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Research Article

The Effectiveness Of Developing The Realistic Mathematics Education Based On Toba Batak Culture Learning Model To Improve The HOTS Capabilities Of Prospective Elementary School Teachers

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ABSTRACT

The aim of the research is to analyze the effectiveness level of the development of the Realistic mathematics education based on Toba Batak culture learning model. The Realistic mathematics education based on Toba Batak culture learning model has fulfilled the effectiveness level to enhance students' HOTS abilities, which include: (a) syntax, consisting of: cultural apperception, problem-solving discussions, patterns of social interaction using representation and problem-solving, reflection on work results, (b) social system built on collaboration principles, (c) management reaction principles where lecturers act as facilitators, (d) supporting system such as: semester lecture plans, teaching materials, lecturer guidebooks, student guidebooks, and student activity sheets, (e) instructional impact in the form of students' HOTS abilities and accompanying impact in the form of scientific attitudes, collaboration, and realistic thinking. The Realistic mathematics education based on Toba Batak culture learning model is equipped with a set of model books, semester lecture plans, teaching materials, lecturer guidebooks, student handbooks, and student activity sheets that have met the effectiveness level. The effectiveness level of the Realistic mathematics education based on Toba Batak culture learning model is influenced by four aspects, namely: The lecturer's capacity to oversee learning scored 4.17 on the NKD scale, placing it in the high category. Student's Higher Order Thinking Skills (HOTS) were rated at 0.85, indicating a high level of proficiency. Active student participation was noted at 25%, categorized as active. Student responses were at 93%, indicating a high level of engagement. The level of students' HOTS abilities through the application of the Realistic mathematics education based on Toba Batak culture learning model has increased from the moderate category to the high category, with an N-Gain score of 0.81 in the high category. The level of active student activities through the application of the Realistic mathematics education based on Toba Batak culture learning model has a value of 25% in the active category. The level of student response to the learning process in implementing the Realistic mathematics education based on Toba Batak culture learning model obtains a value of 93 in the high category.

Keywords: Higher-Order Thinking Skills , Realistic mathematics education based on Toba Batak culture Learning Model, *Suhi Ni Ampang Na Opat*

1 INTRODUCTION

Teaching mathematics differs from teaching subjects in other sciences. Mathematics has specific characteristics where its objects of study are abstract and cannot be directly sensed. These abstract objects are commonly referred to as mental or conceptual objects., (Sumardyono, 2004). Teaching something that cannot be sensed is more challenging than teaching something that can be sensed. This difficulty affects mathematics teaching, which often focuses solely on formulas and their application in mathematical problems that have little connection to reality. The lack of connection between mathematical content and reality then leads to most prospective primary school teachers having a low interest in learning mathematics. Students/mahasiswa should not be seen as passive receivers of ready-made mathematics, (Freudenthal, 1991).

HOTS learning is based on several components, namely analysis, evaluation, logical reasoning, critical thinking, problem-solving, and creative thinking, (Hasyim, 2019). HOTS abilities can be trained by providing reasoning-type questions during the learning process, (Tambunan, 2019). HOTS is characterized by the ability to manage information beyond mere recall or memorization, (Manik, 2020). HOTS plays a crucial role in enhancing the effectiveness of the learning process, (Yaniawati, 2013). It can be said that HOTS can lead prospective elementary school teachers to success in learning, (Tanujaya, 2016). Therefore, lecturers become facilitators who provide support, source information, and guide prospective elementary school teachers to obtain real learning experiences as an effort to develop HOTS, (Rosidin, 2019).

The observations suggest that the Higher Order Thinking Skills (HOTS) of prospective elementary school teachers are currently at a low level, with an average score of 1.45. This indicates that their HOTS abilities in addressing the provided questions are categorized as inadequate. These findings underscore the overall deficiency in the HOTS capacities of prospective elementary school teachers. Consequently, there is a pressing need for effective and efficient teaching strategies in organized learning processes. Learning mathematics should involve active engagement, emphasizing problem-solving within real-life contexts. Additionally, it is crucial for students to have the opportunity to independently rediscover mathematical concepts, fostering a highly interactive teaching-learning environment, (Fauzan, 2002).

The learning model using Realistic mathematics education is a method of presenting learning by connecting it directly to real-life contexts as a source of development and application area through mathematical processes both horizontally and vertically, (Tandililing, 2010). A learning model can be considered as a Realistic mathematics education learning model if the learning model consists of five characteristics as follows: (1) Contextual use, (2) Use of models, (3) Use of own products and construction, (4) Interactive character of the teaching process, and (5) Linkage with other learning or materials, (Treffers, 1987). Spatial abilities taught using realistic mathematics are better than spatial abilities taught with conventional approaches, (Syahputra E. , 2013). There is an interaction between the learning approach and the school rank regarding the improvement of spatial abilities. Following learning using realistic mathematics education is categorized as better in terms of mathematical communication skills, positive attitudes toward mathematics learning, and activity during the learning process compared to following conventional learning, (Sulastri, 2009).

