Recostructing the Physics Teaching Didactic based on Marzano's Learning Dimension on Training the Scientific Literacies

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Abstract. Scientific literacy is currently considered as an important aspect supporting an useful citizenship ability for civilians inhabiting highly developed countries as well as developing countries. Consequently, certain countries recommended this scientific literacy to be applied at a national curricula. The PISA study showed the Indonesian scientific literacy level of 1, which means as just simple science phenomenon that could be exactly descibed by a student. This condition indicates that common science teachings do not optimally facillitate students to guide the scientific literacy. By proposing this research, the science didactic reconstruction will be offered in order to gain the students' scientific literacy evaluated from the qualitative analysis of the action research and the students' respons during learning science. The qualitative evaluation was developed based on the Marzano's learning dimension about the scientific literacy. This research, involving 29 students as participants, analyzed the improved physics teaching didactic as described in the following sentences. The teaching reconstruction concerned a high attention to the development of the structural knowledge. The knowledge was acquired from a real phenomenon followed by giving the instructed questions as the second learning dimension. The third dimension of leearning reconstruction aimed to provide the knowledge repetition on an appropriate science context. At the fourth dimension, the reconstruction should be improved in order to find the best treatment for the students. Hopefully, they can control the physical parameter and evaluate the result of their investigation related to the given science problems. It can be concluded that most of the students were interested in learning science. However, the productive learning didn't accompany students to the Marzano's second, third, and fourth learning dimensions.

1. Introduction

Nowdays, the science literacy is a purpose of the science teaching [1].Dewey (1904) stated that learning science guided with the direct student's inquiry experience is important to be prepared in order to improve their science literacy [2]. Moreover, the National Science Education Standard initiates the science literacy including (a) the scientific concept and the scientific process for physics and biology, (b) the inquiry scientific method, (c) the application of science in daily life, (d) the social and environment implications of science to the technology development [3]. In 1990, the brenchmarks for science literacy developed by the National Research Council for the National Science Education Standarexplainedabout how the students delvelop their science literacy and how the literacy can be improved to achieve the standardized level. This council also focused on the science literacy development to be applied at the elementary and middle school levels. According to Five (2014), science literacy is identified as the ability to comprehend the scientific process and the meaningful activity involvement acquired from the scientific information presented in a daily life [4]. Futhermore, the National Research Council (1996) stated the scientific literacy as the knowledge and the understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity [3]. Therefore, the science literacy can be defined as the ability to comprehend the knowledge to be applied in a daily life, and it is required for the personal decision making and the active civil participation. Science literacy gives high attention to the use of science effectively with respect to the nature phenomena [4].

Science literacy as the knowledge and the competence is important to be attained by civils of a developing country as well as a developed country in order to build the national curricula implemented at the elementary and middle schools [5]. This program can support students the ability to solve their problems happening in a daily life. Consequently, science literacy is the students' right to be realized from a high quality science teaching [6]. Since 2005, the survey about students' comprehension on science literacy in the middle school has been taken involving 628 students from 5 different schools. The result showed that the students' science literacy must be improved including their abilities in explaining the science phenomena, contructing and evaluating the experiment, and interfering the scientific evidences [6]. The previous stategies to improve the students' science literacy has been performed by applying the level of inquiry and using the scientific approach. The finding presented that students' science literacy could be slightly improved, but the students tend to accomplish the literacy using sporadic ways. Hence in this research, the consecutive approach will be carried out to discover the ways in exercising students' science literacy.

The research is conducted in order to improve the quality of science teaching using Marzano's dimension approach [9]. This approach consists of first dimension D1 for positive perception and attitude, second dimension D2 for knowledge building, third dimension D3 for knowledge refining, fourth dimension D4 for knowledge broadening, fifth dimension D5 for habit of mind. The first and fifth dimensions of D1 and D5 are closely related to the pedagogy foundation in training the science literacy. The figure 1 illustrate the relationship among the Marzano's dimensions.

