Improving Students Executive Function through Brain-Based Physical Education Learning

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Abstract: This study aims to compare the improvement of executive function of students who follow traditional physical education learning and those who follow Brain-Based Physical Education Learning (BBPEL). The method used in this study was quasi experimental method with unequivalent design pre-post-test control group design. The research subjects are Junior High School students class VII about 39 students. The treatment lasted for 8 meetings. The executive function is measured by a word-color test stroop. The results of this study indicate that there is a significant gain-score difference in the ability of executive function between BBPEL group (= 17,4685 sec) and traditional group (= 11,0237 seconds) p = 0,043 <0,05. Conclusion, physical education can contribute positively to the executive function of the student, and the contribution can be optimized with the BBPEL learning model significantly.

1 INTRODUCTION

The learning process is very essential; it should teach students how to learn. In 21st century, as the age of advanced technology, the success of life is definitely increasingly dependent on the mastery of the executive function process, namely goal setting, planning, organizing, prioritizing, initiating, change (shifting), and self-monitoring (self-monitoring). Academic success will also depend on the ability of students to organize their time, organize and prioritize materials and information, distinguish core ideas in detail, change approaches flexibly, monitor their own progress and reflect on their work. Learning that does not sharpen this executive functional process will lead to a separation between what is taught in school and what students need to succeed in school or later in real life or work life. Real life requires individuals to be able to learn independently and organize and put together the rapidly changing information that is acquired through the Internet or other web-based media (Metzler, 2017).

A good executive function is needed by Indonesians in the future so as not to erode the times, and ultimately become a slave in their own country when the current globalization can no longer be contained. Therefore the teacher should apply a comprehensive plan of learning that can be more than just delivering the material but at the same time improving the executive function of the students. "The core of the teaching process is the arrangement of environments within which the students can interact and study how to learn" (Joyce and Weil, 1996). Such comprehensive learning planning is a learning model used by teachers in teaching students. The comprehensive plan includes the theoretical basis, the learning objectives, the teacher's expertise in the content of the lesson, the learning activities appropriate to the stage of student development, expectations of teacher and student behavior, unique learning structure, outcome measurements and how to verify the implementation of the model itself (Metzler, 2017).

In the last two decades, along with technological developments in the field of neuroscience, knowledge of the workings of the brain began to give effect to the model of learning in the classroom. Imaging Technologies such as Magnetic Resonance Imaging (MRI), functional MRI (fMRI), Electroencephalography (EEG), computed tomography (PAT), computed axial tomography

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(CAT) and molecular biology examinations such as enzyme-linked immunoassay (ELISA) to explore the functional neuroanatomy of the learning process. Information gained from these modalities builds a scientific bar illustrating how the biological learning process actually works. Educational experts then take this scientific bar and apply it to classroom learning, then Brain-Based Learning (BBL) was born (Craig, 2003; Willis, 2008; Jensen and Rohwer, 1966).

In addition to the learning model, as mentioned above nutritional factors and physical activity can give effect to the learning process. For nutritional factors in general, of course we still have to expect a lot on improving the nutritional quality of families that deal with the nation's economic sector. We can use physical activity as a weapon to improve the quality of learning itself because physical activity provides positive benefits to the brain. Physical activity promotes cerebral capillary growth, cerebral blood flow, oxygenation, neurotrophic production, growth of hippocampal cells (learning and memory centers), neurotransmitter levels, development of anterior connections, neural network density, and brain tissue volume. These physiological changes are associated with increased attention capability, improved information processing, storage, and retrieval, as well as improved coping and positive affect (Centers for Disease Control and Prevention, 2010).

In the Indonesian curriculum, physical activity is only accommodated by physical education subjects. That is just 3 hours of lessons in the latest curriculum. Nevertheless, it is of course very important to utilize these subjects as a weapon to enhance executive function, BDNF levels and ultimately student academic achievement. The unique characteristic of the physical education subject itself has actually contributed significantly to the students' cognitive dimension (Suherman, 2013). However, this donation is underestimated by the students, teachers, principals and Indonesians in general. Physical education is marginalized precisely because the assumption of these subjects is unimportant and may even interfere with student academic achievement (Hardman et al., 2005).

