Students’ self-efficacy of mathematics through brain based learning

L Riskiningtyas¹,* and M N Wangid²

¹Magister Pendidikan Dasar, Universitas Negeri Yogyakarta, Jl. Colombo No. 1, Caturtunggal, Depok, Sleman, Yogyakarta 55281, Indonesia
²Departemen Pendidikan Dasar, Universitas Negeri Yogyakarta, Jl. Colombo No. 1, Caturtunggal, Depok, Sleman, Yogyakarta 55281, Indonesia

*lili.riskiningtyas2016@student.uny.ac.id

Abstract. Self-efficacy is a capability needed by students in mathematics. The research aims to determine whether there are differences of brain based learning and direct instruction model on students’ mathematics self-efficacy. This research was quasi experimental research with pretest-posttest control group design. The population was fourth graders of State Elementary Schools in Yogyakarta academic year 2017/2018. The sample was randomly assigned to either the treatment or the control group. The data was collected by using self-efficacy scale. The data analysis used independent sample T test. The results show that brain based learning model used in experimental class was more effective in increasing self-efficacy than direct instruction model used in control class. Brain based learning was a learning model that could facilitate students to develop self-efficacy. Brain based learning emphasized a comfortable, fun, emotionally engaging learning environment, and the learning process corresponded to students’ brain abilities to learn.

1. Introduction

Mathematics is one of the subjects being taught from elementary school to higher education. Mathematical knowledge and skill are required to solve daily life-related problems. Various simple to complex activities in the society involve problem solving in mathematics. Today, many students consider that mathematics is a difficult, stressful and boring subject [1]. The difficulty in mathematics is influenced by students’ belief to face it. Many students have low achievement in mathematics because they have low trust in their abilities in solving mathematical problems. One of the important parts in belief is self-efficacy. Self-efficacy is the belief in one’s capabilities to organize and execute the courses of action required to manage prospective situations [2]. In accordance with Bandura, Schunk & Miller explains that self-efficacy is one’s capabilities to accomplish a task [3]. Self-efficacy is one’s self-belief in his capability over the tasks to achieve the goals and solve a problem [4]. Students with strong belief to learn to accomplish a task will participate easily, work harder and stay longer in facing difficulties than those with low self-efficacy. Thus, self-efficacy is the student’s belief in his/her capabilities to accomplish a task. Self-efficacy has four main sources, mastery experience, mastery experience, vicarious experience, verbal persuasions, and physiological and emotional states [5]. They are the factors influencing self-efficacy of students. Self-efficacy is one of the factors influencing mathematical achievement. Self-efficacy correlates positively to mathematical achievement [6-8] Academic self-efficacy plays an
essential role in building learning motivation to achieve academic skills [9]. The success of mathematical achievement is by cultivating and strengthening students’ academic self-efficacy. Self-efficacy, goals, and academic achievement are interrelated [10].

Based on the explanation above, self-efficacy is very important in mathematics, therefore, teacher needs to develop students’ self-efficacy. One of the ways is by applying a learning model which can develop self-efficacy. Alternative learning model which can be applied is brain based learning model. Brain based learning is a learning aligned with how the brain works and certain function related to the learning naturally designed to learn [11]. Different with traditional method, brain based learning emphasizes meaningful learning rather than memorizing [12]. Brain based learning is a term used to describe how to apply theory about brain to help children maximize their learning potentials [13]. Brain based learning created relax, fun, active, and meaningful learning environment. The results show that brain based learning do not only increase students’ achievement but also give motivation to the teacher and students in learning [14,15]. As disclosed by Hill [16] that brain based learning with significant mastery experience is able to increase students’ academic effectiveness and achievement, and academic self-efficacy will increase the relation between students who follow brain based learning with academic achievement. The results of a research by Oghynous [17] show that the application of brain based learning is effective in increasing students’ self-efficacy. The analysis results on self-efficacy scores after treatment is that the experimental group shows much better self-efficacy than the control group. It is because brain based learning process creates active and meaningful learning atmosphere by considering convenience in learning. Thus, students are more motivated and confident.

The aim of this research is to find out the difference of brain based learning model application’ influence compared to direct instruction model on student’s mathematical self-efficacy. In this research, students of experimental class were given brain based learning treatment. Brain based learning application comprised six steps: Pre-Exposure, Preparation, Initiation and acquisitions, Elaboration, Incubation and insert a memory, Verification and checking conviction, Celebration and integration [11]. While control class was given direct learning.

2. Eksperimental method
This research was quasi experimental research with pretest-posttest control group design. The population was all 611 fourth graders of State Elementary Schools in Yogyakarta. The sample was randomly assigned to either the treatment or the control group. Experimental group was given treatment of brain based learning model and control group with direct instruction. Experimental and control group consisted of 124 and 125 students, respectively. Self-efficacy data was collected by using self-efficacy scale of 23 statements. Instrumental development of the research adopted Usher and Pajares’s [18] instrument about validation study of self-efficacy sources in mathematics learning. Self-efficacy scale was developed based on Bandura’s theory on self-efficacy sources.

3. Result and discussion
Data of preliminary phase results obtained through interviews with teachers and students, syllabus document collection and learning implementation plan and textbooks Mathematics SMA / MA / SMK Grade X.

