Development of Cooperative Learning Think-Talk-Write (TTW) Models Based on Batak Culture to Improve Students' Mathematical Critical Thinking Ability

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Article Info	Abstract
	This study aimed to develop valid, practical, and effective Think-Talk-Write (TTW) learning tools based on Batak culture. Plomp's research design was used in this study. This development research product was a valid, practical, and effective TTW learning tools based on Batak culture, which can improve students' mathematical critical thinking ability. The results of the study are (1) TTW learning model based on Batak culture belonged to the valid category; (2) the practicality of the TTW learning tools based on Batak culture belonged to the high category; and (3) the effectiveness of the TTW learning tools based on Batak culture based on (a) classical student learning completeness was 88.89%; (b) the use of learning time criteria was in the high category; (c) the teacher's ability to manage learning criteria was in the high category, and (d) many students gave positive responses to the components and learning activities. Key Words: Critical Thinking, Development, Think-Talk-Write

Introduction

Mathematics is essential in life. Mathematics is a tool to think logically in solving life problems (Dewimarni, 2017; Graciella & Suwangsih, 2016; Susanto et al., 2018). However, students' critical thinking ability has been low. Thus, mathematics critical thinking ability is an essential mathematics basic competence (Widyatiningtyas et al., 2015), supporting students to regulate their study skills (Aizikovitsh-Udi & Cheng, 2015). Critical thinking means reflective thinking that focuses on deciding the believed act (Fuad et al., 2017). Considering the importance of these abilities, one of the effective strategies is using an appropriate learning model (Morin et al., 2017). One effective and appropriate learning model is Think-Talk-Write (TTW) (Angriani et al., 2016).

Education is said to be of quality if the educational processes can produce individuals or human resources that benefit society and nation development. Mathematics is one of the science that underlies the progress of science and technology. It can be seen as a structured and integrated science, the science of patterns and relationships, and how to understand the world. When implementing mathematics learning, students get the opportunity to develop systematic, logical, and critical thinking in communicating ideas or solving mathematical problems.

According to the Ministry of National Education, several indicators need to be developed in learning mathematics, such as mathematical understanding, problem-solving, critical thinking, reasoning, and communicating (Depdiknas, 2006). Critical thinking is one of the essential skills in learning mathematics. If the thinking process is well established, it can build an understanding of mathematical ideas and easily understand it.

When studying mathematics, students are expected to achieve the five mathematics learning objectives as formulated by the National Council of Teachers of Mathematics (2000). The five standard mathematical learning process are problem-solving, reasoning and proof,

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communication, connections, and critical thinking. Meanwhile, the five mathematics standards of content are numbers and operations, problem-solving, geometry, measurement, and opportunities and analysis.

One of the study's objectives the mathematics states by NCTM are standard of content and process standards. Learning emphasizes reasoning activities and critical thinking, which are near related to high student achievement. Even Posamentier and Stepelmen (1990) put critical thinking as the first sequence of 12 essential mathematical components and learning to solve problems (Posamentier & Stepelmen, 1990). At the same time, PISA (Program for International Student Assessment) and Bloom's Taxonomy put the problem-solving skills at the Higher-Order-Thinking level of 6 or C6. Based on PISA's (Program for International Student Assessment) survey in 2015, Indonesia ranked 62 out of 70 countries (OECD, 2016).

Students' mathematical critical thinking ability are low. The formation of quality human resources has not been realized. The Global Talent Competitiveness Index (GTCI) reported in 2017 shows that Indonesia's global talent competitiveness index ranks 90th among 118 countries in the Asia Pacific region (Lanvin & Evans, 2016). Indonesia received a score of 36.81 which low compared to the highest score obtained by Switzerland (74.55). Indonesia's position is much lower than Singapore (2nd) and Malaysia (28th). The scores of the two countries were 74.09 and 56.22. The index is measured based on the ability of a country to compete in scoring talent and human resource capabilities. This has shown the low quality of Indonesian students' mathematical knowledge at the international level. In SMA Negeri 1 Medan, students' mathematical critical thinking ability are seen from the questions tested in class students' answers. This is confirmed by Yuliani&Saragih (2017), who said that students are expected to use mathematics and mathematical mindset in daily life and study many kinds of sciences stressed on the logical arrangement, student's character building, and also ability to apply mathematics. In a student-centered learning approach, students build knowledge by exploring some situations and real-world problems through the mathematical process(Yuliani & Suragih, 2015). Mathematics is not presented as a ready-made product to be transferred to the students by imitating, practicing repetition, and memorizing (Saragih & Napitupulu, 2015).

