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Effectiveness of Brain-Based Learning Models on Creative Thinking Skills and Students' Learning Outcomes in History Subjects

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ABSTRACT:

Education in the 4.0 era directs human civilization to informative spaces based on technological developments. In achieving efforts to optimize human resources in cognitive awareness, the brain-based learning model is the answer to the problem of learning models in the digitalization era. In this study, a brain-based learning model was applied to determine the effectiveness of increasing creative thinking skills and learning outcomes for students in history subjects. The research design in research is quasi-experimental. The sample in this study were students of class XI IPS 3 at Kencong High School for the 2022/2023 academic year. The effectiveness test formula is based on the pretest and posttest divided by the standard deviation. The results of the effectiveness test were 2.70 and 1.42 included in the high category. Thus, this study recommends using brain-based learning to optimize creative thinking skills and learning outcomes, because this model makes the learning process of students more effective, interactive, and flexible.

Keywords: *Brain-Based Learning, Creative Thinking Skills, learning outcomes.*

INTRODUCTION

Education, like the world's level of progress and civilization, is always experiencing alteration and renewal. In the field of education, the presence of transformation refers to key factors in training young people to be engaged and productive members of society (Bedir, 2019). Education, particularly in the 4.0 age and increasing globalization, is required to bridge user wants and issues in satisfying the needs of students' characteristics and learning methods. As a result, education should be capable of producing flexible, adaptable, and inventive outputs and learning processes (Cholily et al., 2019). In order to achieve such outputs and processes, educators needed to actively contribute to developing learning alternatives. Moreover, the adult learning process now has to integrate technology (ICT and IoS), so that the achievements obtained from the learning process in the digital-based literacy era are collaboration skills, communication skills, creative thinking skills, and creativity (Solihin et al., 2019; Widiana et al., 2017; Ellahi et al., 2019; Doringin et al., 2020; Anggraeini & Umamah, 2019). In this case, educators must ensure that students achieve the goals of learning by developing technological skills to facilitate continuous learning

(Rufaidah et al., 2021). In achieving the skills that have been described as a manifestation of the success of the learning process, learning elaborates on the 4C skills (creativity, critical thinking, communication, and collaboration).

However, empirical facts in research conducted by Armadi and Sihabuddin (2021) show that students in the technological era tend to be monotonous and bring up very textual ideas, which is why it requires students to take notes. This is an indication of students' lack of creative thinking. Low creative thinking ability is also influenced by teachers who are not precise in choosing learning models and making questions that are less varied (Umamah et al., 2021). This is also an indication of creative thinking skills. According to research conducted by Al-khawaldeh and Qattawi (2014), the urgency of creative thinking is emphasized by the individual's need to adapt to an ever-changing and complex world. So that it can enable each individual to generate innovative solutions, think critically, and identify problems from various perspectives.

In addition, a lack of understanding and awareness of the importance of creative thinking in education and a lack of training and learning that focus on developing creative thinking skills can also hinder the learning process (M.T.R. El-Aqeeli, 2018). Unsupportive environmental factors, such as a curriculum that is too focused on factual knowledge and evaluation that places more emphasis on correct answers, can also hinder the development of creative thinking (T. Dahlan, D. Darhim, 2018). This demonstrates that students who use brain-based learning approaches, or brain-based learning (BBL), have high learning results. The teaching and learning process in the classroom also has problems in education related to the application of the brain-based learning (BBL) approach. Although this approach helps in understanding student characteristics, there are still deficiencies in addressing students' emotional intelligence, historical empathy, and stress management. In addition, students also experience anxiety when facing historical tests that involve large amounts of data that require memorizing facts, even though they have been given training on different memorization techniques (Arifin, 2018; Darmawan et al., 2022; Duman, B., 2010). Using mind maps in history textbooks can help students organize and relate information visually and creatively

Referring to existing research opinions, it shows contra-prepositions on aspects of cognitive abilities that are biased between students and educators, so that they do not achieve the ultimate learning objectives that produce significant outputs. To deal with these problems, solutions are needed in the context of education, which can develop students' abilities to face the challenges and changes that occur in a world that continues to experience development. Creative thinking allows students to see problems from various perspectives, produce innovative solutions, and develop high adaptability. In addition, creative thinking can also improve critical thinking skills, communication, collaboration, and problem solving, which are important skills in everyday life and the world of work. Therefore, education that encourages and develops creative thinking in students is very important (M.T.R. El-Aqeeli, 2018).

