Sys Rev Pharm 2020;11(6):1269-1272
A multifaceted review journal in the field of pharmacy

Enhancing Analogy on Physics Subject: A Scientific-Based Descriptive Approach

Endang Surahman[1] and Rina Satriani Marganina[2] Vita Meylani[3]

[1]Departement of Physisc Education, Universitas Siliwangi, Jl. Siliwangi No. 24, Tasikmalaya 46115, Indonesia
[2]Senior High School State 1, Jl. Rumah Sakit No. 28, Tasikmalaya, 46115, Indonesia
[3]Departement of Biology Education, Universitas Siliwangi, Jl. Siliwangi No. 24, Tasikmalaya 46115, Indonesia
Email: vibriovita@unsil.ac.id

ABSTRACT
The mastery of physics subject of Senior High School students in Tasikmalaya city is not evenly distributed and less satisfied as expected. This study aims to analyze the student ability in constructing physics analogy of Senior High School. The research method used in this research was descriptive analytics which is a case study. The population of this study were Senior High Schools State 1 students in Tasikmalaya city, while the samples were the students of class XII MIA 1 and MIA 2 State Senior High School 1 in Tasikmalaya city taken with purposive sampling technique as much as 78 students. Data collection techniques in the research were a written test to measure student ability in constructing physics analogy. In general, the results of the analysis indicate that the student ability in constructing physics analogy in Senior High School State 1 at Tasikmalaya city was spread unevenly, but if viewed by sex their ability was spread evenly in groups of men rather than women. It was also found that the students' ability in constructing physics analogy was spread evenly among high achieving student rather than low achievers. Based on the student's answer in the test of the ability in constructing physics analogy, it turned out the skill that measured in the test, skill distinguished the observation and conclusions. In general, have a lot capability and skill of the least controlled by students was the skill of observing the situation critically. Of the above findings, it could be said that Senior High School students that have been able to build a physics analogy will have a great opportunity to succeed in learning or will achieve a good achievement in learning.

Keywords: Analogy, Scientific-Based Descriptive Approach, Physics Subject

INTRODUCTION

Analogical reasoning is often described as being composed of: 'base' domain retrieval, mapping, use and verification. The subject of base domain retrieval has attracted much less attention that the ability to construct and utilize a mapping given both base and target domains (Brna, & Duncan, 1996). The creativity required to search for appropriate information is illustrated admirably by Clement's demonstration that physicists were capable of generating analogies in a creative manner through an exploration of the behavior of a 'square' spring (Clement, 1988). Analogy ability is one of the abilities needed by students to solve problems encountered in daily life so it needs to be improved. This is supported by (Gentner, & Gentner, 1983) that teaching a specific analogy for circuits could affect student's ability to solve problems that exploited the nature of the analogy presented. The assumption is that students build on prior knowledge, and can capitalize on analogical relations between related 'domains' of knowledge. While Genter and Genter found generally positive results, Black found no clear evidence for a significant role for analogy in learning about electric circuits (Black, 1987). The other research has used different base domains to teach aspects of elec- tricity with results that appear to be closely related to those obtained by Genter and Genter (Dupin & Joshua., 1989; Joshua & Dupin., 1993).

One effort that can be taken to improve learning outcomes is to intensify the development of students' ability on constructing a physics analogy through scientific processes, this is in accordance with the essence of science that consists of products and processes, which in the execution of teachers' not only teach the scientific products but also explain the process of how it are obtained by scientists. This is supported by (Groppe, 1991) that the analogy in the physics classroom involves describing physical concepts in term of objects and experiences that are directly familiar to the student. This following by Sharma (2017) that analogies have been widely used as tools for teaching difficult science concepts. Podolefsky (2005) said that analogies are ubiquitous in physics, because they are used by working physicists, physics teachers, and students learning physics. Beside that Sharma (2017) said some teachers use analogies deliberately to help students build new knowledge by transferring and applying prior knowledge and skills to new learning situations. Furthermore, the majority of the participants sometimes use analogies in class as evidenced by the responses to the questionnaire's items as well as by the teachers' statements during the interviews (Jonane, 2015).

The analogies that formed by the students can be said to be true if the analogies are formed through a process that characterized by a scientific method that originated from fact and formed on the basis of physics concepts that have been mastered by the students. Analogies can form a hypothesis, because a hypothesis was born from a well-known theory, the hypothesis is then tested using specific new evidence that may be supportive or against such theory (Lawson, 2002).

