Reducing the students' misconceptions on the theory of heat through cognitive conflict instruction (CCI)

by Heny Ekawati Haryono

Submission date: 25-Dec-2022 08:37PM (UTC-0700)
Submission ID: 1986615363
File name: 2_CCI.pdf (444.87K)
Word count: 176
Character count: 23995

AIP Conference Proceedings

Reducing the students' misconceptions on the theory of heat through cognitive conflict instruction (CCI)

Cite as: AIP Conference Proceedings **2330**, 050001 (2021); https://doi.org/10.1063/5.0043400
Published Online: 02 March 2021

Heny Ekawati Haryono, Khafidhoh Nurul Aini, Achmad Samsudin, et al.

View Online Export Citation

ARTICLES YOU MAY BE INTERESTED IN

The transformation of two-tier test into four-tier test on Newton's laws concepts
AIP Conference Proceedings **1848**, 050011 (2017); https://doi.org/10.1063/1.4983967

The structure of knowledge and students' misconceptions in physics
AIP Conference Proceedings **1916**, 050001 (2017); https://doi.org/10.1063/1.5017454

Development of four-tier diagnostic test for identifying misconception in chemical equilibrium
AIP Conference Proceedings **2215**, 020004 (2020); https://doi.org/10.1063/5.0000510

AIP Publishing

© 2021 Author(s).

Reducing the Students' Misconceptions on the Theory of Heat through Cognitive Conflict Instruction (CCI)

Heny Ekawati Haryono[1, a)] Khafidhoh Nurul Aini[1, b)] Achmad Samsudin[2, c)], and Parsaoran Siahaan[2, d)]

[1]*Universitas Islam Darul 'Ulum, East Java, Indonesia*
[2]*Universitas Pendidikan Indonesia, West Java, Indonesia*

[a)]Corresponding author: henny@unisda.ac.id
[b)]khafidhohnurul@unisda.ac.id
[c)]achmadsamsudin@upi.edu
[d)]parsaoransiahaan@upi.edu

Abstract. Science learning is closely related to scientific concepts. A misconception is the most important aspect in science learning activities. Cognitive conflict is a condition where there is a mismatch between the cognitive structures that a person has with information that has just been obtained from outside. Uncertainty, doubt, confusion, contradiction, contrary to what is on his mind, are signs of cognitive conflict. This research aimed at revealing the influence of cognitive conflict instruction on students' understanding of heat concept at five schools in Lamongan; SMP negeri 1 Pucuk, SMP Negeri 1 Lamongan, SMP Negeri 3 Lamongan, SMP Negeri 1 Sukodadi dan SMP Negeri 2 Sukodadi. Wrong misconceptions of the concept will have a negative impact on subsequent scientific concepts, so it needs treatment to avoid it more and more misconceptions. The misconception will result in students experiencing repeated errors for concepts at the next level. This study aims to describe students' misconceptions about the heat material in class VII Junior High School. The data collection tool in this research was in the form of optional diagnostic tests double with four alternative answers, open reasons, accompanied by a level of confidence. Research result showed that there is a misconception in the understanding of heat material that is equal to 40%. Many students' misconceptions occur in concepts related to the relationship between temperatures with heat changes in the form of substances.

INTRODUCTION

Cognitive conflict Instruction (CCI) is conceptual change strategies in an effort to change student misconceptions towards the correct concept, stated that Cognitive conflict is an essential condition for conceptual change. (1) revealed several things that need to be considered in strategy implementation Cognitive conflict, namely: 1) how is the profile of students' prior knowledge, 2) done with be careful, do not strengthen the stability of student misconceptions, and 3) must be able destabilizing student misconceptions. Physics is a subject that difficult to understand by the students. In learning physics, students have to use mathematical, symbols and intuition language influence to construct student's conception. Incorrect understanding of mathematical language and intuition can cause misconceptions. Some Researchers and education scholars conducted research to investigate and overcome misconceptions. (2) 5E approach to reduce the use of alternative concepts students, (3) followed by identifying misconceptions by using a conceptual test, (4) uses the concept of change strategy to eliminate the student misconceptions. The term misconceptions expressed differently by researchers. Alternative concept, is one of the term was also used by researchers of Physics (2). Misconception is consider as a student's conception different from that understood the concept of scientists (experts). (5) revealed that" misconceptions to refer only to the phenomenology of patterns in students' responses that are inconsistent with expert understanding (6).Physics misconceptions can occur to anyone at any level of education, whether in elementary school, high school students, students, even teachers or lecturers. In K13, physics is a subject that requires more understanding. This is done through learning activities in secondary schools that can be

