Enhancing students' motivation through brain-based learning

A Sani*, D Rochintaniawati and N Winarno

International Program on Science Education, Universitas Pendidikan Indonesia, Jl. Dr. Setia Budhi No. 229, Bandung 40154, Indonesia

*aulianuriy@student.upi.edu

Abstract. The aim of this study is to investigate the effect of brain-based learning on students’ motivation in learning the electric circuit. The participants come from one of International school in Bandung, Indonesia. The method used in this research was quasi-experiment which used two classes with one control group and one experimental group. The control class consists of 23 students and the experimental class consists of 26 students. In the experimental class used brain-based learning and the control class used lecture-based learning. The results of this research show that the average gain of the experimental class was 0.033, while the control group was -0.038. The results showed that the motivation in experimental class was statistically different with the control class. Based on this results showed that brain-based learning can be an alternative tool to improve students’ motivation.

1. Introduction

Brain-Based Learning is a learner-centered and teacher-facilitated strategy that utilizes learners’ cognitive endowments and emphasizing meaningful learning, it is not only memorization [1]. In general, the Brain-Based Learning is a strategy implemented based on the brain-based learning principles that based on observation and previous research related to the human. Brain-Based Learning was designed so that it will fit the function of human brain. All teaching process are essentially brain-based, but Brain-Based Learning is a strategy that can be used to make brain potentially used in a learning process [2].

Researchers have investigated Brain-Based Learning in science education are the students’ attitude level, academic achievement [1], motivation, knowledge retention, and students’ understanding [2]. One of the perspectives from which researchers have investigated Brain-Based Learning in science education is the students’ motivation on learning science. Some research explored that Brain-Based Learning can increase students’ motivation in learning science [3]. The previous study was found that students who followed the Brain-Based Learning possessed a better physics learning motivation compared to students who received conventional learning [4]. In some studies, Brain-Based Learning were prepared concepts such as “electrochemistry” [1]; “force and motion” [2]; “cell division and heredity” [5]; “electrochemical cell, acids, bases” [6]; and “movement and power.”

The previous study, the researchers have investigated students’ motivation in learning science using Brain-Based Learning based on gender [1]. The previous study have investigated students’ motivation in learning science using Brain-Based Learning with document analysis (journal documentation) and case study (interview technique) [4]. Another study, it was measured the motivations of students in using Brain-based Learning towards chemistry course which consists of 15 items with no specific aspect [1]. However, this study used six scales for measuring students’ motivation which are self-efficacy, active learning strategies, science learning value, performance goal, an achievement goal, and learning
environment stimulation [7]. There are 35 questions from all six aspects. Therefore, this study have more detail result than the previous study. This study was investigated the difference of students’ motivation in both control class and experimental class in learning physics especially for electric circuit topic. There are three teaching materials about the electric circuit, which are circuit component, series circuit, and parallel circuit. The aim of this study is to investigate the effect of Brain-Based Learning on students’ motivation in learning the electric circuit.

2. Method
A quasi-experimental design was used in the study. The study utilized a pre-test and post-test design. Quasi-experiment provides the researcher which the opportunity to assess the effects of interventions or treatments [8]. By applying this method, there were two groups which are control and experimental group. The research design can be shown in Table 1.

| Select Control Class | Pre-test | Lecture-Based Learning | Post-test |
|----------------------|----------|------------------------|-----------|
| Select Experimental Class | Pre-test | Brain-Based Learning | Post-test |

This quasi-experimental research approach involved a sample constitutes 49 students: 26 (11 female, 15 male) in an experimental groups and the other 23 (10 female, 13 male) in a control group. The study population in this research was 8th-grade students, selected from one of International school which implements Cambridge Curriculum in Bandung, West Java, Indonesia. Students in both group come from similar educational and socio-economic backgrounds. Their ages ranged between 13-14 years old. The sample was taken by cluster random sampling technique. Cluster random sampling is defined where one is obtained by using groups as the sampling unit rather than individuals [9]. The data of the sample can be seen in Table 2.

