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An Identification of Students' Mental Model On Heat Convection Associated with the Implemented of Learning Model

Suci Hendriani [1,a)], Andi Suhandi [2,b)]

[1]*Program Studi Pendidikan Fisika, Sekolah Pascasarjana Universitas Pendidikan Indonesia (UPI)*
Jl. Dr. Setiabudhi No. 229, Bandung, Indonesia
[2]*Departemen Pendidikan Fisika, Universitas Pendidikan Indonesia*
Jl. Dr. Setiabudhi No. 229, Bandung, Indonesia

[a)]Corresponding author: sucihendriani@student.upi.edu
[b)] andi_sh@upi.edu

Abstract. This study aims to describe the students mental model in the tenth grade to explaining the concept of heat convection. This research use a descriptive method and implemented in four senior high schools. One school applied the conventional learning model and three schools applied the innovative learning model consisting of the Direct Instruction (DI), Problem Based Learning (PBL) and Interactive Lecture Demonstration (ILD). The subjects of research are 168 students. The instrument for data collection used understanding test with eight open ended questions with two cases form convection phenomenon. Data analysis is divided into two stages, the first stage to find the level of understanding and the second stage to find the mental models. The students mental models are divided into three level : initial, synthetic and scientific. The results for the level of mental model for the first and second phenomenon that use conventional learning models is 55% and 90% for initial, 45% and 10 for synthetic and 0% for scientific. The level of mental model that use Direct Instruction (DI) is 46% and 80% for the initial, 50% and 20% for synthetic and 4% and 0% for scientific, while using Problem Based Learning (PBL) is 42% and 74% for initial, 54% and 26% for synthetic and 4% and 0% for scientific, and using Interactive Lecture Demonstration (ILD) is 47,91% and 77,09% for the initial, 45,83% and 22,91% for synthetic and 6,25% and 0% for scientific. There are differences in the level of students mental model that use the conventional learning model, Direct Instruction (DI), Problem Based Learning (PBL) and Interactive Lecture Demonstration (ILD).

INTRODUCTION

Mental models are the ideas in someone is mind that they use to describe and explain the phenomenon. To explain a phenomenon, mental models act as the role of "surrogate" to describe the concept. This substitute role in explaining the concept of a person is called a mental model [1]. Chan and Black concluded that the construction of a mental model of the heart of meaningful learning [2]. Mental models are the internal representations of students in accessing the structure of knowledge (content knowledge and experience owned daily) used in solving problems. According to D. Gentner, the mental model is a representation of multiple domains or circumstances that support comprehension (understanding), reason (reasoning), and prediction (prediction) [3]. The mental models is interesting to study because: 1). mental models affect students' cognitive function, 2). Mental models can provide valuable information to researchers about the composition of the concept of science education of the students [4]. The role of mental models is to explain the reasoning individual when he tried to understand, explain and predict the final state of a phenomenon [5].

There are several factors that become the source of formation of students' mental models. The results of previous research says there are several factors that can affect each individual mental models such reasoning, the explanation of teachers, reading books, everyday experience, and never experiment [6]. Commentary for the learning of the less effective teachers will produce a variety of alternative concepts in the minds of their students so that it will produce a different mental model representation [7]. According to Coll, teachers need to understand the mental models of the students to be able to design an appropriate learning strategies so that

learning becomes more effective and avoid misconceptions [8]. According to Arend, each teacher should be able to manage and choose a model of learning for their students so that learning objectives can be successful as expected [9]. Teach a given subject should have the learning model that best suits the objectives to be achieved. Choosing a learning model must have a thorough consideration and appropriate. Currently, many innovative learning models or modern are constantly being developed by experts including the Direc intruction (DI), Problem Based Learning (PBL), Interactive Lecture Demonstration (ILD), and so on.

