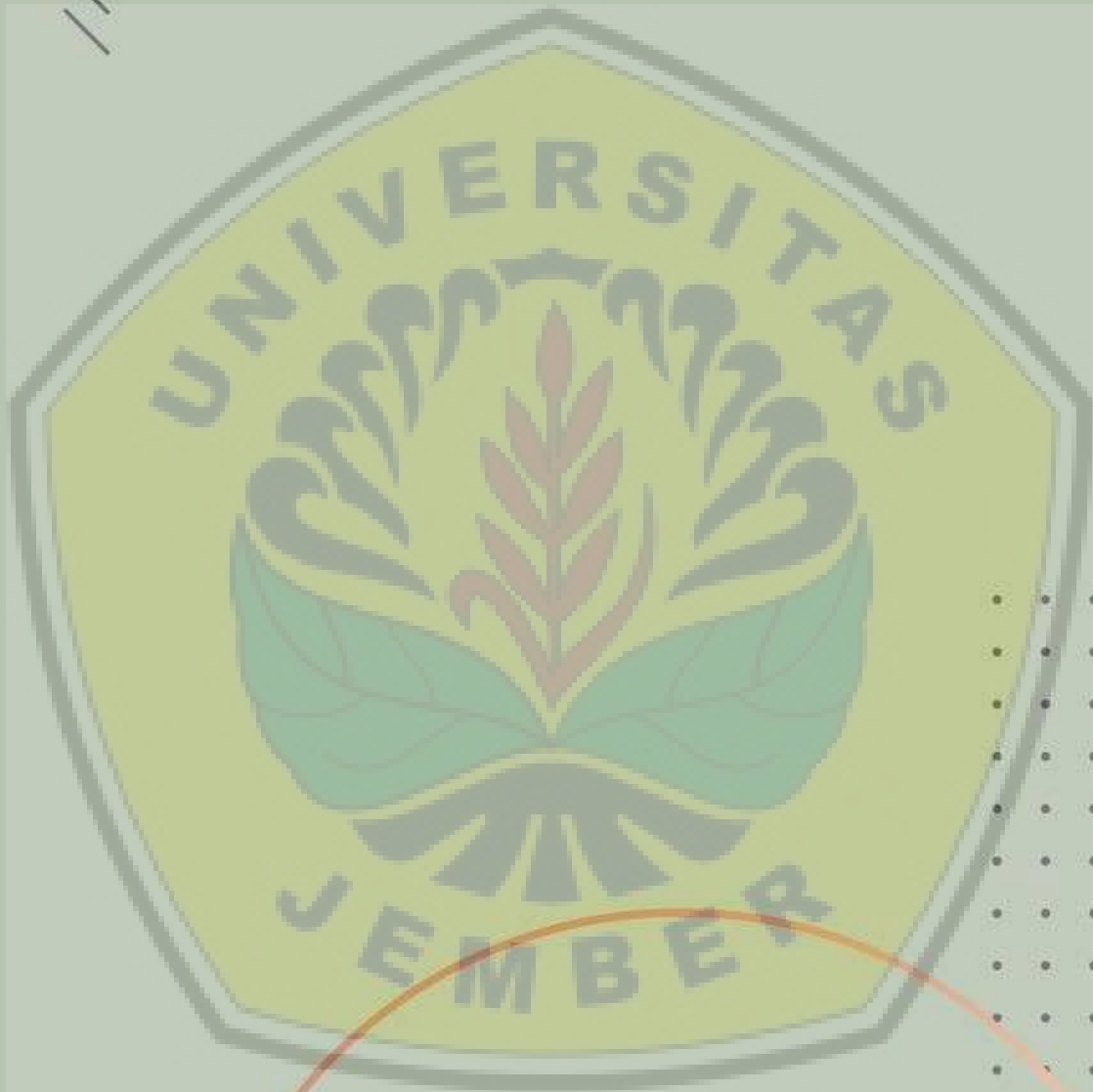


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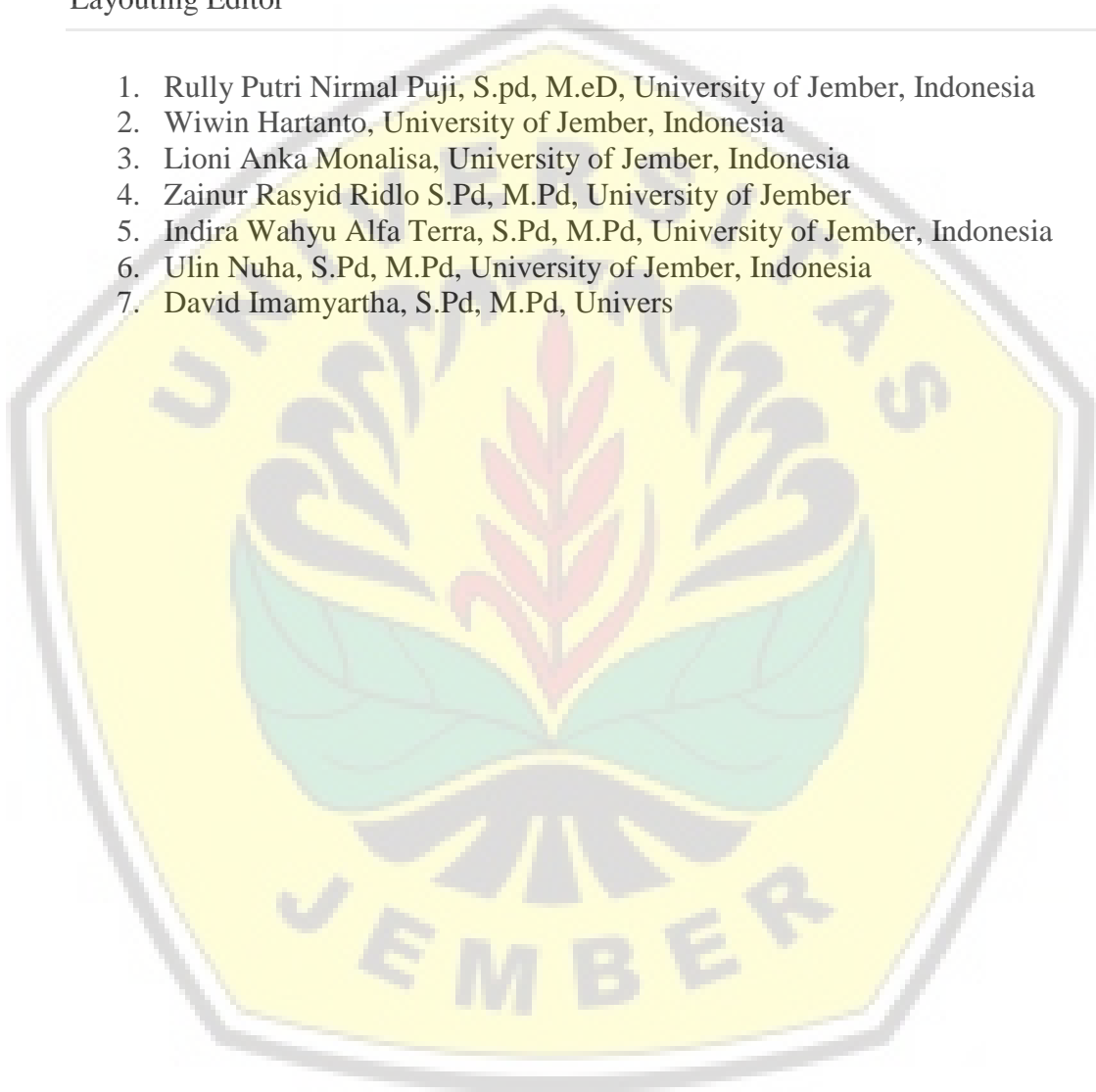
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The Development of Brain-Based Learning Model Based on Reciprocal Teaching (BBL-RT) for Learning Biology in High School