| Group | Population | Sample | Percentage (%) | Total (%) |
|-------|------------|--------|----------------|-----------|
| Control | 8th grade | Male | 13 | 56.52 | 100 |
| | | Female | 10 | 43.48 | |
| Experiment | 8th grade | Male | 15 | 57.70 | 100 |
| | | Female | 11 | 42.30 | |

In this study, the experimental group was given Brain-Based Learning that includes activation, clarification of the outcome and painting the big picture of the lesson, making the connection, doing the learning activity, demonstration of student understanding, review of student recall and retention, and previewing the new topic. While the control group followed the Lecture-Based Learning that includes demonstration and discussion, in learning the topic of “Electric Circuit”, according to the IGCSE physics syllabus. Students’ learning motivation from both groups was measured before and after the intervention to determine the effectiveness of the implemented Brain-Based Learning. The research was done in five meetings. The first meeting was for pre-test, the second until forth meeting was for implemented Brain-Based Learning and Lecture-Based Learning, and the fifth meeting was for post-test. Data gathering method is done by giving (Students Motivation towards Science Learning) SMTSL Questionnaire was chosen to complete this study. There are six aspects in SMTSL Questionnaire, which are: self-efficacy, active learning strategies, science learning value, performance goal, an achievement goal, and learning environment stimulation [7]. In this study, students’ motivation is measured in pre-test and post-test for both groups.

Students’ motivation in learning electric circuit was measured using SMTSL (Student Motivation Toward Science Learning) questionnaire which was developed by Tuan et al. [7] SMTSL was a
questionnaire in form of Likert-type items to assess students’ motivation. The students answered the items in the questionnaire on a Likert scale of 1 to 5, where 5 stood for “strongly agree”, 4 stood for “agree”, 3 stood for “no opinion”, 2 stood for “disagree”, and 1 stood for “strongly disagree”. In the analysis, 5-point was given for “strongly agree” option while 1-point was given for “strongly disagree” option for positive items. On the other hand, 1-point was given for “strongly agree” option while 5-point was given for “strongly disagree” option for negative items. In Table 3, there are five scale and six aspects which are self-efficacy, active learning strategies, science learning value, performance goal, an achievement goal, and learning environment stimulation.

| Scale                  | Category and Number | Total |
|------------------------|---------------------|-------|
| Self-efficacy          | Positive Statement: 1, 3 | 7     |
|                        | Negative Statement: 2, 4, 5, 6, 7 |       |
| Active learning strategies | Positive Statement: 8, 9, 10, 11, 12, 13, 14, 15 | 8     |
|                        | Negative Statement: - |       |
| Science learning value | Positive Statement: 16, 17, 18, 19, 20 | 5     |
|                        | Negative Statement: - |       |
| Performance goal       | Positive Statement: - | 4     |
|                        | Negative Statement: 21, 22, 23, 24 |       |
| Achievement goal       | Positive Statement: 25, 26, 27, 28, 29 | 5     |
|                        | Negative Statement: - |       |
| Learning environment stimulation | Positive Statement: 30, 31, 32, 33, 34, 35 | 6     |
|                        | Negative Statement: - |       |
| Total                  |                     | 35    |

3. Results and discussion

It has been proved in some studies that among various motivation factors in exploring students’ motivation, self-efficacy, active learning strategies, science learning value, performance goal, an achievement goal, and learning environment stimulation do contribute to students’ science learning motivation [7]. Therefore, the statistical test was done in order to calculate the difference of students’ motivation in learning electric circuit between the experimental and control class. The figure 1 below is the recapitulation of the statistical test result of the experiment class and control class.