One of the sub subject of physics is abstract and deals with everyday life is the phenomenon of heat convection. A good understanding of the phenomenon of convection heat is required to construct a scientific theory of energy transfer phenomena in general [3]. Past studies focused on how students' understanding and overview of the dynamic process of heat convection phenomenon [10]. The main objective of this study was to describe the students' understanding of the concept of convection heat after being given a lesson by the teacher using conventional and innovative learning model.

EXPERIMENTAL

This study identifies students' mental models through a level of understanding that is associated with learning model applied by teachers. Therefore, based on the focus of the study, the method used in this research is descriptive method. This research was conducted in four high schools namely MAN 1 Sumedang, MAN 2 Sumedang, MA Plus Al Munir Sumedang, and MAS Mathla'ul Anwar Menes Center Pandeglang. The number of samples in this study were 168 students in tenth graders. 40 students using the conventional model, 30 students using Direc intruction (DI) models, 50 students using Problem Based Learning (PBL) models, and 48 students using Interactive Lecture Demonstration (ILD) models.

In order to elicit the mental models of students, a data collection tool based on Saglam-Arslan & Devecioglu [11] and including 8 open-ended questions. Students are given two cases form convection phenomenon. The fisrt phenomenon about Air Conditioner (AC) usually stamp in side of room and the second phenomenon about in the night the amonia is smell around fertilizer plant factory wereas not in the afternoon. The phenomenon is equipped with 4 questions such as: 1). The explanation of the phenomenon, 2). What explains the concepts of physics phenomenon, 3). Providing examples of other similar phenomenon, and 4). Explain the physical meaning of the phenomenon.

Data analysis was performed two stages, the first stage is to analyze the level of understanding of each student whether using conventional model, PBL, DI, and ILD. The second stage is to analyze the results of the level of understanding into the mental models [12].

Students Level of Understanding

Data obtained from the instrument was analyzed to understand levels of understanding show below in Table 1. These level of understanding as suggested by Saglam-Arslan & Devecioglu (2010).

TABLE 1. Evaluation Rubric for Level of understanding

Level of Understanding	Score	Criteria
Sound Understanding (SU)	4	• Answer that include all aspect of a valid answer.
Partial Undesrtanding (PU)	3	• Answer that include only one aspect but not all aspect of a valid answer. • Answer that include some aspects of a valid answer and some misunderstandings.
Incorrect Understanding (IU)	2	• Insensible information. • Incorrect information.
No Understanding (NU)	1	• Complete repetition. • Irrelevant answer. • Vague answer.
No Response (NR)	0	• Leaving blank. • Answering “I don’t know” • Answering “I don’t undestand”

Students Mental Model

In the second stage of the study, student answer were analyzed according to the models shown below in Tabel 2. Theses models as suggested by Kurnaz (2015).

TABLE 2. Evaluation rubric for mental model

Model of Understanding	Criteria	Level of Understanding
Scientific	Perception and depiction described by students in accordance with the scientific concept. Answer the understanding level of 3 (PU) or 4 (SU).	$\begin{bmatrix} 3 & 3 & 3 & 3 \\ 4 & 4 & 4 & 4 \end{bmatrix}$
Synthetic	Perception and depiction described by students only contains partial concepts that are in accordance with the scientific concept. Answer the understanding level of NR to SU.	$all\ others\ posibilities$
Initial	Perception and depiction described by students does not contain the expected scientific concept even students respond with another alternative concept. Answer the understanding level 0 (NR) to 2 (IU)	$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 \\ 2 & 2 & 2 & 2 \end{bmatrix}$

RESULTS AND DISCUSSION

The achievement result of understanding level is presented at Tabel.3 and Tabel.4 after analyzing the students' answers to each question number.