The 4th International Conference on Mathematics and Science Education (ICoMSE) 2020
AIP Conf. Proc. 2330, 050001-1–050001-6; https://doi.org/10.1063/5.0043400
Published by AIP Publishing. 978-0-7354-4074-6/$30.00

used as capital for mastering science and technology in further education. So that mastery of competency standards can be achieved, students must be able to understand certain sub-topic concepts in a learning activity. According to (7) students do not enter lessons with an empty head that can be filled with knowledge. But instead the student's head is full of experience and knowledge related to the lesson being taught. Student intuition about a concept that is different from physics scientists is called misconception. This can cause difficulties when learning a concept. Based on (8) research on the development of concept change with cognitive conflict learning in students' understanding of the concepts of temperature and heat, the test results show that the average posttest score of students in the experimental class is higher than the control class at the end of learning about understanding the concept of temperature and heat. Specifically (9) in his research stated that the cognitive conflict approach in learning physics is quite effective in overcoming misconceptions in students in order to form a higher science balance. Stimulation of cognitive conflict in learning physics will greatly help the process of assimilation to be more effective and meaningful in students' intellectual struggle. For this reason, the cognitive conflict approach needs to be done in physics learning strategies. The purpose of this study is whether the cognitive conflict approach in learning physics has a significant influence on physics misconceptions and whether the cognitive conflict approach in learning physics has a significant effect on physics learning outcomes (10).

LITERATURE REVIEW

Misconceptions will be formed if a person's conception of a material does not match the conception accepted by scientists or experts in their field. A student misconception can come from several reasons. Student misconceptions can come from students themselves, namely students misinterpret the symptoms or events encountered in their lives. Misconceptions experienced by students can also be obtained from learning from the teacher. Learning by the teacher may be less directed so that students make a wrong interpretation of a concept, or maybe the teacher experiences a misconception of a concept so that what he conveys is also a misconception. Misconceptions originating from these teachers were also emphasized by (11) who stated that misconceptions might also be obtained through the learning process at the previous educational level.

The condition of misconception possessed by someone, especially teachers and students cannot be left without any effort to correct it, because the misconception will hinder the acquisition and processing of further concepts. The concept is the basic foundation of science (12). Theory and law for example is an explanation of the relationship between concepts. If someone is still experiencing a misconception, the theory and law that are built from the concept will also experience errors. The steps teachers can take to help overcome student misconceptions are: (1) identifying student misconceptions; (2) finding the cause of misconception; and (3) seeking appropriate treatment to overcome the misconception (9). To correct misconceptions that occur in students or to minimize misconceptions that will occur when learning takes place, methods can be used such as: conceptual change (Conceptual Changes), constructivism, POE (Predict-Observe-Explain), PDEODE (Predict-Discuss-Explain-Observe-Discuss-Explain), and Cognitive Conflict Instruction (CCI) (13).

Cognitive conflict Instruction is a learning strategy that exposes students to a situation which is contrary to the concept and then the students are directed on experiments or demonstrations to prove the concept. Cognitive conflict Instruction (CCI) is a strategy conceptual (conceptual change Instruction) which can destabilize the misconceptions students to get a true scientific concept. Thus, cognitive conflict strategy is a learning strategy that accommodates difference, be open and provide the stimulus more effective in helping students improve their understanding of the concept and building science. Thus the rationale that prompted researchers to identify and analyze the causes misconceptions before teaching students with cognitive conflict strategies and to identify and analyze the changes in students' understanding of the concept after learning provision with cognitive conflict Instruction (CCI) in a matter of heat (14).

