Text Based Analogy in Overcoming Student Misconception on Simple Electricity Circuit Material

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Abstract. Some researchers have found that the use of analogy in learning and teaching physics was effective enough in giving comprehension in a complicated physics concept such as electrical circuits. Meanwhile, misconception become main cause that makes students failed when learning physics. To provide teaching physics effectively, the misconception should be resolved. Using Text Based Analogy is one of the way to identifying misconception and it is enough to assist teachers in conveying scientific truths in order to overcome misconceptions. The purpose of the study to investigate the use of text based analogy in overcoming students misconception on simple electrical circuit material. The samples of this research were 28 of junior high school students taken purposively from one high school in South Jakarta. The method use in this research is pre-experimental and design in one shot case study. Students who are the participants of sample have been identified misconception on the electrical circuit material by using the Diagnostic Test of Simple Electricity Circuit. The results of this study found that TBA can replace the misconception of the concept possessed by students with scientific truths conveyed in the text in a way that is easily understood so that TBA is strongly recommended to use in other physics materials.

1. Introduction
Physics lessons are believed to be the foundation in understanding the complexities of modern technology, but many high school students do not like Physics because they are abstract so they are difficult to learn. In addition to the lack of supporting laboratory equipment, poor teaching methods as there are still many teachers who teach by lecture methods, discussions, and rely solely on reading books focused on memorizing formulas, and poor mathematical abilities [1] make students less likes Physics.

Another fact that often occurs in Physics learning is that students still have difficulty in understanding the concept of Physics. This difficulty can lead to students experiencing an alternative understanding of the concepts of Physics being studied. Before studying Physics, all students already have experience with Physics events, such as seeing free falling objects, experiencing electric shock, using energy, seeing collisions, and so on. With that experience then the minds of students have
formed a prejudice and theory of students, about the events of the Physics. Prejudice and brevity of experience in life often lead to thinking about Physics and not necessarily true. If the prejudices formed are false, it will usually be very difficult to fix, because accidentally it has been consistently the wrong concept of Physics to be the handle of his life. This becomes one of the major sources of difficulty in Physics learning.

Electrical material is one of the basic materials in Physics. Its application covers many aspects of everyday life. Physics concepts in electricity are mostly invisible, and difficult to learn and learn significantly. Not a few students, prospective teachers and teachers Physics can have difficulties in understanding electrical concepts, especially in electrical circuits. Difficulties of students, prospective teachers and Physics teachers to understand a concept can lead to misconception. Analogy is believed to influence students' understanding of electrical circuitry and help students to correct their misconceptions on this material [2].

Understanding the scientific knowledge of reading a text depends on the reader's pre-knowledge of the concept he is studying. Practical activities in laboratories, demonstrations, and other activities should be integrated with text so that students gain an understanding of the scientific knowledge they are studying [3]. The reason that makes textbooks and teaching materials in the form of text becomes the dominant source of knowledge. Text-based methods can facilitate the need to overcome misconceptions, so the development of conceptual knowledge, identifying misconceptions, and designing instructional materials especially the current text is urgently needed [4].

In the field of science, expository texts have had a bad influence as a means of gaining understanding, learning, and conceptual change. Expository texts are difficult to understand because there are unrealistic assumptions about the background of the reader's knowledge, many technical vocabularies therein, the juxtaposition of new concept and the imperative to conclude in order to reach the reader's understanding. Therefore it is necessary instructional text that aims to give understanding to the reader and change the wrong conception to the reader. The integration between reading comprehension and the instruction of science in the text is needed to change the conception of its readers [4].

Text-based analogy is believed to solve problems and be effective in explaining the concept of science. Text-based analogy will be very useful for teachers, of course, by including and emphasizing the description of relational elements in it, so it will provide impressive information. This text will help learners to understand the differences, so that students do not experience misconceptions due to errors in determining analogous concepts or misconceptions resulting from the concept of analogy and the concept of target. Through the process of comparing and discussing the differences there is one way to improve the potential for misconceptions (Iding, 1997).

From the result of the research, it is found that analogy instruction can help students to change misconceptions into scientific conception by activating their misconception, generating dissatisfaction, and presenting correct explanation, easy to understand and reasonable. From this research also obtained that analogical instruction can influence their understanding of Physics concepts such as electrical concept. In analogy there is a concept analogous to the concept of the target, made an explicit relationship and teachers who teach must know the difficulties of students in understanding the scientific conception in order to design the material to create a meaningful learning atmosphere [6]. Analogy also improves students' thinking skills such as reasoning ability and critical and creative thinking skills [7]. Therefore the analogy learning model must be adopted by all science teachers especially Physics teachers in teaching some abstract concepts to students in the classroom rather than by conventional lecturing methods as a measure to improve achievement [8].
In order for the benefits of the analogy approach to be achieved there are three essential elements for the teaching of analogies to be systematic [9]:

a. The need for information on the background of the students' knowledge so that the concept or the analog situation chosen has been commonly known to the students.

b. The concept of analog and the concept of target must be correctly identified by the teacher in order to guide the students well.

c. The part where there are limitations in a broken analogy or unusable part shall be explicitly identified and submitted.