According to Shawn Glynn (1995) in Fathurohman (2014) there are six steps that the teacher should do to attract or obtain an analogy, that is: 1) introduces that target concept. The target concept is a concept that is not common or well-known and will be taught to students, 2) reviewing the analogy concept. Analogy concept is a common or well-known concept and usually has been taught to the students first, identifying or searching for relevant features or attributes between target and analogy. Collecting all the features or attributes of both the target concept and the analogy concept to be identified, 4) mapping the similarities between analogous and target concepts. The process of benchmarking all the features or attributes obtained is called mapping. If there are many similar features/attributes, an analogy can be drawn or retrieved. More features/attributes similar means the analogy is getting better, 5) identifying or looking for exceptional circumstances for which the analogy is not working. Features or attributes that are not similar are exception to the analogy, and 6) take conclusions about target concepts. The formation of a new physics analogy in high school students, is difficult because it requires a deep understanding of physics and through a long process. Measurement of ability to construct a physical analogy in this study, emphasizes more on the characteristics of physics analogies in high school students than the formation of a new physics analogy.

The factors that influence the formation of an analogy are internal factors and external factors. Internal factors in the example are the intellectual and non-intellectual factors. Intellectual factors such as intelligence and logic operations capabilities, while non-intellectual factors such as motivation, participation and others. External factors such as teachers, teaching and learning process, culture and others. In this study is limited to internal factors only, especially intellectual factors. According to Boo Hong Kwen & Toh Kok Aun (1985) in Fathurohman (2014) Dupin & Joshua (1989), some of advantages of teaching using analogy are: 1) as a tool for teaching conceptual change, 2) the analogy provides visualization and an understanding of abstract concepts that refer to real-life examples, 3) the analogy may trigger students interest in learning because it has a motivational effect, and 4) the analogy requires teacher to consider students' preconceptions of the material to be thought and can eliminate or reduce misconceptions on the material being thought. Model Teaching with Analogies (TWA) that developed by Glynn (1995) create a comparison map (mapping) between the referral concept and the target concept. When there are similarities between the two concepts, then a thought analogy can be constructed. The election of the analogy concept needs to be careful, if the students get a less familiar analogue concept then the students will not be able to understand the content of the learning, likewise when the target concept is easy to visualize then the analogy learning is no longer required.

In composing an analogy, one must already process skills that correspond to the necessary behaviour in forming an analogy. In addition, he should also draw the conclusions of the usefulness and possibilities of such analogy. Based on the above description it is clear that the process of composing an analogy comes from observations and then tested by observation. The process is an endless cycle, so it appears the dynamics of scientific development. This study aims to analyze the student ability in constructing physics analogy of Senior High School. The research method that used in this research is descriptive analytics which is a case study.

RESEARCH METHOD

Time and place of research

The research was held on August 23rd until September 15th 2017, the method that used in this research was analytical descriptions of case study. The population in this research were the students of Senior High Schools that taken with purposive sampling as much as 78 students. Data collection technique was a written test to measure the student ability in constructing physics analogy.

The instrument of ability in constructing physics analogy

To measure students' abilities in constructing physics analogies, then arrange the ability to build physics analogies (TACPA). The preparation of TACPA is based on two main criteria. First, it is based on desirable behavior for students in terms of their ability to construct physical analogies that include basic behavior namely 1) observing situations critically, 2) differentiating observations and conclusions, 3) formulating problems, 4) analyzing and determining priorities, and 5) formulate a hypothesis. The second is the topics and subjects' students have learned (Anderson, 1970).

Based on these two criteria, the TACPA's stages were as follow: 1) information from the teacher and by looking at the applicable syllabus, determined the topics that have been taught, 2) formulating the physics phenomena in such a way as to create conditions that enable the emergence of desirable behaviour, and conformity with physics concepts studied by students, 3) in order to create conditions that enable the formation of images in students, the phenomenon being formulated should show different symptoms. There are five measured skill were downgraded to 12 questions in the test of ability in constructing physics analogy. As for the details are shown in table 1.

Table 1. The instrument of skill measured in TACPA questions.