The traditional physical education learning model that is applied by majority of physical education teachers in Indonesia may be one of the causes of physical education benefit to students' unseen cognition increasing. The study of physical education in Indonesia for decades is similar to physical education in America hundreds of years ago, that is prioritizing the physical aspect. Because of the former colonized wounds, the founding fathers of the Indonesian nation try to use sport as a strategic and political tool, to break out of the collective inferiority of being a newly independent nation after so many centuries of colonized and systematically ignored. The growing belief that sport can be an evidence that the Indonesian people have the same potential and ability with other nations. This is demonstrated through the efforts of the Indonesian nation to take part in various regional and international sporting events. What happened then, the paradigm of physical education at the level of educational unit is also shifted. Physical education no longer becomes an educational tool, but is sharpened into a tool to help the sport movement as an enforcer of the nation's posture, so that more seeds of the sportsperson can be prepared. As a result, as we can see today, physical education is more oriented towards sporting achievement than as a tool in the process of socializing and educating children through sport. So strong the paradigm of sports achievement in our physical education, until now the paradigm is still strongly gripped by the physical education teachers. With the wrong paradigm, the sports program in physical education more emphasizes the hope that the program ends on the early benefits of early breeding benefits. In short, the main goal of physical education is the physical aspect.

Therefore, it is important to recognize whether a model of physical education in accordance with the principles of BBL (Brain-Based Physical Education Learning / BBPEL) can accommodate intracurricular physical activity in schools that can improve executive function. Existing physical education models (Personalized System for Instruction, Cooperative Learning, The Sports Education Model, Peer Teaching Model, Inquiry Teaching, and The Tactical Games) contain elements of BBL learning but are not comprehensive. For example cooperative learning model but ignore the personal aspects and tactical games that emphasize the competition. Moreover learning physical education which is traditional one-way direct teaching in the form of skill-drill-game. The teacher gives an example of a physical motion skill. Then all students must master the motion skills by doing drill (repetition-repetition) to be able to perform similar movements in accordance with the theory and examples of teachers. After mastering the motion, students perform games that require these motion skills. Traditional learning models contain elements of physical activity that can naturally provide cognitive

benefits, but the character of learning causes the benefits of physical activity is not optimal.

2 METHODS

2.1 Procedure

The Research was conducted in 5 months at SMP Lab School Universitas Pendidikan Indonesia Bandung. Method of research used in this research Quantitative method with quasi experiment, unequivalent control group design. The participants are junior high school students class VII. Two classes were selected as sample with similar cognitive ability and academic achievement (evidenced by the Initial test). Two other classes with other similar subject's teachers are also chosen. The number of students in the two classes is at least 20 people. These two classes will be divided into two groups, namely the treatment group and the control group. Group assignment is done by random assignment.

2.2 Instrumentation

The name of this test comes from the name of the main developer; John Ridley Stroop who published in 1935 with an article entitled "Studies of Interference in serial verbal reactions", although the first publication was done by James McKeen Cattell and Wilhelm Maximilian Wundt in his doctoral dissertation research. This test has been used by many researchers in various fields, until it is included in the "Citation Classic" which means it has been quoted more than 160 times since 1966.

Stroop Color-Word Test and all its variations consist of 3 cards: Word Card (W), Color Card (C) and Color-Word Card (CW). The word card consists of a list of words for color (eg red, green, yellow, blue) printed in black ink; the color card is a sequence of colors according to the color on the card; while the word color card is a list of words printed in a different color to the meaning of the word (example: red word printed with green ink color). Subjects are asked to read aloud the color word (W card), mention the color (card C) and mention the color of ink writing by heeding the meaning he said (CW card). The time required to complete the task is the score of the test.

TWKS rationalization is used for ocus ic d executive function. The executive function is a mental process that is central to decision-making, goal planning and behavioral selection. This process involves the dorsolateral prefrontal cortex brain area (DLPFC) and the anterior ocus ic d cortex (ACC). Brain imaging techniques, including MRI, fMRI and PET have shown that the main areas involved in the Stroop test process are the dorsolateral prefrontal cortex (DLPFC) and anterior ocus ic d cortex (ACC) areas of the brain. Specifically when both are activated while resolving task conflicts and capturing the errors made, the prefrontal dorsolateral cortex will work to support memory and other executive functions, while the anterior cortex cursor is responsible for selecting the appropriate response and allocating attention.

DLPFC creates rules for the brain in order to complete the test task. In the Stroop effect, it also involves areas in the brain involved in color perception, but not in areas involved in word coding. Biases and irrelevant information appear, for example the fact that the 3ocus3ic perception of the word is more prominent than the printed word. Then the middle of the DLPFC will select a representation that will satisfy the task. Relevant information should be separated from irrelevant information. Therefore 3ocus is applied to the ink color, rather than to the word. Furthermore the posterior part of the ACC will be responsible for the decision made (whether the answer is right or wrong). After responding, the anterior part of the ACC will evaluate the response, whether true or false. The activity in this area will increase as the error probability increases.