Students use existing concepts in their mind to interpret new phenomena, in the process of changing the conception of the stage is called assimilation. However, the concept of the students is not sufficient for students to understand other phenomena well, so students must rearrange the main concept, in the process of changing the conception of the stage is called accommodation [10]. Through assimilation, students use their pre-knowledge to respond to new phenomena. Accommodation is a process of cognitive conflict that occurs because of differences between students' pre-knowledge with existing scientific explanations. There are several conditions that must be met so that the stage of accommodation can be passed by students well [10], including:

a. Dissatisfaction, students should be aware of the concept that is inadequate.

b. Clarity, new concepts must be understood by students.

c. It makes sense, students find a new logical concept and can be imagined in his mind

d. Fruitful, new ideas are formed and students must be able to solve the same problem with the new concept they have.

Sevim (2013) has tested the effectiveness of CCT compared with learning analogies in overcoming misconceptions and found that analogy learning is more effective in changing student conceptions. Other supporting activities are needed to accompany CCT such as demonstration activities, computer simulations, CBL learning, cartoon concepts, or others. On the basis of the advantages of learning analogies in overcoming misconceptions of students then the authors feel the need to conduct further research on the development of learning analogies in other forms such as in the form of text. In this research the text in question is Text Based Analogy (TBA).

1.1. TBA Structure

TBA created with the aim of addressing student misconceptions refers to the making of Conceptual Change Text (CCT). [11]–[13] CCT is made in five planned sections with conditions of dissatisfaction, clarity, plausibility and fruition as developed by Posner et al. (1982) later by incorporating an analogy approach to the explanatory section of concepts in the text as described in [9], [14].

The following is an oriented TBA structure to address student misconceptions, including:

a. First, the identification of student misconceptions to reveal the concept images that exist in the minds of students. This section aims to let students realize that they lack knowledge in answering questions in the first section. The cases expressed in the text should also be related to daily life so that students are more easily aware of their conceptual mistakes and to attract attention so that students continue reading the text. This first part is the step of the student's dissatisfaction with his conception.

b. Second, it presents the common concept errors and the evidence that the concept is wrong and the students are aware of it. Students are encouraged to think more deeply about the topic so that students' minds are stuck in confusion and uncertainty. In this condition students are expected to have a high curiosity about the information provided in the text. It aims to get
students to question the conceptions that exist within themselves and see the lack of ignorance. In other words this is the part where conflicts are made to reinforce students’ dissatisfaction with their own conceptions.

c. Thirdly, in this part the scientific truth about the intended concept is given very clearly and must be understood. For example it should be supported with graphics and images, which are visual tools that easily attract the attention of students and make knowledge become permanent. Explanation of the scientific truth in this section is:
1) Introduce the concept of target to the students.
2) Remind students of the concept of being an analogy tool, the concept can be derived from objects, processes, or events that must have been known by previous students.
3) Identify the relevance of the concept into an analogy tool with a targeted concept.
4) Students are then invited to relate the same thing from concept to tool of analogous with the concept target.
5) Students are also led to know the part that becomes the limitations between the concept of a analogous tool with the concept of the target, so that in the end students are expected to draw their own conclusions in mind.

d. Fourth, when students already understand the difference between misconception and correct scientific explanation, they are asked to express an opinion. This section aims to measure how much awareness has been raised and see if the student still has a question mark in his mind.
e. Fifth, this section aims to understand whether students have understood the text well. Students are assisted by teachers drawing conclusions on the basis of texts. With the new concept available, students are expected to transfer that knowledge and solve new problems in order for the newly acquired knowledge to be permanent.