The Toba Batak culture is one among the many cultures in Indonesia. Toba Batak culture has its own uniqueness, which encompasses 9 cultural values: Kinship, Religion, Hagabeon, Hasangapon, Hamoraon, Hamajuon, Law, and Security. The Toba Batak are well-known for the Batak philosophy called "*Suhi Ni Ampang Na Opat*". The form of *Suhi Ni Ampang Na Opat* is essentially square, slim in the middle, and rounded on the top (its surroundings) - like a cup, but with the difference that the 'Ampang' must have a square base. The purpose and intention of our ancestors in creating this were nothing but the unity of the four pillars (4 family elements) or solidifying an agreement within one Batak custom/tradition.

Based on the background above, the advantages of the Realistic mathematics education learning model are as follows: a) Providing opportunities to rediscover mathematical concepts, making the teaching-learning process highly interactive, b) Enhancing the teaching of mathematics and making it not only more relevant to students in Indonesia but also changing the classroom atmosphere, c) Assisting elementary school teacher candidates in acquiring information, ideas, skills, values, ways of thinking, and self-expression goals, as well as teaching them how to learn, d) Improving students' abilities to understand concepts, representations, metacognition, problem-solving, communication, and abstraction, e) Providing opportunities to practice and develop critical thinking skills used as learning stimuli so that they learn actively, giving them opportunities to observe, identify variables, design investigations, interpret results, formulate hypotheses, and organize conclusions, f) Igniting enthusiasm for learning, avoiding boredom, and influencing interest and motivation in the learning process, g) Interacting with others more effectively.

2 LITERATURE REVIEW

2.1. Realistic Mathematics Education (RME) in Indonesia

Realistic Mathematics Education (RME) was first developed by Freudenthal in 1971 at Utrecht University, the Netherlands. According to (Freudenthal 1991), learning mathematics is an activity, so the mathematics class is not a place to transfer mathematics from teachers to students, but a place for students to rediscover mathematical ideas and concepts through exploring real-world problems. Realistic mathematics education is an approach to learning mathematics that places mathematical problems in everyday life, making it easier for students to grasp the material and gain direct experience through their own experiences. Realistic problems are used as a source of emerging formal mathematical concepts or knowledge, where students are guided on how to think about solving problems, find problems, and organize the main issues. Therefore, RME becomes an alternative in mathematics education in this study.

In addition, the reasons for this selection are based on the facts and ontological concepts of the research field. One of them is that the substance of mathematics subjects is abstract, so mathematics learning should start from concrete to abstract. This explanation supports RME as a specific learning approach for mathematics that bases learning on concrete things.

Further explanation is provided by (Van den Heuvel-Panhuizen 2014), that the use of the word "realistic" actually comes from the Dutch word "zich realiseren," which means to imagine. So, RME not only shows the connection with the real world but also refers more to the focus of realistic mathematics education, namely emphasizing the use of situations that can be imagined by students. According to (Hadi 2005), in realistic mathematics, the real world is used as a starting point for the development of mathematical ideas and concepts. Further explanation states that realistic mathematics education starts from children's lives, which can be easily understood by children, real, and accessible to their imagination, making it easy for them to seek possible solutions using their mathematical abilities. According to (Tarigan 2006), realistic mathematics learning emphasizes the importance of the real context known to students and the process of constructing mathematical knowledge by students themselves. In line with the opinions of the experts mentioned above, (Aisyah 2007) states that the realistic mathematics approach is a mathematics learning approach developed to bring mathematics closer to students. Therefore, real-life problems are raised as the starting point for mathematics learning. The use of realistic problems aims to show that mathematics is actually closely related to students' daily lives. In addition, RME emphasizes mathematical process skills, discussion, collaboration, arguing with classmates so that they can discover and ultimately use mathematics to solve problems both individually and in groups. However, it should be noted that RME does not only stop at using realistic problems. Realistic problems are only an introduction for students to enter the mathematical process.

Mathematization is a process of mathematizing a phenomenon. In the application of RME, there are two types of mathematization: horizontal mathematization and vertical mathematization. Horizontal mathematization relates to the process of generalization, which begins with the identification of mathematical concepts based on regularities and relationships found through visualizing and schematizing problems. So, in horizontal mathematization, students try to solve real-world problems using their own language and symbols, and still rely on models. Unlike vertical mathematization, which is a form of formalization where the mathematical model obtained in horizontal mathematization becomes the basis for the development of more formal mathematical concepts through the process of vertical mathematization. In other words, these two types of mathematization cannot be separated sequentially, but they occur alternately and gradually (Wijaya 2012).
So, in RME, realistic problems are used as the main stimulator in the effort to reconstruct students' knowledge. In addition, the application of RME is accompanied by the use of models so that the learning conducted can be truly imaginable by students, thus referring to solving problems with various alternatives through the mathematization process carried out by the students themselves.

