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The enhancement of students' ability in problem solving and mathematical disposition aspect through brain-based learning model

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Abstract

The main purpose of this research is to analyze the achievement and the increasing of students' problem solving ability and students' mathematical disposition as the result of learning application through Brain-Based Learning model and conventional learning comprehensively. This research uses the mix method with concurrent triangulation. The research results show that: (1) The students' ability of problem solving using Brain-Based Learning model reaches classical learning mastery, (2) the students' achievement of problem solving using Brain-Based Learning model is higher than that of using conventional learning, (3) the students' enhancement of mathematical disposition using Brain-Based Learning model is the same with the achievement of using conventional leaning, (4) there is a few correlations between the achievement of problem solving ability and mathematical disposition, as well as their enhancement. To get comprehensive and accurate representation about the enhancement of mathematical disposition through Brain-Based Learning, it is necessary to conduct the future similar study with the same objects yet longer duration.

1. Introduction

Education has an important role in the process of creating a good quality human resource due that it can create knowledge and human characteristics to be better. One of required lesson in the elementary and high education curriculum is mathematics. Mathematics is important to give to students to assist them with the ability of problem solving as well as the ability of logical, analytical, critical, creative, and associative thinking. Those abilities are needed by students as assistance to prepare themselves to face real life.

One of mathematical abilities which are needed by students based on Indonesian National Professional Certification Department is the ability of problem solving. National Council of teacher of Mathematics (NCTM, 2000) also states that problem solving is one of basic abilities in mathematics learning. Indeed, it is an essential mathematical ability to help students to apply and compile some mathematical concepts as well as to take decision (Tambychik & Thamby, 2010). The problem solving ability is needed in the society (Bell, 1978) likewise in the mathematics learning. There are several problems solving steps, as follows: (1) understanding the problem, (2) arranging strategy in problem solving, (3) doing strategy to solve problem, (4) looking back the result, and (5) making conclusion.

Besides the cognitive aspects, the affective aspect are also needed to have by students since by having affective attitudes in mathematics learning, students will have respectful attitude toward mathematical advantages in daily life so that they have senses of happiness, curiosity, attention, and interest in learning mathematics, as well as diligent and confident attitude in solving mathematical problem. Those attitudes in the affective aspects are the attitudes as the base of students' mathematical disposition development. Based on NCTM as stated by Sumirat (2013) that mathematical disposition is an interest and a

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respect toward mathematics. The indicators of mathematical disposition are (1) confident while solving mathematical problem, communication ideas, and giving reasons; (2) flexibility in expressing mathematical ideas and trying many alternatives idea to solve problem; (3) persevering to finish mathematical tasks; (4) interest, curiosity, and ability in mathematics; (5) tendency to monitor and reflect the thinking process and self-work; (6) valuing mathematical application in other fields in daily life; and (7) rewarding toward mathematics' cultural role and mathematics' good value as language tool.

Moreover, mathematical disposition will be developed when students learn other aspects of competence. It also has a strong relation with one of mathematical basic abilities that is problem solving. As Polya's statement cited by Merz (2016) highlights that developing disposition is a part of one's thinking behaviour in problem solving. Mathematical early ability is also needed to be given attention before starting learning since students' early ability influences their problem solving ability. It is in accordance with Jatisunda (2016) who argues that students' early mathematical ability has influence on their problem solving ability. The early ability also represents students' readiness in gaining learning given by the teacher (Lestari, 2017). In the process of learning, their mathematical disposition can be seen from their wishes to change its strategy, reflection, and analysis to gain a solution, for example in classroom discussion process (Kesumawati, 2017).

However, the importance of problem solving and mathematical disposition is not yet suitable for the SMP Negeri 1 grade VII students' problem solving and mathematical deposition abilities. Based on the interview with mathematics teacher and experience while holding Teaching Practice for Senior College Students (Praktik Pengalaman Mengajar or PPL), it is found that students ability in problem solving is low. They still find difficulties while solving problem in form of descriptive question given by their teacher. The low ability of problem solving of SMP Negeri 1 Boja students is also shown by the result of Odd Mid Semester Test (Ujian Tengah Semester Ganjil) assessment of grade VII students which was held on October 2017. There are 6 questions which measure problem solving ability. From the result of that test, it is gained score of 24 from maximum score 40 as the average score of VII grade students in the questions measuring problem solving. Followings are the example of students' answer in problem solving question (The price of a pair of shoes is 40% more expensive than the price of a pair of slippers. If the price of a pair of slippers Rp75.000, 00, then calculate the price of a pair of shoes!).