Measured Skill	Number of Question in TACPA
1. Observe the situation critically	1, 2, 3
2. Distinguish observation and conclusions	4, 6, 11
3. Formulate the problem	5
4. Analyse and set priorities	8, 9
5. Formulate a hypothesis	7, 10, 12

RESULTS AND DISCUSSION

Results

After the students answer the given questions, then they were checked to classify students who are able and unable on the rubric that had been provided. Table 2 shows the results obtained from a description of the student's ability in constructing physics analogy based on the measured skill from the tabulated criteria as predetermined.

Table 2. Distribution of students in constructing physics analogy.

Measured skill	Able	Unable	Percentage (%)	
			Able	Unable
1. Observe the situation critically	23	55	29.5	70.5
2. Distinguish observation and conclusions	74	4	94.9	5.1
3. Formulate the problem	57	21	73.1	26.1
4. Analyze and set priorities	62	16	79.5	20.5
5. Formulate a hypothesis	56	22	71.8	28.2

Table 2 shown that 70,5 % students were unable to observe the situation critically, but skill of distinguish observation and conclusions, formulate the problem, analyze and set priorities, and formulate a hypothesis more than 70% were able. Even though skill of distinguish observation and conclusions is the highest percentage of able skill. Furthermore, analysis skill based on sex, the following distribution is obtained (table 3):

Table 3. Distribution of students in constructing physics analogy based on sex.

Measured Skill	Percentage (%)			
	Able		Unable	
	M	F	M	F
1. Observe the situation critically	38.9	21.4	61.1	78.6
2. Distinguish observation and conclusions	100	90.5	0	9.5
3. Formulate the problem	83.3	64.3	16.7	35.7
4. Analyze and set priorities	88.9	71.4	11.1	28.6
5. Formulate a hypothesis	77.8	66.7	22.2	33.3

M : Male
F : Female

Table 3 shown that the male students have highest skill of distinguish observation and conclusions until 100%, but not much different from the results of female students for this skill (90,5%) able. And overall, of the skills male students have more than 75% able, excepting skill of observe the situation critically less than 40% able. By this fact, analogy abilities of male students higher than female students.

Discussion

"analogy" refers to comparisons of structures or relations between two domains (Dult, 1991), which involve the "transfer of relational information from a domain that already exists in memory (usually referred to as the source or base domain) to the domain to be explained (referred to as the target domain)" (Vosiadou & Ortony., 1989). The finding of this research that the percentage of students who are able to build analogies in physics concepts is higher than unable. But observe the situation critically skills is lowest percentage of able students. This occurred due to the demands of this behavior were the students must make a critical observation, in the sense that it should be able to see the subtle differences that no one else noticed. Observe the situation critically is the first skill which using all of the sensory and it's should be carefully. Besides that, this skill needed basic knowledge of concept so that it can be constructed their observation with concept and make it's more real. Analogies may make new information more concrete and easier to imagine (Shapiro, 1985). This is also highlighted by (Black, 1979;Davidson, 1976;PAlvio, 1983), even though it appears not to be totally clear in which way "analogical visuals" ease learning except that they relate the new to something very familiar to the learner. It can be caused because the analogy developed is more a visual concept than a constructive analogy.

Otherwise, another finding of this research are the male students more dominant able in all of the skill of the measured than female students, excepting for the observe the situation critically. It is shown that there are differentiated skill between male and female students in constructing physics concept analogoy. In line with this, [20; 21; 22;23] observed that gender has significant influence on science achievement while [24 & 25] found that gender has no significant influence on achievement in science. The influence of gender on achievement is therefore still a controversial one among science researchers. It is therefore imperative for more studies into the role of gender in students' achievement in science.

It was we highlighted that the analogies used by the teachers were mostly analogies of form/appearance. We realized that even in cases in which teachers have used analogies that belong to the domain of physics, they made them mostly using physical similarities (appearance), instead of looking at structural similarities. From Bachelard, those analogies do not have "strong" relationship with the object of study, represent epistemological obstacles, and do not contribute to the formation of the scientific mind.

CONCLUSION

The conclusion of this research is that most students have been able to construct physical concepts by analogy on various skills except critical observation. this ability is more dominant in male students than female students

ACKNOWLEDGMENTS

On this occasion I would like to thank to heads of Senior High School State 1 Tasikmalaya City and LPPM-MP Siliwangi University who gave permission to carry out this research.