Based on the existing problems, there is research as an antithesis that is aimed at bridging the problem of learning process habits by using the BBL learning model approach. The results of Umamah's research (2017) show that in the empirical conditions reviewed above, it is necessary to rearrange the curriculum, which is a very dilemmatic effort. On the other hand, empirical issues that are complex in learning must be clarified. There are several main problems in the current learning dynamics, so the treatment that can be done is in the form of

cognitive strengthening (creative thinking), which is innovative. The resulting impact is in the form of productive behavior. From several studies related to BBL, one of which was conducted by Agus Suprianto (2017) and Jensen & McConchie (2020), it was said that there was an increase in students' creative thinking skills after receiving learning using brain-based learning. This learning produces better output than conventional learning.

The technology-integrated BBL model will help teachers meet their needs as a whole and also replace literacy-poor learning models with technology-integrated (literacy-rich) teaching and learning facilities. Brain-based learning also encourages the use of creative thinking methods such as brainstorming, problem solving, and lateral thinking. Teachers can use these techniques in the learning process to encourage students to think innovatively, see problems from various perspectives, and come up with creative solutions. (Ghavifekr & Rosdy, 2015). In line with this opinion, in research using the BBL approach, students prepare themselves to solve problems by learning to think, looking for answers, and asking others through discussion and communication.

In line with the statement of the Minister of Education and Culture (2022) Concerning Guidelines for Implementing Curriculum in the Context of Recovery of Learning and the principles contained in the circular of the Minister's decision, learning emphasizes social, cognitive, emotional, and technological competence in learning (Rufaidah et al., 2021). In line with the character and principles of BBL, the implementation of the independent curriculum will be optimally carried out relying on the implementation of the BBL model, which includes a cognitive aspect approach and social competence as indicated by creative thinking skills. On the other hand, referring to the findings of field observations at SMAN Kencong, Jember Regency, East Java, as the locus and focus of the research, information was obtained about learning methods that were not yet integrated with technology. As a result, there is no interaction that encourages communication processes and cognitive abilities between students and educators. The output resulting from implementing the learning model is a decrease in student learning outcomes (Umamah et al., 2022). Based on the findings of previous research and information from the results of field observations, this study designed a learning tool with a technology-based BBL learning model, with a focus on results on the level of creative thinking skills and student learning outcomes in history subjects. Therefore, the purpose of this research is to verify the effectiveness of the BBL model on students' creative thinking skills and history learning outcomes.

METHODOLOGY

The approach used in this study is a quantitative approach with a quasi-experimental research model. This study uses three variables consisting of the technology-integrated BBL model (as variable X), creative thinking skills (as variable Y1), and learning outcomes (as variable Y2). The focus of the research is Kencong State High School in the 2022–2023 academic year.

Henceforth, the experimental class and the control class are selected by selecting two classes that have an average value that is almost the same. Then the XI IPS 3 and XI IPS 1 classes were chosen. The selection of two classes with a high average aims to provide treatment for creative thinking skills. It is necessary to have a high understanding, and the assumption is that if the average value of the daily test results is higher, it is easier to be invited to think creatively. As proof that the two classes are homogeneous, a homogeneity test is carried out.

Table 1: Test Levene

		Levene Statistic	df1	df2	Sig.
Learning outcomes	Based on Mean	.524	1	60	.472
	Based on Median	.391	1	60	.534
	Based on Median and with adjusted df	.391	1	59.993	.534
	Based on trimmed mean	.594	1	60	.444

(Source: primary data processed)

Based on the data above, it shows a significance value of 0.472 (0.472 > 0.05), which means that the values of the two classes to be used have homogeneous data. So that the class is feasible to use as a research sample. So then, the selection of class samples was carried out, namely class XI IPS 3 as the experimental group and class XI IPS 1 as the control group, with the consideration that, besides being homogeneous, the average daily test scores were almost the same. After determining the experimental class and control class, the two classes will be given treatment. The control class was given treatment using the BBL model (class XI IPS 3), and the control class was given treatment using the problem-based learning (PBL) model. This is done to find out whether there is significant effectiveness between the two learning models.