Stroop test is easy to do. It can be applied to people start from the age of 6 years to 80 years. The test officer also requires only a short course of training because he or she only does little intervention on the subject.

2.3 Treatment

The experimental treatment in question is the giving of physical education subject by using BBPEL. BBPEL is given for 8 meetings (one meeting per week for two months). It was given in accordance with the schedule of physical education subjects in school, for 3x 40 minutes per meeting. The treatment in the group is the provision of traditional physical education lesson learning, using direct teaching strategy: skill-drill-games. Teachers give examples of specific sports skills, have students practice those skills and then use them in the game intact. As with the treatment group, traditional physical education learning is also provided for 8 meetings (one meeting per week for two months). It was given in accordance with the schedule of

physical education subjects in school, for 3x 40 minutes per meeting.

Traditional physical education materials are also adapted to the 2013 curriculum materials: (1) Big Ball Game Using Basketball (2 meetings); (2) Big Ball Game Using Soccer Game (2 meetings); (3) Small Ball Game Using Cash Game (2 meetings); (4) Small Ball Game Using Badminton Game (2 meetings).

In order for the implementation of BBPEL learning model to be treated from this research is applied well, so that the research is valid, then validation instrument has been tested by the physical education expert and has been tested in preliminary research.

In order for this study not to violate ethics and human rights, it is done in such a way as to follow the principles established by the research ethicists. The researcher refers to the 10 principles of The Nuremberg Code based on Ethical Issues in Behavioral Research Basic and Applied Perspectives, Second Edition by Allan J. Kimmel.

3 RESULTS

Using the Shapiro-Wilk normality test and the Lavene homogenity test with a 0.05 cut off point it was found that the research subjects' age, weight and height were normal and invasive distributed. As for independent sample T-test, there was no difference between characteristic of age, body weight and height between treatment group and invasiv group (respectively p = 0,105; p = 0,507; p = 0,251).

Table 1: Characteristics of Research Subjects.

Characteristics	Treatment Group (BBPEL) n=20		Control Group (Traditional PE) n=19	
	Mean	SD	Mean	SD
Age (years)	12,92	0,51463	12,64	0,50
Weight (kg)	49,39	14,98	46,34	13,23
Height (cm)	154,7	8,15	151,47	9,02

Characteristics of research subjects are shown on table 1. The age difference affects the executive function, therefore with the nvasive research subject characteristics in terms of age, weight and height increases the internal validity of this study.

In addition, for the two intake classes to be sampled this study is taught by teachers of mathematics subjects, English and the same nvasive language. Both classes also received the same nvasive treatment from the school environment as it was regarded as the two brightest students' classes at the school based on the admission nvasive at school (The subject was in the first year of Junior High School). The above conditions are expected to have an equal influence between the two groups in order to avoid the bias of influence from the academic environment on student academic achievement after treatment.

This study is also expected to be followed by all students in the intact class, but because this research involves taking a blood sample that is nvasive, then after the explanation of detail (informed consent) to students and parents through a classroom teacher approach; only 20 subjects from each class are willing to participate. The actual number of students in one intake class is 30 students each. In order not to disrupt the natural situation of the learning environment, then all students still learn together (not separated) without each other knowing who is not willing to be the subject of this study.

Table 2: Mean Score of Executive Function Performance.

Variable	Treatment Group (BBPEL) n=20		Control group (Traditional PE) n=19	
	Mean	SD	Mean	SD
Executive Function Pre (second)	84,76	16,98	72,57	13,22
Executive Function Post (second)	67,3	11,26	61,54	9,89

From the table 2 above, we can see that before treatment, the average ability of the student executive function in the control group was slightly better than the students' ability in the BBPEL group (72.57 seconds, compared with 84.76 seconds). However, after treatment, the ability of the student executive function in the BBPEL group was slightly better (67.3 seconds compared to 61.54 seconds).

Based on the result of statistical descriptive analysis, it is known that the data of all variables in each group are homogeneous and normally distributed (Shapiro-Wilk Normality test p> 0.05 and Lavene homogenity p> 0,05).

Both treatment groups experienced improvement in executive function of students after getting physical education for 8 times meeting, p <0.005 with paired sample T-test.

Table 3: Results of Paired Samples Test Results of Executive Functions Before and After Obtaining BBPEEL and Traditional PE Learning.

