analysis includes content structure analysis, procedural analysis, information process analysis, concept analysis, and goal formulation. Basic competencies, core competencies, and indicators are included in the task analysis. Concept analysis is used to discover the major concepts being taught, organize them into a material concept map, and determine which sub-chapters will be taught. The formulation of learning objectives serves as the foundation for developing exams and learning device designs. The arrangement is based on the SMP/MTs curriculum's basic competencies. Misconceptions can be caused by students, teachers, learning environments, teaching methods, and textbooks in general (Suparno, 2013).

2. Design

This process aims to provide teaching materials. The preparation of tests, media selection, and format selection is all done at this stage. Test preparation is used to determine student learning outcomes after participating in teaching and learning activities. The test is also to find out whether students have misconceptions or not. Media selection is carried out to determine the appropriate media in presenting learning material, adjusted to the characteristics of students and the facilities available in the school. This process also determines the types of tools and materials needed during the learning process. the selection is done by reviewing the existing device format adopted from relevant teaching materials including lesson plans, textbooks, student activity sheets, observation sheets.

3. *Develop*

The stage aims to produce revised teaching materials based on input from education experts including; validating the device by educational experts followed by revision I and limited trial (Trial I) then, revision II. The next step is trial II for the total numbers of students in the classroom. The results of the validation of teaching materials by the validator can be seen in Table 4.

Table 4. The results of the assessment of teaching materials

No	Types of Teaching Materials	Assessment Aspects	Average Score	Category
1	Lesson plan	Learning objectives	3.97	Very good
		Learning Activities	3.47	Good
		Time	3.31	Good
		Learning Media	3.25	Good
		Serving Method	3.58	Very good
		Bahasa	3.44	Good
2	Textbooks	Components and Content Eligibility	3.30	Good
		Language Component	3.00	Good
		Serving components	3.10	Good
3	Student Worksheets	Instructions	3.90	Very good
		Content eligibility	3.30	Good
		Procedure	3.40	Good
		Question	3.50	Very good
4	Test	Instructional aspects	3.84	Very good
		Construction questions	3.60	Good
		Language and question writing	3.23	Good

The lesson plan instrument is categorized as good based on the results from the analysis in Table 4: (a) The developed lesson plan fulfills the lesson plan components as stated in PP 19 of 2005 Article 20: learning, and assessment of learning outcomes; (b) The developed lesson plan fulfills the lesson plan components as stated in PP 19 of 2005 Article 20: learning and assessment of learning outcomes; (c) Based on the average value of the lesson plan eligibility validation value from the two validators is 3.

The textbook validation results from each validator ranged from 3.0-3.3. This indicates that BAS is in a good category, valid and usable, with minor changes. The results of the Student Worksheet feasibility evaluation demonstrate that each validator gives good validation results with a score between 3.0 and 3.9 and a reliability coefficient value of more than 90%. This signifies that the student worksheet belongs to a good category and is therefore acceptable and usable with minor revisions. The worksheets designed emphasize the process of learning concepts and developing social communication skills that encourage students to work together in groups (didactic requirements), student worksheets that are simple to grasp (construction criteria), and clear language and visuals (technical

requirements). A good student worksheet, according to Darmodjo (1992, in Rohaeti), must meet didactic, construction, and technical standards.

The results of the study agree with those of (Fatimah 2016; Multasyam et al., 2016), who found that all learning tools that have been validated by professionals are classified as valid. According to research Ihsani et al, (2020), the average percentage score of the validity of the three validators' learning tools is 88.62 percent with very valid criteria.

The dimensions of knowledge are factual knowledge, conceptual knowledge, procedural knowledge, and metacognitive knowledge, according to Anderson and Krathwol (2001), while the cognitive dimension is divided into six levels: remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6). Table 4 shows that each validator gives a value between 3.2 and 3.8 in the test eligibility validation as a whole. This means that the test belongs to a good category and can be used with few changes.