2.2. Steps of Realistic mathematics education Implementation

Every model, approach, or learning technique has structured implementation procedures according to its characteristics. Likewise, with Realistic mathematics education, the following are the steps of Realistic mathematics education implementation in learning as proposed by (Zulkardi 2003): a. The initial step is to prepare realistic problems, b. The lecturer must truly understand the problem and have various strategies that students may take in solving it, c. Students are introduced to the learning strategies used and introduced to realistic problems, d. Then, students are asked to solve the problem in their own way, e. Students try various strategies to solve the problem according to their experience, both individually and in groups, f. Then, each student or group presents their work in front of the class, and other students or groups give feedback on the presenter's work, g. The lecturer observes the class discussion and provides feedback while guiding students to find the best strategies and discover rules or principles that are more general, h. After reaching an agreement on the best strategy through class discussion, students are invited to draw conclusions from the lesson. At the end of the learning, students must complete evaluation questions in formal mathematics.

According to (Wijaya 2012), the process of mathematization to solve realistic problems in the application of Realistic mathematics education is as follows: a. Starts with a real-world problem, b. Identifying relevant mathematical concepts with the problem, then organizing the problem according to mathematical concepts, c. Gradually leaving the real-world situation through the process of assumption formulation, generalization, and formalization. This process aims to translate real-world problems into representative mathematical problems, d. Solving mathematical problems (occurs in the mathematical world), e. Translating mathematical solutions back into real solutions, including identifying the limitations of the solution.

According to (Freudenthal 1991), the stages or steps in realistic mathematics education (RME) learning are as follows: a. Preparation ; The first thing to do in this stage is to condition students for further learning by starting the learning with presenting real problems for students according to their experiences and knowledge levels.

The problem should preferably provide opportunities to evoke various problem-solving strategies, so that students are immediately involved in meaningful learning. In addition, the lecturer must truly understand the problem and have various strategies that students may take to solve it, b. Opening; In this part, students are introduced and guided to solve real problems using the learning strategies that will be used, then students are asked to solve the problem themselves by making statements to guide them to find a solution, c. Learning process; Students try to solve problems using various strategies. The lecturer observes student activities, both individually and in groups. Then, students are given the opportunity to present their work either individually or in groups and comment on their classmates' work, indirectly training students' courage to express their opinions. The lecturer observes the discussion process by guiding students to find the best strategies to solve problems and guiding students to find strategies and discover rules or principles that are more general.

According to (M. 2001), the steps of Realistic Mathematics Education are as follows: 1) Understanding contextual problems. At this stage, the lecturer presents contextual problems to students. Then, the lecturer asks students to understand the problem first. 2) Explaining contextual problems. This step is taken when students have difficulty understanding contextual problems. At this step, the lecturer provides assistance by giving necessary clues or questions that can guide students to understand the problem. 3) Solving contextual problems. In this stage, students are encouraged to solve contextual problems individually or in groups based on their abilities using the provided clues. 4) Comparing and discussing answers. At this stage, the lecturer initially asks students to discuss their answers. 5) Summarizing. From the discussion results, the lecturer directs students to draw conclusions about problem-solving, concepts, procedures, or principles that have been built together.

Based on the above opinions, it is known that the implementation of Realistic mathematics education begins with the emergence of realistic problems. It is followed by the process of solving problems that occur in the mathematical world and then translated back into real solutions. The result of this process is then published through class discussions and concluded with a summary of the problem-solving.

2.3. Batak Culture

The initial concept of culture originated from E.B. Tylor, who proposed that culture or civilization is a complex whole that includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by humans as members of society. This definition of culture encompasses material and non-material aspects, as Tylor stated that culture is the whole complex that includes knowledge, beliefs, arts, morals, laws, and other capabilities and habits acquired by humans as members of society (K. 2001). Culture is a conceptual tool for interpretation and analysis (Garna, Judistira. K., 2000). Therefore, the existence of culture is crucial, as it supports discussions about the existence of a society. Culture as a cultural system, activities, and physical creations of humans within a society where its emergence is obtained through learning processes, both formal and informal.

This indicates that culture does not appear on its own but exists because of humans in social communities, thus human, society, and culture support each other. Humans create culture as an effort to sustain their lives on this earth, as with culture, humans can fulfill their roles as stewards on earth. Through culture, human religious life becomes apparent, distinguishing them from other creatures on earth.

