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THE EFFECT OF BRAIN BASED LEARNING ON SECOND GRADE JUNIOR STUDENTS' MATHEMATICS CONCEPTUAL UNDERSTANDING ON POLYHEDRON

I Made Suarsana, Ni Putu Santhi Widiasih, I Nengah Suparta
Universitas Pendidikan Ganesha, Jl. Raya Sesetan No.196, Pegok, Denpasar, Bali, Indonesia
Email: suarsana1983@gmail.com

Abstract

The aim of this study is to examine the effect of Brain Based Learning on second grade junior high school students' conceptual understanding on polyhedron. This study was conducted by using post-test only control group quasi-experimental design. The subjects of this study were 148 students that divided into three classes. Two classes were taken as sample by using cluster random sampling technique. One of the classes was randomly selected as an experimental group and the other as control group. There were 48 students in experimental group and 51 students in control group. The data were collected with post-test which contained mathematical conceptual understanding on fractions. The post-test consisted of 8 essay question types. The normality and variance homogeny test result showed that the scores are normally distributed and have no difference in variance. The data were analyzed by using one tailed t-test with significance level of 5%. The result of data analysis revealed that the value of t-test = 6,7096 greater than t-table = 1,987, therefore; the null hypothesis is rejected. There is positive effect of Brain-Based Learning on second grade junior students' conceptual understanding in polyhedron.

Keywords: Brain Based Learning, Mathematical Conceptual Understanding, polyhedron

Abstrak

Penelitian ini bertujuan untuk mengetahui apakah pemahaman konsep matematika siswa yang dibelajarkan dengan model Brain Based Learning (BBL) lebih baik daripada pemahaman konsep matematika siswa yang dibelajarkan dengan pembelajaran konvensional. Jenis penelitian ini adalah eksperimen semu dengan desain penelitian Post Test Only Control Group Design. Populasi penelitian ini adalah seluruh siswa Kelas VIII SMP PGRI 8 Denpasar Tahun Ajaran 2016/2017 yang terdistribusi ke dalam 3 kelas. Pengambilan sampel dilakukan dengan teknik cluster random sampling untuk memperoleh 2 kelas sebagai sampel penelitian. Data pemahaman konsep matematika siswa diperoleh menggunakan tes dengan bentuk uraian. Data dianalisis menggunakan Uji-t satu ekor pada taraf signifikan 5%. Hasil uji hipotesis menunjukkan bahwa t_{hitung} = 6,7096 lebih dari $t_{tabel = 1,987}$ sehingga H_0 ditolak. Terdapat pengaruh positif dari *Brain-Based Learning* pada pemahaman konseptual siswa kelas II tentang polyhedron.

Kata kunci: Brain Based Learning (BBL), Pemahaman Konsep Matematika, Bangun Ruang

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Learning mathematics has become a necessity for an individual's full development in today's complex society (Ignacio et al, 2006). Mathematics conceptual understanding is the ability to understand concepts, oration and relation in mathematics (Kilpatrick et al, 2001). Student ability to understand a concept, oration, and relations in mathematics need to be built optimally. It aims to fulfill all the competencies to be achieved in learning. Conceptual understanding also plays important role in building the cognitive framework of the students so their understanding on learning materials can be developed optimally. Students must learn mathematics with understanding, actively build new knowledge from previous experience and knowledge (NCTM, 2000). Conceptual understanding also

essential in building the knowledge students already had.

The ability in understanding a concept makes students able to associate material that has been taught and the new one. This make the students build up the cognitive structure optimally. According to Kilpatrick *et al* (2001), conceptual understanding can help student to avoid obstacles in solving a problem. The ability of students to understand the concept can minimize chances of constraints in the problem settlement. It provides an opportunity for students to master competencies optimally. Students can understand a concept that is taught optimally by optimizing the learning situation in the classroom. The learning process in classroom should be creatively and innovatively designed. Teachers should apply learning models that make the classroom situation more conducive to support the learning process.

Hidayat & Iksan (2015) states that Indonesian students conceptual understanding is at the lowest level. Students are unable to transform non-formal knowledge into formal knowledge. This is supported by Costu *et al (*as cited in Hidayat & Iksan: 2015) who states that the majority of students are successful in mathematics but fail to solve a daily problems. This is because students not yet able to relate the knowledge they get previously and the new knowledge they just got. Furthermore, according to TIMSS (Trend in Mathematics and Science Study) survey in 2011, second grade junior high school students in Indonesia ranked 38th among 42 participants countries in mathematics tests. From the international average score of 500, Indonesian students only get average score of 386.