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ABSTRACT

One of the learning models which supported the students to be active is BBL-RT learning model. This research was intended to obtain a valid, practical and effective BBL-RT learning model. The type of this research was R&D and its research model was ADDIE (Analyze, Design, Development, Implementation, and Evaluation). Analyze stage: analyzing the problem to develop the learning model. Design stage: making the instruments of learning and research. Development stage: conducting the validation and small-scale testing. Implementation stage: conducting the class-scale testing. Evaluation stage: drawing a conclusion of BBL-RT learning model which was proven to be valid, effective and practical to be used by teachers. The mean result obtained from the learning instrument validation was 91, under "very valid" category. The high value obtained from normalized gain was 0.80. The mean results on the percentage of students' and teachers' responses were categorized into "excellent" in which the teachers' responses was as much as 97% and the students' was 86%. It can be concluded that BBL-RT learning model was valid, effective and practical.

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INTRODUCTION

Education, according to the 21st century skill implemented by the government is exploring the students' abilities in finding out and developing the knowledge that they have gained from any sources of knowledge. The 21st century skill refers to an important skill which is suitable to the current demands of the development. The 21st

century skill plays an important role in education as it helps each individual to be effective as a student (Griffin and Care, 2015). The trend of science learning in the 21st century is on 4C covering: communication, collaboration, critical thinking and problem solving, creativity and innovation (Anderson and Krathwohl, 2001).

The paradigm of 21st century learning is oriented to the students' abilities in acquiring the information through authentic sources, problem-solving ability, thinking critically and creatively, and being in team-work to achieve the learning objects (Yue, 2019). It suits the 21st century education which is related to the world of science and technology comprehensively (Putrid and Aznam, 2019). One of the 21st century learning on science field comes from one of biology characteristics in which it is about studying the problems related to natural phenomena and the application of biology in developing the technology to overcome the social-life problems (Saputri et al., 2018). Thus, based on the standard of science and biology education; the students' first real experiences in developing their skills, practices, and knowledge are able to help them learn science (Reiss, 2018).

Nowadays, the implementation of 21st century skill becomes one of the solutions to develop the students' skills and make them take an active role in the classroom. Education based on 21st century skill is able to make the students play an active role during the teaching and learning process (Zamorana et al., 2019). Active learning involves various ways to make students active from the beginning of learning through the activities done within group and have them think of the lesson in a short time (Shekhar et al., 2018). The effective learning is reached through the students' active involvement in learning (Ruisoto and Juanes, 2019). Active learning helps them produce a learning atmosphere between the students and teachers in which the students enjoy learning, the information is in long-term memory, encourage them to get a better understanding on the things they do, and affect the learning outcomes positively (Surakarn et al., 2020 and Hyun et al., 2017).

The lack of students' interests in reading and teacher's mastery while teaching cause the low learning outcomes on biology lesson. The difficult terms found on the biology learning material made the students put less interest in reading as the terms were hardly to be understood and remembered (Putra, 2019). Moreover, the students found it hard to understand the biology material since teacher's mastery in teaching was still relatively low (Hartini et al., 2019).

It is also supported by the data of google-form questionnaire distributed to biology teachers in Jember which revealed that 75.6% of them still used the lecture method, it was the reason why they got less teaching-mastery as the method used was lecture method while teaching. The teachers relied on the lecture method since their learning strategies were not well-arranged (Sanjaya and Budimanjaya, 2017). Also pointed out that the teacher's role was also using different kinds of teaching method which met the students' needs (Alhirtani, 2020). In fact, even though the revised 2013 curriculum had already been implemented at several schools, the learning process conducted by biology teachers was still on the knowledge mastery (theoretically) rather than the skills possessed by the students especially in developing the students' creativities which was productive (Julianto and Husin, 2018). The data taken from Program for International Student Assessment (PISA) showed that in 2015, Indonesia was on the 63rd rank out of 72 countries and it represented the low quality of education in Indonesia (Aseptianova et al., 2019).

The lack of students' understanding on biology material was because of their less-interests in reading through various learning sources before and during the learning process, and re-reading the material which was previously studied (Wati and Dewi, 2018). Therefore, the implementation of 21st century skill focused on student-centered so that they became the independent students by getting the meaningful learning which they engaged on and created by themselves.