Several definitions of culture as a whole have been explained above, and from these definitions, all human thoughts about culture are realized. Koentjaraningrat outlines three forms of culture, namely: 1. Culture as a complex of ideas, concepts, values, norms, and regulations. This nature is in line with its basic form, which is still something abstract and cannot be described concretely. Part of it still remains a framework of thought or discourse in the mind. Anthropologists and sociologists refer to it as a cultural system, 2. Culture as a complex of activities and patterned actions of humans in society. This category includes human order in socializing and communicating, as well as interacting with each other in society. Unlike cultural systems, this form of cultural pattern is very visible and can even be documented because it is apparent in the behavior of community life, 3. Culture as objects created by humans. Also known as physical culture and requires a lot of explanation. Because it is the total of physical results and the totality of culture. Its concrete nature makes this third form more visibly clear, observable, and tangible.

(Koentjaraningrat 1996) groups cultural aspects based on the dimension of form, namely: 1. Social system, which describes human behavior in carrying out a task or all movements performed by humans from moment to moment, from day to day, and are activity patterns based on the system, 2. Cultural system, which describes the ideas, concepts, or philosophies of a culture and their place in the minds of individuals, 3. Cultural value system, which are ideas learned by individuals in a particular culture from an early age and are therefore difficult to change, Based on the references above, some tangible forms of Batak culture include: 1. Concrete objects such as traditional houses, woven mats as seats, Batak drums, monuments, sigale-gale (puppets), ulos (woven cloth), 2. Social systems such as family lineage, the Batak language, mutual cooperation (marsidapari), open cultural characteristics, Batak dances (tor-tor), kinship, Batak script (Batak script), national Batak songs

(O tano batak), proverbs (umpasa), metaphors (umpama). Open-minded attitudes, enjoyment of dialogue, and so on, 3. Cultural systems such as the philosophy of Suhi Ni Ampang Na Opat, Batak numerals, 4. Value systems such as the right foot first, shaking hands with the right hand, Batak cuisine, democracy as a value of the philosophy of Suhi Ni Ampang Na Opat, ancestral education values, and others.

2.4. Batak Toba

The meaning of the word "Batak" until now has not been accurately and satisfactorily explained. According to Warneck, "Batak" means "nimble horse rider," but according to H.N Van Dier, the word "Batak" means "infidel," while some say it means "slaves with a mark or sign." Initially, the Batak tribe already had a name called "Batak," which emerged after the existence of Siraja Batak. Many believe that the emergence of the term "Batak" is derived from the word "Bataha," the name of a region in Burma where the origin of the Batak people was before they moved to the Nusantara archipelago, and from the word "Bataha," it later evolved into the word "Batak." Therefore, the naming of the Batak ethnic group and land did not originate in North Sumatra. According to Parkin, who stated that the term "Batak" comes from "Batah," which then changed its pronunciation to "Batak" due to changes that occurred in the old Batak script where there was no "k," while the letter "h" at the end of each word was pronounced as "k." In literature, especially in the Malay Dictionary, the term "Batak" not only refers to the designation of a clan in Sumatra but also means "roaming," "plundering," "banditry," and "seizing."

According to J. Pardede, the identity of the Batak community is known for its prominent trilogy of identities: customs, language, and clan, all of which are a complete unity. Customs cannot be presented without the means of the Batak language, and also without the presence of clan elements structured in the Batak philosophy called Dalihan Na Tolu, which consists of hula-hula, boru, and dongan sabutuha, the implementation of customs would not be possible. These three dimensions form a unity, where it seems that over time, the clan element has taken a strong position from all three. According to Pardede, the presence of modernization currents, the influence of Christianity and Islam which have eroded some Batak customs, however, never stopped those customs, and also with the language that must be preserved from the pressure of the national language, has dynamically shifted the Batak language. The clan element is the only identity of the Batak tribe that remains existent and perseveres, as seen in Batak communities in rural and urban areas who use their clans as identity even though they may not understand Batak customs and language.

2.5. Understanding Suhi Ni Ampang Na Opat

This means the four corners of a basket with the same size, function, and existence at the same time. The four corners symbolize Suhut Sihabolan (the family that will carry out the customs), Namarhahamaranggi (siblings of those who will carry out the customs), Saboltok (siblings at the level of father/grandfather who will carry out the customs), and Boru (the clan of the woman who will carry out the customs). The values in Suhi Ni Ampang Na Opat represent noble values in the human heart; holong (love), dame (peace), lasniroha (joy), and harapan (hope).