The importance of learning independence for students is conveyed by the results of Darr and Fisher's (2004) study, which reported that independent learning ability correlates positively with student learning success (Darr & Fisher, 2004). Students with high success levels make higher goals, use more effort, survive longer when facing difficulties, and most likely use independent learning strategies (Bandura, 1997). Most students find solutions through self-regulatory activity by analyzing problems, monitoring the completion process, and evaluating the results (De Corte, 1996).

Improving learning outcomes requires an improvement in the learning process. The excellent quality learning process becomes a necessity. The government has designed various efforts to improve the quality of human resources in Indonesia. Learning tools can increase students learning outcomes by up to 85% (Syahputra & Utami, 2019). One of the factors that can improve students' mathematical critical thinking ability is innovative and student-centered learning models. Based on an interview with a mathematics teacher at SMA Negeri 1 Medan, innovative learning models have not been effectively implemented. Therefore, the learning model used in this research was TTW. TTW model will help students develop thinking skills, critical thinking skills, and learn adults' roles to become independent learners (Arends, 2008).

Teachers and lecturers' importance mentions the importance of using learning tools in Law No. 14 of 2005 in carrying out professional duties. Teachers are obliged to plan lessons, carry out quality learning processes, and assess and evaluate the learning outcomes. It is also available in the 2013 curriculum that a teacher must utilize the learning resources and develop media or other learning resources.

Learning tools used by teachers have not been directed to teaching higher-order thinking. Thus, the learning needs learning tools that cover the mathematical critical thinking ability and students' learning independence. This study developed a TTW learning model based on the Batak culture in lesson plans (RPP), student worksheets, and mathematical critical thinking tests based on the above conditions and expectations.

The Research Methods

This research was development research using Plomp's development model (Plomp, n.d.). This research was conducted online through Google Meeting and WhatsApp group. To support the implementation of learning, tools are needed that facilitate the planning, implementation, and evaluation of learning. A learning tool is a collection of learning resources that enable students and teachers to do learning activities. Learning tools consist of the syllabus, lesson plan, student worksheet, and test.

Subjects and Objects of Research

The subjects of this research were 36 students of SMA Negeri 1 Medan in class XMIA8 and XMIA10. This study's object was a mathematics learning tools in the form of a lesson plan, student worksheet, and mathematical critical thinking ability test.

Instruments and Data Analysis Techniques

The instruments in this study were tests, questionnaires, and observation sheets. The details are presented in Table 1.

Table 1. Data Analysis Instruments and Techniques

Rated Aspect	Instruments	The Observed Data	Respondents
The validity of TTW learning tools based on Batak culture	Validation sheet	TTW learning tools based on Batak cultural (lesson plan, student worksheet, mathematical critical thinking ability test)	Expert/Specialist
The practicality of TTW learning tools based on Batak culture	Validation sheet	TTW learning tools based on Batak cultural (lesson plan, student worksheet, mathematical critical thinking ability test)	Expert/Specialist
	Teacher and student interview sheets	Learning tools implementation	Observer
	Observation sheet	Learning tools implementation	Observer
Effectiveness of TTW learning tools based on Batak culture	Test	Mathematical critical thinking ability test	Student
	Observation sheet	Teacher's ability to manage learning	Observer
	Questionnaire	Students' responses	Student

The Validity of the Developed TTW Learning Tools Based on Batak Culture

Five experts validated the developed learning tools. The validity criteria of the learning tools are as follows:

Table 2. The Validity Criteria

Va or Average Total Value	Validity Criteria
$1 \leq Va < 2$	Invalid
$2 \leq Va < 3$	Less Valid
$3 \leq Va < 4$	Quite Valid
$4 \leq Va < 5$	Valid
$Va = 5$	Very Valid

Source:(Sinaga, 2007)

Annotation: Va is the value of determining the level of prevalence and learning devices using TTW based on Batak culture.