This research indicated that reciprocal teaching approach improved the students' active roles through independent and creative learning by empowering their metacognitive skills. In addition, it should be noted that the implementation of reciprocal teaching learning also had its own weaknesses. Reciprocal teaching on its implementation made the students feel unmotivated since they were exposed only to textbooks (especially on passive students) (Lestari and Widyaningrum, 2016).

A good reciprocal teaching learning approach is able to be done by collaborating with a fun learning model. The use of fun learning model reduces the students' boredom and gets them more motivated in participate the learning process. Brain-Based Learning (BBL-RT) learning model is considered as a fun learning model by emphasizing on the learning enthusiasm along with its basic principle to develop the potential of think naturally by optimizing the brain power (Herliandy et al., 2018). The use of reciprocal teaching approach emphasized on critical thinking through the empowerment of metacognitive skills to improve the students' learning outcomes. Moreover, Brain-Based Learning model provides them freedom to develop their potential of thinking naturally, in which it is based on the function of two parts in the brain. The syntax of BBL learning model, covering: 1) Pre-preparation; 2) Preparation; 3) Initiation and Acquisition; 4) Elaboration; 5) Memory incubation and insertion; 6) Verification and Checking Conviction; and 7) Celebration and Integration (Jensen, 2008).

BBL-RT learning model as a modified learning model was resulted from the combination of BBL model based on reciprocal teaching. BBL-RT learning model was expected to support the learning process in accordance with the education demands of 21st century skill and become a good learning model. A good learning model has several criteria, consisting valid (theoretical), effective (related to learning objectives) and practical (the developing-things can be applied) (Plomp and Nieveen, 2013).

METHODOLOGY

The type of this research was research and development. This research was intended to obtain a model guidance-book containing the stages of an effective and practical BBL-RT learning model to be used in schools.

The research model used was ADDIE. There were five stages of ADDIE development covering; Analyze, Design, Development, Implementation, and Evaluation.

The development test of BBL-RT learning model was done at SMA Negeri Rambipuji in Jember Regency, East Java. It was conducted from August to November in 2019/2020 Academic Year. 34 students of X MIPA 4 at SMA Negeri Rambipuji were chosen as the subjects of this research.

a. The Validation of Learning Model Product

Analyzing the results of validation data by using:

$$\text{Validation} = \frac{\Sigma \text{obtained score}}{\Sigma \text{maximum score}} \times 100$$

..... (1)

The data obtained from the validation results done by the experts were grouped on the following criteria group:

Table 1. The Validation Criteria of BBL-RT

Score	Validation Category	Explanation
$84 \leq x \leq 100$	Very Valid	It is very ready to use in the teaching and learning process
$68 \leq x < 84$	Valid	It can be used by giving more components as they are considered less. The components should not be too big and basic.
$52 \leq x < 68$	Enough	It can be used by revising several inappropriate components.
$36 \leq x < 52$	Less Valid	The revision should be done by re-investigating and finding out its weaknesses for its improvement.
$20 \leq x < 56$	Invalid	Almost all components should be revised.

b. The Practicality of Learning Model

The data results of students' questionnaire was calculated by using the following formula:

$$\text{The percentage of response} = \frac{\Sigma \text{ the scores from the data collection result}}{\Sigma \text{ maximum score}} \times 100\%$$

..... (2)

The percentage results of teachers' and students' responses were changed into the qualitative data and analyzed by using the criteria formula on Table 2.

Table 2. The Criteria of Teachers' and Students' Responses on BBL-RT Learning Model

Percentage (%)	Category
$84 \leq x \leq 100$	Excellent
$68 \leq x < 84$	Good
$52 \leq x < 68$	Enough
$36 \leq x < 52$	Poor
$20 \leq x < 36$	Very Poor

c. Effectiveness of Learning Achievement

The measure of the effectiveness of the students' cognitive learning achievement was based on Normalized gain with the following formula:

$$\text{Normalized gain (g)} = \frac{\text{posstest score} - \text{pretest score}}{100 - \text{pretest score}}$$

..... (3) (Hake in Kagan, 2016)

The scale used in the data of normalized gain was categorized on Table 3.