Literally, Suhi Ni Ampang Na Opat means a square basket. Analogously, Suhi Ni Ampang Na Opat represents a kinship system as a form of cooperation/participation of individuals/groups in realizing cultural values. Participation takes the form of material assistance, money, energy, skills, and constructive ideas. Participation without expecting repayment, and in turn, according to the role and function of marriage ritual. Suhi Ni Ampang Na Opat forms harmonious and prosperous relationships. In the marriage ritual, Suhi Ni Ampang Na Opat provides many benefits, such as facilitating and smoothing the implementation of marriage rituals. In other words, Suhi Ni Ampang Na Opat can help with expenses and strengthen the sense of togetherness and kinship among close and distant relatives.

The formation of Ampang is one form of culture. According to defining the concept of culture consists of explicit and implicit behaviors. Patterns are obtained in the form of symbols as the ethnic group's characteristic achievements through artifacts. Ampang is a category of artifact. Ampang is passed down through symbols as the achievement of the Toba Batak tribe in making Ampang from bamboo. Ampang made from bamboo is one form of culture. This is in line with the theory of culture as part of the human-made environment. The environment of the Toba Batak ethnic group is dominated by bamboo. Therefore, the bamboo used to make Ampang comes from the environment of the Toba Batak ethnic group. The purpose of the square four (4 kinship elements) is to reach an agreement in customs. Symbolically, Suhi Ni Ampang Na Opat is kinship in a customary feast. Suhi Ni Ampang Na Opat has four corners, equal corner sizes, and cannot be separated and mutually dependent. The four corners of Ampang Na Opat, the cultural values of the Toba Batak ethnic group, are that these four groups have equal strength and cannot be replaced. Each group depends on and supports each other to form a round of ideas. If one group is absent, the strength of carrying out the customs is unbalanced. For there to be gaps between each other. If there is a gap, then there is something wrong, incomplete for the marriage custom. Conflict may occur between the organizers and the guests. Therefore, balance must be maintained to avoid deterioration in life.

In addition to the kinship system in Batak society, philosophy is a guideline for behavior and a reference in every community activity such as marriage ceremonies, funerals, and deliberations, and in philosophy there are also guidelines for behavior, in other words, "etiquette" both in socializing and when interacting with small to large kinship environments. The philosophy of Suhi Ni Ampang Na Opat comes from the word Suhi which means corner, ampang is a measure of one paddy can, and Na Opat means four. Suhi Ni Ampang Na Opat is essentially a square four, slim in the middle and round at the top (around it) → like a cup, the only difference being that the Ampang mentioned must be square four at the base. The purpose and intention of the ancestors in making this is nothing but the four elders (4 family elements) united or consolidated in one agreement in a Batak custom/tradition. This Ampang is commonly used for storing rice, fruit, carrying yields from fields/farms, and can also be used by mothers for shopping at the market or for carrying cloth laundry if going to the lake or river. It is said to be most commonly used for carrying the bones of the kings during sacred ceremonies. The symbolism of Suhi Ni Ampang Na Opat is the ties/kinship in a Batak customary feast. One representative or delegate from the 4 individuals/kinship elements/families must participate, if not, then Suhi Ni Ampang Na Opat will not proceed as it should.

2.6. Philosophy of Suhi Ni Ampang Na Opat

The meaning of the philosophy of Suhi Ni Ampang Na Opat and its components include: 1. Hula-hula: Hula-hula are those who organize an event and inform (Sungkem) the clan members of the wife conducting a ceremony to support the implementation of the upcoming event, 2. Dongan Tubu : Dongan Tubu consists of all siblings of the same clan, especially those with the closest family ties, who must be involved in the implementation of an event, 3. Boru: Boru comprises all close relatives who have married the siblings of the person conducting the ceremony, 4. Raja/Raja Huta/Ale-ale**: Raja/Raja Huta/Ale-ale form a group that participates in the execution of an event. In the past, Raja was also called Bius or Raja Bius, or Tunggani Huta. They play a role in providing input for the good things to be implemented in a ceremony. Meanwhile, Raja Huta, which only exists in one village, is also included. Nowadays, this is commonly practiced in migrant areas where the community is no longer homogenous but still closely related in terms of kinship. Ale-ale usually serves as a place to confide to support morale and material support for the implementation of an event.

The basic meaning of the four corners is that there are four subgroups, namely dongan tubu, hula-hula, boru, and Raja/Raja Huta/Ale-ale, which form a group in solving problems. Each individual in the subgroup has their own personality and dignity, knowing their rights and responsibilities as responsible parties according to their position when a problem arises. The backbone inside Ampang is interpreted as a problem. Problems arise from one of the groups and are assigned to the dongan tubu subgroup, but the problem must be resolved together with their different rights and responsibilities from the dongan tubu, hula-hula, boru, and Raja/Raja Huta/Ale-ale perspectives. Thus, the result of solving a problem is the culmination of the thoughts of the four subgroups (interpersonal) and is internalized within the dongan tubu subgroup (intrapersonal).