Meanwhile, the product-moment correlation formula was used to calculate the validity and ability of the mathematical critical thinking test:

$$r_{xy} = \frac{n \Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{\{n \Sigma X^2 - (\Sigma X)^2\}\{n \Sigma Y - (\Sigma Y)^2\}}}$$

Annotation:

X : Score item r_{xy} : Test validity coefficient

Y : The total score   n : The number of many respondents who took the test

In determining the reliability coefficient, the alpha formula was used as follows:

$$r_{11} = \left(\frac{n}{n-1}\right)\left(1 - \frac{\Sigma \sigma_1^2}{\sigma_1^2}\right)$$

Annotation:

r_{11} : Test reliability coefficient

$\Sigma \sigma_i^2$: The number of variance scores per test item

σ_i^2 : Total variance

n : The number of test items

The Practicality TTW Learning Tools Based on Batak Culture

The first analysis of the practicality was the validation sheet results, where all experts stated that learning tools could be used with minor revision or no revision. To see the learning tools' practicality, an observation sheet was used with the following criteria:

Table 3. Level of Practicality Criteria

P	Practicality Criteria
$0 \leq P < 1$	Poor
$1 \leq P < 2$	Low
$2 \leq P < 3$	Moderate
$3 \leq P < 4$	High
$4 \leq P \leq 5$	Excellent

Annotation: P is the average score

The learning tools are practical or easy to implement if the practicality is at least at the high category.

The Effectiveness of TTW Learning Tools Based on Batak Culture

The criteria state that students can represent mathematically if 85% of students obtained a minimum of 75. The percentage can be calculated using the following formula:

$$Persentage\ of\ Agreement = \frac{Agrements(A)}{Disagreemnet\ (D) + Agreements(A)} \, x 100\%$$

Teacher's Ability to Manage Learning

The teacher's activity to manage the learning process is the ability to develop a familiar and lively learning atmosphere. The steps by Hobri developed by Suryaningsih in 2014 was used to assess this aspect. Since the range of scores is 0 to 5, the interval length within this score range is 5. To determine the criteria of the effectiveness of the teacher's ability to manage the learning, this interval is subdivided into five equal intervals:

Poor: If $0 \leq P < 1$

Low: If $1 \leq P < 2$

Moderate: If $2 \leq P < 3$

High: If $3 \leq P < 4$

Excellent: If $4 \leq P \leq 5$

Students' Responses

Students' questionnaire responses were analyzed by calculating the percentage of the number of students who responded positively to each of the categories asked in the questionnaire by using the following formula:

$$PRS = \frac{\sum A}{\sum B} \, x 100\%$$

Description:

PRS: Percentage of students who respond positively to each of the categories asked

ΣA: Proportion of students who choose

ΣB: Number of students (respondents)

The criteria state that students who respond positively should be greater than or equal to 80% in each trial, as stated by Sinaga in 2007.

The Improvement of Mathematical Critical Thinking Ability

The following formula was used to calculate the improvement of students' mathematical critical thinking ability after using the developed mathematical learning tools:

$$Gain = \frac{posttest\ value - pretest\ value}{ideal\ value - pretest\ value}$$

With the following criteria:

Table 4. Gain value Category

Gain Value	Category
gain < 3.0	Low
3.0 < gain < 7.0	Moderate
gain > 7.0	High

The scale to determine the improvement of students' critical thinking based on scores obtained is as follows: (Prastini & Retnowati, 2014)

Table 5. Level of Mastery of Student Learning Independence

No	Conversion Value		Category
	Value (x)	Alphabet	
1	$90 < x \leq 100$	A	Excellent
2	$82 < x \leq 90$	B	High
3	$72 < x \leq 82$	C	Moderate
4	$0 < x \leq 74$	D	Low

The Results of the Research and the Discussion

After conducting the research, several results were obtained: the validity, practicality, effectiveness of teaching materials, and students 'mathematical critical thinking ability.