The instrument in this study was a questionnaire and a test of 30 multiple choice questions in domain C4 (analyzing). The questions used were developed in accordance with HOTS guidelines and adapted to creative thinking skill indicators. On the one hand, the use of instruments to measure creative thinking ability in the form of projects (performance) with assessments according to indicators is based on Silver's theory (1997), which gives a score of 4 if the results meet the indicators of creative thinking ability. Before the research instruments were given to students, trials were first carried out to measure the level of validity and reliability. After the questionnaire, pre-test, and post-test have been declared valid and reliable, the instrument is suitable for use as a data collection tool. Furthermore, the control class will be given treatment in the form of a brain-based learning (BBL) model, and the experimental class will be given a treatment of a problem-based learning (PBL) model. The two classes that had been treated were given a posttest to see the differences between the two models. The hypothesis test in this study is that the effectiveness test is calculated using effect size (d) or effect size based on the difference between the two average posttest (Mpostest) and pretest (Mpretest) scores divided by the standard deviation (spread) of the average student scores. These two values can be seen in the output of the t-test (Paired Sample T-test) column mean and standard deviation.

$$ER = \frac{Mpretest - Mpostest}{standar\ deviasi}$$

The value of the effect size (d) is based on the criteria of Cohen (2007), with an explanation listed in the table below.

Table 2: Score criteria *effect size*

Value *effect size (*d)	Interpretation
0-0,20	Weak effectivines
0,21-0,50	Simple effectivines moderate effectivines
0,51-1,00	High effectivines
>1,00	

(Sumber: Cohen, 2007)

RESULT

a. Test prerequisite analysis

1). Normality Test

Analysis and prerequisite testing are carried out to meet the requirements before testing the hypothesis. The analysis prerequisite tests used are the normality test, the regression homogeneity test, and the linearity test. Normality test was measured from the results of pretest and posttest data of both samples, namely the control class (XI IPS 1) which was given the treatment of Problem Based Learning model and the experimental class (XI ips 3) which was given the treatment of brainbased learning model. The normality test formula used is Kolmogorov-Smirnov assisted by SPSS for Windows version 25. Decision-making criteria using a significance level of 5% so that:

- If the sig value> 0.05 then H0 is accepted (normally distributed)
- If the sig value <0.05 then H0 is rejected or Ha is accepted (not normally distributed).

The results of the pretest and posttest data normality tests for creative thinking ability and student learning outcomes in the control class (XI IPS 1) are as follows:

Class		Kolmogrov Smirnov		
		statistic	**df**	**sig**
Pretest	Control	**0,144**	**30**	**0,112**
	Eksperimen	**0,116**	**32**	**0,200**
Postest	Control	**0,146**	**30**	**0,101**
	Eksperimen	**0,131**	**32**	**0,174**

Table 3: Normality test results

(Source: Primary data processed)

Based on the output results of the normality test using the Kolmogrov-Smirnov test in Table 3, the significance value for the experimental class was 0.200 for the pretest data and 0.174 for the posttest data, while the significance value for the control class was 0.112 for the pretest data and 0.101 for the posttest data. Based on the decision-making criteria, the value of the results of the research on the ability to think creatively for the two classes has a significance value above 0.05 so that H0 is accepted, meaning that the pretest data is normally distributed and the posttest data is normally distributed.