	Paired Differences		Sig (2-tailed)
Pair executive function before and after treatment on both groups	Mean	SD	0,000
	14,32872	10,03989	0,000

From the table 3 above, taking into account the results of the executive function of the treatment and

control group students we can see that the average initial ability of the control group executive function is much better than the treatment group. Both have improved after learning physical education. However, the final ability of the executive function in both groups is not very different. Thus it can be assumed that there is an increase in the higher ability of executive functions in the treatment group.

Table 4: Comparation of Executive Function Before and After Treatment Between Groups.

Variable	Treatment Group (BBPEL) n=20		Control Group (Traditional PE) n=19	
	Mean	SD	Mean	SD
Executive Function Pre (second)	84,76	16,98	72,57	13,22
Executive Function Post (second)	67,3	11,26	61,54	9,89

Comparation of executive function before and after treatment between groups are shown on table 4.

Table 5: Description Variable Gain Score.

Group	Mean	Std. Deviation	N
Treatment	17,4685	11,71071	20
control	11,0237	6,74946	19
Total	14,3287	10,03989	39

Description variable gain score are shown on table 5. To examine the difference in executive function performance between groups by considering the possibility of influence of initial condition of group executive function (pretest), assumption and restriction tests were done in advance.

There is a reasonable correlation between the dependent variables (Correlation is called reasonable i.e. when the positive does not exceed r = 0.90 and the negative correlation does not exceed r = -0.40 EF_Post with EF_Pre r =, 798 <0.90) Correlation EF_ with another variable is negative because the value of EF_ is the time required to complete the cognitive task that is inversely proportional to the cognitive abilities shown by other variables.

Furthermore, T test to determine the difference EF_Pre (Pre performance test results executive function) between groups.

From the result of T test above, it is concluded that there is significant difference between pretest of executive function and both groups (p = 0,017 <0,05). This causes the subsequent analysis to not be used for the analysis of the variance by using the pre-test of the executive function as a co-variant, since assumptions and restrictions are not met (Owen, 1998; Mayers, 2013; Breukelen, 2006). So then the ANOVA test is used with gain score. Gain score is obtained by looking at the performance improvements that occur in both groups. The requirement to use gain score calculation is fulfilled with high correlation between post test result of executive function with pretest of executive function (r = 0,798).

The average of executive function improvement in the treatment group was 17.4685 seconds, while the average control group increased by 11.0237 seconds.

Table 6: ANOVA Gain Score Pre-Post Test Executive Function Tests of Between-Subjects Effects.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	404,706[a]	1	404,706	4,371	,043	,106
Intercept	7909,891	1	7909,891	85,433	,000	,698
Treatment Group	404,706	1	404,706	4,371	,043	,106
Error	3425,668	37	92,586			
Total	11837,548	39				
Corrected Total	3830,374	38				

a. R Squared = ,106 (Adjusted R Squared = ,081)

From result of ANOVA test are shown on table 6 above, the significance 0,043 <0,05, thus H0 is rejected. In conclusion there is a difference in performance improvement of executive function among group of students who follow BBPEL learning and traditional pela learning.

4 DISCUSSIONS

Executive function has a locus in the prefrontal cortex circuit. Several studies have demonstrated activation in the area of the brain that includes the middle-frontal, superior frontal, superior and inferior parietal regions of the anterior cingulata speral cingulata. Physical activity alone activates the brain area more than the motor area (Davis and Lambourne, 2009).

Previous research on executive function has become neurological and neuropsychological domains, emphasizing the primary function of the prefrontal cortex in controlling executive processes and related behaviors. But then there was a shift along with the build-up of bridges between health care practitioners and practitioners in the field of education (Metzler, 2017).

The academic success of this digital age is increasingly related not only to students' technological skills, but more importantly how they master goal setting, planning, prioritizing, organizing and maintaining manipulating information in shifted working memory (shifting) with flexible and self-monitoring (self-monitoring / self-checking); which collectively all these abilities are considered as executive functions (Metzler, 2017).

This seems to be in line with the philosophy of the essence of teaching that Joyce and Weil (1996) has delivered, that the teaching mission of the teacher is not merely the content of the material, but teaches students how to learn. For the next ten or twenty years, material presented by teachers may no longer be contextual; then what students need is the ability to learn independently (Joyce and Weil, 1996).

The way to improve executive function is an area now under study in education through improvements in teaching strategies to curriculum adjustments (Metzler, 2017). Implementation of efforts for a policy approach takes time, especially in Indonesia. Meanwhile, one way to improve the executive function that is already present in the curriculum in Indonesia as one of the compulsory subjects at every level of the school from elementary, middle, and even on some courses in universities; namely the subject of physical education.

