



Textbook Using a Brain Based Learning Model Assisted by a Scientific Approach for Learning Critical Thinking Skills

Amin Harahap^{1*}, Rohani², Almahdi Rambe³, Marzuki Ahmad⁴, Dwi Putria Nasution⁵ 

¹ Mathematics Education, Faculty of Teacher Training and Education, Labuhanbatu University, Labuhanbatu, Indonesia

² Information Technology, Faculty of Science and Technology, Labuhanbatu University, Labuhanbatu, Indonesia

³ Mathematics Teacher, Elementary School Mathematics, SD Negeri 04 Rantau Selatan, Labuhanbatu, Indonesia

⁴ Mathematics Education, Faculty of P-MIPA, South Tapanuli Educational Institution, Padangsidimpuan, Indonesia

⁵ Mathematics Teacher, Mathematics Specialization, SMA Negeri 2 Padangsidimpuan, Padangsidimpuan, Indonesia

ARTICLE INFO

Article history:

Received June 01, 2024

Accepted November 10, 2024

Available online November 25, 2024

Kata Kunci :

Buku Ajar, Brain Based Learning, Pendekatan Saintifik, Berpikir Kritis

Keywords:

Textbooks, Brain Based Learning, Scientific Approach, Critical Thinking



This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.

Copyright ©2024 by Author. Published by Universitas Pendidikan Ganesha

ABSTRAK

Rendahnya kemampuan berpikir kritis siswa menjadi permasalahan utama dalam penelitian ini. Selain itu dalam pembelajaran ditemukan buku teks yang digunakan kurang bervariasi dan tidak mengarahkan siswa untuk mengembangkan kemampuan berpikirnya. Model pembelajaran yang dapat memaksimalkan kemampuan berpikir adalah Brain Based Learning (BBL) dan pendekatan pembelajaran yang mempunyai tahapan-tahapan yang jelas dan dapat dimasukkan dalam buku teks adalah pendekatan saintifik. Tujuan penelitian ini adalah mengembangkan buku ajar dengan model BBL berbantuan pendekatan saintifik dalam mengajarkan keterampilan berpikir kritis siswa. Model pengembangan yang digunakan adalah Model ADDIE yang meliputi tahapan analisa, desain, pengembangan, implementasi, evaluasi. Instrumen penelitian meliputi lembar validasi, angket dan tes. Data penelitian meliputi data validasi produk yang diperoleh dari validasi ahli, data respon produk yang diperoleh dari hasil angket respon siswa, dan kemampuan berpikir kritis siswa yang diperoleh dari tes. Data yang diperoleh dianalisis dengan menggunakan teknik deskriptif kuantitatif dan kualitatif. Analisis data yang dilakukan menunjukkan hasil pencapaian Validity Mean Percentage Score (PRS) sebesar 84,74 (valid), kepraktisan pencapaian PRS sebesar 80,59 (praktis), dan pencapaian efektivitas PRS sebesar 89,31 (efektif). Analisis data yang dilakukan menunjukkan bahwa produk yang dikembangkan memenuhi kriteria valid, praktis dan efektif serta layak digunakan sebagai buku teks. Berdasarkan capaian tersebut, maka pengembangan produk buku teks dengan model pembelajaran berbasis otak layak dan baik untuk digunakan dalam mengajarkan keterampilan berpikir kritis matematis siswa.

ABSTRACT

Students' low critical thinking skills are the main problem in this research. Apart from that, in learning it was found that the textbooks used were less varied and did not direct students to develop their thinking abilities. The learning model that can maximize thinking abilities is Brain Based Learning (BBL) and the learning approach that has clear stages and can be included in textbooks is the scientific approach. The aim of this research is to develop a textbook using the BBL model assisted by a scientific approach in teaching students' critical thinking skills. The development model used is the ADDIE Model which includes the stages of analysis, design, development, implementation, evaluation. Research instruments include validation sheets, questionnaires and tests. Research data includes product validation data obtained from expert validation, product response data obtained from student response questionnaire results, and students' critical thinking abilities obtained from tests. The data obtained was analyzed using quantitative and qualitative descriptive techniques. The data analysis carried out showed the results of achieving a Validity Mean Percentage Score (PRS) of 84.74 (valid criteria), the practicality of achieving PRS of 80.59 (practical criteria), and achieving PRS effectiveness of 89.31 (effective criteria). The data analysis carried out shows that the product developed meets the criteria of being valid, practical and effective and is suitable for use as a textbook. Based on these achievements, the development of textbook products with a brain-based learning model is feasible and good for use in teaching students' mathematical critical thinking skills.

*Corresponding author.

E-mail addresses: marzuka686@gmail.com (Amin Harahap)

1. INTRODUCTION

Thinking skills are important to develop because learning must always require students to be able to solve various problems (Dekker, 2020; Nurfaizah et al., 2022). Through the process of solving various kinds of problems, students' thinking abilities can improve and develop (Marzuki et al., 2021; Rohani et al., 2022). The problems students face in obtaining solutions cannot be separated from their thinking abilities, one of which is critical thinking abilities. Critical thinking is searching, obtaining, evaluating, analyzing, balancing and imagining information as a teacher to develop thinking with self-awareness, thus involving creativity and the ability to take risks using data (Arif et al., 2019; Yusupova, 2019). With this understanding, critical thinking includes knowledge, skills, and attitudes that emphasize reasonable and reflective thinking in solving problems that involve curiosity, daring to take risks, and practicing high-level thinking. Critical thinking is not a single way of thinking, but is a complex multidimensional cognitive process that is very important to use in decision making. Critical thinking ability is a student's cognitive process in analyzing the problems they face, identifying and reviewing information to develop strategies for the problem itself (Mahanal et al., 2019; Pertiwi et al., 2023; Prasetyo & Firmansyah, 2022). Mathematical critical thinking skills can train students to be good at reading the situation of each problem, evaluating and drawing conclusions about certain conditions so that the knowledge students build becomes stronger and is not easily forgotten (Harahap et al., 2023; Rijal et al., 2021; Şahin et al., 2019). Critical thinking skills in this research are seen from the ability to interpret, analyze, evaluate and conclude. Critical thinking skills are the basis of the thinking process for analyzing arguments and stimulating ideas for any meaning or other forms of interpretation to develop logical thinking patterns.

