

Pre-service Elementary Teachers' Mental Model on Heat Transfer Concept as the Effect of Applying CDOI Model Integrated MIKiR Approach

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Article Info

Abstract

Keywords:
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Mental Model;
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The purpose of this study is to strengthen the mental model of prospective elementary school teacher candidates by using the MIKiR (*mengalami, interaksi, komunikasi, internalisasi, and refleksi*) method, which is directed towards conceptual growth and is based on the MIKiR framework (CDOI Model). The research was carried out utilizing a pre-experimental approach with a pretest-posttest design in one group for this study. The research was carried out on pre-service primary teachers at the Universitas Riau, in Indonesia. The instrument used to collect data was a heat transfer conceptual understanding test (HTCU Test), which consisted of three sections of the question, each of which had previously been verified and evaluated to ensure that the participants were eligible. Using the MIKiR approach (experiencing, interaction, communication, and reflection), this study found that implementing the CDOI model of conceptual development-oriented instruction had a high level of success in enabling the creation of mental models. Furthermore, it can aid in the conceptualization and development of the concept of heat transfer and the formulation and overall knowledge of the concept.

Kata Kunci:
Model CDOI;
Heat transfer;
Mental Model;
Pendekatan MIKiR

Abstrak

Penelitian ini bertujuan untuk meningkatkan mental model calon guru SD melalui pendekatan MIKiR (*mengalami, interaksi, komunikasi, internalisasi, dan refleksi*) yang berorientasi pada pengembangan konseptual (*Model CDOI*). Penelitian ini dilakukan dengan menggunakan metode pra-eksperimen dengan *one group pretest-posttest design*. Penelitian dilakukan pada calon guru SD di Universitas Riau. Instrumen yang digunakan untuk mengumpulkan data adalah tes pemahaman konsep perpindahan panas (*HTCU Test*) yang meliputi tiga bagian soal yang sebelumnya telah divalidasi dan diuji kelayakannya. Hasil penelitian ini menunjukkan bahwa penerapan model CDOI (*conceptual development-oriented instruction*) melalui pendekatan MIKiR memiliki efektivitas yang tinggi dalam memfasilitasi pencapaian mental model. Serta dapat mempermudah proses pengembangan konseptual yang mengarah pada pembentukan dan pemahaman konsep perpindahan panas secara menyeluruh.

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INTRODUCTION

Every pre-service teacher has to analyze problems according to experience, knowledge and the ability to connect learning and expertise that forms problem-solving patterns. Education as a means of forming pre-service teachers' mental models makes a substantial contribution to educational advancement. The mental model underlying the learning approach is knowledge representation that is implied, incomplete, inaccurate, and incompatible with normative knowledge in various domains for the subject's interaction with the world and sources of knowledge derived from the perceptive and manipulative experiences of the subject (Basori, Suhandi, Samsudin, Kaniawati, & Rusdiana, 2020).

The primary purpose of mental models is to explore initial knowledge, explain in more detail and make good predictions about the concept in science. The mental model can be seen as a mental simulation of an existing problem situation as a causal model of a system (Tumay, 2014), analogue representations of reality in certain cases to determine internal representations as decision making in certain conditions and to link concepts or prior knowledge (Taher, Hamidah, & Suwarna, 2017). A mental model represents each student when understanding a science concept (Haili et al., 2017; Parlina et al., 2019; Hermita et al., 2020; Hermita et al., 2021). The study of students' mental models is beneficial to find out their cognitive development. In table 1 can be seen some previous research on mental model studies.

Table 1. Results of mental model studies

Researchers	Result of study
Johnson-Laird, 1983	Mental models allow someone to predict how a system works or predict how problems will be solved
Halford, 1993	Mental models reflect the structure of phenomena in everyday life when a person is exposed to a situation, event, task, problem, procedure, or concept.
Greca & Moreira, 2000	Humans use this mental model to reason, explain, predict phenomena and/or produce expressed models
Johnson-Laird, 2006	The error in predicting lies in one's weakness to see all alternative solutions. Although other predictions are the main function of mental models, it is not clear to what extent students can carry out their mental models to make predictions on an event.
Kurnaz & Eksi, 2015	Mental model is one of the basic abilities that students must have.