In the analysis of students’ motivation using SMTSL questionnaire, the scores from pretest and posttest on the control group and experiment group were computed. The result of N-Gain score is shown in Figure 1. For the experimental class got N-Gain of 0.033 and it was categorized as low improvement [10]. While the control class got -0.038 which categorized as decrease [10]. The results in N-gain showed that in experimental group the score for aspect self-efficacy 0.004; active learning strategies 0.02; science learning value 0; performance goal 0.1; achievement goal 0.017; and learning environment stimulation 0.057. While in control group the score for self-efficacy 0.073; active learning strategies -0.028; science learning value -0.046; performance goal -0.048; achievement goal -0.011; and learning environment stimulation -0.076.

The result of N-Gain in experiment class got better score than the control class because in experiment class they learnt using Brain-Based Learning that includes seven steps which are activation, clarification of the outcome and painting the big picture of the lesson, making connection and develop meaning, doing the learning activity, demonstrating students’ understanding, review of student recall and retention, and previewing the new topic. The difference of steps between experiment class and control
class are mind map, break, brain gym, music, and rewards in the end of the lesson. The results from this study is in line with previous study that Brain-Based Learning can improve students’ motivation in physics [4], biology [5], and chemistry [6].

According to the result of the research, the detail of students’ motivation on six aspects in SMTSL can be described. The score of each aspect shows the different result of students’ acquisition either in pre-test or post-test. In the pre-test, from both classes generally the students obtained the highest score in active learning strategies. In addition, the lowest pre-test score obtained by both classes is in the aspect of performance goal.

Students’ self-efficacy was improved after learning using Brain-Based Learning approach. N-Gain score for the experimental group is 0.004 but the control group who used Lecture-Based Learning got the higher N-Gain score which is 0.078. This may relate to intrinsic motivation [5]. Although both of the group got low improvement [10] for self-efficacy aspect the average posttest score for the experimental group is higher than the control group. Students in control group had more self-efficacy than the experimental group.

Students’ active learning strategies were boosted after learning using Brain-Based Learning approach compared to the group who used Lecture-Based Learning. Experimental group got 0.02 while the control group got -0.028. Students played an active role to understand new electric circuit topic by associating them with their previous experiences using active learning strategies such as discussion in a group. The students were actively engaged in a group discussion with their peers and the teacher when clarified their understanding. In the group discussions, students had the opportunity to exchange ideas with their peers.

Students’ performance goal was also improved after learning using Brain-Based Learning approach compared to the group who used Lecture-Based Learning. Experimental group got 0.1 while the control group got -0.048. It expresses that the student’s goals in science learning are devoted to competing with the other students and attracting the attention of the teacher. It is related to extrinsic motivation [5]. The teacher gave rewards to the groups who get the highest score. A reward is simply a strong positive feeling to the brain [11].

Another finding in this research showed that students taught using Brain-Based Learning improved achievement goal and learning environment stimulation factors better compared to the group who used Lecture-Based Learning. Experimental group got 0.017 for achievement goal and 0.057 for learning environment stimulation factors.

![N-Gain Score](image)

**Figure 1.** N-gain in each aspect for both class.

According to the result of the research, the detail of students’ motivation on six aspects in SMTSL can be described. The score of each aspect shows the different result of students’ acquisition either in pre-test or post-test. In the pre-test, from both classes generally the students obtained the highest score in active learning strategies. In addition, the lowest pre-test score obtained by both classes is in the aspect of performance goal.

Students’ self-efficacy was improved after learning using Brain-Based Learning approach. N-Gain score for the experimental group is 0.004 but the control group who used Lecture-Based Learning got the higher N-Gain score which is 0.078. This may relate to intrinsic motivation [5]. Although both of the group got low improvement [10] for self-efficacy aspect the average posttest score for the experimental group is higher than the control group. Students in control group had more self-efficacy than the experimental group.