2) Homogeneity test

In the homogeneity testing stage, it is applied with the aim of seeing sample data from the experimental class and the control class having the same or different variants. Homogeneity testing is applied with the aim of seeing sample data from experimental and control classes have the same or different variants. Homogeneity testing requires a test of homogeneity of variance analysis with Levene statistics using the help of a program on SPSS version 25 for windows. The criteria for decision making are:

a. If sig. > 0.05 then H0 is accepted (homogeneous sample data)
b. If sig.<0.05 then H0 is rejected or Ha (sample data is not homogeneous)

Table 4: Results of Homogeneity Test of Creative Thinking Ability

Data	***Levene test statistic***	**df2**	**Sig.**	**Information**
The value of creative thinking before treatment	0,004	70	0,948	Homogeneous

(Source: Primary data processed)

Based on the data presented in Table 4, the value of the ability to think creatively before treatment in the control class and experimental class was 0.004 with a sig. 0.948 > 0.05. The conclusion obtained from the homogeneity test for the value of the ability to think creatively is that H0 is accepted, and both the value of creative thinking from the control class and the experimental class state that the data is homogeneous.

Table 5: Results of Learning Outcome Homogeneity Test

Data	***Levene test statistic***	**df2**	**Sig.**	**Description**
The value of learning outcomes before treatment	0,017	70	0,896	Homogeneous

(Source: primary data processed)

Based on the data presented in Table 5, it shows that the Levene test statistical homogeneity test for the value of learning outcomes before treatment in the control class and experimental class was 0.017 with a sig. 0.896 > 0.05. The information that can be obtained from the homogeneity test for the value of creative thinking ability is that H0 is accepted and both the learning outcomes of the control class and the experimental class are stated to be homogeneous.

(3) Homogeneity test from regression

Regression testing aims to determine whether there is a relationship between the covariate and the independent variable. The test was carried out with a significance level of 0.05. The slope of the regression line can be said to be mutually homogeneous if the interaction

between the covariates and the independent variables has a significant value of more than 0.05.

Table 6: Creative Thinking Skill Regression Homogeneity Test Results

DATA		Type III Sum of Squares	Df	Mean Square	F	Sig.
PRETEST * CLASS	*	.190	1	.190	2.372	.129

(Source: primary data processed)

Table 7: Results of Regression Homogeneity Test of Learning Outcomes

DATA	Type III Sum of Squares	Df	Mean Square	F	Sig.
PRETEST * CLASS	.743	1	.743	1.760	.190

(Source: primary data processed)

Based on the data presented above in Table 6, Table 7 shows the results of the homogeneity test of creative thinking skills regression and learning outcomes with significance values of 0.129 > 0.05 and 0.190 > 0.05. So, it can be concluded that the results of the two regression homogeneity test values for creative thinking and learning outcomes are greater than the significance level of 0.05, so that the assumption of homogeneity of the regression is met.

(4) Linearity Test

The next stage is to carry out a linearity test. The test is intended to determine whether there is a linear relationship between the covariates and the dependent variable by using the F-test. Assumption of linearity as follows:

a. Sig value. > 0.05, there is no significant linear relationship between the covariates and the dependent variable
b. Sig value. <0.05, there is a significant linear relationship between the covariates and the dependent variable

Table 8: Linearity Test Results for Creative Thinking

DATA	Type III Sum of Squares	Df	Mean Square	F	Sig.
PRETEST	2232.265	1	2232.265	27822.668	.000

(Source: primary data processed)

Table 9: Linearity Test Results Learning Outcomes

DATA	Type III Sum of Squares	Df	Mean Square	F	Sig.
PRETEST	2847.758	1	2847.758	6747.217	.000

(Source: primary data processed)

Based on the data presented above in Table 8 and Table 9, a significance value of 0.000 and 0.00 is calculated. Since the two sig values (2-tailed) are smaller than the significance level of 0.05, it can be concluded that the linearity assumption of the regression is met. Thus, the assumption of linearity from the regression has a sufficiently strong reason for using the pretest variable as a covariate.

a. Test the Effectiveness of the Brain Based Learning Model

The t test can be carried out if the analysis prerequisite test has been fulfilled with the aim of seeing the effectiveness of the BBL model treatment on creative thinking skills and student learning outcomes. The difference test (paired sample t-test) is a reference to see the difference between the pretest and posttest mean values and also the standard deviation used in the effectiveness test formula.