The Validity of Learning Tools

The experts had measured the validity. Based on material expert analysis results, the developed learning tools obtained an average value of total validity, as shown in Table 6 and Table 7.

Tabel 6. The Validation of the Learning Model

Aspects	Aspect Average(A_i) Model's book	Total(V_0)	Validity Degree
Supporting theory	4.75		
Syntax	4.90		
Social system	4.83		
Principles of reaction and processing	4.76		
Support system	4.60	4.77	**Valid**
Instructional and accompaniment impact	4.70		
Implementation of learning	4.81		
Learning environment and management tasks	4.83		
Evaluation	4.80		

Table 7. The Validation of Lesson Plan and Student Worksheet

Aspects	Aspect Average(A_i)		Total(V_0)		Validity Degree
	Lesson Plan	Students Worksheet	Lesson Plan	Students Worksheet	
Template	4.90	4.97			
Language	4.95	4.94	4.87	4.89	**Valid**
Content	4.78	4.77			

Based on Table 6 and Table 7, the total average value was at an interval of $4 \leq \text{Va} < 5$. It means that the developed learning tools were valid.

The Practicality of the Learning Tools

The practicality aspects obtained two results; namely, the experts stated that the developed learning tools could be used with minor revision. The implementation was in the high category (the teaching material is applicable). Based on observation, the average values of observations in Experiment I and Experiment II are shown in Table 8.

Table 8. The Average Value of Implementation in Experiment I and II

The Average of All Experts	Aspects observed	Meeting $\overline{P_2}$			Total $\overline{P_3}$	Average	Note
		1	2	3			
Experiment I	Syntax	3.50	4.00	4.25	3.92	3.76	
	Social system	3.50	3.75	4.00	3.75		
	Principles of reaction and processing	3.42	3.57	3.85	3.62		High (Practical)
Experiment II	Syntax	4.25	4.50	4.75	4.50	4.50	
	Social system	4.25	4.50	4.50	4.58		
	Principles of reaction and processing	4.28	4.42	4.57	4.42		

Based on Table 8, the average value was in the high category ($3 \leq P \leq 4$) with an interval of $4 \leq Va < 5$. Based on the criteria of implementation, it means that the developed learning tools were categorized as practical. This is supported (Napitupulu, Syahputra, Sinaga, 2020), who states that the data obtained indicated that learning tools based on PBL-AAF could be useful, practical, and combinatory improvement ability.

The Effectiveness of the Learning Tools

The criteria for determining the effectiveness of the learning tools in Experiment I and II consisted of four indicators as follows:

Completeness

Based on the research findings in Experiments I and II, the completion results can be seen in Table 9.

Table 9.The Classical Completion of Mathematical Critical Thinking Ability in Experiment I and II

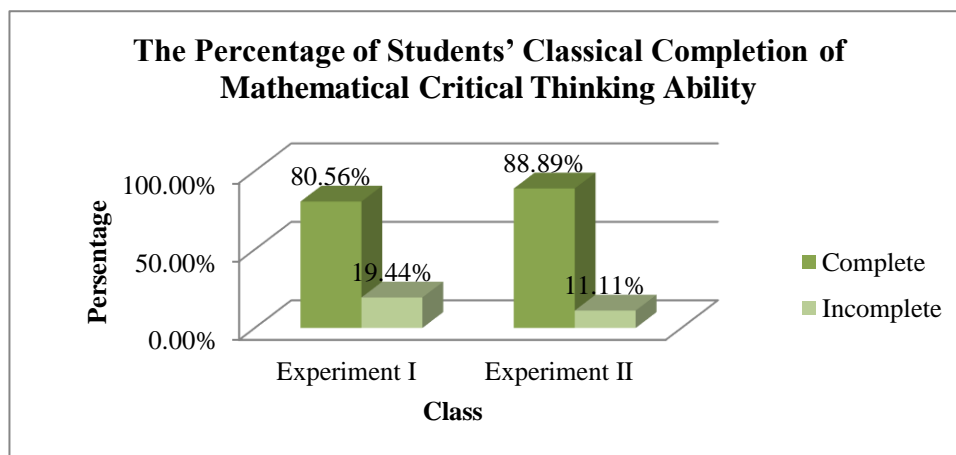| Categories	Mathematical Critical Thinking Ability			
	The Total of Students		Percentage	
	Experiment I	Experiment II	Experiment I	Experiment II
Complete	29	32	80,56%	88,89%
Incomplete	7	4	19,44%	11,11%
Total	36	36	100%	100%

