Development of learning devices: brain-based learning and mathematics critical thinking

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Vera Dewi Susanti[1], Fatriya Adamura[2], Restu Lusiana[3], Tri Andari[4]

Department of Mathematics Education, Universitas PGRI Madiun, Jl. Setiabudi 85 Madiun 63118, Indonesia

[1]vera.mathedu@unipma.ac.id.,[2]fatriya.mathedu@unipma.ac.id
[3]restu.mathedu@unipma.ac.id,[4]tri.mathedu@unipma.ac.id.

Abstract. The low percentage of logarithms lesson only 22.36%[1]. The solution to overcoming the problems experienced by these students is through a brain-based learning approach that can help students to understand, think critically in solving logarithms problems. Development research is carried out using a modified 4-D model consisting of define, design, and develop. The research instruments used were validation sheets, legibility validation sheets, and student response questionnaires. Data analysis was performed on each data obtained with research instruments. The conclusion obtained is that the brain-based learning cooperative learning device in the form of good student worksheets has been achieved because the validator team states that the learning tools developed are valid, and the implementation of the trial, the device meets specific requirements. 81.23% above the minimum criteria value and 76 % of students experience an increase in cost from the previous value. This shows that using worksheets students can improve students' critical thinking skills.

1. Introduction

Based on [1] shows that the percentage of absorption of mastery of material for math problems in class X on the National High School Examination in Madiun district in the 2015/2016 Academic Year on the logarithmic element is meager at 22.36%. One way to overcome this problem is to approach learning [2] so that logarithmic material can be understood and absorbed well into the brain of

students. Brain-based learning is a learning approach that uses concepts to create education oriented toward efforts to empower students' brain potential.

According to [3] brain-based learning can improve students' critical thinking skills through several skills such as, seeking possibilities and probabilities (erupting quickly in groups, making formulas, surveys, causes), debate skills and discussion, identification of errors, nonconformities, and incoherence , examine alternative approach approaches (changing the reference frame, thinking outside the box, etc.), hypothesis-testing strategies. Meanwhile, according to [4], [5] the application of Brain-Based Learning can influence students' critical thinking skills.

Katagiri[6] who stated that "the most important ability that arithmetic and mathematics source need to cultivate order to instill in students to think and make judgment independently is mathematical thinking." In other words, mathematical thinking is the main ability in calculation and mathematics lessons, which need to be instilled in students so they can think and make decisions independently. And[7]–[9] who stated that "brain teaching emphasizes how the brain learns naturally and is based on what we currently know about the actual structures and functions of the brain at several developmental stages. Although brain-compatible teaching is not a panacea or magic bullet to solve all of education's problems, as teachers, we must understand certain principles and use effective strategies in purposeful ways." In other words, a good learning strategy can maximize brain development because the brain works according to existing knowledge.

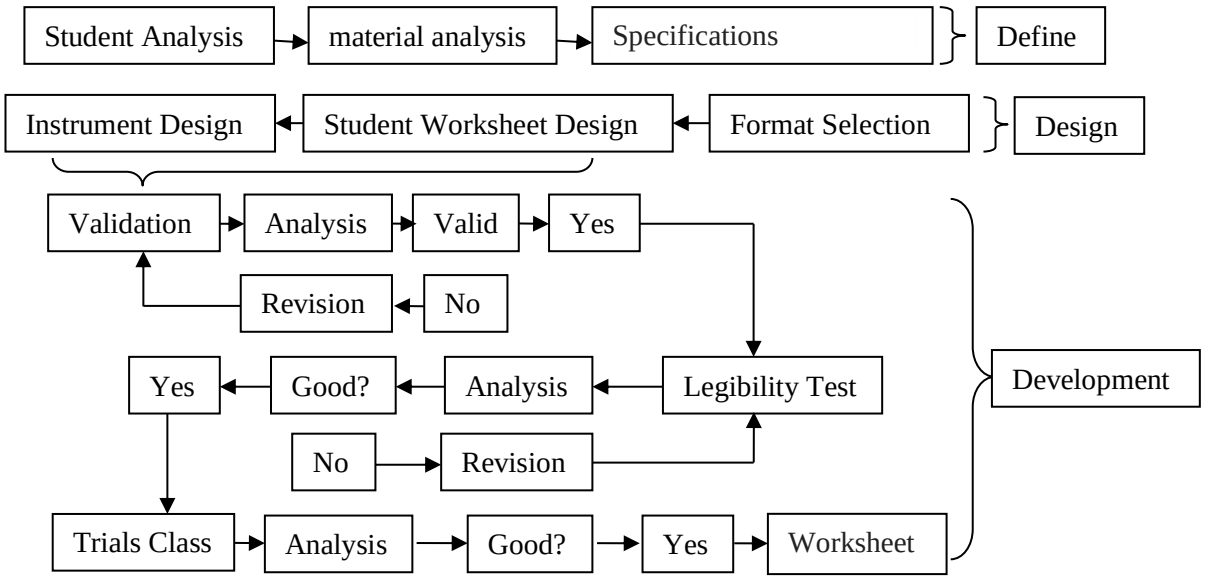
The brain which receives a threat feeling from the learning experience prevents the remembering of information related to this experiment [9], [10]. Apart from that, when the brain notices that the experience is important most of the learning is permanent. [5], [11]. The establishing of discussion groups, conducting exercises, using the learned items and peer teaching activities also provide the retention of the learning[5], [12]. In [13]about current fashion for brain-based learning, in which value-laden claims about learning are grounded in neurophysiology. In this study, what will be discussed is how to make learning tools in the form of student worksheets with a brain-based learning approach.