Table 3. Criteria of Normalized gain

Normalized gain Score	Normalized gain Criteria
Normalized gain ≥ 0.70	High
$0.30 \leq \text{normalized gain} < 0.70$	Moderate
Normalized gain < 0.30	Low

(Hake in Nissen, 2018)

RESULT AND DISCUSSION

a. The process results of Developing BBL-RT Learning Model

This section discussed about the process of developing BBL-RT learning model based on the development model ADDIE.

1) Analyze stage

This stage consisted of identification of the problem from the results of questionnaire spread out through google form for teachers and students in Jember regency who was represented in the subject teacher deliberation (Biology Teacher Organization), core competencies and basic competencies analysis, task analysis, and needs analysis of the teachers and students. The results covered the common problems faced by all the teachers in Jember regency in term of the implementation of the curriculum 2013 yet teachers still used one type of learning model and the learning achievement was categorized as low.

The results of problem identification from 131 respondents consisting of 97 respondents by google form and 34 students at the research context were first, teachers conducted uninteresting learning in the biology class with the percentage of 53.4%. Second, in delivering biology material, the teacher mostly used lecture method with percentage of 75.6%. Third, the learning process implemented by the teachers was less utilized audio like music, video, and etc. with the percentage of 30%. Fourth, the learning process implemented by the teacher was commonly involved visual learning such as picture, torso, and etc. by 76%. Fifth, the learning process was less involving kinesthetic such as practicum and observation by 38%. According to (Addae and Baffour, 2018) who stated that lecture method was less beneficial if it is too often used and it is unexciting in a long time which makes the students passive in the classroom learning process.

Identification was also done from the results of interview with the biology teacher. Based on the results of the interview, it was found that the biology teacher at SMAN Rambipuji have known Brain-Based Learning model yet he does not know the reciprocal teaching approach. The learning model that is commonly implemented in the classroom was Students Team Achievement Division (STAD) and the conventional one. The reason relied on the students' response who said that they understood easily if they were given a task (in the form of questions) before the teacher explained the material in the next meeting. The model of Student Team Achievement Division (STAD) is a learning that requires the students to do meaningful learning, teaching is no the transformation of knowledge from the teacher to the students but rather it emphasizes the efforts to facilitate the students (Ariani and Agustin, 2018). However, the fact showed that the learning model left the students with passive participation in the learning process through little peer tutor learning. This was caused by STAD model that has not completely involved the students to be active in the learning process.

The learning approaches mostly used in biology class was scientific and contextual approaches. It was because the approaches were in line with the material (curriculum) and students' characteristics. Scientific and contextual approaches were one of the approaches required in revised-curriculum 2013. However, in fact, specific learning approach like reciprocal teaching has not been employed by the teacher (Kusumaningrum et al., 2017 and Paramita et al., 2016). Reciprocal teaching helped students to be able to explain the learning material independently and shared information with others as well as raised question. Meanwhile, in conventional learning, raising question is the job of the teacher without involving the students' participation

(Prasetio et al., 2018). Besides, the students' achievement from the results of STAD implementation, especially in X MIPA 4 class as the classroom scale test in this research was categorized as low with only 7 students has score above the minimum criteria.

The researcher developed BBL-RT learning model based on the core competence 1 until 4, yet the core competence 3 and 4 tended to the material that would be taught to the students, and the material used in the basic competence 3.2 and 4.2. It was chosen by the researcher because the learning material was, according to the teacher, categorized as moderate so it helped students to understand and explore animals and plants around their school environment. According to (Julianto and Husin, 2018) who mentioned that in learning biology, the students not only read and memorize the concepts, facts, or phenomena, but also they should be able to discover concepts toward what they learn. The learning process that involved kinesthetic like direct observation helped students to understand the concepts of natural diversity material.