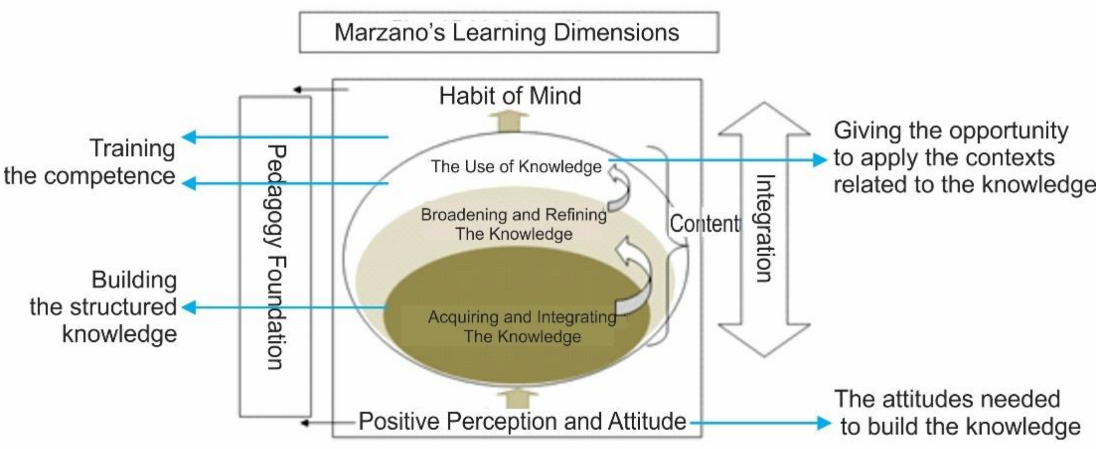

Figure 1. The relationship among the Marzano's dimensions in order to train the science literacy

According to the Marzano's learning dimensions, a teacher firstly accompanies the students to possess the positive perception and attitude in all of the processes of acquiring, broadening, and applying the knowledge. Theteacher engagement is needed to simplify the problems so that the students will not be frustrated in handling their difficulties. The engagement will also contribute to the improvement of the meaningful students' attention to acquire a good perception. On the other hand, a teacher should facillitate the students to think productively called as the habit of mind. This habit is required during acquiring, integrating, broadening, refining, and applying the knowledge. The scientifc questioning ability of a teacher will obviously assist the students in habituating their mind[6].

In the case of students' ability to acquire the concept of heat transfer, some misconceptions were found, and some students felt difficult to understand some concepts of heat transfer such as the heat is comprehended as the temperature transfer, the heat is the internal energy, and the heat is also influenced by the specific heat and the mass. To make a meaningful teacing as well as to give a good motivation to students, a teacher have to provide some applications related to the heat concept in a daily life called as a contextual base approach [10, 11]. A good student's perception and attitude needs certain activities involving the knowledge acquiring. Some science demonstrations can be shown to students in order to engage the students' interest and to discover the students' misconception through giving the cognitive conflicts [12]. Moreover, the contextual problem may also be presented to students with the intention of the students' interest [13]. Finally, a teaching should be directed to construct good scientific attitudes, and it is better if a relation between science and their future career could be introduced to students [14].

Some science literacy problems had by the Indonesian students were found that they don't have enough knowledge to discuss with a teacher, so the new knowledge couldn't be acquired [15]. If a teacher do not provide an appropriate aperception, students will not accomplish a desirable knowledge constructivism because the students' knowledge is not inexpedient with the new introduced knowledge. Therefore, a teacher needs to be patient to elaborate the knowledge so that the students will ready to attain a new knowledge. The infusion reading strategy might be proposed to a teacher with the purpose of handing the gap between students' knowledge and a new knowledge. For a students who not be accustomed to accept a new information, a teacher might provide a suitable article regarding the basic knowledge required to pursue some scientific questions and answers. Thus, the discussion can be well cunducted [16].

A teacher commonly uses an available textbook to teach the concept of heat transfer without considering the knowledge cunstructing structure, whereas this structure needs to be elaborated by a teacher through analyzing contextual science evidences which are easy to be observed by students in constructing their factual knowledge [17].In this research, the concept of heat transfer is constructed using the factual knowledge. It can be considered that the heat is not the internal energy of an object, but it is an energy transferred due to the two different object temperatures while the temperature is a physical parameter possessed by two different systems when they reach the termal equilibrium. Actually, these definitions must be constructed using some facts given through open-ended inquiry elaborated by a teacher [18]. A science concept might be constructed to students using the inquiry process causing the habit of mind.

In the students' knowledge refining as the third dimension of D3, the process is related to comparing, the inductive reasoning, the deductive reasoning, the error analysis, constructing support, abstracting, and analyzing the science phenomena. Fourth dimension of D4 about the perspective and the use of knowledge is related to making a decision, science investigation, conducting the experiment, solving the problems, seeking the new invention, and analyzing the system [9]. Those third and fourth dimensions contribute to facillitating the science literacy regarding describing the science phenomena, constructing and evaluating a scientific investigation, interpreting data and scientific evidences. Moreover, broadening the knowledge needs to be engaged to students by questioning science phenomena. This process is also necessary to improve the students' productive thinking. The engagement can be elaborated by explaining the scientific information, and showing the experiment resultsincluding datum and graphs. This work will provide students the opportunity in interpreting data and scientific evidences. Finally, a teacher should evaluate the students' work [7].