According to Mullis *et al* (2012) divided TIMSS aspect into three domains of knowing, applying, and reasoning. Knowing domain includes facts, concepts, and procedures that students need to know to proceed to the second domain that is the applying domain. This domain focuses on students ability to apply the knowledge and conceptual understanding in order to solve problems or answer questions. Meanwhile reasoning domain is more than just finding solutions to routine problems, but also including foreign situations, complex contexts, and multistep problems. One aspect in the objective of mathematics subjects is to understand mathematical concepts and to explain the connection of concepts. These points belong to the knowing and applying domain on TIMSS, where the average percentage of correct answers to Indonesian students in 2011 by TIMSS survey are: 31% for knowing, 23% for applying, and 17% for reasoning. The average is below the average percentage of international correct answers which are: 49% for knowing, 39% for applying, and 30% for reasoning.

Educational achievment is considered as the most important indicators of successful scientific and educational activities, examining factors affecting students ‘s academic achievement (Saravani et al, 2016). According to statement above, academic achievement is the most important aspect to achieve in every learningprocess. Adegoke & Ajadi (2016) states that the students’ low achievement occur due to the use of teaching methods that are unsuitable and ineffective. Low learning achievement indicates that the students not yet mastered the competence optimally. One indicator of low student achievement is the lack of conceptual understanding. Lack of concept understanding causing low level topic understanding. İt will make learning purpose connot be reached. Corresponding to PISA survey results, Indonesian students achievement is ranked 63 out of 70

countries with an average score of 386, while the international average score is 490. "Rated aspects are the ability of understanding, problem solving, reasoning ability, and communication skills" (David Kastberg, 2016). Result of TIMSS (Trend in Mathematics and Science Study) and PISA (Programme International for Student Assesment) study above shows that the ability of Indonesian students in mathematics, especially the conceptual understanding ability is still categorized as low.

Student's Conceptual understanding can be optimized by planning and arranging both lesson plan, media, and teaching materials to be use in learning activities. The planning can be integrated holistically in the form of learning model. It required a learning model that can optimized students's conceptual understanding or optimize the work of the brain in understanding a concept. Learning model that is expected to give positive influence to the students's conceptual understanding is *brain based learning* model. "*Brain based learning* is a learning process that is aligned with a brain designed naturally to learn" (Jensen, 2008:12).This is supported by the results of research conducted by Nur (2016) which revealed that the ability of students to think mathematics creatively and learning independently by using brain based learning (BBL) model is better than students using conventional learning model.

In addition, research conducted by Mustiada (2014), the student's results of learning Science in the experimental group using *brain based learning* (BBL) model containe a character based learning is higher than the students' learning outcomes in the control group using a conventional learning model. In accordance with that, the results of research conducted by Fitriana (2016) showed that learning with *brain based learning* model by using concept maps have the results of learning Science-Biology better than *brain based learning* model using discussion method. Based on the results of research by Dewi (2013), Web-based *brain based learning* model can theoretically be used to improve students' mathematical connection ability.

Based on the explaination and results of the study above, the implementation of *brain based learning* model is expected to positively affect the students' mathematics conceptual understanding. With the alleged existence of a positive influence between the application of *brain based learning* models with mathematics conceptual understanding, it is necessary to conduct a research to determine the effect of the application of *brain based learning* model to students' mathematics conceptual understanding.

METHOD

This research is quasi experiment using post-test only control group design. Quasi experiment research can be used to identify the effects caused by different treatment given to each classes and the researchers did not controls all variable and experiment strictly condition (Sugiyono, 2015) .The study is done in junior high school PGRI 8 Denpasar that last for one month start from february until march 2017.Population in research are all 148 8^{th} grade students of SMP PGRI 8 Denpasar which are divided into 3 classes :VIII.1, VIII.2, and VIII.3.

Prior to the determination of sample, first the researcher undergone a equality of the population by using analysis variance (ANAVA) one-tail in students' mathematics UUB (Ulangan Umum Bersama) data

of class VIII on academic year 2016 / 2017. The sample of this research consist of 99 students which distributed into 2 classes: VIII.1 as a control group and VIII.2 as a experiment group. The sample were taken specified by using clusters random sampling technique.The number of students on control group are 51 student and the number of students on experiment group are 48 students.