The task analyses were about observation around the school environment and discussion on students' worksheet. Students' worksheet was used as the tool to optimize the students' learning achievement and improve their involvement in the teaching and learning process (Kawuwung and Paat, 2018). Besides, the use of students' worksheet in learning could help the students to be more active in doing a series of activities in the students' worksheet so the students were enthusiastic in the learning activities (Hakim et al., 2020). While, the results of questionnaire using google form which had spread out to the students and teachers showed that 19 teachers (79%) and 131 students (90%) were agree if there would be a development of a new learning model like BBL-RT. This is due to the obstacle during the learning process such as students' lack of motivation and focus in understanding the material given by the teacher. Furthermore, the students felt that the delivery of the material by the teacher was boring.

The conclusion was that the teaching way mostly used lecture method supported by few audio and kinesthetic activities. Due to this, the researcher chose Biology subject as it was easy to teach in limited time in the research. Therefore, the material of natural diversity was chosen to be taught to the students. Regarding the school where the research was conducted, it was possible to do an observation about natural diversity because the school was in an agroecosystem area.

2) Design stage

This stage covered the making of initial product design like formulating the objectives by adjusting the element of audience, behavior, condition, and degree (ABCD). The preparation of benchmark reference tests conducted by arranging cognitive test in the form of pretest and posttest, while the psychomotor test was in the form of task that done by the students covering observation of natural diversity gene level and species in the school environment based on the rubric of psychomotor. The selection of media in this research was based on the development of BBL-RT learning model, that were students' worksheet, powerpoint, video, chart, realia (endemic plant lie Javanese chili) and whiteboard. Finally, there was an initial design consisted of syllabus, lesson plan, as well as pretest and posttest with 5 essay questions in C3-C5 level. The arrangement of learning instrument was important, in line with (Nuraini et al., 2016) learning instrument ease the teacher in the teaching and learning process

because each activity implemented to the students was organized well. This triggered the students positively to response to the learning material.

3) Development stage

This stage consisted of validation of the product of BBL-RT learning model that was developed. The validation of product of BBL-RT learning model was done by two experts from development (lecturer) Graduate Program of Biology Education, user validator (teacher), and critics and suggestion from university students (3 students) as well as the students' responses showed during the learning. The results were tested in a small scale at X MIPA class seen by 9 students in 3 categories (3 low-achiever student, 3 moderate achiever students, and 3 high achiever students) which was heterogeneous (male and female) to know the initial condition of developing BBL-RT learning model before it was tried out in classroom scale. The results of students' learning achievement were as follows.

Table 4. Learning Achievement of small scale test of BBL-RT (N=9)

Aspect			Category
Cognitive	Mean score of <i>Pre test</i> ±SD	46±10.90	
	Mean score of <i>Post test</i> ±SD	87.14±10.17	
	<i>N-gain</i>	0.77	High
Psychomotor	Mean score of <i>Score</i> ±SD	76±6.77	Good

4) Implementation stage

Based on the results of small scale try out had been revised and showed positive result. The development of BBL-RT learning model was tried out in classroom scale at X MIPA 4 class with 34 students. The results of the implementation showed that based on six elements in model development (syntax, social system, reaction principle, supporting system, instructional impact, and side effect), only in syntax the learning process using BBL-RT learning model needed to be revised.

First, the syntax of BBL-RT learning model in the stage of preparation, which previously the teacher did not mention about reward in the learning, he did it in the middle of teaching the material. Therefore, the teacher needed to add reward giving in the initial step of learning in order to make the students be more active and enthusiastic following the learning process. Second, in the stage of elaboration where firstly the teacher gave fewer questions to the students individually or in group, he did it in the end of discussion because of the limited time. Then, in the next meeting the teacher gave question after giving explanation from the students' question, in order to make them think more critically and understand the material. However, overall, the six elements that should be included in the development of BBL-RT learning model such as social system, reaction principle, supporting system, instructional impact, and side effect had been covered sufficiently. Their students' learning achievement in the classroom scale try out is as follow.