The meaning of the four equal corners in terms of length and size is justice and democracy. Justice means that if one subgroup does not function, the problem to be solved will not be resolved. If unilateral decisions are made, it will have consequences on future life, such as danger, unresolved problem solving, and loss of dignity. This is possible to occur. Therefore, in the course of cultural systems, the utilization of the social interaction pattern of Suhi Ni Ampang Na Opat in forming study groups and solving problems can be interpreted in the following diagram.

2.7. Understanding Higher Order Thinking Skills (HOTS)

HOTS, often referred to as high-level thinking skills or concepts, is a concept of educational reform based on Bloom's taxonomy that began in the early 21st century. This concept is incorporated into education aiming to prepare human resources to face the industrial revolution. In the 21st century, human resources are expected not only to be workers who follow the government but also to have 21st-century skills. The obligation to educate the nation's children to become creative and competent individuals is explicitly stated in Article 3 of the Republic of Indonesia Law on the National Education System, which states: "National education functions to develop the abilities and shape the character and civilization of the nation in order to cultivate the nation's life, aiming for the development of students' potential to become people who are faithful and devoted to the Almighty God, have noble character, are healthy, knowledgeable, skilled, creative, independent, and become democratic citizens who are responsible." HOTS is not a subject, nor is it an exam question. According to Abduhzen, HOTS is the ultimate goal achieved through an approach, process, and method of learning.

Higher-order thinking skills, or commonly known as high-level thinking skills, are thinking processes that require students to develop ideas in a way that gives them new understanding and implications. Limpan describes high-level thinking as involving critical and creative thinking guided by ideas of truth, each with its own meaning. Critical and creative thinking are interdependent, as are criteria and values, reasoning, and emotions. HOTS was first proposed by Brookhart, who defined "this model as a method for transferring knowledge, critical thinking, and problem-solving. HOTS is not just a test model, but also includes a learning model. The teaching model must include thinking skills, while the assessment model of HOTS requires students to be unfamiliar with the questions or tasks given." According to Lewis and Smith, higher-level thinking will occur if a person has information stored in memory and acquires new information, then connects, organizes, and develops this information to achieve a goal or obtain possible solution answers to a confusing situation, and higher-level thinking skills include critical thinking, creative thinking, problem-solving, and decision-making.

According to Thomas & Thorne, HOTS is "a higher level of thinking than memorizing facts, stating facts, or applying rules, formulas, and procedures." This opinion is in line with Onosko & Newman, HOTS is "non-algorithmic and defined as the potential use of the mind to face new challenges that have never been thought of by students before." According to Underbakke, "HOTS is also called strategic thinking skills, which is the ability to use information to solve problems, analyze arguments, negotiate issues, or make predictions." Higher-order thinking skills are cognitive operations that are highly needed in thinking processes consisting of short-term memory. When associated with Bloom's taxonomy, higher-level thinking includes analysis, synthesis, and evaluation. Furthermore, higher-order thinking skills (HOTS) are much more needed today than in previous times. Not far from the previous understanding, HOTS according to International Standards, such as the Organization for Economic Cooperation and Development (OECD), TIMMS, and PISA, is defined as the ability to apply knowledge, skills, and values in reasoning and reflection to solve problems, make decisions, and create innovative things.

In the regulations of the Minister of Education and Culture of the Republic of Indonesia, it is also explained in Regulation No. 54 of 2013 that "Graduate competency standards are the qualifications of graduates that include attitudes, knowledge, and skills." And in Ministerial Regulation No. 22 of 2016 concerning the standard of basic and secondary education processes, the assessment of knowledge aspects is divided into 5 levels: remembering, understanding, applying, analyzing, and evaluating. From several understandings above, it can be concluded that HOTS is a high-level thinking skill that must be possessed by students, which not only tests intellectual abilities in terms of memory but also evaluates creativity, analysis, and critical thinking about students' understanding of a subject matter and emphasizes critical thinking about problem-solving. So here, high-level thinking skills do not only test the ability to memorize subject matter but rather focus more on application.

2.8. Indicators of HOTS

Learning and assessing high-level thinking skills fundamentally constitute meaningful learning and assessment, not just memorization, because this learning and assessment enable students to: 1) transfer and apply knowledge and skills they already possess to new contexts or more complex ways; 2) think critically, apply wise judgment, or produce reasoned critiques; 3) solve problems by identifying and solving problems in their lives (PNRI 2019). According to (Rahayuningsih 2018), the critical thinking process consists of 4 stages: 1) receiving information, 2) processing information, 3) storing information, and 4) retrieving information. The results of Ningsih's research (2011) found that there are 4 important aspects of critical thinking adopted from Seifert and Hoffnung, namely: 1) basic operations of reasoning, when someone is able to think critically, they have the ability to explain, generalize, draw conclusions, and formulate logical things; 2) domain-specific knowledge is an understanding of the content related to existing problems; 3) metacognitive knowledge; and 4) value, beliefs, and dispositions, which involve objective assessment.