Figure 1. The Percentage of Students' Classical Completion of Mathematical Critical Thinking Ability

Based on Table 9 and Figure 1, the posttest result in Experiment I did not meet the criteria of classical completeness (85% of students should achieve ≥75). However, the posttest result in Experiment II met the criteria of classical completion. This is supported by Yuliani & Saragih (2015), who state that the learning tools based on guided-discovery met are validity, practicality, and effectiveness criteria. The learning tools based on the guided-discovery model can improve the conceptual understanding and mathematical critical thinking ability (Yuliani & Suragih, 2015).

The Use of Learning Time
Observation data on the use of learning time for each meeting (with a total of three meetings) are presented in Table 10.

Tabel 10. The Average Values of Learning Time Indicators in Experiment I and II

No.	Aspects observed	Meeting			Average	Note
		I	II	III		
1.	The duration of learning does not exceed ordinary learning	5	5	5	5	
2.	Each learning stage is completed according to the specified time	4	5	5	4,67	4,67
3.	The time given at each stage of learning is sufficient	4	4	5	4,33	

Based on Table 10, viewed from the first indicator, learning duration did not exceed ordinary learning. The use of learning time's score was 4,6, so it can be concluded that the effectiveness of learning in terms of learning time was in the high category.

Teacher's Ability to Manage Learning
The result of observation found that the teacher's ability to manage learning based on the cultural perception was 4,20 (stage 1), based on thinking and understanding the concept through Batak culture was 4,67 (stage 2), based on the talks or discussions with subgroups with a transitional interaction pattern of *dalihan natolu* was 4,34 (stage2), and based on the findings of the mathematical object and reinforces the new schemata was 4,63 (stage 3).

Students' Responses
Based on the analysis of students' responses, the first aspect's percentage results, which stated that they were happy with the learning material, reached 85,55%. The second aspect's percentage results, which stated that they were happy with the lesson plan, reached 85,55%. The third aspect's percentage results, which stated that they were happy with student worksheets, reached 83,33%. It indicated that the students were pleased by the classroom's learning atmosphere (83,33%), and they were happy with how teachers manage the learning (86,11%).

Improvement of Mathematical Critical Thinking Ability
The data obtained from Experiment I and II were analyzed by comparing students' mean scores to know the improvement of mathematical critical thinking ability. The description is shown in Table 11.

**Table 11. The Description of the Mathematical Critical Thinking Ability**

Description	Experiment I	Experiment II
Highest Score	91	94
Lowest Score	65	64
Average	77,50	80

Based on Table 11, the average of students' mathematical critical thinking ability based on the posttest results in Experiment I was 77,50, which then increased to 80 in Experiment II. Furthermore, the improvement of students' mathematical critical thinking ability in Experiments I and II can be seen in Table 12.

Table 12. The Average Score of Students' Mathematical Critical Thinking Ability

Indicators	Mean for Each Indicator		
	Experiment I	Experiment II	Mean
Identification	3,47	3,55	0.08
Generalization	2,78	2,94	0.16
Analysis	2,67	2,82	0.15
Solve the problem	3,44	3,50	0.06