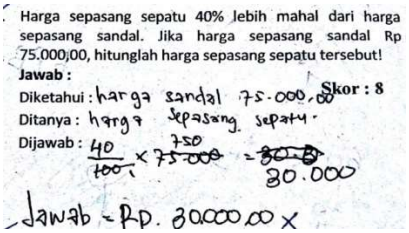
Harga sepasang sepatu 40% lebih mahal dari harga sepasang sandal. Jika harga sepasang sandal Rp 75.000,00, hitunglah harga sepasang sepatu tersebut!
Jawab :
Diketahui : harga sandal 75.000,00 Skor : 8
Ditanya : harga sepasang sepatu
Dijawab : 40/100 × 750 = 30.000
Jawab = Rp. 30000,00 ×

Figure 1. Example of Students' Answer 1

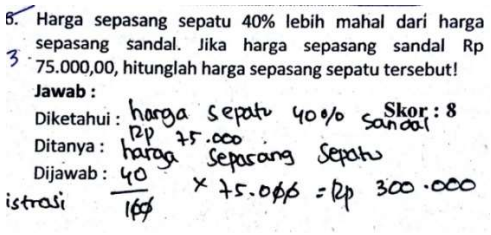
6. Harga sepasang sepatu 40% lebih mahal dari harga sepasang sandal. Jika harga sepasang sandal Rp 75.000,00, hitunglah harga sepasang sepatu tersebut!
Jawab :
Diketahui : harga sepatu 40% sandal Skor : 8
Ditanya : harga Rp 75.000 sepasang sepatu
Dijawab : 40/100 × 75.000 = Rp 300.000
istrasi

Figure 2. Example of Students' Answer 2

Based on the first figure, the student does not understand the question well which is shown when he does not completely write down what is known from the question and from the less correct answer. On the contrary, in Figure 2, student seems to write down what is known and asked well, although the answer is not completely correct. Actually, the wrong answer can be anticipated by reexamining the counting result gained.

Based on the interview and experience while doing in preliminary research, the researcher also found that most students did not know the use of mathematics in daily life. It seems to be the reason why many students have low learning motivation in mathematics which makes their mathematical disposition is low as well. From the students' explanation, most of them were not confident in doing mathematics in daily practice and test since they considered mathematics as a difficult subject, having too many complicated formulas, and hard to understand. Their less confidence was also showed in the mathematics lesson, they tended to be afraid to give opinion and ask question. The inactive and indifferent attitude was also showed when they got difficult question; they chose to stop working on the question. It also indicates their indifference and inactivity in finding how to work on unexplained questions in the classroom, even though they have many learning resources besides from their teacher to gain solution from their

unexplained question such as from the book, internet, asking to their friends, relatives, or asking to teacher outside the lesson hour. From their explanation, the researcher notes that mathematical disposition of SMP Negeri 1 Boja students is quite low.

Based on the facts above, learning which can increase students' problem solving and mathematical disposition is needed. Learning used Brain-Based Learning (BBL) model is expected to fulfill this need. Jensen (2008) states that Brain-Based Learning is a learning adapting to how brain works and the presence of natural design which motivates students to learn. According to Jensen (2008: 484-490), Brain-Based Learning model has seven steps activity, as follows: (1) pre-exposition, (2) preparation, (3) Initiation and acquisition, (4) elaboration, (5) incubation and formation input, (6) verification and assurance checking, (7) celebration and integration. The explanation about the planning step of Brain-Based Learning will be explained in the next discussion. Further, Brain-Based Learning uses mind mapping and instrumental music to assist learning. Toward mind mapping, the student will easily comprehend and remember the lesson material, at the same time, music will help them to stimulate brain to work more and create better balance. Instrumental music is the kind of music which has the biggest role in the students' score achievement in the algebra material.

Learning using Brain-Based Learning gives opportunity to students to develop ideas and find strategy of problem solving. Adejare (2011) states that Brain-Based Learning makes students being able to solve mathematical problem. Another research done by Zaini et al (2016) and Shodikin (2016) which show that the problem solving ability can be increased. Though the increasing of students' achievement in the aspect of problem solving ability will also increase the mathematical disposition (Taufiq, 2016). Based on the preliminary research, a research about the increase of ability of problem solving and mathematical disposition through Brain-Based Learning model toward SMP Negeri 1 Boja grade VII students is necessary to conduct.