Table 10: Results of the effectiveness test of creative thinking skills

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Pre-test Post-test	-1.200	.407	.074	-1.352	-1.048	-16.155	29	.000

(Source: output *spss 26 for windows*)

Table 11: The results of the test of the effectiveness of learning outcomes

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Pre-test Post-test	-1.100	.845	.154	-1.352	-1.415	-7.131	29	.000

(Source: output *SPSS 26 for windows*)

Sig (2-tailed) based on the data presented in tables 10 and 11 above shows that 0.000 <0.005. So, it can be concluded that the scores of students before the BBL model treatment were significantly different from those of students after treatment. The next step is the effectiveness test stage with the effect size formula, which shows the size of the effect object produced between before and after the BBL model treatment. The difference in mean scores between the pretest and posttest in the mean creative thinking skills and learning outcomes column is -1,200 and -1,100, while the distribution of student scores is in the standard

deviation column. The deviation is between 0.407 and 0.845. Then the effectiveness value test is obtained as follows:

a). the results of the effect size test of creative thinking skills

$$ER = \frac{Mpretest - Mpostest}{standart\ deviation}$$

$$ER = \frac{1,100}{0,407} = 2,70$$

b). the results of the effect size test of learning outcomes

$$ER = \frac{Mpretest - Mpostest}{standart\ deviation}$$

$$ER = \frac{1,200}{0,845} = 1,42$$

Based on the results of the calculation of the effect size (d) above, it is between 2.70 and 1.42. Referring to Cohen's criteria (2017) for one group design, it can be concluded that the effectiveness of the BBL model treatment is > 1.00, which means it is included in the high category.

DISCUSSION

Based on the stages in the research data processing process, it consists of a validation process aimed at ensuring that the instruments used are appropriate and can be used (reliable). In the research data processing process, validity and reliability tests were only carried out for the instrument, with a total of 30 instrument items. On the one hand, the use of instruments to measure creative thinking skills in the form of projects (work performance) with assessments in accordance with indicators is based on Silver's theory (1997) by giving a score of 4 if the results meet the indicators of creative thinking skills.

The results of the effectiveness test (effect size) show that the application of the BBL model to the learning process in schools can have a large effect on students' cognitive learning outcomes. The findings of this study are reinforced by the effectiveness given to the class taught using the BBL model in showing advantages such as students tending to be better able to understand C4 analyzing (differenting, organizing, attributing) compared to the control class, which was given treatment with the PBL model and tended not to be able to express the ideas or values that underlie the material. This is because the BBL model itself is a learning model that emphasizes the concept of constructivism, which shows that learning is more effective and meaningful because it emphasizes creative activities such as building (constructive) (Widiana et al., 2017). In addition, BBL also encourages students to prepare themselves to solve problems by learning to think, looking for answers, and asking other people through group discussions (Agus Suprianto, 2017). In addition, the BBL model has an effect on students' creative thinking abilities, which can be observed from a high level of efficacy, so that students can solve problems and provide ideas in their own way (Imanuel et al., 2021).

The BBL model can also encourage students to always learn to think creatively, which will have an impact on improving student learning outcomes. As stated by (Jensen & McConchie (2020; Badriah & Ramdani, 2018), This is also evidenced by research conducted by Fajriati et al. (2017) showing that the learning outcomes of students who use the BBL model are quite good, this is because the BBL learning model is learning that can improve brain

chemistry and stimulate willpower and perseverance, which affect creative thinking and learning outcomes.

By moving through the following seven phases, the syntax of the BBL model might improve the success of students' attempts to be more engaged in the learning process: The first step of pre-exposure is the phase of increasing students' curiosity; this phase serves as a review for the brain before delving further. The second stage of planning Students are urged to establish anticipatory circumstances in this phase, but with a bit more learning preparation, such as relating today's learning subject to past information. Educators reinforce learning in the third phase of initiation and acquisition so that it can be developed in accordance with learning objectives. Elaboration, often known as the processing step, is the fourth phase. The teacher supports students in holding conversations and gives reinforcement during the learning process at this level. Incubation and entrance into memory are the fifth and final steps. Rest time is prioritized in this phase to be spent optimally, such as reviewing previously learned content. The sixth step of verification and verifying confidence in this phase focuses on prior stages that have been examined in order to determine the deficiencies of each stage that has been performed earlier. The final stage is celebration and integration, or rewarding students who participate in the learning process.