To recording the problems, as for briefly procedure described as follows: (1) Conducting observations; (2) Do the equality to determine the sample as well as determine control group and experimental group; (3) Design a support system and the instrument to be used in the research; (4) Validating the contents, validity points and reliability for research instruments; (5) Applying treatment of 5M (Mengamati, Menanya, Mengumpulkan Data, Mengasosiasi, Menyimpulkan) learning to the control group and applying model brain based learning on the experimental group (pre-explanation, preparation, initiation and aquitition, elaboration, incubition, verification, integration) in polyhedron ; (6) Do a post-test to the classes; (7) Analyzed data tests results to test the hypotheses put forward; (8) Prepared a report as results of the study.

In collecting the data, the researcher use essay test as the instrument. The essay test designed in accordance to understanding mathematics conceptual in the national council of the mathematics teachers (NCTM) 2000 namely (1) describe concepts in their own words; (2) identify or give examples and non-examples of concepts; (3) use correctly concepts in a variety of situations. The instrument would be trustworthy if it is passed two critical qualities: valid and reliable (Arikunto, 2002). Intrument of the test which has been drawn up beforehand tested the validity of its contents by Gregory testing. An instrument said to be trustworthy when the lateral extent the validity of the contents is 0,70 $\leq$ the validity of the contents $\leq$ 1 (Gay, 1996). The bigger of the validities' contents, the more trustworthy it is to be used.After checking the validity of the test contents, it is continued by testing the validity of tests using grains correlation product moment of Carl Pearson. A correlation coefficient product moment than the r-table the first significance 5% and degree of freedom $n - 2$. If r-xy > r-table so the grains concerned other wise valid (Candiasa, 2011). Reliability testing done to a formula the coefficients of alpha (Alpha Cronbach).Reliabilies instrumentcriteria used is reliability of guilford criteria. The question to be used at least the reliability being or at r11 > 0,40 intervals.

The analyzed data that used is the result test of understanding mathematics conceptual of both classes sample. Before the hypotheses test begins, first the data must be meet a mathematics prerequisite is derived from a population that normal distribution and having variance homogeneous. Normality testing to scatter data was undertaken to Kolmogorov-Smirnov technique. The maximum of D-value or D-test compared to the D-table with significant 5%. When D-test < D-table so the null hypothesis is accepted (Candiasa, 2010).With the conclusions that the students understanding mathematicsconceptual derived from a population that normal distribution.

Testing of homogeneity data was undertaken used Levene test (Candiasa, 2010). Value of W compared with F-table, which F-table = $F_{\alpha(k-1,n_{total}-k)}$ with significant 5%. When W < F-table so the

null hypothesis is accepted(Candiasa, 2010). With the conclusions that the data hashomogeneous variance.If a prerequisite testing has done, process can proceed with the testing of hypotheses.

The testing of hypotheses is done with one-tail t-test (right tail) with significant 5%. Value of t-test compared with t-table with degrees freedom ($n_1 + n_2 - 2$), when value t-test> t-table, where t-table = $t_{\alpha(n_1-1,n_2-1)}$ so null hypothesis is rejected (Candiasa, 2010).With the students' understanding mathematics conceptual using brain based learning model better than students' understanding mathematics conceptual using conventional model.

RESULT AND DISCUSSION

Result

Analysis descriptive results of students' mathematics conceptual understanding can be seen in Table 1.

Table 1. The results of the analysis descriptive of students' mathematics conceptual understanding

Variable	Group	
	Experiment	Control
N	48	51
$\bar{X}$	21,291	15,647
Standard Deviations	4,161	4,203

As shown in Table 1, the average score of students' mathematics conceptual understandingof experimental group is higher than students' in control group. Standard deviations for experiment group is 4,161 and for the control group is 4,203. The results of normality test on students' mathematics conceptual understanding data using a Kolmogorov-Smirnov technique can be seen in Table 2.

Table 2. The results of normality testing students' mathematics conceptual understanding

Group	D-test	D-table	Description
Experiment	**0,1176**	**0,1269**	**Normal**
Control	**0,1143**	**0,1269**	**Normal**

As shown in Table 2, the value of D-test on experiment group is 0,1176 and value of D-table on experiment group is 0,1266. This mean 0,1176 < 0,1269 it, so that data experiment group derived from a population that normal distribution.To that control group D-test obtained the value of as much as 0,1143 while for value of D-tabel to that control group is 0,1266, this indicates 0,1143 < 0,1269 it, so that data the control group also derived from a population that normal distribution. The results of homogeneity testing variance data students' mathematics conceptual understanding by Levene test can be seen in Table 3.