Regarding to above-mentioned explanation, the research problems are (1) does the students problem solving ability using Brain-Based Learning gain classical complete learning, (2) is the students' achievement of problem solving ability by using Brain-Based Learning model higher than those who use conventional learning, (3) is the students' enhancement of problem solving by using Brain-Based Learning higher than those who use conventional learning, (4) is the students' enhancement of mathematical disposition by using Brain-Based Learning model higher than those who use conventional learning, (5) is there any correlation between the achievement of students' problem solving ability and students' mathematical disposition, (6) is there any correlation between the enhancement of students' problem solving ability and the enhancement of students' mathematical disposition.

2. Methods

This research used the mixed method with concurrent triangulation strategy. Mixed method with concurrent triangulation is the mixed method in which its research procedures meet and compile qualitative and quantitative data to gain comprehensive analysis of research problem (Creswell, 2013).

The population of this research is students of VII grade of SMP Negeri 1 Boja of academic year 2017/2018 (Odd Semester). While the quantitative research design used in this research is the True Experimental Design with Pretest-Posttest Control Group Design Type. In this design, there are two groups which were experiment and control group were each chosen by using random sampling. The design of this quantitative design can be seen in Table 1.

Table 1. Quantitative Research Design

Group	Sample	*Pretest*	Action	*Posttest*
Experiment	A	O_1	X	O_2
Control	B	O_1	Y	O_2

Note:
A,B : random sample
O_1 : Pretest (before given action)
O_2 : Posttest (after given action)
X : Lesson using Brain-Based Learning
Y : Lesson using conventional learning model

Learning in the experiment group was held by using Brain-Based Learning model for three meetings. The material used is Linear Equation and Inequalities in One Variable Material. The variable of this research consists of two variables which are free variable and bound variable. The free variable is the learning using Brain-Based Learning model and conventional learning model,

while the bound variable is the ability of problem solving and mathematical disposition.

Data compiling was done by using documentation method, test method, Likert scale method, interview method, and observation method. Documentation method was conducted to gain written data or pictures such as the list of students' names and the score of Odd Mid Semester Mathematics test assessment of students grade VII SMP Negeri 1 Boja. Then, students' activity photographs during research, as well as other data were also used for the sake of research. Test method used is problem solving ability test in the form of descriptive question. Then, Likert scale method was used to know students' mathematical disposition. While interview method was used to find problems to examine and know all details from the resources in the aspect of problem solving and mathematical disposition ability. Observation method was done by the researcher and the mathematics teacher to find out students' activeness during learning and ongoing learning process.

The choosing subject in the interview was done by using purposive sampling technique with consideration used is by choosing one high group subject, one medium group subject, and one low group subject based on students' posttest problem solving and mathematical ability score from the experiment and control classes with the categories shown in the following table:

Table 2. Grouping of Students Groups Based on Gained Score

Score	Category
Score ≥ 75%	High
55% < Score< 75%	Medium
Score ≤ 55%	Low

Adopted from Dewi (2017)

To analyze the data, this research used device trial analysis test, trial scale mathematical disposition, and research data analysis. Research data analysis was done through two steps, namely the early data analysis and final data analysis. Early data was gained from the students' score of Mid Semester Test assessment in the problem solving questions. Then, early data analysis was tested using normality test, homogeneity test, and two means equality test. As well as the final data, the normality test, homogeneity test, proportion test, gain test, one side mean equality test, and correlation analysis were also done.

3. Results & Discussions

Based on the early data analysis, it is found that early data of experiment and control class normally distribute and have homogeny variants. It shows that both samples come from population which has equal on the early condition. The data spread of students' early problem solving ability in the experiment and control classes can be seen from figure 3. The final data, whether the pretest and posttest of problem solving ability from both classes, also normally distribute and have homogeny variants, as well as the early score and final score of mathematical disposition.