Critical thinking is thinking well and reflecting or studying about other people's thinking processes [14]. Critical thinking is an organized process that allows students to evaluate the evidence, assumptions, logic, and language that underlies the statements of others [15]. Critical thinking is a process of using thinking skills in a controlled and precise way to help a person compile, evaluate and apply decisions about what is believed and done [16]. The use of group investigation-based book on numerical analysis has been meeting the completeness criteria classical learning that is 84.32 %[17].

Through this research, researchers want to reveal whether using student worksheets can also improve critical thinking success.

2. Method

The model of learning device development in this study is :



Analysis of this research are as follows :

2.1. Analysis of valid learning device validation data according to the validators if the validators provide a minimum assessment of 3.

2.2. The formula analyzes legibility validation results:

$$\frac{\text{many students respond}}{\text{many students follow validity readability}} \times 100\%$$

2.3. Analysis of student response data obtained through questionnaires was analyzed and categorized as positive if the percentage of students' positive response was at least 80% for each aspect.

2.4. The ability of students to carry out critical thinking skills mathematically increases if there is an increase in scores after the use of student worksheets and the average class is more than 75%.

3. Results and Discussions

3.1. Define Phase

Student Analysis: Many Students have not been understood logarithm material yet.
Material Analysis: Material that is used is logarithm material.
Specification of Learning Outcome Reaching: Characteristics of logarithm and step for solving the problem that relates to the logarithm.

3.2. Design Phase

3.2.1. Format Choosing: Lesson plan format is accorded to principle, characteristic, and learning step is oriented with BBL and learning content.

3.2.2. First Planning Of Learning Tool is student worksheet that contains learning material and question of the logarithm.

3.2.3. First Planning Of Research Instrument

First planning of research instrument consists of a learning tool validity sheet, student worksheet readability validity sheet, and student response sheet.

3.3. Develop Phase

In the developing phase, some activities that have been done are expert validity, readability validity, and experimenting of a learning tool.

3.3.1. The result of Expert Validity

The effect of expert validity shows that student worksheet valid with the suggestion from validator is giving learning objectives in student worksheet.

3.3.2. Readability Validity

The result of student worksheet readability validity is shown in the following table.

Table Analysis Result of Student Worksheet Readability Validity

Learning Tool	Scoring Aspect	Criteria	Quantity	Percentage (%)	Category
Student Worksheet	The content of Student Worksheet	Mn	6	100	Interesting
		Tm	0	0	
	Performance of Student Worksheet	Mn	6	100	Interesting
		Tm	0	0	
	Explanation of Student	Ab	0	0	A little confusing explanation
		As	3	50	

	Worksheet Sentence Difficulty	Ta	3	50	
		Ya	4	66,67	There is a difficult sentence

The result of readability validity is used to revise Draft II.

Tabel Revision based on Result of Readability Validity

That is Revised Worksheet	Before Revision	After Revision
	It is needed for adding the step of Brain-Based Learning at the beginning of student worksheet.	It has been added the step of Brain-Based Learning at the beginning of student worksheet.

3.3.3. Experimenting Of Learning Tool

The result of Student Response Questionnaire

Table Result of Student Response Questionnaire for Learning Tool and Learning Process (Experimenting Class)

No	Responded Aspect	Scoring/Opinion	
1	Can you understand student worksheet language or no?	88,23 % clear	11,77% not clear
2	Do you interest with student worksheet layout (writing, illustration, and picture position) or no?	94,12 % Interested	5,88% Not Interested
3	Do you like student worksheet or no?	88,23% Nice	11,77% Not Nice
4	Do you agree if next learning will use similar learning or no?	94,12%Nice	5,88% Not Nice

Based on the table, positive student response is 85%, so that the learning tool is not revised.

3.3.4. Critical Thinking Skills

From the results of the test scores show that 81.23% above the minimum criteria value and 18.77% below the minimum criteria value and 76 % of students experience an increase in cost from the previous value. This shows that using worksheets students can improve students' critical thinking skills.

3.4. Research Result Discussion

Reaching of learning tool criteria of problem-based learning shows that student worksheet valid and student response is positive. This shows that learning tool oriented brain-based learning for

practicing analytical thinking capability was gotten by using modified 4-D model. Learning tools that are gotten are lesson plan and student worksheet. This according to[18], [19].*The principles and techniques of BBL have been applied to school children to promote achievement in science and social science courses and to improve attitudes and learning processes*[5], [20].In other words, applying the BBL model can increase student learning result and improve student critical thinking capability.

4. Conclusion

The conclusion obtained is that the brain-based learning cooperative learning device in the form of good student worksheets has been achieved because the validator team states that the learning tools developed are valid, and the implementation of the trial, the device meets specific requirements. Other than that, from the results of the test scores show that 81.23% above the minimum criteria value and 76 % of students experience an increase in cost from the previous value. This indicates that using worksheets students can improve students' critical thinking skills.

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