These findings are supported by theoretical and empirical research done by Febriana et al. (2019), which shows that the brain-based learning paradigm influences students' creative thinking abilities. This was also emphasized. Furthermore, a similar study conducted by Utama et al. (2018), entitled "Application of the Brain Based Learning Approach as an Effort to Increase Learning Creativity in Social Studies Subjects," discovered that using the Brain Based Learning (BBL) model can increase student learning creativity. Previous research, specifically that conducted by Agus Suprianto and Mirza (2017) with the title "Creative Thinking Ability of Students Through Using Brain Based Learning Approach," stated that increasing students' creative thinking abilities after receiving learning using brain-based learning was better than conventional learning. According to this hypothesis, students in studies employing the brain-based learning technique prepare themselves to solve issues by learning to think, look for solutions, and question others through group discussions (Agus Suprianto, 2017). The final stage is celebration and integration, or rewarding students who participate in the learning process.

Students with creative thinking talents might be influenced by the brain-based learning approach itself. It may be observed in the area of strong self-efficacy, which is the ability to solve and propose suggestions for issues provided in a clear, entertaining manner. Students in the intermediate self-efficacy group are able to construct solutions in clear words and in their own language to clearly express issues and solutions (Imanuel et al, 2021). Based on prior studies, the title "The Effectiveness of Brain-Based Learning Assisted by Schoology Toward Students Creative Thinking and Self-Efficacy" shows that brain-based learning has an influence on creative thinking skills. According to Badriah and Ramdani's (2018) study, "Brain Based Learning (BBL) Model to Improve Learning Outcomes of Elementary School Students on the Subject of the Indra System," the brain-based learning model can influence student learning outcomes. The findings of this investigation support earlier studies. A comparison of brain-based learning models in the control and experimental groups yielded pretty substantial findings, particularly in the cognitive domain at C3. C4 and C5 levels in the experimental group were significantly higher than in the control group.

Jensen (2009) asserts that instructors are supposed to be able to select learning that will boost brain chemistry, willpower, and perseverance in order to improve learning outcomes. Brain-based learning, according to Akyürek's (2013) and Saleh and Subramaniam's (2018) research, can improve student learning outcomes and raise motivation and attitudes.

The brain-based learning paradigm used in history learning, namely in the control class, has a positive impact on learning results. The difference in average scores achieved between the pretest of 76 and the posttest of 84 demonstrates this. The brain-based learning model, on the other hand, outperforms the problem-based learning model. This is obvious from the experimental class's average, which is 78 for the pretest and 88 for the posttest. The experimental class has a higher average value than the control class. Based on the average value of the two classes' learning outcomes, the experimental class outperforms the control class. Thus, teaching a brain-based learning model to the experimental class produces better learning results than teaching a problem-based learning model to the control class.

As a result, while both the brain-based learning model and the problem-based learning model are influential, the brain-based learning model outperforms the problem-based learning model in terms of influencing students' creative thinking abilities and learning outcomes.

CONCLUSION

Based on the results and discoveries discussed in the results and discussion section, it is determined that the BBL model is very beneficial in improving creative thinking abilities and student learning outcomes in history topics. The BBL model's efficiency may be demonstrated in the effect size (d) calculation findings of 2.70 and 1.42, with the qualifier of being very successful. According to the results given above, information acquired from study results indicates a large output from learning outcomes based on the BBL Model. Empirical findings, on the other hand, suggest that the adaptive and flexible BBL learning model can be combined with changes in the continuing digital technology era, allowing the BBL model to be used as a history learning model in schools.

Suggestions for additional study improvement suggest that various challenges were found throughout the research process that need to be addressed. Environmental, visual, psychological, and brain dysfunction elements all play a role in the successful use of the BBL paradigm. It should be highlighted that one of the most common hurdles in work study is that the interactions between educators and students must be given greater attention at each step since, with the characteristics of the BBL model, educators are expected to be more quickly aroused by the requirements of students. Another challenge with the BBL model is that it requires excellent time management so that there are no shortages or extra time limitations throughout the learning process in class.

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