2. Experimental Method
The research method is a scientific way to get valid data with the purpose to be found, developed, and proven, a certain knowledge so that in turn can be used to understand, solve and anticipate problems in the field of education [15]. Considering the research needs and time constraints, the sample selection is not done randomly, but based on the pre-established group of classes, the research method is the Pre-Experiment Design [16] research method. The research design is the design of how the research is carried out. The research design used in this research is One Shot Case Study Design [16]. Where there is a group given treatment with Text Based Analogy (TBA) with simple electrical circuit material and then observed the result [15], research design can be seen in table 1.

| Treatment | Observation |
|-----------|-------------|
| X         | O           |

Explanation:
X: One group using Text Based Analogy (TBA) treatment with Simple Electricity circuit material
O: Observation

The population of this study is the 9th grade students in MTsN 32 Jakarta 2016/2017 academic year which amounted to 28 people. The sampling technique is by purposive sampling, where the
samples studied are the students who have received the learning of electrical circuit material and experiencing misconception on the electrical circuit material.

This research is done through three stages, namely requirement study stage, design stage, and development stage.

2.1. Stage of study needs

This stage is a stage of deep exploration of the issues studied. Some of the activities undertaken at this stage are literature studies on journals and research reports on student misconceptions on the concept of electrical circuits, the role of text in changing conceptions, texts with analogous approaches, and subjects of MTs class 9 electrical circuit, analysis of text availability on circuit concepts Electricity, determining the types of student misconceptions on the concept of electrical circuits, as well as the preparation of research instruments, instrument validation, and improvement.

2.2. Design stage

1.) Preparation of the initial draft of TBA, at this stage is done making a text design that will be developed by analogy approach with the aim of overcoming misconception. Preparation of the initial draft refers to student misconceptions and the concept of electrical circuits.

2) The validity of a text consists of the validity of the content and the validity of the construct. Content validation consists of aspects of physical content conformity, analogy approach and conceptual alteration approach. While construct validation consists of linguistic aspect and conformity with research purpose. Text validation is performed by three experts or experts. Validation results determine whether the text is feasible or not for use in learning.

3) Evaluation and revision of the text.

2.3. Implementation stage

After analyzing the instrument validation result from the experts, then performed the implementation phase.

2.4. Stages of data processing and reporting

At the stage of data processing, the first part of the text is an expression of student misconception and the last part is the expression of new and scientific knowledge gained from reading the text. If students experience a conceptual change from misconceptions to having scientific knowledge and they feel confident, then the student is said to have overcome his misconceptions but, if the student of misconception and remain in his belief then the student is said to remain in a state of misconception despite reading the text.
3. Result and Discussion

3.1. Instrument TBA

| Part I |
|--------|
| Let's learn Series Electric Circuits |

Isyani feels very frightened, how not, when it's night and dead lights. Isyani hastily retrieved the flashlight on the desk beside her bed. Flashlight can not be lit and not usually the flashlight becomes very hot. Soon Isyani quickly turned off the flashlight and remained in the darkness. The next day at the IPA laboratory of Madrasah where he went to school, Isyani tried several series as in the pictures below and raises several questions.

Help Isyani yes friends answer the questions below!

Answer the following questions!

If both lights are identical, ideal wire and large voltage 9 Volt batteries as in Figure 1, how do you think the large electric current flowing into lamp B if the electric current is turned on lamp A? Why is that?

![Picture 1](image1.png)

Picture 1

| Part II |
|---------|
| How about your answer in part 1 earlier? Approximate your answers with the statements below. The following is an incorrect but common statement: |

Electric current flowing to lamp B will be smaller because it has been used by lamp A.

What about the answers you gave earlier? Is it the same as the above statements? If your answer is the same as the statements above, then the answer is wrong and you are in a state of misconception. All right, now read the following text very carefully.
Part III

A. Target Concept : Series Electric Circuit

B. Analog Concept : Water Flows on Pipes

C. Related relation between Series Series Electricity with Water Flow on Pipe

| Circuit Concept | Water Analogy Concept in Pipe | The concept of series electric circuit target |
|-----------------|------------------------------|-----------------------------------------------|
| Water debit     | Electric current flow        |                                               |
| Pipe            | Wire carrier                 |                                               |
| Pump            | Battery                      |                                               |
| Big moss in the pipe | Obstacles or light bulbs |                                               |
| Water Pressure  | Different electric potential |                                               |
| Tap             | Switch                       |                                               |

Electric current is the flow of electrons through the wire conductor, because we can not see the electrons then to facilitate the required electrical circuit analogy.