Table 5. Learning Achievement of BBL-RT Model in Classroom Scale Trials (N=34)

Aspect			Category
Cognitive	Mean score of <i>Pre test</i> ±SD	14.15±7.68	

Aspect		Category
	Mean score of <i>Post test</i> ±SD	83.08±9.77
	<i>N-gain</i>	0.80
Psychomotor	Mean score of Score±SD	83±9.30
		High Good

5) Evaluation Stage

This stage consisted of improvements during the learning model development process which were in the development and implementation stages. This final stage of ADDIE was in the form of a revision of the data analysis results of validity, practicality, and effectiveness of the Brain-Based Learning model based on Reciprocal Teaching (BBL-RT) for the students' learning process. The revision step was carried out to improve the BBL-RT learning model that had been developed. Implementing a design model with ADDIE learning system which was done systematically and systemically helped a learning model designer to design a simple and easy to learn learning model (Priyadi, 2009).

This stage determined the development of BBL-RT learning model that was developed with results that already met the elements required in the development of models such as syntax, social systems, reaction principles, support systems, instructional impacts, and accompaniment impacts including valid, effective, and practical. According to (Hijrianti, 2017 and Plomp & Nieveen, 2013) in the development of learning models must pay attention to the existence of syntax, social systems, reaction principles, support systems, instructional impacts, and accompaniment impacts.

b. Validation of BBL-RT Learning Model

The validation of BBL-RT learning model was obtained from the validation sheets given to the validators. Validation analysis consisted of analyzing instrument validation data by two development experts (lecturers) and product validation data for BBL-RT model by two development experts (lecturers) and one user (teacher). The results of the instrument validation analysis are presented on Table 6 and the results of the validation analysis of BBL-RT model products are presented on Table 7.

Table 6. Validation Data of Development Instrument of BBL-RT Learning Model (N=2)

No.	Indicators	Average Validation Results ± SD	Category
1	Instruction		
2	Content	86±9.19	Very Valid
3	Language		

Table 7. Validation Data of Development Product of BBL-RT Learning Model (N=3)

No.	Instrument Document	Average Validation Results ± SD	Category
1	Learning Model Handbook		
2	Syllabus	91±0.5	Very Valid
3	Lesson Plan		

No.	Instrument Document	Average Validation Results \pm SD	Category
4	Pretest-Posttest		

The validation results of the development product of BBL-RT model were included in the valid category. In accordance with the opinion of (Sugiarti et al., 2017) who stated that the learning model is said to be valid if the three elements of validation, which are validation by the expert (lecturer), user (teacher) and audience (students) which are known from the results of the students' response questionnaire are all valid.

c. Effectiveness of BBL-RT Learning Model

An analysis of the effectiveness of the BBL-RT model development that was developed certainly was obtained after the BBL-RT model experienced an evaluation and trial process. The analysis was carried out on the learning process by observing the improvement on learning achievements and students' activities before and after the application of the learning model developed (Suherman, 2018).

Table 8. Normalized Gain Analysis Results in Class Scale Trials (N = 34)

Normalized gain	Criteria
0.80	High

Based on Table 8, it can be seen that students' cognitive learning achievements was in the high category. Therefore, the BBL-RT learning model can be effectively applied by the teacher. This was supported by the affective aspect; students had shown a better active role.

Table 9. Analysis Results of the Students' Psychomotor Effectiveness at Class Scale Trial (N = 34)

Meeting	Average value \pm SD
Meeting 1	80 \pm 7.59
Meeting 2	83 \pm 9.30
Meeting 3	86 \pm 7.15

Based on Table 9, it is shown that the results of the students' psychomotor effectiveness in each meeting scored above 80. Based on the effectiveness of the implementation of the BBL-RT learning model, it was stated that the BBL-RT learning model was said to be effective. Cognitive learning achievements are obtained from the pretest and posttest. Affective learning achievements are the average value of cooperative attitude, enthusiasm, ability to interact, responsibility, and confidence. Psychomotor learning achievements are the results of the average score in presentation skill and report on practicum or observation (Jayanti et al., 2019). Psychomotor assessment can be done using observation (Prameswati, 2019). Therefore, the learning model is effective if there is an increase experienced by students in cognitive learning achievements that is seen from the pretest and posttest values on each material given (Yerimadesi et al., 2019).