However, the reality on the ground is that learning activities do not fully involve the development of critical thinking skills as shown by student achievements at international and national levels. For the mathematics category, Indonesia is ranked 7th from the bottom, 73rd out of 79 countries, with a score of 379 compared to the international average score of 459 (OECD, 2019). This achievement is an illustration of students' critical thinking abilities in solving problems that are still lacking. Furthermore, from the results of interviews conducted by researchers with one of the mathematics teachers in the city of Padangsidempuan, information was obtained that it was known that 20% of students were active in class and 80% were inactive in class. Further information was obtained that students' critical thinking achievements tend to be low. Apart from that, it was also stated that the textbooks used did not support students to be active in learning activities. Textbooks should be designed to be attractive by paying attention to students' brain abilities and using appropriate models and modeling approaches so that students are more stimulated to pay attention to the material being studied, and help students understand the learning material which leads to achieving learning goals. .

One way to overcome the problems stated previously in accordance with the 2013 curriculum is to use a student-centered learning model, namely by implementing the Brain Based Learning (BBL) learning model (ElAdl & Saad, 2019; Mekwan & Poonputta, 2023). The application of the BBL model influences students' critical thinking abilities and will improve their critical thinking abilities (Diani et al., 2020; Solihah et al., 2020; Tuti & Sri, 2019). BBL views learning as an active process where creativity is fostered through challenges (Koşar & Bedir, 2019; Marzuki et al., 2019). Learning with the BBL model does not focus on sequence but prioritizes students' enjoyment and love of learning (Imamah et al., 2020; Mekwan & Poonputta, 2023; Ode et al., 2020). In this way students can absorb the material studied easily. Brain Based Learning (BBL) is learning that is able to provide space for students to think freely without pressure, a supportive learning environment, and full of stimulation that stimulates creative thinking (Putri et al., 2020; Thonsakul & Poonputta, 2019). Through BBL students are involved in various thinking activities in a variety of activities in collaborative learning groups, providing a safe environment for sharing thoughts and ideas, reducing anxiety and threats, offering flexibility, providing resources, and providing feedback in a timely manner (Şahin et al., 2019; Winter, 2020).

BBL considers nature and how the brain is influenced by the environment and experiences. Furthermore, learning activities using the BBL model can be carried out in the following stages: preparation, namely the teacher carries out initial learning activities which include conveying objectives and apperception; initiation and acquisition, namely the teacher creates a connection between the knowledge previously possessed by students and the material to be studied; elaboration, namely students are trained to develop their critical thinking skills; incubation and memory input, namely emphasizing the importance of rest time and time to review lessons; teacher verification and evaluation directs students to conclude the subject matter studied and provides critical thinking ability tests. Therefore, this learning does not require students to just study, but rather stimulates and increases students' interest in learning on their own (Nassar, 2019; Sitorus & Diana, 2023). So it can have a positive impact on student learning outcomes.

Furthermore, to further maximize students' BBL activities, they need to be integrated with an approach that is appropriate to the learning activity situation.

One learning approach that is relevant to the current situation is the scientific approach. The scientific learning process consists of five main learning experiences, namely observing, asking, gathering information, associating, and communicating (Prakoso et al., 2018; Wijaya et al., 2022). Learning with a scientific approach encourages the development of students' attitudes, knowledge and skills to be better based on scientific principles (Istuningsih et al., 2019; Tuti & Sri, 2019). This approach is included in the student-centered approach, because the process prioritizes student activity in the learning process and the teacher acts as a facilitator. The scientific approach requires students to be actively involved in learning. In learning activities with a scientific approach, learning is generally carried out through small group discussions which are formed by taking into account the heterogeneity of students' mathematical abilities. Students with high mathematical abilities help students with low mathematical abilities in understanding concepts. Apart from that, in learning students are given the opportunity to face various problems encountered in everyday life. The use of a scientific approach motivates students to learn scientifically systematically through observing, asking, collecting information, processing, presenting, reasoning, drawing conclusions and communicating (Amran et al., 2020; Fitriana et al., 2019; Yusupova, 2019). By collaborating the Scientific approach with the BBL model, it is hoped that mathematics can be taught well. This is in line with what was expressed by previous research findings which revealed that the application of the brain-based learning model with a scientific approach in students' mathematics learning was carried out effectively. With a learning process with a scientific approach, students are able to apply critical thinking skills in everyday life (Laksana et al., 2020; Niswani & Asdar, 2022)

Various previous studies that are relevant to the research conducted reveal that the development of BBL-based teaching materials is suitable for use as learning media in elementary schools and junior high schools (Antini et al., 2021; Lestari, 2020; Maesarani et al., 2022). From this description, the development of textbooks that use the BBL model is still very limited, especially using the BBL model with a scientific approach to teach critical thinking skills to Madrasah Tsanawiyah students. The novelty in this research is that in this research a mathematics textbook product was developed using the BBL model assisted by a scientific approach. Furthermore, textbook products are designed to teach students critical mathematical thinking skills. Therefore, researchers are interested in conducting research regarding the development of textbooks using the BBL model assisted by a scientific approach to teach students critical thinking skills at MTs Negeri 1 Padangsidimpuan.

The novelty of this research lies in the integration of the Brain-Based Learning (BBL) Model with the Scientific Approach in developing textbooks specifically designed to improve students' critical thinking skills. The BBL model which focuses on understanding how the brain works in learning has not been widely applied in the preparation of textbooks, especially in Indonesia. This approach allows a more natural learning process and is in accordance with the way the brain works, so that students can be involved emotionally and cognitively in learning activities. In addition, by combining the Scientific Approach, this textbook not only accommodates knowledge-based learning but also thinking skills-based learning. This research innovates in designing textbooks that integrate these two approaches, resulting in teaching materials that are not only informative but also support the development of critical thinking skills in a holistic and structured manner. The aim of the development research carried out is to produce textbook products with a brain-based learning model assisted by a scientific approach that is suitable for teaching students' thinking skills at MTs Negeri 1 Padangsidimpuan. Feasibility in this case is reviewed from 3 aspects of the quality of the product being developed. These three aspects include aspects of validity, practicality and effectiveness. The product being developed is said to be feasible if it has passed a validation process from experts with valid criteria, and has been tested to meet practical and effective criteria.