2. Methods

This research aims to qualitatively analyze the physics teaching reconstruction on the topic of heat transfer based on Marzano's learning dimensions in order to train the science literacy [19]. The description of teaching reconstruction is obtained from the students' response during learning science, the students' worksheet answers, and the profile of science literacy. The concept of heat transfer will be presented to students with the aim of training the science literacy. The learning process will be profiled to understand its treatment to indonesian students. The research is participated by 29 students in a middle school Bandung categorized as an ordinary school cluster. The students are grouped into 5 teams. To obtain an obvious observation data, the students' activities are monitored using a video recorder. Moreover, the students' worksheet answers indicating the students' responses are interpreted qualitatively as tabulated in tabel 1.

Tabel 1. Interpretation of students' response based on the students' worksheet answers [20]

Percentage (%)	Interpretations
100	all
76-99	almost all
51-75	mainly
	half
50	almost half
26-49	rarely
1-25	nothing
0	

3. Results And Discussion

According to the students' worksheet and the direct class observation recorded by the video, the description of students' learning achievement on the topic of heat transfer are shown in table 2.

Tabel 2. The profile of students' learning achievement based on their answered worksheets and the direct observation

No	Learning Activities	Findings	Observation results and recommendations
1	Defining the temperature	(71%) The students are mainly able to define the temperature. Some students were unable to define the temperature as two or more systems attaining the termal equilibrium.	Some students were difficult to define the temperature comprehended from the direct observation. Consequently, the demonstration of defining the temperature should be engaged by questioning science structurally. The students' observation might also be followed by discussing students' finding in defining the temperate.
2	Describing the heat	(57%) The students are mainly able to describe the heat as the energy transfer. Some students explained the heat as the energy transfer, which was not affected by the temperature difference of two object.	Some students considered the heat as the internal energy possessed by an object. It could be demonstrated that the sporadic particles' movement in the high temperature fluid will disperse quicker than the sporadic particles' movement in the low temperature fluid, so the temperature is reated to the internal energy of certain objects.
3	Explaining the effect of the heat absorbed by an object	(63%) The students frequently comprehend the heat, which is able to increase or decrease the object temperature. It is interesting that the	The phenomenon of an heated object should be demonstrate. When an object is being heated, the termal expansion will occur. It should be considered during the discussion about the physical and chemical changes to an objecy during the heat treatment.

Tabel 2. The profile of students' learning achievement based on their answered worksheets and the direct observation

No	Learning Activities	Findings	Observation results and recommendations
		heat was able to change the shape of an object although this phenomenon was not shown directly.	
4	Defining the termal expansion	(86%) Almost all of the students are able to define the termal expansion. However, (14%) the students rarely state the termal expansion as a reversible process.	The description should be dirrected by showing a related phenomenon. For example, a teacher demonstrates a baloon, expanded by a heated air, showing a reversible process.
5	Elaborating the inquiry questions	(86%) Almost all of the students are able to provide the inquiry questions.	A teacher shows a video regarding the termal expansion on two different metal rods. Afterwards, he guides the students making a graph L=f(T). Based on the graph, the students provide inquiry questions helped by a teacher. At the beginning session, a teacher has a significant role to direct students on elaborating inquiry questions.
6	Determining the dependent, independent, and controlled parameters	(29%)few students who enable to determine the dependent, independent, and controlled parameters	The students haven't recognized the dependent, independent, and controlled parameters obtained from the previous experiment. Consequently, a graph showing the relationship among the dependent, independent, and controlled parameters cannot be considered by the students. Therefore, through conducting the termal expansion experiment, a teacher must demonstrate which one is dependent parameter, independent parameter, and controlled parameter.
7	Constructing the experiment procedure	(49%) Almost half students are able to construct the experiment procedure, but only 29% students who completely compose the experiment procedure.	Although the students were able to take the data, they couldn't contruct the experiment procedure systematically. Thus, a teacher needs to guide the students writing an experiment procedure on the available worksheet.
8	Making a table	(43%) Almost half students are able to tabulate the datum taken from their observation.	A teacher should emphasize the parameters measured by the students and he also should discuss about drawing an efficient graph.
9	Making a graph using excell program	(14%) Few students enable to make a graph using excell program.	Although all of the groups were equipped by the computers, almost all students didn't have the initiative using excell in making a graph. This condition happens because each

Tabel 2. The profile of students' learning achievement based on their answered worksheets and the direct observation