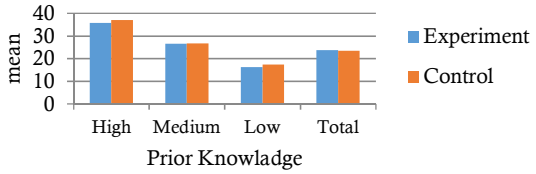

Figure 3. Students' Early Problem Solving Ability Spread Diagram

Hypothesis test 1 was done to find out that grade VII students' problem solving ability in the Linear Equation and Inequalities in One Variable Material using Brain-Based Learning model reaches classical completeness. Learning minimal completeness criteria are based on the minimal completeness criteria in the mathematics subject of SMP Negeri 1 Boja, which are from 71 students, the presentage of students who had reached KKM (compleness criteria) is minimally 71%. Based on right side proportion test it is gained value Z_{count}= 2,04 > Z_{table}= 1,64, so that H_0 is rejected while H_1 is accepted. It means that the students' problem solving ability in the Linear Equation and Inequalities in One Variable Material using Brain-Based Learning (BBL) has reached classical completeness.

The hypothesis test 2 was conducted by using test for right side means to examine whether the achievement of students' problem solving using Brain-Based Learning model is better than the using conventional learning. Data used were the posttest of students' problem solving ability score from two classes. From the test result, it is gained that t_{count}= 2,63 > t_{table} = 1,67, so H_0 is rejected which means that students' achievement of problem solving ability using Brain-Based Learning is better by using conventional learning.

Students' achievement of problem solving ability can be seen in the diagram in the following figure.

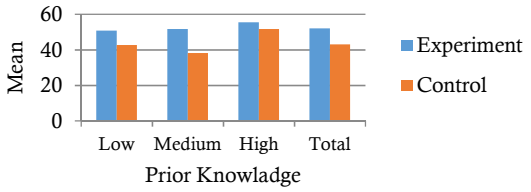

Figure 4. Problem Solving Achievement Diagram

Based on diagram above, it can be seen that the mean of students' achievement of problem solving in the low, medium, and high experiment class using Brain-Based Learning is higher than the means of students' achievement of problem solving with equal early ability. Then, students' achievement of problem solving ability in the experiment class is higher than that of control class.

While hypothesis test 3 was done by using test for right side means equality to examine whether the students' enhancement of problem solving ability using Brain-Based Learning is better than using conventional method or not. The data used was the score of 9 problem solving abilities enhancement gained from the students' problem solving pretest and posttest in two classes. From the test result, it is found that $t_{count} = 2,36 > t_{table} = 1,67$, so that H_0 is rejected which means that the students' achievement of problem solving ability using Brain-Based Learning is better than using conventional learning. Students' achievement of problem solving ability can be seen in the following diagram.

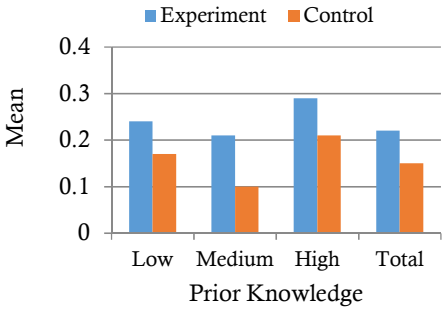

Figure 5. Problem Solving Enhancement Diagram

Based on figure above, it shows that students' achievement of problem solving with the low, medium, and high early ability in experiment class using Brain-Based Learning is higher than with conventional learning. In addition, the students' achievement of problem solving ability in the experiment class is higher than in control class.

The research result shows that early ability of problem solving in the high category has influence on the achievement and enhancement of problem solving. This is encouraged by Lestari' research (2017) which shows that there is another factor which influences students' learning result besides the early ability for instance, learning motivation, learning behavior, learning anxiety, and other external factors such as family, school environment, society, and economic situation.

Hypothesis test 4 was done through a test for one side means equality toward the students' enhancement of mathematical disposition. The data used was the score of mathematical disposition enhancement gained from early and final scores of mathematical disposition in the experiment class and control class. From the test result, it is found that $t_{count} = 0,12 > t_{table} = 1,67$, so that H_0 is rejected which means that the enhancement of students' mathematical disposition using Brain-Based learning model and conventional learning is equal.

Hypothesis test 5 was done to analyze the correlation between the achievement of problem solving and mathematical disposition ability and also to find out the portion of its relation. Tha data used were the posttest of problem solving ability data and students' final score of mathematical disposition in the experiment class. From the measurement result, it is obtained that correlation coefficient r is 0,113 with very low category, meanwhile, the determination coefficient is COPAA R^2=0,013=1,3% which means that the portion of influence of problem solving achievement toward mathematical disposition is only 1,3%, the rest 98,7% depends on the other factors.