Table 1 emphasizes that the study of mental models has to be carried out as early as possible and should be carried out in each learning process so that their competencies can be seen and directed towards appropriate learning. The implementation CDOI model integrated MIKiR approach is able to accommodate pre-service elementary school teachers. This is because the collaboration CDOI model and MIKiR approach can be shown the results of pre-service elementary teachers' cognitive domain representation clearly and comprehensively. Learning with the MIKiR Approach brings pre-service elementary teachers to the whole learning process. This is because every stage of learning involves them actively and systematically so that the development of their mental models can be measured

Understanding the development of students' mental models is very useful in improving children's skills in 21st-century learning. The same thing is also emphasized by Saputra and Al Siddiq (2020) that one of the abilities that must be possessed is digital literacy. In particular, digital literacy is a set of knowledge and abilities that a person has in understanding, evaluating, and using information obtained with a focus on ethics to communicate and interact in everyday life (Noh, 2016). Life skills or competencies can be improved through the CDOI model learning

integrated MIKiR approach. This can be seen from the change in their mental models during the activity. In addition, in the "Interaction" and "Communication" stages MIKiR approach, digital literacy competencies are highly needed to be able to explore various sources and how to communicate them so that a valid and scientific conclusion is generated.

Mental models are generally part of metacognition. This is based on the mental model of a person will develop when the metacognitive also develops. Metacognition is a person's ability to think, such as planning, predicting, reflecting, and evaluating the actions taken, so that they can control activities consciously about their cognitive processes (Weinert and Kluwe, 1987). Metacognition skills can be continuously trained and developed by reading, especially when determining the main idea. During reading and understanding a sentence, the increase in metacognition skills causes the learning process to be self-regulated through information sharing activities both in groups and in-class discussions (Setiawati & Corebima, 2018 and Astriani et al., 2020). This means that metacognition and mental models can be improved through active learning.

Education is inseparable from the educator or teacher whose decisive role is achieved education. Educators' professionalism can be measured through insights into the knowledge they have (Samad et al., 2014). Efforts to improve teacher professional competence can be started from improving the comprehension ability of the material widely and deeply to prospective educators, which can be described through the level or level of understanding and mental models they have. One of the conditions of being a kindergarten teacher is must understand all the subjects in the school (Hermita et al., 2020). Lack of understanding of a concept will affect pre-service teachers ability in developing knowledge, reasoning and professionalism as a teacher for the future. Understanding the concept of pre-service teachers can affect class mastery and learning quality. In this case, pre-service elementary school teachers need to understand the prior concepts in learning, one of which is the material about heat transfer. Generally, there are courses in the basic concepts of natural science that pre-service elementary school teachers must take.

In addition, conceptual understanding is the ability to understand the meaning of material learned to classify a group of objects (Madu & Orji, 2015). To improve the conceptual understanding in learning the natural science basic concepts, most researchers use media or teaching aids. Using media, the learning process can also be supported by an appropriate learning approach. Teaching and learning activities in class are very important to use a learning approach to be directed and systematic. Besides that, the learning approach can also help students understand learning material. Learning must provide sufficient space for students to be more active and confident in the learning process in the classroom to support students to have a deep understanding of the scientific concepts being studied.

The mental model is one of the precise and complete representations coherent with scientifically accepted knowledge, external representations that belong to a particular community, and coherence with the scientific knowledge of that community (Biemel & Kedmi-Shahar, 2018). This external representation can be realized as a mathematical formulation, analogy, or material artefact. Deep learning will result from the evolution of mental models that exist in students when they participate in teaching and learning activities to the conceptual model they teach, when they identify, at this final stage, conceptual and mental models.

Improving students' conceptual understanding can be done by implementing learning strategies that can actively involve students. Ahmadi (2011) explains that learning can be active through the active involvement of students both physically and mentally in terms of expressing reasoning, communicating ideas, expressing the right form of representation and expressing all of it to solve problems. The learning approach is able to develop the maximum potential of students (Yantoro, 2020). Active learning that is felt to improve various competencies of learners is active learning with the MIKiR (experiencing, interaction, communication, and reflection) approach. Alpusari et al. (2019) explained that learning with The MIKiR approach consists of five steps: experience, interaction, communication, internalization, and reflection, suitable for application in teaching and learning activities. Because by using the MIKiR approach, each student is invited to be directly involved and more active in the teaching and learning process in the classroom to develop their learning potential better. Learning in learning generally requires more understanding

of learning concepts and connecting these concepts to everyday life. The most important thing is that students master the basic concepts in science lessons. Science learning activities are critical to apply the approach to teaching and learning activities so that the teaching and learning process can become deep learning.

METHOD

The method in this study uses single-case experimental designs. Sugiyono (2014) explained that Pre-experimental design is a design that includes only one group or class that gave pre and post-test. This one group pre-test and posttest design was carried out on one group without a control or comparison group. The sample of this study consisting of 100 pre-service elementary school teachers from one university in Riau Province was used as a research sample.