Table 3. Test results of homogeneity variance data students' mathematics conceptual understanding

Group	Varians	W	F-table	Description
Experiment	17,3174	0,0241	3,9391	Homogeneous
Control	17,6729			

As shown in table 3, it shows variance results in experiment group of 17,3174 and variance in the control group 17,6729. Value of W obtained 0,0241 and value of F-table obtained 3,9391. Can be seen that value W< F-table namely 0,0241 < 3,9391 which means sample group has homogeneous data of mathematics conceptual understanding.

Test of normality and the homogeneity shows that data of a group of experimentation and the control group derived from a population that normal distribution and having variance of a homogeneous. Test because a prerequisite has fulfilled, hence the testing of hypotheses can be done by using t-test the one-tail (right tail) to see the whereabouts differences students' mathematics conceptual understandingwho learned with a brain based learning model with students who learn on the conventional learning model. The results of the hypotheses testing of data student's mathematics conceptual understandingwith t-test can be seen in Table 4.

Table 4. The results of t-test data student's mathematics conceptual Understanding

Group	**n**	$\mathbf{S^2_{gab}}$	$\mathbf{S_{gab}}$	$\mathbf{t_{test}}$	$\mathbf{t_{tabel}}$	**Description**
Experiment	48	17,500	4,1834	6,7096	1,9847	hypotheses null rejected
Control	51					

As shown in table 3, the t-test result is 6,7096 and t-table is 1,9847 , this means that value of t-test > value of t-table namely 6,7096 > 1,9847. It can be concluded that null hypothesis were rejected and alternative hypothesis is accepted. In other words, student's mathematics conceptual understandingwho learned with brain based learning model is better than using conventional learning model.

Discussion

Based on the result of score data hypothesis testing of students' mathematics conceptual understanding to the experimental class and control class where the data were tested by using the t-test of one tail, obtained the conclusion that the students' mathematics conceptual understanding which was taught by the learning model of brain based learning is better than using the conventional learning. This means that the application of learning model of brain based learning on mathematics learning gives a meaningful impact on students' mathematics conceptual understanding.

Based on those discoveries, it is found that the students' mathematic conceptual understanding

who were taught by brain based learning model is better than using conventional learning model. This statement is supported by some relevant researches, among others: (1) According to the results of research conducted by Nur (2016) that is the ability to think creatively mathematically and student learning independence using brain based learning model (BBL) is better than students using conventional learning model. The ability of mathematical creative thinking is based on a understanding of mathematical concepts. A good mathematic conceptual understanding is needed to improve the ability of mathematical creative thinking, because in the ability of mathematical creative thinking, students are required to be more creative in applying the concepts and reasoning of mathematics in problem solving which indirectly requires the students to understand the concept first. With the increasing ability of mathematical creative thinking, it is certain that understanding of mathematical concepts also increased. Therefore, it can be seen the relationship between the ability to think mathematically creative with the understanding of mathematical concepts. (2) The research conducted by Mustiada (2014). In his research, the result of science learning of the students in the experimental group using brain based learning model (BBL) has a higher character than the students' science learning outcomes in the control group using conventional learning model.

To obtain the maximum achivement, one component that must be maximized is the understanding of concepts. After the conceptual understanding, students are expected to apply, in the ability of a person to apply or use general ideas, ordinances or methods, principles, formulas, theories, etc. (3) The result of research conducted by Fitriana (2016) showed that the learning of brain based learning using mapping concept of IPA-Biology learning has better result than the learning of brain based learning using discussion method. In line with that, the research conducted by I Gusti Agus Made Mustiada (2014) showed that there is a link between conceptual understanding with student learning outcomes. If student learning outcomes increase then indirectly can be understood students' conceptual understanding has increased before. (4) Dewi in 2013 conducted similar research. The result showed that brain based learning assisted with website can theoretically be used to improve students' mathematical connection ability. The ability of mathematical connections is used to study several mathematical topics that are interconnected with each other. There are several activities that include mathematical connections, one of which is understanding the equivalent of representation concepts. To release those activities include a mathematical connection that is required understanding of mathematical concepts. As the ability of mathematical connections increases, it is based on an understanding of a concept that has also increased previously. So that can be seen the relationship between the ability of mathematical connection with the understanding of concepts.