2. METHOD

This research is ADDIE development research which consists of the stages of analyzing, designing, developing, implementing, evaluating. The research design is presented in Figure 1. To produce a good product, textbook products were developed through three quality aspects which include validity, practicality and effectiveness (Lee & Owen, 2020; Nieveen, 2010). The analysis stage includes Need Assessment, namely a needs assessment carried out to determine the gap between actual and ideal conditions. Where in this research an assessment of the material, mathematics curriculum, student characteristics, and analysis of student work plans, analysis of learning materials, task analysis, and analysis of ongoing learning objectives were carried out in this research. Next, a Front-End Analysis is carried out to collect techniques that can be used as solutions to existing gaps. The design stage is the design stage for the textbook product being developed. The textbook is designed using the BBL model assisted by a scientific

approach to teach students critical mathematical thinking skills according to the results of the analysis stage that has been carried out previously. Apart from that, instruments to support research activities were also designed.

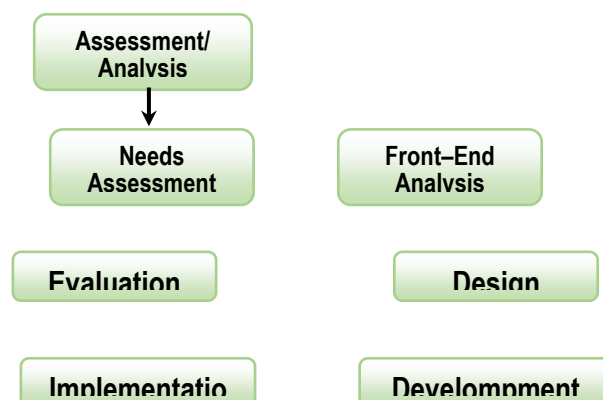


Figure 1. Development of the ADDIE Model Lee & Owen 2004

The development stage is carried out to obtain textbook products. This activity is carried out by validating previously designed mathematics textbook products with validators involving language, material and media experts. At this stage the product being developed will receive comments and suggestions for improvement from the validator. The result of this stage is to obtain a textbook product that meets the validity criteria. The implementation phase aims to test products that have been previously obtained on a limited basis. This aims to see the readability of the product that has been developed so that it is more suitable for application at the next stage. This stage is carried out to obtain criticism and input from the subject regarding the product being developed which is useful for improving the product. The evaluation stage aims to measure the level of conformity of the product with the research objectives, in other words to test the level of practicality and effectiveness of the product. Testing activities were carried out using a quasi-experimental design using a one-shot case study design (Arif et al., 2019; Solihah et al., 2020). The experimental design is as presented in Figure 2.

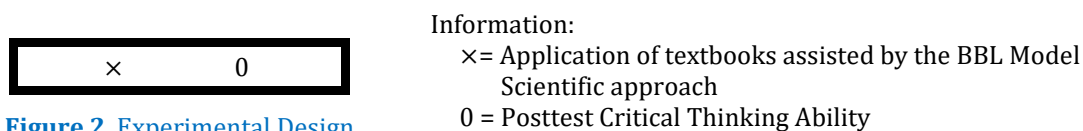


Figure 2. Experimental Design

The experimental design was carried out in one research class where subjects were treated by carrying out learning using the BBL model assisted by a scientific approach. At this stage, a trial is carried out on the textbook product being developed, which is then given an assessment instrument to measure the practicality and effectiveness of the textbook. The textbook product trial activity was carried out on class VIII students at MTs Negeri 1 Padangsidempuan involving one class of research subjects, namely students from class VIII-11 at MTs Negeri 1 Padangsidempuan, totaling 32 people. The subjects consisted of 15 male students and 17 female students.

Textbook product development involves instruments for collecting data, both qualitative data and quantitative data. The instrument for collecting qualitative data was the researcher himself who was assisted by accompanying instruments, namely observation sheets and interview guide sheets. Qualitative data collection instruments are generally used at all stages of development, but are more dominant at the analysis stage. Furthermore, the quantitative data collection instruments consisted of textbook validation sheets, student and teacher response questionnaire sheets, and student critical thinking ability test sheets in mathematics subjects. Research data was analyzed using quantitative and qualitative descriptive techniques. Qualitative descriptive analysis is used to analyze data obtained from the Assessment/Analysis stage. Quantitative descriptive analysis was carried out to determine the validity, practicality and effectiveness of the textbook products being developed. This data is analyzed by determining the average score, which is then continued by determining the Average Percentage Score (PAS) and then interpreting

the data. The criteria for interpreting research data are: The category of component achievement in percentages is defined as very good criteria $\Leftrightarrow 90 \leq \text{PAS} \leq 100$, good $\Leftrightarrow 80 \leq \text{PAS} < 90$, fair $\Leftrightarrow 70 \leq \text{PAS} < 80$, bad $\Leftrightarrow 60 \leq \text{PAS} < 70$ and very bad $\Leftrightarrow 0 \leq \text{PAS} < 60$ (Sudjana, 2007). A validated component meets valid criteria if $\text{PAS} \geq 70$ or at least is in the sufficient category.

3. RESULTS AND DISCUSSION

Results

As explained in the development method, the initial stage carried out is analysis. At the analysis stage, it is known that the current condition of the students is junior high school students with an average age of 14 years. These students are faced with an independent curriculum that requires them to have "4C" skills which include critical, creative, communication, collaboration. The material studied by students is algebraic operations which include algebraic forms, addition and subtraction of algebraic forms, multiplication of algebraic forms, division of algebraic forms, simplification of algebraic forms. In accordance with the subject matter, there is an expected goal, namely applying algebraic operations involving rational numbers to symbolic problems and applying algebraic operations involving rational numbers to verbal problems. Furthermore, based on the analysis, the relevant learning approach applied is an approach that includes observing, asking, trying, analyzing, communicating. Furthermore, in learning activities students are required to optimize their critical thinking activities in using logic to consider arguments in providing conclusions.