Student Understanding Level at First Convection Phenomenon (about Air Conditioner usually stamp in side of room)

TABEL 3. Percentage of question and answer level of understanding

	Conventional				DI				PBL				ILD			
Level	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
[4] SU	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2	2
[3] PU	-	5	25		30	34	29	15	14	32	36	12	37,5	35,4	25	10,4
[2] IU	60	95	75	95	50	47	52	40	54	56	48	36	62,5	16,6	64,6	33,3
[1] NU	40	-	-	5	20	15	19	43	32	12	14	50	-	47,9	8,3	54,2
[0] NR	-	-	-	-	-	-	-	2	-	-	-	2	-	-	-	-

Tabel.3 shows the percentage of students' level of understanding on the concept of heat convection about an explanation for the reason Air Conditioner (AC) usually stamp in side of room. The result of the students' level of understanding in explaining the reasons for the installation of air conditioning placed above the room at the Sound Understanding level is completely absent using conventional, DI, either PBL or ILD models. This shows that students do not fully understand the concept. Students have more understanding at Incorrect Understanding level to explain the phenomenon of AC installation. While students who use the ILD model that reaches the level of understanding of Partial Understanding is about 37.5% more than the understanding of students who use DI 30% and PBL 14% while, no one use conventional models that reaches this level. For the 2nd question of physics concepts that appropriate the phenomenon, 95% of students with conventional models answered incorrectly. Students using ILD as much as 35.4% achieved an understanding of Partial Understanding level, slightly better than PBL and DI. Most students mention the concept of air conditioning installation is the

concept of temperature, they were also answer heat and heat transfer only with not specific explanation that match with the concept of heat convection. For the third question on the same phenomenon as the phenomenon of AC installation, students using PBL and ILD as much as 2% reach Sound Understanding levels and more students understanding at the Incorrect Understanding level. It shows that students have difficulties in giving examples of similar phenomenon because the concept of the phenomenon is poorly understood by them. Question number-4 students many interpret the physical concept is wrong and even wrong. However, students using conventional models are more at Incorrect Understanding level than others.

Student Understanding Level at Second Convection Phenomenon (about in the night the amonia is smell around fertilizer plant factory whereas not in the afternoon)

TABEL 4. Percentage of question and answer – level of understanding

	Conventional				**DI**				**PBL**				**ILD**			
Level	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
[4] SU	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
[3] PU	6	-	-	2	13	6	4	-	2	24	2	4	16,7	-	8,3	-
[2] IU	80	69	84	78	80	94	50	50	58	26	20	24	83,3	100	87,5	81,3
[1] NU	14	31	16	20	7	-	26	45	36	46	52	52	-	-	4,2	18,7
[0] NR	-	-	-	-	-	-	20	5	4	2	26	20	-	-	-	-

Tabel.4 shows the percentage of students' level of understanding on the concept of heat convection about in the night the amonia is smell around fertilizer plant factory were not in the afternoon. In this second phenomenon, the average level of students' understanding becomes decreased. The result of the students' level of understanding in explaining the reason for the smell of ammonia at night at Sound Understanding level is totally absent either using conventional, DI, or ILD models and only 2% is achieved by students using PBL. Meanwhile, at the level of Partial Understanding is more achievable by students than the ILD model is about 16.7% also for the level of Incorrect Understanding is more achieved by students using ILD. For the 2nd question of the physics concepts that fit the phenomenon, 100% of students from the ILD model responded incorrectly. Based on students understanding the phenomenon is an example of the concept of radiation and evaporation. However, for the PBL model as many as 24% of students at the level of Partial Understanding, it shows a better ranking compared with other models. Question 3 regarding examples of suitable phenomena, students from the conventional class none at all reach the level of Partial Understanding, of DI class, PBL and ILD reaching the Partial Understanding level of 4%, 2% and 8.3%. Featureless, student exemplifies the phenomenon that is not appropriate until categorized in Incorrect Understanding, even there are not a few students also write the wrong answer or example that given is a concept on other materials physic. On the other hand, the fourth question about the physical meaning of ammonia odor concept, some students in class DI and PBL were not giving responses.

Student Mental Models at First Convection Phenomenon (about Air Conditioner usually stamp in side of room)

To get a mental model, adapted to the characteristics of the students 'answers are contained in Table 2. The results of the classification of the level of students' mental models shown in Table 5 and Table 6.