The early stages of the brain based learning model, namely preparation and pre-exposure, on the application of teachers involves mind mapping made by teachers as interesting as possible so that students are interested in learning. Mind mapping serves to facilitate the information organization that reflects thoughts, problems, attention and relationships with the previous learning. Thus, students can longer remember the concepts of material that has been studied. At this stage, the teacher is also

conditioned to make the learning atmosphere conducive and fun. Teachers could invite students to create mind mapping in accordance with the students' creation, so that students are interested to read mind map that they made. Students make a masterpiece in the form of mind mapping and shown at the end of learning that will be displayed in the class.

The next stage is the stage of initiation and acquisition, where the discussion in groups, students are able to share information that is complied with peers. In addition to groups learning, it can improve students' motivation learning. In group discussion, students are given the opportunity to teach and explain information or concepts to group members as well as to help strengthen the mastery of a particular concept or information. Group discussions can also trains students 'democratic attitudes to play active role in arguing, looking at friends' opinions, brainstorming, correcting misconceptions and completing their knowledge. In this stage the teacher becomes a facilitator. When the students are not undersand well, the teacher approaches the group and explains it so the discussion goes smoothly. Students discuss other students worksheets designed by teachers to make it easier for students to understand basic concepts. Therefore, the formulas can be found and students can answer the questions given correctly.

In applying the elaboration stage, the teacher asks one of the group representatives to present or communicate the results of each group's discussion. One representative is chosen by the teacher randomly, all students must prepare themselves, not just one student. Through elaboration, students can learn to summarize information in their own words. This also train students' courage to come forward and express their opinions. After that, the teacher gives the opportunity to other students to express their opinions to the group of presenters. There is a positive process of exchanging information and teachers motivate students who want to discuss or ask for good two-way communication. From the discussion between groups studenta can complete the answers of one student with another student.

In applying the incubation stage and inserting the memory, students are given the opportunity to repeat, remembering to rewrite the concepts that have been given in a fun way to optimize the students' mathematics conceptual understanding. By rewriting, the students can better remember the concepts that taught so as to minimize the misconception in learning. In addition, teachers also use classical music and brain exercises (brain games) which are fun, so that students are interested to try it. The application of music and brain exercises in learning can enhance pleasure for learners and give learners a feeling that their class is a fun place and helps learners to relax and mark important moments or events in learning. Each teacher's learning gives different and non-monotonous music to a single music, as well as brain gymnastics, various brain exercises, from very easy to difficult, so that much variation in the learning takes place.

In addition, the brain based learning model also provides verification and confidence checks, where teachers through question and answer questions with students discuss what has been learned and minimize misunderstanding of students 'answers. It can be done by checking the students' answers

so students are sure their answers are not mistaken or wrong. Teachers provide reinforcement of students who are correct or students who are still not correct in answering the problems from teachers; thus, students' do not experience mental breakdown when the teacher verify and check their confidence.

In every interrupted learning, teachers always take time to give brain teashing (surprise) in the form of reprimand, or challenge to answer the problem suddenly to students who are sleepy, chatting in class, or who are not paying attention to the teacher. Brain teashing can dilute the atmosphere and create a sense of reluctance to the teacher so that the learning process can run conducively.

At the end of the learning the teacher held a celebration or integration of the learning process of students both individually and in groups. This is usually done by giving applause and gifts to students who are considered achievers at the time of learning, be it brave to answer teacher questions from inappropriate answers up to the right answers or correctly answering questions during brain exercises. They also can be given reinforcements. This is intended to engage students to be more actively learning and more motivated than ever.

CONCLUSION

The results of current study can provide significant information for those who works in educational institutions. Considering the role and importance of matemathics concept understanding, the role of teachers in the implementation of learning models of brain based learning as a facilitator along the learning process, ranging from introducing students with mind map to facilitate students in understanding information related to the concept of learning, providing conditions conducive and fun for students so it appears motivation in students to understand the concept of learning so that will be achieved also optimizing the students' mathematics conceptual understanding.These advantages make the learning model of brain based learning interesting and able to accommodate students, as well as encourage the students' mathematics conceptual understanding development.In addition, based on the results of research that has been conducted, to other interested researchers, it is advisable to conduct in-depth research on the learning model of brain based learning with larger population and broader learning materials to find out the effect of its application in learning mathematics. In addition, interested researchers can conduct research on the creativity and motivation of students who learned by using brain based learning model, because the supporting impact of this learning model is increasing creativity and motivation of students.

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