The next stage is the design stage. At this stage, a textbook product will be prepared which will be developed with the title algebraic operations. The textbook is prepared on various algebraic operations with the BBL model using a scientific approach which refers to teaching students' mathematical critical thinking skills. Apart from that, instruments supporting product development were also prepared, including validation instruments, textbook practicality instruments, and critical thinking ability tests. Apart from that, BBL model learning tools with a scientific approach were also prepared which supported product testing activities during 4 meetings which included lesson plans and worksheets. The next stage is the development stage which includes validation of previously designed textbook products with 4 validators through reviewing aspects of linguistic format and content. Validator assessments based on validated aspects are presented in [Table 1](#).

Table 1. Recapitulation of 4 validators' Assessments of Textbook Products

NO	Component	Average Score	NOT	Criteria	Interpretation
1	Formal Aspect	15.60	83.00	Good	Legitimate
2	Language Aspects	16.50	80.83	Good	Legitimate
3	Content Aspects	17.11	85.56	very good	Legitimate
	Amount	16.68	83.42	Good	Legitimate

Judging from the results of the textbook validation carried out by the validator, the highest validation score achieved was content validation, then continued with format validation, and continued with language validation. Furthermore, by paying attention to comments or suggestions from validators, there are dominant points including the format aspect, namely: Images must be colorful and attractive; Need to fix typos and need to create a more attractive design; You should pay more attention to image placement to make it neater. Regarding linguistic aspects, namely: The situations used in the book must be close to the students' situations; Instructions in textbooks need to be clarified; The abilities that are developed must be given more attention. Regarding the content aspect: The indicators used need to be more specific and measurable; It is necessary to pay attention to the suitability of learning objectives and indicators; The context used must support students' thinking processes. The PAS values obtained from the validation results of the three aspects used can be seen in [Figure 3](#).

After the product has been validated by experts who have competence in textbook product development and revision suggestions have been completed, it then enters the implementation stage. The implementation stage is carried out by providing textbooks that have been developed to a sample of students who are the subjects in developing textbook products. This is done to carry out simulations or see the readability of the textbook products being developed. Through this stage, input is obtained for improving the textbook as well as considerations in using the textbook. The implementation stage carried out provides information that the validated textbook product can be well understood by students and the subjects sampled at this stage can understand well the concepts contained in the textbook.

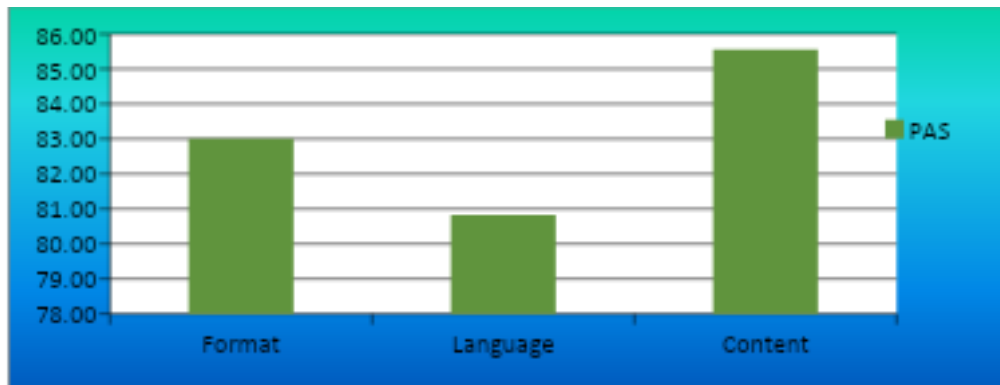


Figure 3. PAS Achievement Graph from Format and Content Language Aspects

The next stage is the evaluation stage. This stage includes testing products developed through the application of textbooks that have been developed in subjects in textbook product development. The implementation stage is carried out by applying textbooks using the BBL model with a scientific approach in learning activities. The learning was carried out in 4 meetings. Each learning meeting uses a time allocation of 40 minutes. Learning activities are carried out like learning in general, including initial, core and closing activities. In learning activities, textbooks that have been previously developed are used as the main source of learning activities in accordance with the RPP and LKPD that have been prepared. After 4 learning meetings were carried out as they should, 2 teachers and 32 students took part in a questionnaire by filling out a practicality questionnaire which aimed to measure the level of practicality of the textbook being developed. The results of the content analysis of the student practicality sheet questionnaire are presented in Table 2.

Table 2. Recapitulation of the Practicality Assessment of Textbook Products

No	Appraiser	Average Score	NOT	Interpretation
1	Teacher	42.50	85.00	Practical
2	Student	40.47	80.94	Practical
Average Amount		40.30	80.59	Practical

Based on the findings that the product developed met the aspects of validity and practicality, an evaluation was carried out on the product developed by reviewing the achievements of students' critical thinking skills in mathematics through the use of textbook products prepared using the BBL model with a scientific approach. Effectiveness analysis was carried out by giving ESSAI test questions to students who had studied with the product being developed. The effectiveness of textbook products can be seen from the achievements of students' critical thinking abilities in mathematics obtained at the evaluation stage. The achievement of students' critical thinking skills after the textbook product was implemented had an average score of 57.91. This achievement has a PAS value of 90.48 which is interpreted as very good. In this way, the effectiveness of implementing the textbook product being developed is met from the aspect of effectiveness.