TABLE 5. Percentage of student mental model at firt convection phenomenon

Mental Model Level	**Learning Model**			
	Conventional	**DI**	**PBL**	**ILD**
Scientific	-	4	4	6
Synthetic	45	50	54	46
Initial	55	46	42	48

Table 5 shows the level of students' mental models of the phenomenon of Air Conditioner (AC) usually stamp in side of room. The level of students' mental models that use more conventional model at an initial rate of 55% and none reach the level of scientific. Students who use innovative learning model, such as DI, PBL, and ILD more reached the level of synthetic (50%, 54% and 46%), while the scientific (4%, 4% and 6%). In this situation, the use of innovative learning models result in a better mental model of the student compared to the mental models of students using conventional learning models.

Student Mental Models at Second Convection Phenomenon (about in the night the amonia is smell around fertilizer plant factory whereas not in the afternoon)

TABLE 6. Percentage student mental model level at second convection phenomenon

Mental Model	Learning Model			
	Conventional	**DI**	**PBL**	**ILD**
Scientific	-	-	-	-
Synthetic	10	20	26	23
Initial	90	80	74	77

Table 6 shows the level of students' mental models of the phenomenon of the night the amonia is smell around fertilizer plant factory wereas not in the afternoon. The level of students' mental models that use more conventional model at an initial rate of as much as 90% and none reach the level of scientific. Students who use innovative learning model, such as DI, PBL, and ILD more reached the level of synthetic ie 20%, 26% and 23%, in this second phenomenon, no one of students achieves a mental model, but the percentage of mental models in the synthetif model is greater in students using PBL.

CONCLUSION

Students use a mental model to understand and explain physical phenomena, especially the invisible. The results showed that student' mental models that use conventional and innovative learning model is very much different. Students are quite diverse describe and explain the phenomenon that occurs during heat convection. The differences are influenced by the learning model applied by teachers when submitting and explaining concepts to students. The mental models that students use innovative learning model is better than the students' mental models that use conventional learning models. PBL models is better than the students' mental models that use DI and ILD models.

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REFERENCES

1. N. Jansoon, R. Coll, & E. Somsook, *International Journal of Environmental & Science Education*, **4** (2), 147-168, (2009*)*.
2. Supriyatman, (Disertasi, Universitas Pendidikan Indonesia) "Pengembangan Program Perkuliahan Kelistrikan Dan Kemagnetan Berbasis Pemecahan Masalah Untuk Memperbaiki Model Mental Dan Meningkatkan Mental Model Ability Mahasiswa Calon Guru Fisika", (2016).
3. Mustaqim, *Prosiding Pertemuan Ilmiah XXIX HFI Jateng & DIY Yogyakarta*, 404-408, (2015).
4. L.A.R. Laliyo, *Jurnal Penelitian Dan Pendidikan*, **8** (1), (2011).
5. M.I. Greca and A.M. Moreira, *Int.J.Sci.Educ*, **22**, 1-11, (2000).
6. S. Rahayu, J. Purwanto, Kaunia, **9** (2), 12-20, (2013)
7. J.W. Lin, & M.H. Chiu, *International journal of science education*, **29** (6), 771-803, (2007).

8. P. Susanty, (Tesis, Universitas Pendidikan Indonesia) "Profil Mental Model Siswa SMA Beserta Faktor-Faktor Yang Mempengaruhinya Menggunakan Tes Diagnostik Project-Observe-Explain (Poe) Pada Materi Larutan Penyangga", (2014).
9. Trianto, "Mendesain Modearan Inovatif Progresif", Jakarta: Kencana Prenada Group (2009).
10. L.G.Chiou, *Phys. Rev. ST Phys. Educ*. Res, 9, 0210119, (2013).
11. Saglam, A. Ausegul, Daveciouglu, and Yasemin*, Asia Pasific Forum of Science Learning and Teaching*, **11** (1), (2010).
12. M.A. Kurnaz, *Educational Sciences: Theory & Practice*, **15** (3), 787-795, (2015).