The teaching materials were subsequently tested on junior high school students in the Lamongan regency once they had been validated. The purpose of the test is to see how effectively students can meet their learning objectives. The initial test (pretest) and the final test were carried out twice in this study (posttest). The results of the tests were utilized to establish the efficacy of the pretest and posttest, as well as to reduce student misconceptions. As shown in Figure 1,

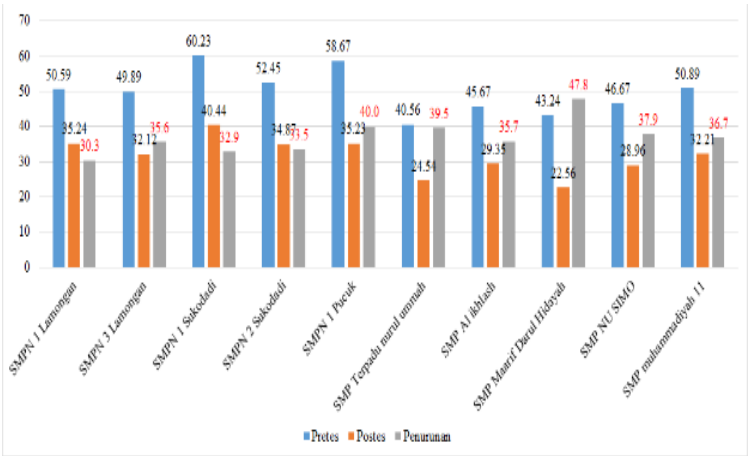

Figure 1. Percentage reduction in misconceptions

Figure 1 shows that the percentage reduction in misunderstandings from 10 junior high schools in the Lamongan regency ranged from 30.3 to 47.8 percent. With a value range of 30 to 70, the lowered percentage of misconceptions falls into the moderate category. Cognitive conflict-based learning is responsible for the reduction in misunderstandings. The learning treatment with a cognitive conflict method reduces physics misconceptions and improves student learning outcomes, not because of the

misconceptions brought by the students themselves (Mosik & Maulana, 2010). The use of cognitive conflict methods can increase student learning results in addition to reducing misconceptions. This is similar with Sugiawati's (2013) findings, which show that the use of cognitive conflict strategies in TPS cooperative learning has a substantial impact on the learning outcomes of class XI IA SMA Negeri 1 Watansoppeng thermochemistry studies.

Based on the explanation above, it can be concluded that cognitive conflict-based teaching materials (lesson plans, textbooks, worksheets, and examinations) are appropriate for junior high school students in the Lamongan regency. According to Hidayatulloh's (2015) research, teaching materials are appropriate for assessment sheets and lesson plans and are especially appropriate for knowledge assessment sheets, attitude assessment sheets, syllabus, student worksheets, and student books, and scientific learning is able to reduce student misconceptions on low to moderate criteria.

4. *Disseminate*.

At this point, researchers are disseminating teaching materials to junior high schools in the Lamongan regency. After applying comprehensive teaching materials based on cognitive conflict strategies to reduce heat conception, The student responses in each school can be seen in Figure 2.