Discussion

Based on the results of the development of the textbook product developed, it can be seen that the development product developed from 3 quality aspects has met the criteria which include valid, practical and effective. These findings indicate that textbook products with the BBL model assisted by a scientific approach developed to teach critical thinking skills are feasible and good to apply in learning based on the data analysis carried out. Validation achievements in terms of format, language and content are in the valid category. Furthermore, the total average PAS achievement from the validation results was 84.74. The results of this research are in line with research findings on the development of BBL-based teaching materials which revealed that through expert assessment in terms of material, design and language of the product being developed, a PAS of 86.61% was obtained in the "Very Good Category" subjects (Antini et al., 2021; Fazil & Saleh, 2020). Furthermore, in the development of textbooks using a contextual approach to teach students' creative abilities, it was revealed that the results of the assessment of 4 validators showed that the overall PAS achievement of the textbook was 81.31, including in the high category, this can be seen from the aspects of format, language and content which were in the category tall. Validation of BBL model

teaching materials through material and media expert testing shows that the results are valid and suitable for use (Maesarani et al., 2022; Zakaria et al., 2021).

Mathematics textbook products using the BBL model with a scientific approach are designed by considering the involvement of students' critical thinking activities in learning. This of course really supports the BBL model, because through the application of BBL learning, learning is created that is oriented towards empowering the brain by creating a challenging learning environment to develop students' thinking abilities (Lestari, 2020; Sabri et al., 2023). Furthermore, the learning approach which includes the stages of observing, asking, trying, associating and communicating is very relevant to the BBL model in teaching students' mathematical critical thinking skills.

The practicality of textbooks is viewed from various aspects which include developing books using the BBL model with a scientific approach, making it easier to complete learning material, using words and language, and presenting critical thinking questions in learning material. The questionnaire carried out provided the results of the percentage of practical achievements that met the practicality criteria. The results of this research are supported by previous research which revealed that the practicality of the BBL learning module analyzed through trials in the small group and large group categories was so good that it did not need to be revised. Through the use of textbook products, students feel happy in building their knowledge through brain-utilizing activities by working together in small study groups. This is because the characteristics of BBL are relaxed, constructivist, emphasizing cooperation, reflecting on material, meaningful learning at each learning stage and contextual (Silvana & Wibisono, 2024; Sitorus & Diana, 2023). Textbook products with the BBL model assisted by a scientific approach that involves student worksheets in their learning really support students' success in thinking critically in learning activities. This has an impact on students becoming enthusiastic and enthusiastic in learning activities (Handayani et al., 2019; Lestari, 2020; Nahdi, 2023).

Learning activities using the BBL approach with a scientific approach are carried out involving textbooks that are developed accompanied by LKS. Learning is carried out by teachers and students quite enthusiastically from the initial activity to the final activity. From several BBL model learning meetings held, there was an increase in teacher and student activity. Through the Brain Based Learning Model assisted by a scientific approach, students play an active role in building and developing the knowledge they have, teachers play a role in providing scaffolding through their role as facilitators and learning mediators. In learning activities, students utilize brain activity to think using the power and function of the brain optimally so that learning becomes meaningful and student learning activities are carried out optimally. Learning activities will improve students' thinking abilities and increase intelligence (Nurbaeti et al., 2021; Thonsakul & Poonputta, 2019).

The quality assessment of the effectiveness of textbook products is seen from the achievement of students' critical thinking skills after implementing textbooks designed using the BBL model with a scientific approach showing an effective interpretation of the criteria. The results of this research are supported by various previous studies, which reveal that the development of textbooks to teach students creative thinking skills is in the medium category of effective criteria. Furthermore, by paying attention to the various aspects carried out, the textbook product developed meets the quality aspects of validity, practicality and effectiveness. This finding is in line with various previous studies which reveal that the development of BBL collaborative learning fulfills the validity aspect in the very valid category, the effectiveness aspect in the good category, and the practicality aspect. Judging from the responses of teachers and students, it is included in the very practical category, namely research. As well as research which reveals that teaching materials with the BBL model developed using a scientific approach have a very valid, very effective and very complete level of validity and can be used without further revision (Nieveen, 2010; Putri et al., 2020; Sabri et al., 2020).

Students' critical thinking skills, which include the ability to interpret, analyze, evaluate and conclude in solving mathematical problems, meet the criteria for the effectiveness of learning that applies textbook products with the BBL model assisted by a scientific approach. By applying the BBL model with a scientific approach, students are more skilled at thinking and accustomed to solving problems that require critical thinking. The learning activities carried out guide students to always actively utilize the performance of their brains in thinking to find solutions to the problems presented. This is because Brain Based Learning is a strategy that facilitates learning activities that involve the power of both hemispheres of the brain (Ode et al., 2020; Prayogi & Widodo, 2021; Rohani et al., 2020). Students optimize brain function to be proactively involved in solving problems continuously and efficiently. This is because in the learning carried out students are carried away by an atmosphere of a strong desire to solve problems by using thinking activities that involve the brain in solving various problems. Students will always look for possible answers, have a curious interest in finding their own answers, and enjoy learning (Astika et al., 2019; Fazil & Saleh, 2020). Through BBL learning, students' critical thinking abilities will increase because students always enjoy using

their thinking activities in learning. Learning that involves students' brain-based thinking activities makes students intelligent, critical and creative and can solve various problems related to everyday life (Prihartini et al., 2021; Tambunan, 2020).

Textbook development was carried out in one learning chapter for junior high school students, namely the chapter on algebraic operations. Meanwhile, at the junior high school level, there are still other lessons related to algebra material such as algebraic factoring, solving algebraic equations, and so on. Thus, the material developed is still limited and needs to be developed into other materials. Furthermore, there are other abilities related to the ability to think in mathematics, namely the ability to think logically and think creatively. Judging from the product development developed in this research activity, it only focuses on critical thinking skills. Therefore, for further research, the development of textbook products using the BBL model assisted by a scientific approach is aimed at teaching creative thinking and logical thinking skills or other high-level mathematical thinking skills.