The last, hypothesis test 6 was done to analyze the correlation between the enhancement of problem solving ability and the enhancement of mathematical disposition which aims to find out the relation portion between the students' enhancement of problem solving ability and mathematical disposition. The data used was the score of the students' enhancement of problem solving and the students' score of mathematical disposition in the experiment class. From the measurement, it is found that correlation coefficient r is 0,339 with low category, while the determination coefficient is R^2=0,115=11,5% which means that the influence size of problem solving ability toward the enhancement of

mathematical disposition is only 11,5%, and the rest 88,5% is influenced by other factors.

3.1. The Result of Students' Work in the Problem Solving Ability Test

To find out the clear representation about the enhancement of problem solving ability, which is the part of the achievement and enhancement of problem solving will be presented based on the indicators.

Table 3. The Means of Problem Solving Based on Indicators

Indicators of Problem Solving Skill	Experiment			Control		
	Begin	Finish	⟨g⟩	Begin	Finish	⟨g⟩
Understanding Problem	3,94 (98,6%)	3,96 (99,1%)	0,33	3,80 (95%)	3,96 (99,1%)	0,82
Arranging strategy in problem solving	1,08 (27%)	2,26 (56,4%)	0,40	0,93 (23,2%)	1,52 (37,9%)	0,19
Doing strategy to solve problem	1,54 (38,4%)	2,82 (70,5%)	0,52	1,18 (29,5%)	2,13 (53,8%)	0,34
Looking back the result	0,08 (8,1%)	0,34 (34,4%)	0,29	0,12 (11,5%)	0,30 (30,3%)	0,21
Making conclusion	0,61 (30,3%)	1,03 (51,2%)	0,30	0,44 (22,1%)	0,71 (35,4%)	0,17
Total	7,25 (48,3%)	10,41 (69,8%)	0,41	6,47 (43,1%)	8,62 (57,4%)	0,25

The achievement of problem solving based on the indicators is presented in the following diagram.

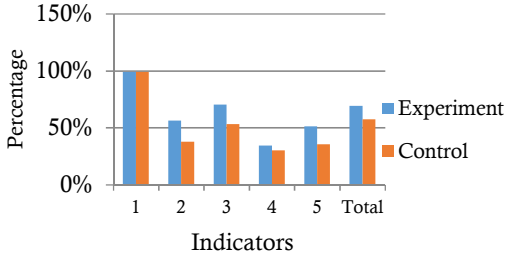

Figure 6. The Problem Solving Ability Achievement Based on the Indicators

The enhancement of problem solving based on the indicators is described in the following diagram.

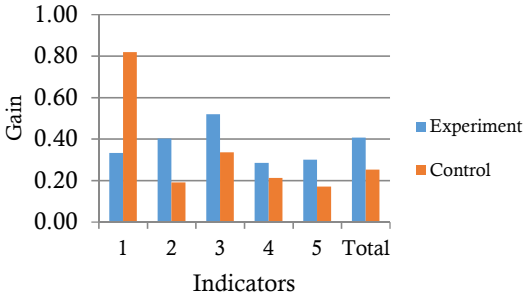

Figure 7. The Problem Solving Enhancement Ability Based on the Indicators

Based on the Figure 6, it can be seen that for 2nd, 3rd, 4th, and 5th indicators, students in the experiment class experience learning using Brain-Based Learning get higher achievement of problem solving ability than the control class which uses conventional learning. Then, for the first indicator which understands problem indicator, students in the experiment class and the control class experience the same problem solving achievement. Totally, students' achievement of problem solving ability by using Brain-Based Learning is higher than conventional learning.

While based on the Figure 7. it notes that for 2nd, 3rd, 4th, and 5th indicators, students in experiment class which were getting Brain-Based Learning gain higher achievement than students in the class control by using conventional learning. However, in the indicator of understanding problem, the control class students get higher achievement than the experiment class. In total, the students' achievement of problem solving ability using Brain-Based Learning is higher than conventional learning.

3.2. The Result of Students' Mathematical Disposition

To find out the clear representation of mathematical disposition achievement, it will be described based on indicators as seen in the following table.