The results of this study indicate a significant increase in the ability to read Color-Word stroop test cards in all students who received physical education BBPEL as well as traditional physical education (before: 78,8262 ± 16, 28448 seconds; after: 64,4974 ± 10, 87664 sec; $p < 0,000$). The initial test is done just before the new semester (second semester) begins, as well as the start of this research treatment. Previously, the test students do not get physical education lesson for a month because of the final exam and the end of semester 1. Therefore, the given physical education lesson is a new treatment received by students of that period.

This increase in executive function is already in line with previous alternatives which show an improvement in executive function in the sample of children due to sports treatment, although alternative measures the ability of its executive function differently (Tomporowski, 2008). The measurement with alternative stroop test is theoretically acute exercise can also improve the results of this test, such as 20 minutes of moderate intensity running on the treadmill (Sibley et al., 2006), 30 minutes cycling (Ferris et al., 2007), 10 minutes cycling. In learning physical education both BBPEL and Traditional in this study there is no measurement of active moving time and the intensity of the sport objectively; but the syntax of teacher learning and supervision ensures that students move intermittently and actively for 3x40 minutes. If the minimum time active student in accordance with the research ever done (Wisconsin Department of Public Instruction, 2011) is 50%, then the assumption of students moving for 60 minutes and the amount is quite adequate.

The most noticeable difference between the student's management that occurs in the learning of BBPEL and traditional is how the learning environment is made in harmony with the nature of the brain. At BBPEL the atmosphere of the learning environment is guarded by taking into account the physiological aspects (paying attention to the hydration of students by providing a special time slot for drinking), as well as the psychological aspects with the creation of a fun, safe, comfortable yet challenging learning environment.

The comfortable learning atmosphere begins with a playful accompaniment, this is also intended to overcome the peripheral attention of the peripheral, and the use of the ear senses. The BBL principle states that the brain at the same time can perform simultaneous jobs, and that in addition to observing one, simultaneously the brain also noticed peripheral. Music on BBL facilitates the working ability of the brain that always wants to be busy (The brain is a parallel processor, Learning involves both focused attention and peripheral perception). At the same time also create a happy atmosphere (Emotions are critical to patterning). This cheerful atmosphere is also created with a carefree heating, moving directly from the beginning of learning.

Another difference to BBPEL with traditional learning is that in traditional learning, students such as robots are guided to perform one particular work, new and should be like that regardless of the initial conditions of the student's abilities. The teacher will perform a certain physical motion demonstration, and then the students are told to imitate and repeat the physical motion.

In BBPEL, students are expected to learn through pattern creation (The search for meaning occurs through "patterning"). From the moment of warming up, physical motion during heating has similarity with the core motion that students will learn at the core of learning. After that the students will see a teacher demonstration of the physical motion activity they will learn that day. Demonstration of the teacher will make students feel comfortable, rather than purely inquiry teaching, where direct learning begins with questions. Demonstrations make students start their own learning with observation. Observation continued by observing themselves and their partners during the

physical movement. After making good observations when viewing teacher demonstrations and while doing it alone with friends, students can then assess the extent of physical movement that they can do. Students can ask themselves why they cannot do it yet, or how to do it better. The teacher will provide a choice of alternative motion exercises that match the basic motor skills that students can take to answer the question. The student is then told to try and reason the physical exercises they choose. Trying and reasoning is done simultaneously, if it meets difficulty, it tries to alternate the motion and the end reaches the final result of how to perform the best physical motion. The nature of such learning methods is expected to be in line with the mechanism of the brain's work, the brain is not forced to learn something like a robot. We have (at least) two types of memory systems: spatial and rote learning The brain understands and remembers best facts and skills are embedded in natural spatial memory) (Caine and Caine, 1991).

In learning BBPEL, in addition to making comfortable with learning physical activity according to their respective development, at each post training that can be selected by students there are challenges to achieve specific targets (Learning is enhanced by the challenge and inhibited by threat; Every brain is unique). Challenges and cheerfulness are also added to semi-competitive games involving previous physical activity.

5 CONCLUSIONS

The difference in the performance of the executive function in the BBPEL group is higher than that of traditional learning groups. Although the aspect of motor activity itself with the intensity and duration is not too different, but the complementary aspects of physical activity is very different. This is considered that the treatment factor given in this study is not the same as physical activity in the form of solid 'exercise training' which is done on a particular subject as in previous studies. The physical activity in this study is part of complex physical education learning. Thus there are other aspects that will affect the brain activity in general and the executive function in particular.

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