The research carried out has produced textbook products in mathematics learning for junior high school students. The resulting textbook product provides direction or guidance in learning activities so that the implementation of the BBL model assisted by a scientific approach can be carried out easily and well. This is because this textbook was developed by adapting the BBL learning model and a scientific approach in its presentation. Textbook products using the BBL model assisted by a scientific approach can be used as an alternative in teaching students critical thinking skills at junior high school level. The implications of this research show that the use of textbooks prepared based on the Brain-Based Learning (BBL) Model and supported by a Scientific Approach has significant potential in improving students' critical thinking skills. The BBL model, which is based on the working principles of the brain in processing information, helps create a learning environment that supports students' natural learning processes. By involving a scientific approach, students are invited to experience the process of observing, asking, gathering information, associating, and communicating, which are important stages in critical thinking. Implementation of this textbook can strengthen students' analysis, evaluation skills and ability to solve problems independently. In other words, the use of BBL-based textbooks with a scientific approach is able to provide a more meaningful and in-depth learning experience, enabling students not only to understand concepts in depth but also to develop critical thinking skills that are essential for successful learning in various scientific fields.

Limitations of this study include the focus on a limited implementation context in a specific classroom environment and the relatively short testing time period. The Brain-Based Learning Model and Scientific Approach applied in this textbook may not fully reflect its effectiveness on various student characteristics or in various learning environments. Additionally, the critical thinking skills measured in this study may require more time to truly develop to their full potential. Based on these limitations, it is recommended that similar research be carried out with a wider sample range and a longer testing time so that the results are more generalizable. It is also recommended that this model be implemented in various subjects or different levels of education to see the consistency of its impact in improving critical thinking skills. Further research should also consider other factors, such as students' cognitive and emotional backgrounds, to optimize the effectiveness of this BBL-based learning model.

4. CONCLUSION

Based on the results and discussion of the research, it was concluded that the textbook using the BBL model assisted by a scientific approach which was developed to teach students' critical thinking skills met the criteria of being valid, practical and effective and suitable for use. in teaching students about algebraic operations material for class VIII junior high school students. Textbooks with the BBL model assisted by a scientific approach tend to convey or guide contemporary learning activities or student-centered learning. Apart from that, the use of textbooks developed in learning encourages students to be more active and makes it easier for students to find the meaning of learning.

5. REFERENCE

- Amran, R., Yokoyama, F., & Nishino, K. (2020). Development Of Active Learning Methods Of English In Japanese High School To Support Students Activities In Group Discussion. *Procedia Computer Science*, 96(65), 1471–1478. <https://doi.org/10.1016/j.procs.2016.08.193>.
- Antini, L., Iriawan, S. B., & Mufliva, R. (2021). Pengembangan Bahan Ajar Berbasis Brain Based Learning Pada Pembelajaran Matematika Kelas Iv Sekolah Dasar. *Jurnal Pendidikan Guru Sekolah Dasar*, 7(1), 83–92.
- Arif, D. S. F., Zaenuri, & Cahyono, A. N. (2019). Analisis Kemampuan Berpikir Kritis Matematis Pada Model Problem Based Learning (Pbl) Berbantu Media Pembelajaran Interaktif Dan Google Classroom. *Seminar Nasional Pascasarjana*, 4(3), 323–328. <https://proceeding.unnes.ac.id>.