The details can be seen in Figure 2
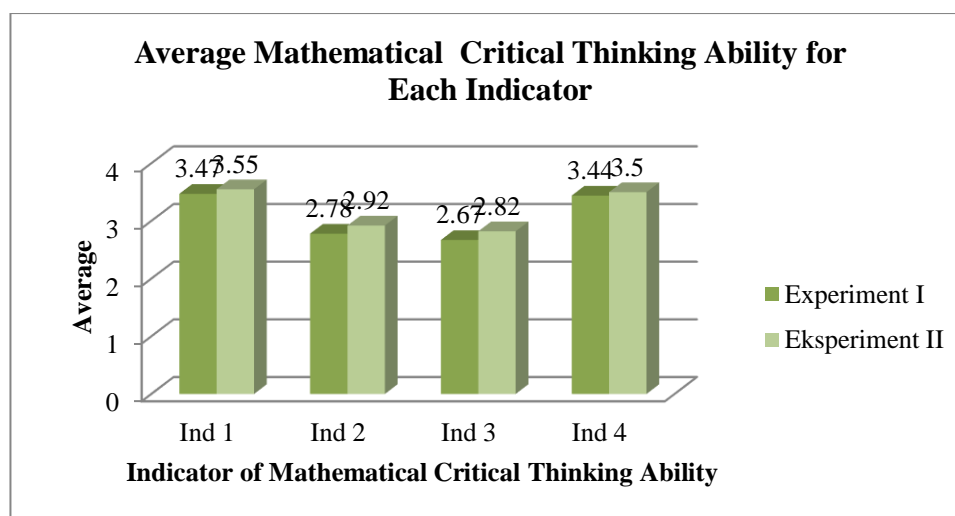
Figure 2: Average Mathematical Critical Thinking Ability for Each Indicator

Based on Table 12 and figure 2, it can be concluded that students' mathematical critical thinking ability increased by applying the developed learning tools. According to Bustami et al. research, the TTW learning model-based picture cards improve critical thinking skills compared to conventional learning (Bustami et al., 2019). Then, Wijaya (2012) states that the context in cooperative learning is aimed at building or rediscovering critical mathematical thinking through the mathematical process (Wijaya, 2012).

Students must experience the stages of critical thinking in developing critical mathematical thinking through TTW. Research by (Sister, Syahputra, Sinaga: 2020) shows that the level of students' creative thinking ability on problem-based learning model from 32 students with 'very low' creative thinking ability was 13%, 'low' creative thinking ability was 6%, 'medium' creative thinking ability was 44%, 'high' creative thinking ability was 5%, and 'very high' creative thinking ability was 3% (Sister et al., 2020). (Fitri, Syahputra, Hermawan: 2019) state that

students' mathematical resilience study taught by the blended learning rotation cognitive conflict strategy is better than those taught through conventional learning. The significant value obtained through ANOVA was 0,000 <significant level of 5%. This shows that there are significant differences in mathematical resilience in both learnings. The significance value of the learning model and the initial mathematical ability was 0.031 <0.05. It can be concluded that there was an interaction between the learning model and the initial mathematical ability in influencing students' mathematical resilience (Fitri et al., 2019).

Conclusion and Suggestion

Based on the discussion, it can be concluded that the developed learning tools have met the validity, effectiveness, and practicality criteria and can use be used in learning. The effectiveness criteria were reviewed from the criteria students' learning mastery and the teachers' ability to manage them. Twenty-nine students (80.56%) met the completion criteria in Experiment I, while in Experiment II, thirty-two students (88,89%) met the completion criteria. The learning time criteria in Experiment I and Experiment II had been achieved. It means that the learning time was effective. The teachers' ability to manage learning in Experiment I and experiment II was already high. Students improved their mathematical critical thinking ability wherein Experiment I obtained 77,50, which then improved to 80 in Experiment II. Also, the student responded positively toward the developed learning tools.

Based on the research results and conclusions, using the Batak culture-based TTW learning tools as an alternative to learning is suggested. The guidance or questions are accessible to students so that they understand the problems quickly. Further researchers want to conduct research that measures students' mathematical critical thinking skills to pay more attention to students' abilities on analysis indicators. Researchers suggest that readers and education practitioners to carry out similar research and are expected to implement Batak Culture-Based Think-Talk-Write (TTW) learning tools in a broader scope by carrying out the implementation stage.

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