The instrument for collecting data is a conceptual understanding test on the heat transfer concept, including three questions. Question-1 (Q1) requires answers in verbal explanations form about the definition of conduction displacement, question-2 (Q2) requires solutions in the form of verbal answers about the physical mechanism of conduction, and question-3 (Q3) requires responses in the form of microscopic representations of the mechanism conduction transfer. The test questions pre-service elementary school teachers with understanding level test related to conduction concept. Sample of understanding level test shown in Table 2.

In previous studies, HTCUC Test has been validated and tested for reliability. Based on the results of expert judgment, the instruments used in this study had construct and content validity.

Table 2. Sample of HTCUC Test on heat conduction concept to identify pre-service elementary teachers' model mental

Indicator	Question
Explain the definition of conduction	1. explain the definition of conduction heat transfer!
Explain the physical mechanism of the conduction process	2. How the heating mechanism can move by conduction!
Expresses in the representation of microscopic images the physical heat conduction process	3. Describe the process of heat transfer microscopically by conduction!

For the purpose of determining the mental model's category of pre-service elementary teachers based on the findings of conceptual comprehension in relation to the heat transfer concept, rubric rules are employed as stated in Table 3.

Table 3. The mental models' evaluation rubric

Category of Mental Models	Content	Criteria
Scientific	Perceptions that coincide with knowledge of scientific: answers at level 3 (PU or PCD) or 4 (SU or CD).	The score for questions A, B, and C all is high (3 or 4)
Synthetic	Perceptions that in part or all do not coincide with scientific knowledge.	The score for questions A, B, and C (some are high (3 or 4), but some are low (0 or 1 or 2))
Initial	Perceptions which do not coincide with scientific knowledge: answers at level 0 (NU or ND), 1 (AC or ID), or 2 (PU-AC or CD-ND).	The score for questions A, B, and C all is low (0 or 1 or 2)

The CDOI model syntax that is applied on heat transfer concept learning consists of seven stages of activities, namely 1) identification of the students' initial mental model, 2) the orientation of the student towards phenomena related to context, 3) the formation of concepts and the construction of understanding content using interactive demonstration methods, discussion classes

and frequently asked questions, 4) monitoring the development of student conceptions, 5) strengthening conceptions and enrichment, 6) reflection and follow-up teaching and 7) identification of the students' final mental model.

FINDINGS AND DISCUSSION

Table 3 shows the scores of each Elementary School teacher candidate in question number 1 part questions 1,2, and 3 HTCUC Test on conduction concept before and after CDOI implementation. The scores obtained by students in each part of the HTCUC test questions on heat transfer concept be predicted that the mental model's categories that each prospective elementary school teacher has.

Tabel 4. Students number in each category of the mental model on heat transfer concept before and after the CDOI model implementation

Before CDOI implementation (Pre-test)				After CDOI implementation (Post-test)					
Mental model categories	Pre-service elementary school			Mental model categories (%)	Pre-service elementary school			Mental model categories (%)	
	P1	P2	P3		P1	P2	P3		
Scientific	0	0	1	0.4	Scientific	13	11	8	10.7
Syntetic	27	31	8	22	Syntetic	58	62	45	55
Initial	73	69	91	77.6	Initial	29	27	47	34.3
Total				100	Total				100

Based on Table 4, data shows changes in the pre-service elementary teachers' mental models category before and after CDOI implementation. There was an increase in some pre-service elementary teachers who reach the scientific or scientific mental model category and a reduction in the number of pre-service elementary teachers who reach the initial mental model category. The number of pre-service elementary teachers who changed their mental model to a scientific mental model was 10.67%, consisting of 13% in question-1, 11% in question-2, and 8% in question-3. We can conclude that the CDOI model implemented by the supported MIKiR approach has high effectiveness in improving the mental model achieved by pre-service elementary teachers from before to after the CDOI application.

Implementing the CDOI model effectively improves the pre-service elementary school teachers' mental model by collaborating MIKiR approach. This is very helpful in the process of describing abstract concepts by carrying out three levels of representation. The research results show that they are structured in learning activities, and active learning can improve pre-service elementary school teachers' conceptual understanding of the heat transfer concept. The presence of the CDOI model is oriented towards conceptual understanding the concepts of elementary teacher candidates and collaborating with the MIKiR approach that emphasizes experimentation, where students are asked to contribute directly to learning activities in each phase (Experiencing, Interaction, Communication, and Reflection) so that students get a complete understanding and building student mental models. This is a way to match the newly acquired pre-service elementary school teachers' knowledge with the knowledge stored in a pre-service elementary school teachers' long-term memory (Setiawati & Corebima, 2018 and Astriani et al., 2020).

These studies also indicate a change in the prospective teacher's mental model for each concept. For more information, see Figure 1.