3.1. Initial data analysis
Initial data collected in this research were pretest score of students’ mathematics self-efficacy. Before treatment, students were given self-efficacy scale to find out how their self-efficacy was. Table 1 shows the normality test on experimental and control group using SPSS 16.00.

| Group     | Statistic | df  | Sig. |
|-----------|-----------|-----|------|
| Experimental | 0.056     | 124 | 0.200|
| Control    | 0.051     | 125 | 0.200|
Table 1 shows that the significance value of experimental and control group’s initial data were 0.200 and 0.200, respectively. Both values were more than 0.05, thus it can be concluded that the data were normally distributed. Table 2 shows the homogeneity test of experimental and control group using SPSS 16.00.

**Table 2.** Homogeneity test of experimental and control group initial data.

| Levene Statistic | df1 | df2 | Sig.  |
|------------------|-----|-----|-------|
| 0.786            | 1   | 247 | 0.376 |

Homogeneity test of both classes used Levene’s test. Table 2 shows that the significance value was 0.376. Significance value was more than 0.05 thus the data of both classes was homogeneity.

3.2. Final data analysis

Final data analysis of this research was posttest scores of students’ mathematics self-efficacy scale. Table 3 shows the normality test of experimental and control group using SPSS 16.00.

**Table 3.** Normality test of experimental and control group final data.

| Group     | Statistic | df | Sig.  |
|-----------|-----------|----|-------|
| Experimental | 0.067     | 124| 0.200 |
| Control   | 0.064     | 125| 0.200 |

Table 3 shows that the significance value of experimental and control group were 0.200 and 0.200, respectively. Both significance values were more than 0.05, thus the posttest data of both classes were normally distributed. Table 4 shows the homogeneity test of experimental and control group using SPSS 16.00.

**Table 4.** Homogeneity test of experimental and control group final data.

| Levene Statistic | df1 | df2 | Sig.  |
|------------------|-----|-----|-------|
| 0.093            | 1   | 247 | 0.760 |

Homogeneity test of both classes used Levene’s test. Table 4 shows that the significance value was 0.760. It was more than 0.05, thus the posttest of both classes was homogeneity. After the requirement test was met, the next step was parametric step using independent sample T-test.

**Table 5.** Independent sample T-test of experimental and control group.

| Group     | N  | Mean  | SD   | t-value | df | sig  |
|-----------|----|-------|------|---------|----|------|
| Experimental | 124| 69.66 | 9.534| 5.195   | 247| 0.000|
| Control   | 125| 63.29 | 9.823|         |    |      |

Table 5 shows that the significance value was 0.000. It was less than 0.05, it can be concluded that there was a difference in experimental and control group. Based on the average scores, students’ mathematics self-efficacy in experimental group was better than control group.

3.3. Discussion

The results show that brain based learning model application was more effective in increasing students’ mathematics self-efficacy than direct instruction. This is because the model emphasized three elements, orchestrated immersion, relaxed alertness and active processing, to optimize learning [19]. Before the
learning process, the teacher prepared students’ environment, physical and emotional condition. The classes were neatly arranged and scented. Brain’s nutrition needed to be considered by providing enough drinks and ensuring students to have breakfast before learning.

In the first step, physical activity was done by giving brain gym. Building physical activity in learning can form good learning practice. Active body will improve active mind [11]. The next step was preparing a project for students to be done in groups. Group division was based on their capabilities in a heterogeneous manner. This was done so that students are more motivated to see their friends in their groups who could do the task well. By seeing their friends who did challenging mathematics tasks successfully could convince them that they could also did that [18].

Students’ experience in doing the given task perfectly will increase self-efficacy. Mastery experience obtained from performance perfection in doing the task will affect students’ self-efficacy because students experience success and failure in completing the task [5]. Bandura’s opinion is supported by Hill [16] that brain based learning involves mastery experience which is significantly able to increase students’ academic effectiveness and performances so that it creates direct relationship between mastery experience, academic achievement and self-efficacy.

The fifth step of BBL was giving rest time for students. They were given a chance to listen to the music in classroom and asked to relax their muscles. Listening to the music in classroom can help them to be focus on mathematics problems they are trying to solve [20]. Using music when they are doing their tasks and taking a break plays important role in writing and remembering information that facilitates the learning independently [21].

The results show that mathematics self-efficacy value of experimental class was better than control class. The results support previous researches that brain based learning not only increases knowledge but also students’ attitudes and retentions in learning [13, 22, 23]. Brain based learning also has a significant relationship of knowledge, belief and learning practice [24]. It is a learning model adjusted to the structure and use of brain optimally by considering positive and negative variables. Creating a fun learning environment without stress and psychological pressure will strengthen self-efficacy, resilience and self-regulation [21]. Stress, nutrition, practice, and social condition affect cognition, attention, discipline, and memory [25]. It can be used to teach mathematics, students will be better at contextual, logical, and creative thinking. It will help to make affective learning achievement better in mathematics [22]. Oghynous’s results show that statistical analysis on self-efficacy scores showed that experimental and control groups were equal before being treated with brain-based teaching, but after the brain-based teaching it was found that experimental group had far better self-efficacy scores than control group. The results implied the positive effect of brain-based teaching on self-efficacy [17].

4. Conclusion
Brain based learning was effective to increase students’ mathematics self-efficacy. Brain based learning steps involved self-efficacy sources such as mastery experience, vicarious experiences, verbal persuasions, and physiological and emotional states. The sources were factors that influenced students’ self-efficacy. Brain based learning application created active and meaningful learning atmosphere by considering comfort in learning. Based on the results of the research, brain based learning model can be used as alternative learning for elementary teachers to increase students’ mathematics self-efficacy. The suggestion for further researchers is that they can use it for other subjects and mathematics abilities.

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