Students’ active learning strategies were boosted after learning using Brain-Based Learning approach compared to the group who used Lecture-Based Learning. Experimental group got 0.02 while the control group got -0.028. Students played an active role to understand new electric circuit topic by associating them with their previous experiences using active learning strategies such as discussion in a group. The students were actively engaged in a group discussion with their peers and the teacher when clarified their understanding. In the group discussions, students had the opportunity to exchange ideas with their peers.

Students’ performance goal was also improved after learning using Brain-Based Learning approach compared to the group who used Lecture-Based Learning. Experimental group got 0.1 while the control group got -0.048. It expresses that the student’s goals in science learning are devoted to competing with the other students and attracting the attention of the teacher. It is related to extrinsic motivation [5]. The teacher gave rewards to the groups who get the highest score. A reward is simply a strong positive feeling to the brain [11].

Another finding in this research showed that students taught using Brain-Based Learning improved achievement goal and learning environment stimulation factors better compared to the group who used Lecture-Based Learning. Experimental group got 0.017 for achievement goal and 0.057 for learning environment stimulation factors.
environment stimulation. While the control group got -0.011 for achievement goal and -0.076 for learning environment stimulation. For achievement goal, students have specific goals which they should have for increasing their skills and success in science learning process [5]. The score for the experimental group was very low and did not report significant improvement. The control group perceived decreasing achievement goal. For learning environment stimulation it is related to the effect of learning environment components like curriculum, teachers’ teaching methods and student’s interaction on motivation [5]. The students in the experimental group had experienced in learning with music. Music can make relaxation and stress reduction [11, 12]. Significant effects of music during learning have been reported, especially with music from the baroque and classical periods [11]. It is proven by Duman [13] that lessons started with the playing of music, group activities, and cooperation among group members was enhanced emotional awareness and relaxation of the students. At the beginning of the lesson, the teacher showed mind map in the experimental group. The utilization of mind maps facilitates meaningful learning [14].

Students who taught by Brain-Based Learning approach did not report significant increases in their science learning value. The N-Gain for experimental group is zero means the score is stable. While the control group perceived decreasing science learning value with score -0.046. This research revealed that students working in the Brain-Based Learning approach perceived the better science learning values with the students who taught used Lectured-Based Learning.

4. Conclusion
Brain-Based Learning appears to have more impact on students’ motivation in learning the electric circuit. The students in the experimental class have N-Gain scored better than students in control class. It can be concluded also that Brain-Based Learning activities improved students’ motivation especially in the aspect of the performance goal, learning environment stimulation, active learning strategies, an achievement goal, and self-efficacy. It is no different for aspect science learning value.

Acknowledgments
Author’s wishing to acknowledge the principal of the school for the permission to conduct the research (teaching in the class for several meetings).

References
[1] Uzezi J G and Jonah K J 2017 Journal of Education, Society and Behavioural Science 21 3
[2] Saleh S 2012 Educational Studies 38 1
[3] Saleh S 2012 International Journal of Environmental and Science Education 7 1
[4] Saleh S 2011 US-China Education Review p 63-72
[5] Akyurek E (2013) Mevlana International Journal of Education (MIJE) 3 1 pp 104-119
[6] Shabatat K and Al-Tarawneh M 2016 Higher Education Studies 6 2
[7] Tuan H, Chin C and Shieh S 2005 International Journal of Science Education 27 6
[8] Cresswel J W 2012 Educational research fourth edition (United States of America: Pearson) p 294
[9] Freankel J R, Wallen N E and Hyun H H 2011 How to Design and Evaluate Research in Education eighth edition (Boston: Pearson) p 264
[10] Hake R R 1999 Analyzing Change/ Gain Score (American Educational Research Methodology)
[11] Jensen E 2008 Brain-Based Learning (United States of America: Corwin Press)
[12] Ozden M and Gultekin M 2008 Electronic Journal of Science Education 12 1
[13] Duman B 2010 Educational Sciences: Theory and Practice 10 4 pp.2077-2103.
[14] Jbeili I M 2013 Procedia-social and behavioral sciences 103 pp 1078-1087