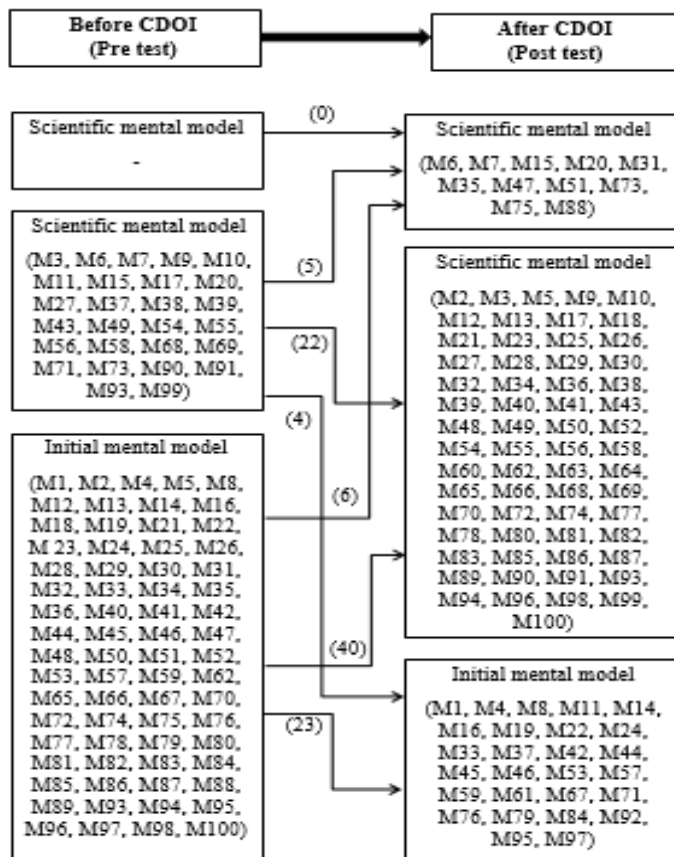


Figure 1. The pattern of mental model category changes obtained by students from before and after the implementation of the CDOI model on the convection concept (Q2)

The CDOI model's application effectively improves the pre-service elementary school teachers' mental model by collaborating the MIKiR approach (Alpusari et al., 2019; Sari et al., 2020). This is very helpful in the process of describing abstract concepts by carrying out three levels of representation. The research results show that they are structured in learning activities, and active learning can improve pre-service elementary school teachers' conceptual understanding of the heat transfer concept. The presence of the CDOI model is oriented towards conceptual understanding the concepts of elementary teacher candidates and collaborating with the MIKiR approach that emphasizes experimentation, where students are asked to contribute directly to learning activities in each phase (Experiencing, Interaction, Communication, Internalization and Reflection) so that students get a complete understanding and building student mental models. This is as a way to match the newly acquired pre-service elementary school teachers' knowledge with the knowledge that has been stored in a pre-service elementary school teachers' long-term memory.

By applying active learning elements, namely the first MIKiR approach, the learning process is experiencing (Setiawati & Corebima, 2018 and Astriani et al., 2020). In this element, the teacher guides students to carry out various activities, namely observing, experimenting, doing work and asking students to have an opinion. In the second step in communication, the teacher is able to excavate deep information from students and motivation that makes students creative and innovative, critical. This communication activity can inspire bravery and fluency in conveying ideas and opinions in public (Taher, Hamidah, & Suwarna, 2017). Communication activities carried out by students through the delivery of work or report activities that have been done by oral and written will build courage and confidence. Reflection is the activity of looking back at the learning

experience so that learning is better in the future reflection activities to bring an attitude to be willing to accept, criticize, and improve themselves. The teacher carries out this reflection activity at the end of each lesson. This activity is to rethink the work that students have done. Reflection activities carried out by the teacher as a benchmark of success in instruction and to know the level of the material completed by students.

CONCLUSION

Researchers have reached the following conclusion based on the results of their research and data analysis: application of the CDOI model with an integrated MIKiR approach has high effectiveness in facilitating the achievement of mental models and can aid the conceptual development process that leads to the formation and overall understanding of heat transfer theory and concepts. Mental models are a component of metacognition, talent or ability that is becoming increasingly important in the age of the Fourth Industrial Revolution (Industrie 4.0) and the twenty-first century. The creation of mental models is intimately linked to the development of digital literacy competencies, which can be enhanced by applying the MIKiR method to the integrated CDOI model. It can continue to develop and provide advice on the MIKiR method to teachers in schools and conduct research into the impact of the MIKiR approach on disciplines besides science. The MIKiR technique will also be investigated at the junior and senior high school levels.

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