Table 3. The relationship of pump function concept with battery function

| Water Analogy Concept in Pipe | The concept of series electric circuit target |
|------------------------------|-----------------------------------------------|
| Pump Function                | Battery Function                               |
| Water flows from pressure supplied by the pump, as is the case with the flow of water in a pipe connected to a water tank. At the time the pump is not operating the water will not flow, but the continuous flow of water will occur if there is a pressure difference generated by the pump. Water flows from the high pressure position to the low pressure position, adding the pump will increase the pressure so that water will flow faster. | Electrons flow because it is generated by the battery. Electrons flow continuously in the circuit. In non-connected conductor wires, free electrons move randomly. This will change when both ends of the wire are connected to the battery. Chemical reactions that occur in the cell produce excess electrons on one end of the cell, which becomes the terminal or negative pole. Meanwhile, the opposite pole, which acts as a positive pole will experience electron deficiency as a result of an electric current flowing. Adding batteries to the circuit increases the electrical energy to make the lights brighter. |

Picture 2. The pump makes a difference in pressure that causes water to flow

Picture 3. The battery makes a potential difference so that the electric current can flow
Table 4. Relationship of the concept of water flows with electric current

| Water analogy concept in pipe | the concept of series electric circuit target |
|------------------------------|-----------------------------------------------|
| Water debit                  | Electric current                               |
| When the pipe is in connected condition, the tap is opened and the pump starts to operate then the water inside the pipe will flow. The water flows as it is pulled by the pump and flows continuously in the pipe. Water will flow from high pressure to low pressure but only the water does not move the pressure and the water will not decrease even though it has passed the tube with a small diameter. | When both ends of the wire are connected to the two battery terminals, the negative poles begin to channel the electrons into the wire. The free electrons in the wire will move through the wire strand to the end connected to the positive pole. This is where the flow of electrons returns to fill the cell, past the positive pole. The current began to flow. It should be noted that the electric current is the flow of electrical charge and the change from one form to another is due to energy rather than electric current flow. Then the electric current will not decrease even though it has flowed through the lights on. |

![Picture 4 Water Debit In the Pipe](image)

![Picture 5 Electrons Flow in a closed circuit](image)

D. Relationship of the Series Electric Series Concept with Water Flow on Pipe

Table 5. The similarities of series electric circuit concepts with water flow in pipe

| No. | Water Analogy Concept in Pipe | The concept of series electric circuit target |
|-----|-------------------------------|-----------------------------------------------|
| 1.  | Water Debit                   | Electric current                               |
| 2.  | Pump Function                 | Battery Function                               |

E. Limitations of Water Flow Analogy on Electric Circuit Concepts

Table 6. Limitations of water flow analogy in pipes to the electric circuit concept

| No. | Location of limitations |
|-----|-------------------------|
| 1.  | When the switch is opened or turned off in an electrical circuit, the current flow will stop even though the circuit is still connected to the battery, but that happens to the water flow in the pipe when the tap is closed and the pump is still running, the water will spill. |
| 2.  | When the switch is closed or turned on then the current will flow, but on the flow of water in the reverse pipe is by opening the faucet then the new water will flow by closing the tap water flow will be stopped. |

F. Conclusion

The following are characteristics of a series circuit, including:

1. Electric current flows with a single path in the circuit, then the current on all devices in the circuit is the same.
2. The total obstacles in the circuit are the sum of all the obstacles along the circuit.
3. The amount of current in the circuit is equal to the voltage given by the battery divided by
   the total number of obstacles in the circuit (Ohm's Law).
4. Ohm's law also applies separately in calculating the magnitude of voltage on each device
   that has different obstacles. Surely it takes a larger electric voltage to face greater obstacles
   and vice versa.
5. If one device is damaged in the circuit then the current in the circuit will stop and all
   existing devices will not work.

Part IV
Is there a difference between the answers you gave in part 1 with the information content in the text?
If 'yes' do you change your mind? If the answer is 'yes', please express your views based on the text
already read at the dots below!

Part V
To knowing your views, after reading the text above, please answer the following questions! There is
a battery and a lamp as in the circuit drawing below.

Battery

Lamp

What about the electric current at points A, B, C, and D as in the picture? Give reasons for the
answers you give!

After reading the text there were 20 students or 71.4% who realized the error of the concept and
get new knowledge and believe in the truth of scientific explanation delivered in the text, while 8
students or 28.6% are still in a state of misconception. The groups selected in this study were
students who had studied electrical circuit material, so the focus of this research focused on text
function in overcoming misconceptions of students.

When students answer the question in part I, it can be observed that they claim the electric current
is consumed by the lamp first powered by the current so that the lamp will dim after the reduced
electric current. The question at the end of the text has the answer that is only implicitly contained in
the text, it aims to see if students understand the concept given the text well so as to apply it in other
situations.
4. Conclusion
TBA is a text that is structured based on conception-altering and analogy approaches. Based on the results of this study it was found that TBA can effectively assist students in overcoming misconceptions experienced. So it is suggested to the Physics teacher to be active in making TBA in other Physics material so that student misconception can be overcome.

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