METHODOLOGY

This study aims to reduce students' misconceptions about the theory of heat through Cognitive Conflict Instruction (CCI). This research was conducted in the even semester 2020/2021 in 5 state junior high schools in Lamongan district, namely SMP Negeri 1 Sukodadi, SMP Negeri 2 Sukodadi, SMP Negeri 1 Pucuk, SMP Negeri 1 Lamongan, and SMP Negeri 3 Lamongan. The subjects in this study were VII grade students who were determined based on purposive sampling techniques. The method used in this study uses a descriptive analysis design that is equipped with data in the form of a percentage of students experiencing misconceptions for each sub-concept. The data source in this study

is the primary data source, because the data is obtained directly from the research subject [8]. This research was conducted by giving written tests using three-level diagnostic tests to students to get information about students' misconceptions about heat material. Before the test is given to students, the test must be in a valid category. To validate questions, questions are given to competent experts in their fields to obtain suggestions and obtain valid results in detecting junior high school students' conceptions of heat material. The instrument test consists of 20 items consisting of 6 topics. The test consists of 20 questions, which have been validated by 3 validations consisting of two lecturers and one junior high school physics teacher. The distribution of three-level diagnostic tests for each topic can be seen in Table 1.

TABLE 1. Distribution of three-tier diagnostic on heat material

Subject Matter	Problem Number
Temperature	9, 10, 11
Heat	1,2, 18, 20
Expansion	12, 13, 14, 15, 16
Effect of heat on objects	3, 17, 19
Change of state	4,5,6,7,8

Data analysis of test results was conducted to find out how students' conceptions of static fluids by referring research to the assessment rubric as illustrated in Table 2.

TABLE 2. Answer category three tier test

Tier 1	Tier 2	Tier 3	Category
Correct	Correct	Sure	Scientific
Correct	Incorrect	Sure	Misconception
Incorrect	Correct	Sure	Misconception
Incorrect	Incorrect	Sure	Misconception
Correct	Correct	Unsure	Lack of knowledge
Correct	Incorrect	Unsure	Lack of knowledge
Incorrect	Correct	Unsure	Lack of knowledge
Incorrect	Incorrect	Unsure	Lack of knowledge

RESULTS

For the initial stage of the study the development of the research, test instrument was then verified through the construct validity test, and the reliability of the test questions (15). The results of the validation assessment by the validator can be concluded that the instrument that has been developed is feasible to be used for research. The reliability of the questions can use the Cronbach's Alpha coefficient and the reliability of the questions is 0.80. This shows that the questions used in the research are reliable. Based on the analysis of answers from 150 high school students to 20 three-tier diagnostic tests to see how students' conceptions can be seen in Table 3.

TABLE 3. Percentage of student' conceptions

Subject matter	Percentage (%)		
	Scientific Knowledge	Lack of Knowledge	Misconception
Temperature	39.33	24.00	36.67
Heat	28.00	26.00	46.00
Expansion	21.33	14.00	64.67
Effect of heat on objects	20.00	24.00	56.00
Change of Being	11.33	37.33	51.33
average	24.00	25.07	50.93

Three-tier diagnostic test reliability on 20 items obtained good results. Based on the results of reliability analysis using Cronbach's Alpha and reliability is obtained as Table 4.

TABLE 4. Reliability analysis of test items

Reliability type	Reliability score	Category
Test-retest reliability	0.80	High

Based on table 4 it can be concluded that 20 items of the three-tier diagnostic test are in the valid category. This is because the reliability value obtained is based on a calculation of 0.80.

DISCUSSION

Misconceptions can occur by anyone and at any level. Both educators and students can also experience misconceptions. Based on the analysis of the data obtained by students' conceptions like Figure 1.

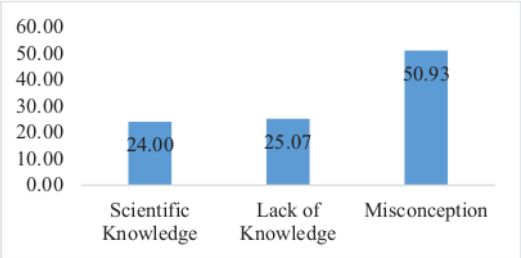

FIGURE 1. Percentage of students' conceptions on the topic heat

For the conception category of students, it was found that half of the study sample experienced misconceptions. Large categories of students' conceptions on the topic of temperature can be seen in Figure 1. Figure 1 shows that more than half of students experience misconceptions about changing topics. Many factors why misconceptions can occur in students, including teacher factors, student factors, book factors, learning methods and others. The Topic of Heat correlation with Change in Temperature is the topic with the lowest misconceptions compared to other topics. The reason why students experience misconceptions about the topic of Heat correlation with Temperature change is because students assume that objects with large heat types will cause them to heat up quickly. Students do not understand correctly what is meant by the heat of type (c), and they have not been able to relate it to changes in temperature (ΔT). The results of this diagnosis are in line with the findings of (16) which states that if the heat capacity is large, the temperature of objects will quickly rise, and (17) in his research found that students do not consider the heating value of the type and heat capacity as a factor that influences temperature changes. Percentage of students' conceptions of Heat correlation with Temperature.