- Astika, L., Husna, N., & Mariyam. (2019). Peningkatan Kemampuan Berpikir Kritis Matematis Siswa Dengan Model Brain Based Learning (Bbl) Materi Persamaan Kuadrat Kelas Ix Di Smp Negeri 3 Singkawang. *Innovative: Journal Of Social Science Research*, 3(6), 8911–8926. <https://doi.org/10.31004/Innovative.V3i6.4837>.
- Dekker, T. J. (2020). Teaching Critical Thinking Through Engagement With Multiplicity. *Thinking Skills And Creativity*, 37(1), 10 1016 2020 100701. <https://doi.org/10.1016/J.Tsc.2020.100701>.
- Diani, H., Irwandani, & Fujiani, D. (2020). Physics Learning With Brain Based Learning (Bbl) Model: Impact On Skills Critical Thinking Skills. *Indonesian Journal Of Science And Mathematics Education*, 02(3), 344–352. <https://doi.org/10.24042/Ijsme.V2i3.4360>.
- Eladl, A. M., & Saad, M. A. E. (2019). Effect Of A Brain-Based Learning Program On Working Memory And Academic Motivation Among Tenth Grade Omanis Students. *International Journal Of Psycho-Educational Sciences* |, 8(1), 42–50. <https://doi.org/https://www.journals.lapub.co.uk>.
- Fazil, F., & Saleh, S. (2020). Kesan Pendekatan Pengajaran Berasaskan Otak Terhadap Motivasi Pembelajaran Sains. *Jurnal Pendidikan Sains & Matematik Malaysia*, 6(1), 68–78. <https://doi.org/https://ojs.upsi.edu.my/index.php/jpsmm/article/view/2160>.
- Fitriana, D., Yusuf, M., & Susanti, E. (2019). Pengembangan Lembar Kerja Siswa Menggunakan Pendekatan Saintifik Untuk Melihat Berpikir Kritis Siswa Materi Perbandingan. *Jpm: Jurnal Pendidikan Matematika*, 10(2), 1–17. <https://doi.org/10.22342/Jpm.10.2.3629.23-38>.
- Handayani, B. S., Kusmiyati, M., Artayasa, I. P., & Merta, I. W. (2019). Developing Learning Devices For Brain Based Learning Model By Using Scientific Approach In Teaching And Learning Biology At Senior High School. *Proceedings Of The 1st Annual Conference On Education And Social Sciences (Access 2019) Developing - Proceedings Of The 1st Annual Conference On Education And Social Sciences (Access 2019) Developing*, 465(Access 2019), 77–82. <https://doi.org/10.2991/Assehr.K.200827.021>.
- Harahap, S. D., Sabri, & Ahmad, M. (2023). Implementation Of The Connected Mathematics Project Learning Model On Students ' Mathematical Critical Thinking Ability. *Jurnal Gantang*, VIII(2), 181–191. <https://doi.org/10.31629/Jg.V8i2.5952>.
- Imamah, A. N., Prihatin, J., & Pujiastuti. (2020). Efektivitas Buku Ajar Digital Sistem Ekskresi Berbasis Brain-Based Learning Dilengkapi Dengan Augmented Reality Dan Couple Card Dalam Meningkatkan Hasil Belajar Siswa Sma. *Saintifika*, 24(1), 1–9. <https://doi.org/https://jurnal.unej.ac.id/index.php/stf/article>.
- Istuningsih, W., Baedhowi, B., & Sangka, K. B. (2019). The Effectiveness Of Scientific Approach Using E-Module Based On Learning Cycle 7e To Improve Students' Learning Outcome. *International Journal Of Educational Research Review*, 3(3), 75–85. <https://doi.org/10.24331/Ijere.449313>.
- Koşar, G., & Bedir, H. (2019). Improving Knowledge Retention Via Establishing Brain-Based Learning Environment. *European Journal Of Education Studies Issn*, 4(9), 208–218. <https://doi.org/10.5281/Zenodo.1298918>.
- Laksana, A. D. S., Prihatin, J., & Novenda, I. L. (2020). The Development Of Collaborative Learning Based On Brain-Based Learning (Bbl) Model For The Junior High School Science Learning In The Agroecosystem Area. *Bioedukasi*, XVII(2), 82–91. <https://doi.org/10.19184/Bioedu.V17i2.14999>.
- Lee, W. W., & Owen, D. L. (2020). *Multimedia Based Instructional Desain Second Edition*. John Wiley & Sons, Inc.
- Lestari, K. E. (2020). Implementasi Brain-Based Learning Untuk Meningkatkan Kemampuan Koneksi Dan Kemampuan Berpikir Kritis Serta Motivasi Belajar Siswa Smp. *Jurnal Pendidikan Uniska*, 2(1), 36 – 46.
- Maesarani, S., R., & Hamzan. (2022). Journal Of Research On Science Education. *Cahaya Journal Of Research On Science Education*, 1(1), 1–14. <https://ejournal.ahs-edu.org/index.php/cahaya/about>.
- Mahanal, S., Zubaidah, S., Sumiati, I. D., & Ismirawati, N. (2019). Ricosre : A Learning Model To Develop Critical Thinking Skills For Students With Different Academic Abilities. *International Journal Of Instruction*, 12(2), 417–434. <https://doi.org/10.29333/Iji.2019.12227a>.
- Marzuki, W., Cahya, E., & Juandi, D. (2019). Students ' Critical Thinking Skills In Solving Mathematical Problems ; A Systematic Procedure Of Grounded Theory Study. *International Journal Of Instruction*, 14(4), 529–548. <https://doi.org/10.29333/Iji.2021.14431a>.
- Mekwan, J., & Poonputta, A. (2023). The Effects Of Integrated Brain-Based Learning And Skills Training In Linear And Quadratic Functions Among Grade 11 Students. *Journal Of Education And Learning*, 12(3), 78–85. <https://doi.org/10.5539/Jel.V12n3p78>.
- Nahdi, D. S. (2023). Meningkatkan Kemampuan Berpikir Kritis Dan Penalaran Matematis Siswa Melalui Model Brain Based Learning. *Jurnal Cakrawala Pendas*, I(1), 13–22.
- Nassar, E. G. A. (2019). The Effects Of Brain Based Learning Approach On Study Habits And Test Anxiety