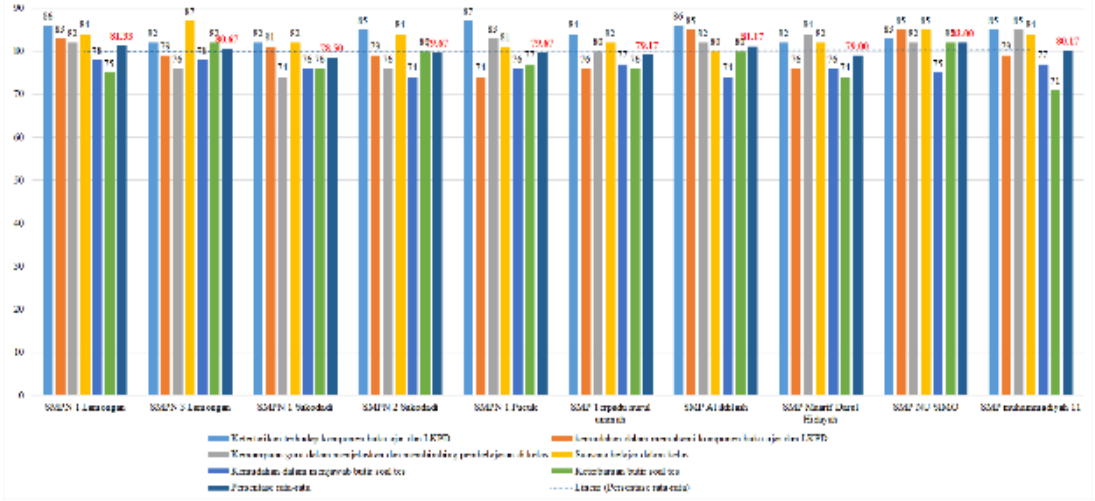

Figure 2. Student responses in each school

Because the average percentage of respondents from each school is 78.50 - 82.00, it can be observed in Figure 2 that the response of users of cognitive conflict-based teaching materials is in a good category (according to Table 1). These results show that they are attracted by the researcher's cognitive conflict-based teaching materials. Suryani et al, (2014) study supports this claim. This student interest will motivate students to learn science, which will increase student learning outcomes by raising student motivation. Cognitive conflict approaches can improve students'

mastery of concepts and engagement, according to Sirait's study (2012).

CONCLUSION AND SUGGESTION

Based on the results of the analysis and discussion, it can be concluded that cognitive conflict-based teaching materials are appropriate for use in the classroom and can help to reduce misconceptions. Students as users gave positive feedback on teaching materials based on cognitive conflict.

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REFERENCES

Adnyani, N. W., Sadia, I. W., & Natajaya, I. N. (2013). Pengaruh strategi pembelajaran konflik kognitif terhadap penurunan miskonsepsi fisika ditinjau dari gaya kognitif siswa kelas X di SMA negeri 1 bebandem. *Jurnal Administrasi Pendidikan Indonesia*, *4*(1).

Anderson, L., Krathwohl, D., & Airasian, P. (2001). *A taxonomy for learning, teaching, and assessing: a revision of bloom's taxonomy of educational objectives*. Boston: Pearson Education Group

Fatmawati, A. (2016). Pengembangan perangkat pembelajaran konsep pencemaran lingkungan menggunakan model pembelajaran berdasarkan masalah untuk SMA kelas X. *Edu Sains: Jurnal Pendidikan Sains dan Matematika*, *4*(2), 94-103.

Giancoli, D. C. (2001). *Fisika edisi kelima jilid 1*. Jakarta: Erlangga.

Haryono, H., Selirowangi, N., & Aini, K. (2018). The development of worksheets ipa with cognitive conflict strategy to reduce misconception in heat material. *International Conference on Mathematics and Science Education of Universitas Pendidikan Indonesia*, *3*, 152-156.

Haryono, H. E., Samsudin, A., Aini, K. N., & Siahaan , P. (2021). Teams' games tournaments with cognitive conflict instruction (CCI) model to unveil students' misconceptions. *Cypriot Journal of Educational Sciences*, *16*(4), 1343–1355. https://doi.org/10.18844/cjes.v16i4.5983

Hewson, M. G. 1988. The ecological context of knowledge: Implications for learning science in developing countries. *Journal of Curriculum Studies*, *20*(4), 317–326.

Hidayatulloh, M., Humairoh, F., Wachidah, U., Iswati, D. A., & Suliyanah, S. (2015). Pengembangan bahan ajaruntuk mereduksi miskonsepsi siswa pada materi rangkaian listrik dengan scientific approach. *Jurnal Penelitian Fisika dan Aplikasinya (JPFA)*, *5*(1), 28-32.

Ihsani, N., Al Idrus, A., & Jamaludin, J. (2020). Perangkat pembelajaran biologi berbasis masalah terintegrasi nilai-nilai islami untuk meningkatkan penguasaan konsep peserta didik. *Jurnal Pijar Mipa*, *15*(2), 103-109.

Ismaimuza, D. (2010). Pengaruh pembelajaran berbasis masalah dengan strategi konflik kognitif terhadap kemampuan berpikir kritis matematis dan sikap siswa SMP. *Jurnal Pendidikan Matematika*, *4*(1), 1-10.

Kristianti, E. (2011). *Penerapan pendekatan konflik kognitif sebagai upaya mengatasi miskonsepsi pada siswa kelas VIII SMPN 10 Tegal dalam pembelajaran pokok bahasan cahaya tahun ajaran 2010–2011*. Doctoral dissertation, Universitas Negeri Semarang (UNNES).