In the heat material is the topic with the biggest misconceptions. Some things that cause students to experience misconceptions about heat material are the assumption that heat is absorbed by objects directly proportional with the temperature of the object this is due to student's difficulty in reading charts and determine temperature changes based on data on the graph.

On the topic of expansion, the main cause of student misunderstanding is that students are required to connect the quantities in the long expansion equation and identify which objects experienced the greatest expansion. Students must understand that the coefficient of expansion of metal length affects the expansion of metal objects. The greater the coefficient of expansion of the length of the object, the easier and faster the metal will expand. Some students have understood that objects which have the highest coefficient of expansion length will expand longer than objects that have lower coefficient of expansion. Then the length increase is also large.

In the matter of the influence of heat on objects more than half the sample misunderstand. The main reason students experience misconceptions about this material is because they assume that giving direct heat will cause thermal equilibrium. Students do not understand the scientific concept of heat balance and change of form. Students assume that when an object melts, the change from solid to liquid makes students assume the objects release heat, there are also those who think the temperature of the object has increased due to the influence of external temperatures so that the ice melts and the temperature rises. Differences in the conceptions of students with actual concepts cause students to experience misunderstandings.

The material change principle has the largest percentage of misconceptions number 3. Some things that cause students to experience a misunderstanding about changing material forms is because the material is considered quite difficult because the material representation and questions that are usually presented in the form of pictures and diagrams are difficult for students to understand. Combining the equation of the effect of heat on temperature and shape change is also considered difficult by students because they often use a diagram of the relationship of temperature and time. The highest misconception is on influence heat towards changes in the form of objects (18).

Students do not understand the scientific concept of changing matter, students tend to have understanding that is not according to the actual concept or wrong concept, mainly relates the phenomenon of changing forms with the state of particles of matter. Material representations and problems during learning which are usually presented in the form of drawings and diagrams are difficult to understand by students (19).

CONCLUSION

Based on the expert validation from the developed three-tier diagnostic test, it can be concluded that the developed instrument is suitable for use in research. The reliability of the question can use the Cronbach Alpha coefficient and the reliability of the question is 0.80. This shows that the questions used in this study are reliable (20). The results of identifying students' misconceptions about heat, it can be concluded that there are still many students experiencing misunderstandings with an average of 50.93% in the main topic of heat and temperature, 36.67% in the sub-topic of temperature, 46.00% in the sub-topic of heat, 64.67% on the expansion material 56.00% on the topic of the influence of heat on matter and 51.33% on the subject matter of matter change. Misconceptions can occur anywhere and by anyone. Based on the previous researches up to this research there are still many students who experience misconceptions about heat. Therefore, we need a learning model that can facilitate cognitive conflict from the student's side so that students' misconceptions can be eliminated. Based on the research results obtained, the things that are suggested; 1) Physics Teachers in five schools in Lamongan; SMP Negeri 1 Pucuk, SMP Negeri 1 Lamongan, SMP Negeri 3 Lamongan, SMP Negeri 1 Sukodadi and SMP Negeri 2 Sukodadi to apply the cognitive conflict instructions (CCI) as an alternative learning strategy in physics learning; 2) For the future research is expected to consider and better understand cognitive conflict instruction, so that future research will no longer face obstacles in the learning process special efforts to empower students optimally

LIMITATIONS

Problems that are developed can used to explain the students' misconceptions on the material temperature and heat. However, based on research limitations that have been done, then the suggestions from researchers need developed diagnostic test questions with low difficulty with increase the number of questions included in the easy category.

ACKNOWLEDGEMENTS

The researchers would like to thank the Ministry of Research and Technology / National Agency for Research and Innovation for providing financial support for this Basic Higher Education Research (PKPT) and to families who have always provided support and encouragement during the research process. To the entire academic community of the Universitas Islam Darul ‘Ulum Lamongan, who have provided support during the writing of this article.