- Among First Year Preparatory School Students With Learning Disabilities. *International Journal Of Psycho-Educational Sciences*, 8(1), 70–75. <https://www.journals.lapub.co.uk/index.php/ijpes>.
- Nieveen, N. (2010). Formative Evaluation In Educational Design Research. An Introduction To Educational Design Research. *Proceedings Of The Seminar Conducted At The East China Normal University, Shanghai (Pr China)*, 89–102. <https://doi.org/https://ris.utwente.nl/ws/portalfiles/portal>.
- Niswani, & Asdar. (2022). The Effectiveness Of Brain Based Learning Model Using Scientific Approach In Mathematics Learning Of Grade Viii Students At Smpn 4 Sungguminasa In Gowa District. *Jurnal Daya Matematis*, 4(3), 349–365. <https://doi.org/10.26858/jds.v4i3.2928>.
- Nurbaeti, E., Sugiharti, M., & Maya, R. (2021). Improving Critical Thinking Ability And Mathematical Disposition Of High School Students Through Integrated Saintific Approach To Brain Based Learning. *Jim: Journal Of Innovative Mathematics Learning*, 2(3), 112–120. <https://doi.org/10.22460/jiml.v2i3.p112-120>.
- Nurfaizah, P., Z., K., & Tejaningrum, D. (2022). Students' Critical Thinking Skills In The Learning Strategy Course Keterampilan Berfikir Kritis Mahasiswa Pada Mata Kuliah Strategi Pembelajaran. *Jurnal Penelitian Ilmu Pendidikan*, 15(1), 46–54. <https://doi.org/10.21831/jpipfip.v15i1.41689>.
- Ode, L., Jazuli, A., Solihatin, E., & Syahril, Z. (2020). *The Effects Of Brain-Based Learning And Project-Based Learning Strategies On Student Group Mathematics Learning Outcomes Student Visual Learning Styles* (Vol. 4, Issue 4, Pp. 4–11).
- Pertiwi, P., Elindra, R., & Ahmad, M. (2023). Efektivitas Penerapan Model Reciprocal Teaching Terhadap Kemampuan Berpikir Kritis Matematika Siswa. *Mathematic Education Journal(Mathedu)*, 6(1), 40–47. <http://journal.ipts.ac.id/index.php/mathedu>.
- Prakoso, A. F., Fitrayati, D., & Dewi, R. M. (2018). Scientific Approach With Problem Posing Integrated In Introductory Microeconomics Theory , Whether Work? *International Journal Of Educational Research Review Scientific*, 3(4), 1–10. <https://doi.org/10.24331/ijere/415828>.
- Prasetyo, N. H., & Firmansyah, D. (2022). Analisis Kemampuan Berpikir Kritis Matematis Siswa Kelas Viii Dalam Soal High Order Thinking Skill. *Jurnal Educatio*, 8(1), 271–279. <https://doi.org/10.31949/educatio.v8i1.1958>.
- Prayogi, A., & Widodo, A. T. (2021). Kemampuan Berpikir Kritis Ditinjau Dari Karakter Tanggung Jawab Pada Model Brain Based Learning. *Unnes Journal Of Mathematics Education Research*, 6(1), 89–95. <https://doi.org/https://journal.unnes.ac.id/sju/ujmer/article/view/18420>.
- Prihartini, E., Lestari, P., & Saputri, S. A. (2021). Meningkatkan Kemampuan Berpikir Kritis Matematis Menggunakan Pendekatan Open Ended. *Prosiding Seminar Nasional Matematika Ix*, 4(3), 58–64.
- Putri, C. A., Munzir, S., & Abidin, Z. (2020). Kemampuan Berpikir Kreatif Matematis Siswa Melalui Model Pembelajaran Brain-Based Learning Cut. *Jurnal Didaktik Matematika*, 6(1), 12–27. <https://doi.org/10.24815/jdm.v6i1.9608>.
- Rijal, M., Mastuti, A. G., Safitri, D., Bachtiar, S., & Samputri, S. (2021). Differences In Learners ' Critical Thinking By Ability Level In Conventional , Nht, Pbl, And Integrated Nht-Pbl Classrooms. *International Journal Of Evaluation And Research In Education (Ijere)*, 10(4), 1133–1139. <https://doi.org/10.11591/ijere.v10i4.21408>.
- Rohani, R., Ahmad, M., Lubis, I. S., & Nasution, D. P. (2020). Kemampuan Berpikir Kritis Matematika Siswa Melalui Model Pembelajaran Kooperatif Tipe Think Pair Share. *Aksioma: Jurnal Program Studi Pendidikan Matematika*, 11(1), 504–518. <https://doi.org/10.24127/ajpm.v11i1.4408>.
- Sabri, K., U., A., M., & Fah, L. Y. (2023). Textbook Effectiveness With Contextual Teaching And Learning Approach On Creative Thinking Ability Elementary School Students. *Dinamika Jurnal Ilmiah Pendidikan Dasar*, 15(2), 118–131. <https://doi.org/10.30595/dinamika.v15i2.18862>.
- Sabri, K., U., & Ahmad, M. (2020). Validitas Buku Ajar Dengan Pendekatan Kontekstual Dalam Membelajarkan Kemampuan Berpikir Kreatif Siswa Sekolah Dasar. *Jurnal Elementaria Edukasia*, 6(3), 1043–1056. <https://doi.org/10.31949/jee.v6i3.6629>.
- Şahin, Ş., Ökmen, B., & Kılıç, A. (2019). The Effectiveness Of The Brain-Based Learning Style Cycle. *Excellence In Education Journa*, 12(1), 82–122.
- Silvana, H., & Wibisono, A. (2024). Penerapan Model Brain Based Learning Dalam Pembelajaran Di Sman 10 Bandung. *Ethos (Jurnal Penelitian Dan Pengabdian Masyarakat)*, 4(2), 303–310. <https://doi.org/10.29313/ethos.v0i0.1976>.
- Sitorus, M. N., & Diana, H. A. (2023). Penerapan Brain Based Learning (Bbl) Berbantu Geogebra Untuk Meningkatkan Kemampuan Koneksi Matematis Siswa Smp Materi Bangun Datar. *Jurnal Karya Pendidikan Matematika*, 9(1), 29–44.
- Solihah, E. E., Utami, S., & Dewi, N. K. (2020). Penyusunan Ensiklopedia Berbasis Keanekaragaman Capung (Odonata) Di Kawasan Air Terjun Teleng Ngawi Sebagai Sumber Belajar Kelas X. *Jems: Jurnal Edukasi Matematika Dan Sains*, 10(2), 424–430. <https://doi.org/http://e->

[Journal.Unipma.Ac.Id/Index.Php/Jems/Article.](https://www.unipma.ac.id/index.php/jems/article)

- Tambunan, H. (2020). The Effectiveness Of The Problem Solving Strategy And The Scientific Approach To Students' Mathematical Capabilities In High Order Thinking Skills *Electronic Journal Of Mathematics Education*, 14(2), 293–302. <https://doi.org/10.29333/iejme/5715>.
- Thonsakul, S., & Poonputta, A. (2019). Development Of Grade 11 Student Learning Achievements On Quadratic Functions Using Brain-Based Learning (Bbl. *Management. Journal Of Education And Learning*, 12(1), 125–131. <https://doi.org/10.5539/jel.V12n1p125>.
- Tuti, M., & Sri, A. (2019). Brain-Based Learning Using Problem Based Learning To Improved Ability Of Critical Thinking And Life Skills Learners Stkip Hamzanwadi Selong. *International Conference On Elementary And Teacher Education (Icete)*, 369–377. <https://www.researchgate.net/profile/Sukardi-Sukardi-2/publication/321574919>.
- Wijaya, A. P., Nusantara, T., Sudirman, & Hidayanto, E. (2022). Students' Analytical Questions And Interaction Patterns In Group Discussion Facilitated With A Scientific Approach Learning. *Mathematics Teaching Research Journal*, 14(2), 45.
- Winter, R. M. (2020). The Benefit Of Utilizing Brain-Based Learning In Higher Education Online Environments. *Journal Of Instructional Research*, 8(1), 82–91.
- Yusupova, N. X. (2019). The Role Of Tests In Determining The Mathematical Ability Of Students. *Central Asian Journal Of Mathematical Theory And Computer Sciences*, 2(12), 25–28. <http://cajmtcs.centralasianstudies.org/index.php/cajmtcs>.
- Zakaria, L. M. A., Purwoko, A. A., & Hadisaputra, S. (2021). The Development Of Problem Based Chemistry Teaching Materials Using Brain-Based Learning Approach: Validaty And Reliability. *J. Pijar Mipa*, 15(5), 554–557. <https://doi.org/10.29303/jpm.V15i5.2258>.