Based on the data analysis of learning achievements, the students' learning achievement increased after the implementation of the BBL-RT learning model. Through the application of this learning model, students with students and students with

teachers created active, meaningful, and enjoyable learning with each other. Active learning helped the storage of long-term memory in understanding the learning. Meaningful learning was obtained by students during discussion activities in the classroom or when observing around the school environment (Fandakova and Bunge, 2016). Teachers must be able to integrate subject matter with the students' real world situations so that the knowledge obtained can be more meaningful and long-lasting (Maulana et al., 2019). Therefore, the teacher determined learning models and strategies that directed students to learn more meaningfully and fun. Meaningful learning can be improved when students are actively involved in the learning process (Nel, 2017). Moreover, stated that meaningful learning will produce meaningful experiences for students and will have a positive impact in improving students' learning achievements (Mawardi et al., 2019).

BBL-RT learning was also fun (joyful learning) and had a positive impact in improving learning achievements. The application of the BBL-RT learning model was fun because it was supported by brain gym activities, videos, listening to alpha music (instrument only), and direct observation around the school. The benefits of a brain gym were being able to activate all parts of the brain for academic abilities, behavioral relationships, and attitudes because the brain is basically divided into two parts, namely the right brain and the left brain. The use of video in learning can increase students' activity in learning and improve learning achievements. Besides the use of video, learning by using music can make the learning atmosphere less tense (Brame, 2016). Listening to alpha wave music (8-13Hz waves per second) is ideal for relieving stress and making a person relaxed or not tense (Lo and Deng, 2019). Joyful learning can improve learning achievements and increase students' activity in learning (Azizah et al., 2019).

d. Practicality of BBL-RT Learning Model

The practicality of the learning model was obtained from the practicality sheet of the learning model consisting of the practicality questionnaire by the teacher and students, then described using a Likert scale (Dewy et al., 2016).

Table 10. Data of Students' Response after the Implementation of BBL-RT Learning Model

No.	Indicator	Average Students' Response \pm SD (%)	Category
1	Learning interest		
2	Learning usefulness	86 \pm 2.56	Very Good
3	Learning interest for the next chapter		

Based on Table 10, it can be seen that the practicality results of the BBL-RT model based on students' responses were very practical. This was because students became excited in following the learning process by using the BBL-RT learning model since at the beginning of learning students were invited to do a brain gym and at the end of the learning students were given a quiz that made the learning process more active and meaningful. In accordance with opinion (Zulaini, 2016) which explained that the brain gym is a series of simple movements that can connect the cooperation between the right and left brain parts, so as to strengthen the collaboration between the right brain and the left brain before being used for activities.

Table 11. Data of Teacher's Response to the Implementation of BBL-RT Learning Model

No.	Indicator	Average Teachers' Response \pm SD (%)	Category
1	Guidelines Clarity for Using the Lesson Plan		
2	Achievement of Competence and Objectives	97 \pm 4.12	Very Good
3	Students' Response		Good
4	Implementation Difficulty Level		
5	Adequacy of Time		

Based on Table 11, it is shown that based on the results of teachers' responses, the BBL-RT learning model was very practical. Therefore, the development of practical BBL-RT learning model to be applied to the learning process and the application of BBL-RT learning model were easy for teachers to apply. The practicality criteria of the learning model are high learning enthusiasm, active students, and positive students' responses (Suastika, 2017). In accordance with the literature according to (Usmeldi et al., 2017) learning model is said to be practical if experts and users (teachers) state that it can be developed and it produces a reality that shows results in the form of positive responses from teachers and students.

CONCLUSION

The results of mean score validation of all products of BBL-RT learning model development was 91 which was included in the very valid category. Based on the results of the analysis using Normalized gain, a value of 0.80 was included in the high category so it can be concluded that the BBL-RT learning model was effective since it was supported by an increase on students' learning achievements through the application of the BBL-RT learning model. In addition, the average percentage of students' and teachers' responses was in the very good category with an average teachers' response of 97% and an average students' response of 86%. Thus, the results of the development of BBL-RT learning model can be declared as valid, effective, and practical to be used by teachers.

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