No	Learning Activities	Findings	Observation results and recommendations
			group could not take the data during conducting the experiment, so it is recommended to ensure that this task is communicated before running the experiment.
10	Making a graph manually	(28%) Few students enable compose a graph manually recorded from experiment result	The students unusually draw a scientific graph. As a result, some groups fell difficult, unconfident, and unabled in creating a graph. It is recommended to a teacher how a good graph is composed both using excell program and a manual graph. In that case, the seconder data is needed to handle the problem.
11	Comparing the prediction to the experiment findings	Only 28% students who enable to analyze the experiment findings	It is recommended to instruct how to analyze a graph and compare it to the prediction or a teoretical framework. A teacher might employ the epistemic knowledge in investigating a graph and making a conclusion.
12	Determining the termal expansion coefficient based on the own graph	(14%) Few students are able to determine the termal expansion coefficient based on the own graph	It could be firstly analyzed that the students didn't have the experience in deriving a graph into a mathematics equation. A teacher requires to explain other related concepts even though the material is presented for a junior high school student.
13	Concluding the findings	(28%) Few students are able to conclude the experiment findings based on their own data	It is needed to model on how the experiment datum are compiled to arrange a conclusion using an epistemic knowledge.
14	Critisizing the results	None of the students enable to critisize their result or give the suggestion based on the experiment conducted	It requires to demonstrate how the findings are being evaluated and how the suggestion is arranged based on their findings.

According to our findings, we suggest to reconstruct the teaching didactic on the topic of heat transfer using Marzano's learning dimensions in order to train the students' science literacy as presented in the following sentences.

1. a teacher should consider the time required to present the learning materials to be adjusted with the available time given by a school. The required information for middle school students or other supporting information should be provided before conducting the experiment. In this case, the information on how to create a scientific graph based on data must be readby students from a module before they enter the class. This module is constructed in order to correct the students' misconceptions using multirepresentative approach equipped with the scientifically directional questions. This step is needed to construct the new knowledge required during conducting the experiment.

2. A teacher requires to analyze the students' characteristics. The students' learning capability will determine the role of a teacher conducting the learning in a class. A teacher will dominantly give the instruction in a class if the class consists of more students with their low abilities in accomplishing the learning materials. Consequently, it should be ensured that the students could encounter their difficulties during learning science, and the tasks have been done by the students so that the students will have the positive perceptions and attitudes. For example, a science-directional question has been demonstrated by a teacher to be solved correctly in order to improve the students' attention. Finally, the students will dominantly take a role in offering their scientific investigation questions.
3. A teacher must firmly conduct the science learning so that the science teaching could be fully dirrected. The concept repetition can be elaborated by a teacher to make sure that the students could accomplish the science learning well. In a group discussion, all students must contribute to their collaboration and cooperative learning.
4. A science demonstration should be well constructed to clearly show the science phenomena. In this research, the tools required to show the termal expansion phenomena on the metal rods during the heat treatment are equipped using microcontroller so that the students will have the factual information about the relation of $\Delta l = f\ (\Delta T)$. The demonstration is followed by offering the sequentially scientific questions with the purpose of the good acquiring and integrating the knowledge.
5. The learning scenario is developed to ensure that each step of broadening the knowledge could achieve the habit of mind. The questions have been elaborated such as why does an object's volume expand when it is being heated?, explain your prediction to the molecular system during termal expansion!, do the objects expand with the same amount?, why do you explain this prediction?. In order to apply those concepts, the students' habit of mind should be well trained by giving the scientifically related questions as follows: how does the working principle of the bimetallic strip?,can all materials be used as the bimetallic strip? what are the scientific requirements to show that phenomena?.
6. It should be ensured that the learning strategies is well constructed in order to train the science literacy including explaining the science phenomena, constructing and evaluating the experiment (comprehending the dependent, the independent, and the controlled parameters), and interpreting the data obtained from the scientific evidence.

4. Conclusions

According to the analysis based on the science learning process on the topic of heat transfer, the reconstruction of physics teaching didactic has been employed using Marzano's learning dimensions which emphasize the certain findings as narrated in the following sentences. It is required to prepare the scientific supporting information that should be comprehended by students before attending the class in order to handle their difficulties to construct the new knowledge. The directional questioning can be elaborated by a teacher in order to acquire the structurally subsequent knowledge while the concept repetition is important to ensure that students have understood the precise context scientifically. Moreover, a teacher must firmly conduct the science learning so that the science teaching could be fully dirrected. Finally, the teaching scenario must be well constructed to ensure that learning strategies could train the science literacy and the productive thinking.

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