Multasyam., Yani, A., Maruf. (2016). Pengaruh model pembelajaran langsung terhadap hasil belajar fisika pada siswa kelas X SMA Handayani Sungguminasa Kabupaten Gowa. *Jurnal Pendidikan Fisika, 4*(3), 298-308.

Mosik & Maulana, P. (2010). Usaha mengurangi terjadinya miskonsepsi fisika melalui pembelajaran dengan pendekatan konflik kognitif. *Jurnal Pendidikan Fisika Indonesia*, *6*(2), 98-103.

Nana, N. (2018). Penggunaan pendekatan konflik kognitif untuk remediasi miskonsepsi pembelajaran suhu dan kalor. In *Prosiding SNPS (Seminar Nasional Pendidikan Sains)* (pp. 8-14).

Pathare, S., & Pradhan, H. C. (2010). Student's misconceptions about heat transfer mechanisms and elementary kinetic theory. *Physics Education*, *45*(6), 629-634

Pesman, H., & Eryilmaz, A. (2010). Development of a three-tier test to assess misconceptions about simple electric ciccuits. *The Journal of Educational Research, 103*(3), 208-222.

Prihatiningtyas, S., & Sholihah, F. N. (2020). Project based learning e-module to teach straight-motion material for prospective physics teachers. *Jurnal Pendidikan Fisika*, *8*(3), 223-234.

Purwanto, M. N. (2000). *Prinsip-prinsip dan teknik evaluasi pengajaran.* Bandung: PT Remaja Rosdakarya.

Riduwan, A., & Akdon, A. (2013). *Rumus dan data dalam analisis statistika*. Bandung: Alfabeta.

Sadia, I W. (2006). *Model konstruktivistik (suatu model pembelajaran berdasarkan paradigma konstruktivisme).* Makalah. Disajikan pada pelatihan strategi pembelajaran inovatif bagi para guru di lingkungan Dinas Pendidikan Kabupaten Klungkung tanggal 1 s/d 2 September 2006.

Sakti, I., Puspasari, Y. M., & Risdianto, E. (2012). Pengaruh model pembelajaran langsung (direct instruction) melalui media animasi berbasis macromedia flash terhadap minat belajar dan pemahaman konsep fisika siswa di SMA Plus Negeri 7 Kota Bengkulu. *In Exacta, 10(*1), 1– 10.

Sirait, J. (2012). Pendekatan pembelajaran konflik kognitif untuk meningkatkan penguasaan konsep siswa SMA pada topik suhu dan kalor. *Jurnal Pendidikan Matematika dan IPA, 1*(2), 26-34.

Stavy, R., & Berkovitz, B. (1980). Cognitive conflict as a basis for teaching quantitative aspects of the concept of temperature. *Science Education*, *64*(5), 679–692

Sugiawati, V. A. (2013). Penggunaan strategi konflik kognitif dalam pembelajaran tps untuk mereduksi miskonsepsi siswa pada materi termokimia. *Jurnal Nalar Pendidikan, 1*(1), 26-31.

Suryani., Sunarno, W., Soeparmin (2014). Pengembangan modul ipa terpadu berbasis konflik kognitif tema peredaran darah di SMP Negeri 6 Wonogiri. *Inkuiri*, *3*(3), 19-29.

Tayubi, Y. R. (2005). Identifikasi miskonsepsi pada konsep-konsep fisika menggunakan Certainty of Response Index (CRI). *Mimbar Pendidikan*, *3*(24), 4-9.

Wahyuni, A. S. A. (2018). Konsepsi dan miskonsepsi siswa, mahasiswa calon guru, dan guru pada topik cahaya dalam pembelajaran fisika. *Jurnal Pendidikan Fisika*, *6*(3), 235 – 250.

Wiradana, I. W. G. (2012). Pengaruh strategi konflik kognitif dan berpikir kritis terhadap prestasi belajar ipa kelas vii smp negeri 1 nusa penida. *Jurnal Pendidikan dan Pembelajaran IPA Indonesia*, *2*(2), 1-19.