Table 4. The Means of Mathematical Disposition Based on the Indicators

Indicators of Mathematical Disposition	Experiment			Control		
	Begin	Finish	⟨g⟩	Begin	Finish	⟨g⟩
Confident in using mathematics	2,42 (60,5 %)	2,65 (66, 2%)	0, 15	2,68 (66, 9%)	2,68 (67 %)	0, 00
Flexibility in doing mathematics	2,60 (65 %)	2,94 (73, 5%)	0, 24	2,46 (61, 4%)	2,74 (68, 4%)	0, 18
Persevering at mathematical task	2,75 (68,8 %)	2,85 (71, 2%)	0, 08	2,58 (64, 6%)	2,58 (64, 5%)	0, 00
Interest and coriosity	2,47 (61,9 %)	2,60 (65 %)	0, 08	2,51 (62, 7%)	2,95 (73, 7%)	0, 3
Monitor and reflect	2,81 (70,2 %)	2,74 (68, 6%)	- 0, 05	2,95 (73, 8%)	2,83 (70, 8%)	- 0, 12
Valuing application of mathematics	3,22 (80,4 %)	3,23 (80, 8%)	0, 02	2,52 (63, 1%)	2,91 (72, 7%)	0, 3
Appreciating role of mathematics	2,65 (66,8 %)	3,14 (78, 4%)	0, 36	2,58 (64, 5%)	3,06 (76, 5%)	0, 34
Total	2,64 (66,7 %)	2,83 (70, 7%)	0, 14	2,62 (65 %)	2,78 (69, 4%)	0, 12

From almost all indicators, the achievement and enhancement of mathematical disposition in the experiment class are higher than the control class, yet the interval of disposition, the achievement of both classes is not significant.

Based on the interview result, subject with low ability of problem solving finds difficulty in making mathematical model of the problem which causes the falseness in the next indicator as well. The same difficulty is also experienced by subject with high category of disposition because of the lack of practice in the Linear Equation and Inequalities in One Variable Material. In addition, subject with medium achievement of problem solving ability finds difficulty in manipulating mathematic completely although he was able to explain. Then, the other difficulty experienced is when he reexamined the result. The same difficulties are also experienced by subject with low and medium mathematical disposition. On the contrary, subject with high ability of problem solving does not find too many difficulties in performing problem solving.

However, the effort to increase problem solving ability through Brain-Based Learning can be seen in some lesson steps such as preparation, elaboration, incubation, and memory input, as well as the verification and assurance checking. The detailed explanation about the enhancement of problem solving ability through Brain-Based Learning Steps will be next explained.

In the preparation steps, students are introduced to the daily problems related to Linear Equation and Inequalities in One Variable Material. In this step, students are accustomed to understand problem about this material which is the indicator of first problem solving. The students' achievement using Brain-Based Learning in the problem solving indicator is 99,1%.

In the next step namely elaboration step, students discuss with group members. Based on the Vygotsy Learning Theory, learning which is done between students is effective in solving problem, emerging ideas and problem solving strategy. In the step of elaboration, the social interaction inside and outside the group happens.

The step of incubation and memory input also aims to increase the ability of problem solving by giving easy practice variation of questions. When they do the practice, they are led to the meaningful learning according to Ausubel Learning Theory. By doing practice, students apply the new fact and experience in the gained concept while they are discussing and doing textbook. Then, when verification and assurance checking, students are asked to do quiz of questions to check the concept of Linear Equation and Inequalities in One Variable Material which is learnt toward problem solving. Above all, it can be concluded that Brain-Based Learning facilitates students to enhance their problem solving ability.

4. Conclusion

From the research result, it can be concluded that: (1) the students' ability of problem solving using Brain-Based Learning model reaches classical learning completeness, (2) the students' achievement of problem solving using Brain-Based

Learning model is higher than using conventional learning, (3) the students' enhancement of problem solving using Brain-Based Learning model is higher than using conventional learning, (4) the students' enhancement of mathematical disposition using Brain-Based Leaning model is same with conventional leaning, (5) there is a very little correlation between the achievement of problem solving ability and mathematical disposition, (6) there is a low correlation between the enhancement of problem solving and mathematical disposition.

Based on the result of the research, it can be stated that Brain-Based Learning model can be used as one of alternative learning models, especially to increase students' ability of problem solving in the Equation and Inequalities in One Variable Material completely and properly, so it can make students accustomed to always check their result and create conclusion with correct reason. To get comprehensive and accurate representation about the enhancement of mathematical disposition through Brain-Based Learning, the next research needs to be done to the same subject with longer duration of research.

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