REFERENCES

1. Baser M. Instruction on Students’ Understanding of Heat and. Eurasia J Math Sci Technol Educ. 2006;2(2):96–114.
2. Kurnaz MA, Çalik M. Conceptions in Science. Physics (College Park Md). 2008;5(1).
3. Fratiwi NJ, Samsudin A, Ramalis TR, Saregar A, Diani R, Irwandani, et al. Developing memori on Newton’s laws: For identifying students’ mental models. Eur J Educ Res. 2020;9(2):699–708.
4. Goulão M de F. The Relationship of e-learner’s with Studies Strategies to Support Learning. Procedia - Soc Behav Sci. 2014;116:362–7.
5. Kirbulut ZD, Geban O. Using three-tier diagnostic test to assess students’ misconceptions of states of matter. Eurasia J Math Sci Technol Educ. 2014;10(5):509–21.
6. Yasin M, Fakhri J, Siswadi, Faelasofi R, Safi’i A, Supriadi N, et al. The effect of SSCS learning model on reflective thinking skills and problem solving ability. Eur J Educ Res. 2020;9(2):743–52.
7. Haryono HE. Jurnal Pendidikan Fisika Universitas Muhammadiyah Makassar The Implementation of Cognitive Conflict Learning Strategy in Efforts to Reduce Heat Misconception in Junior High School Students Implementasi Strategi Pembelajaran Konflik Kognitif Dalam. 2020;8:319–27.
8. Başer M. Effect of conceptual change oriented instruction on remediation of students ’ misconceptions related to heat and temperature concepts. J Maltese Educ Res. 2006;4(1):64–79.

9. Sözbilir M. A review of selected literature on students' misconceptions of heat and temperature. Boğaziçi Univ J Educ. 2003;20(1):25–41.
10. Fenditasari K, Jumadi, Istiyono E, Hendra. Identification of misconceptions on heat and temperature among physics education students using four-tier diagnostic test. J Phys Conf Ser. 2020;1470(1).
11. Sagala R, Umam R, Thahir A, Saregar A, Wardani I. The effectiveness of stem-based on gender differences: The impact of physics concept understanding. Eur J Educ Res. 2019;8(3):753–61.
12. Purwanto MG, Nurliani R, Kaniawati I, Samsudin A. Promoting the hydrostatic conceptual change test (HCCT) with four-tier diagnostic test item. J Phys Conf Ser. 2018;1013(1).
13. Haryono HE. the Effectiveness of Science Student Worksheet With Cognitive Conflict Strategies To Reduce Misconception on Heat Concept. J Pena Sains. 2018;5(2):79.
14. Sukariasih L. the Use of Cognitive Conflict Strategy To Reduce Student Misconceptions on the Subject Matter of Rectilinear. Int J Educ Res. 2016;4(7):483–92.
15. Jusniar J. Misconceptions in Rate of Reaction and their Impact on Misconceptions in Chemical Equilibrium. Eur J Educ Res. 2020;9(4):1405–23.
16. Taştan Ö, Yalçınkaya E, Boz Y. Effectiveness of conceptual change text-oriented instruction on students' understanding of energy in chemical reactions. J Sci Educ Technol. 2008;17(5):444–53.
17. Saputra O, Setiawan A, Rusdiana D, Muslim. Analysis of students' misconception using four tier diagnostic test on fluid topics. Int J Adv Sci Technol. 2020;29(1):1256–66.
18. Kaniawati I, Fratiwi NJ, Danawan A, Suyana I, Samsudin A, Suhendi E. Analyzing students' misconceptions about Newton's Laws through Four-Tier Newtonian Test (FTNT). J Turkish Sci Educ. 2019;16(1):110–22.
19. Ratnasari D, Sukarmin S, Suparmi S, Aminah NS. Students' Conception on Heat and Temperature toward Science Process Skill. J Phys Conf Ser. 2017;895(1).
20. Suliyanah, Putri HNPA, Rohmawati L. Identification student's misconception of heat and temperature using three-tier diagnostic test. In: Journal of Physics: Conference Series. 2018.

Reducing the students' misconceptions on the theory of heat through cognitive conflict instruction (CCI)

ORIGINALITY REPORT

16%	5%	11%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Lei Zhou, Zhenzhen Zhang, Bingchao Zhang, K. T. Tse. "Receptivity-orientated drag reduction of twin cylinders by steady leading-edge suction control based on adjoint method", Physics of Fluids, 2022 Publication	11%
2	www.researchgate.net Internet Source	5%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		