REFERENCES

1. Brna, P., & Duncan, D. (1996, July). The analogical model-based physics system: a workbench to investigate issues in how to support learning by analogy in physics. In International Conference on Computer Aided Learning and Instruction in Science and Engineering (pp. 331-339). Springer, Berlin, Heidelberg.
2. Clement, J. (1988). Observed methods for generating analogies in scientific problem solving. Cognitive Science, 12(4):563-586.
3. Gentner, D. and Gentner, D.R. (1983). Flowing waters or teeming crowds: Men- tal models of electricity. In Gentner, D. and Stevens, A., (eds.), Mental Models. Lawrence Erlbaum Press. 10
4. Black, D. (1987). Can pupils use taught analogies for electric current? School Science Review, 69(247):249-254.
5. Dupin, J.J. and Joshua, S. (1989). Analogies and "Modeling Analogies" in teaching: Some examples in basic electricity. Science Education, 73(2):207-224.
6. Johsua, S. and Dupin, J-J. (1993). Using "Modelling Analogies" to teach basic electricity: A critical analysis. In Caillot, M., (ed.), Learning Electricity and Elec- tronics with Advanced Educational Technology, volume 115 of NATO ASI Series F. Springer-Verlag~ Berlin.
7. Groppe J.A. (1991). Physics by Analogy in Physic by analogy. Washington DC: The Maret School 3000 Catherdral Ave NW The Physics Teacher 29:408
8. Sharma R M 2017 Analogies in Physics: Experiences of Trinidadian Physics Teachers Electron. J. Sci. Educ. 21(4) 65–81
9. Podolefsky N 2005 The Use of Analogy in Physics Learning and Instruction 1–17
10. Jonane L 2015 Using analogies in teaching physics: A study on latvian teachers' views and experience J. Teach. Educ. Sustain 17(2) 53–73
11. Lawson, A. E. (2002). What does Galileo's discovery of Jupiter's moons tell us about the process of scientific discovery? Science & Education, 11(1), 1-24.
12. Fathurohman A 2014 Analogi dalam pengajaran fisika J. Inov. dan Pembelajaran Fis. ISSN 2355-7109 1(1) 74–77
13. Anderson, N. H. (1970). Functional measurement and psychophysical judgment. Psychological review, 77(3), 153.
14. Duit, R. (1991). On the role of analogies and metaphors in learning science. Science Education, 75,649-672.
15. Vosniadou, S., & Ortony, A. (1989). Similarity and analogical reasoning: A synthesis. In S. Vosniadou & A. Ortony (Eds.), Similarity and analogical reasoning. Cambridge: Cambridge University Press, pp. 1 - 17.
16. Shapiro, M. A. (1985, May). Analogies, visualization and mentalprocessing of science stories. Paper presented to the Information Systems Division of the International Communication Association.
17. Black, M. (1979). More about metaphor. In A. Ortony, Metaphor and thought. Cambridge: Cambridge University Press, 19-43.
18. Davidson, R. D. (1976). The role of metaphor and analogy in learning. In J. R. Levin & V. L. Allen (Eds.), Cognitive learning in children: Theories and strategies. New York: Academic Press, 135-162.
19. Paivio, A. (1983). The mind's eye in arts and science. Poetics, I2(1), 1-18.
20. Ogunleye, B. O. 2002. Evaluation of the Environmental Aspect of the Senior Secondary School Chemistry Curriculum in Ibadan, Nigeria. Unpublished Ph. D Thesis, University of Ibadan, Nigeria.
21. Ogunneye, W. 2003. Students understanding of the concept of gradient in Physics. A case study of Physics student from Tai Solarin College of Education Ijebu Ode. Journal of the Science Teachers Association of Nigeria 38 (1&2) 100-106.
22. Ezirim, M. U. 2006. Scaling up girl's participation in science education: towards a score card on quality education. E. Okeke and M. Opara (Eds) Science Teachers Association of Nigeria. Gender and STM Education Series (1).
23. Okwo, F. A and Otubar, S. 2007. Influence of gender and cognitive styles on students' achievement in Physics essay test. Journal of Science Teachers association of Nigeria 42 (1 & 2).
24. Agommuoh, P. C. and Nzewi, U. M. 2003. Effects of videotaped instruction on secondary school student's achievement in Physics. Journal of the Science Teachers Association of Nigeria 38 (1&2) 88-93.
25. Babajide, V. F. T. 2010. Generative and Predict-Observe-Explain Instructional Strategies as Determinants of Senior Secondary School Students' Achievement and Practical Skills in Physics. Unpublished Ph. D Thesis, University of Ibadan, Nigeria.