According to (Amalia 2020), the indicators for assessing HOTS questions are as follows:

Indicators of HOTS Questions:	Indicators of Thinking Process:	Assessment Indicators:
1. Identifying and linking relevant information from a problem.	1. Writing what is known and asked in one's own language or in mathematical sentences.	1. Able to state what is known and asked and write it in their own language.
2. Integrating ideas to solve problems.	2. Finding connections between the facts in the problem and the concepts they have so that students can work according to the concepts.	2. Able to identify the connections between the facts in the problem and the material used.
3. Formulating appropriate ideas.	3. Making a solution plan accurately and sequentially according to the concepts they understand.	3. Able to create a plan and explain logically the method to be used for solving.
4. Drawing accurate conclusions based on information from a problem.	4. Stating and explaining the steps taken to solve the problem to understand the concepts they grasp.	4. Able to demonstrate the chosen method for solving the problem.
5. Developing or creating new alternatives in problem-solving.	5. Reviewing errors made at each step to find the correct answer.	5. The subject is able to review again, but there is one problem that is not solved correctly.

According to (Treffers 1987), assessment indicators of HOTS based on the characteristics of Realistic Mathematics Education are as follows: The use of Context, Use Models, Bringing by vertical instrument, Student Contribution, Interactivity, and Intertwinment.

3 METHODS

The data obtained are analyzed to address the question of whether the Realistic mathematics education based on Toba Batak culture learning model, learning tools, and instruments being developed meet the criteria of effectiveness. Data obtained from experts and practitioners are analyzed to determine whether the Realistic mathematics education based on Toba Batak culture learning model, learning tools, and instruments being developed meet the validity criteria in terms of theoretical foundation strength and consistency among model components internally. Meanwhile, data from field trials (in classrooms) are used to determine whether the Realistic mathematics education based on Toba Batak culture learning model, learning tools, and research instruments being developed meet the criteria of effectiveness.

The research data are analyzed using descriptive statistical analysis. Descriptive statistics can take the form of frequency tables, cross-tabulation tables, and basic statistics such as mean, median, mode, and variance. Here are the data analysis techniques obtained.

1. Implementation of the Realistic mathematics education based on Toba Batak culture Learning Model

The determination of the usefulness of the Realistic mathematics education based on Toba Batak culture Learning Model is based on the consistency of two measures: intended ↔ perceived (IP), obtained from assessments by experts and practitioners, and intended ↔ operational (IO), obtained from observations by observers during classroom implementation of the learning.

a. IP from Experts and Practitioners

The effectiveness of the Realistic mathematics education based on Toba Batak culture Learning Model is evaluated through assessments conducted by various experts and practitioners, specifically mathematics education lecturers specializing in advanced elementary school classes. These assessments take into account their theoretical understanding and practical experience to ascertain the feasibility of implementing the Realistic mathematics education based on Toba Batak culture Learning Model in real-world educational settings, considering its components and provided resources. Following the evaluations by the expert panel, the average score provided by each expert is calculated. This average score is then compared against predefined intervals to determine the degree of implementation of the Realistic mathematics education based on Toba Batak culture Learning Model, as detailed in Table 1 below:

Table 1. Level of implementation according to Experts of the Realistic mathematics education based on Toba Batak culture Learning Model

Range of values	Description
$1 \leq IP < 2$	Extremely Low
$2 < IP < 3$	Low
$3 < IP < 4$	Medium
$4 \leq IP < 5$	High
$IP = 5$	Extremely High

Adapted from, (Sinaga, 2007)

b. IO from Observers

The practicality of implementing the Realistic mathematics education based on Toba Batak culture Learning Model in the classroom with the provided learning tools (intended ↔ operational or IO) is assessed through evaluations conducted by observers. These assessments utilize a dedicated observation sheet designed specifically to evaluate the model's implementation.

The activities carried out to analyze the implementation data obtained from observation results include: a. Condensing the findings of the learning implementation observations into a table encompassing aspects (Ai), indicators (Ii), and values Pj for 2 sessions, b. Calculating the average value of the observation results for 2 sessions and for each observation indicator using the provided formula.

$$Ii = \frac{\sum_{j=l}^{n} P_{ji}}{n}$$

With:

Pji = the data value of observation in the j-th meeting for the i-th indicator,

n = the number of meetings

The outcomes acquired are subsequently recorded in the relevant column within the table. Determine the average value for each observation aspect using the formula;

$$Ai = \frac{\sum_{j=l}^{n} I_{ji}}{m}$$

With:
Ai = the average value for aspect i,
Iij = the average for aspect i, indicator j,
m = the number of indicators in aspect i
The acquired results are then documented in the suitable column of the table.
a. Determine the IO value or the total average value from the average value for all aspects using the formula;

$$IO = \frac{\sum_{i-l}^{n} A_i}{m}$$

With:
IO = the cumulative average value for all aspects
Ai = the mean value for aspect i, with n denoting the total number of aspects

Furthermore, this average aspect value (IO) is referenced against the intervals to determine the level of implementation of the Realistic mathematics education based on Toba Batak culture Learning Model as shown in Table 2 below:

Table 2. Level of implementation according to Practitioners of the Realistic mathematics education based on Toba Batak culture Learning Model

Value intervals	**Description**
For IO values ranging from 1 to less than 2	Extremely Low
For IO values ranging from 2 to less than 3	Low
For IO values ranging from 3 to less than 4	Medium
For IO values ranging from 4 to less than 5	High
IO equals 5	Extremely High

Adapted from, (Sinaga, 2007)

3. Effectiveness of the Realistic mathematics education based on Toba Batak culture Learning Model

The evaluation of the efficacy of the Realistic mathematics education based on Toba Batak culture Learning Model relies on the alignment of two metrics: intended ↔ experiential (IE), derived from assessments conducted by experts and practitioners, and intended ↔ attained (IA), derived from the achievement of effectiveness indicators/aspects established through the analysis of field trial data.

a. IE from Experts and Practitioners

The evaluation outcomes provided by experts and practitioners, drawing on their theoretical expertise and practical experience, ascertain the potential effectiveness of implementing the Realistic mathematics education based on Toba Batak culture Learning Model in Mathematics education within the classroom (intended ↔ experiential or IE), taking into account the model's components and the resources provided for learning. Following these evaluations by experts and practitioners, the average score given by each evaluator is calculated. This average score is then compared against predefined intervals to gauge the degree of effectiveness of the Realistic mathematics education based on Toba Batak culture Learning Model, as illustrated in Table 3 below:

Table 3. Level of Effectiveness of the Realistic mathematics education based on Toba Batak culture Learning Model

Value Range	**Description**
$1 \leq IE < 2$	Extremely Low
$2 \leq IE < 3$	Low
$3 \leq IE < 4$	Medium
$4 \leq IE < 5$	High
$IE = 5$	Extremely High

Adapted from, (Sinaga, 2007)

b. IA from Field Trial Data Analysis

The achievement of IA (intended ↔ attained) of the Realistic mathematics education based on Toba Batak culture Learning Model is determined based on empirical data from the implementation of the Realistic mathematics education based on Toba Batak culture Learning Model in the field (classroom learning) reviewed from 4 aspects of model effectiveness determination, namely: (1) improvement of students' Higher Order

Thinking Skills (HOTS) classically, (2) achievement of the ideal percentage of student and teacher activity time, (3) achievement of teacher's ability in managing learning, (4) Percentage of students who respond positively to learning elements and tasks. The analysis of data from the measurement of these four aspects of model effectiveness can be outlined as follows.

1) HOTS Ability Test

To illustrate the achievement of students' HOTS abilities, with the orientation towards increasing the level of HOTS abilities achieved by students. A score is considered highly effective if 80% of students in the learning program are able to achieve the benchmark success indicator value set beforehand.

Based on the above reference, the criteria state that the mastery of HOTS abilities for prospective teachers with the Realistic mathematics education based on Toba Batak culture learning model is at least a moderate level of mastery of the taught material. This means that students are able to achieve a minimum score of 60 out of two HOTS ability tests (with a maximum score of 100). Furthermore, the criterion for classical mastery of HOTS abilities is that at least 80% of prospective teachers participating in the learning program are able to achieve at least a moderate level of mastery of the material or at least 80% of prospective teachers participating in the HOTS ability test are able to achieve a score of 60 out of two HOTS ability tests (with a maximum score of 100). The score interval for determining the level of mastery of prospective teachers is categorized as follows.

Table 4. Level of Higher Order Thinking Skills (HOTS) Ability of Students in the Realistic mathematics education based on Toba Batak culture Learning Model

Value Range	**Description**
$0 \leq TP < 40$	Extremely Low
$40 \leq TP < 60$	Low
$60 \leq TP < 75$	Medium
$75 \leq TP < 90$	High
$90 \leq TP \leq 100$	Extremely High

Adapted from, (Sinaga, 2007)

To assess the enhancement in Higher Order Thinking Skills (HOTS) among students in the Elementary School Education Study Program subsequent to engaging in Elementary Mathematics Education lectures utilizing the Realistic mathematics education based on Toba Batak culture Learning Model, a Normalized Gain (N-Gain) examination is conducted, comparing pre-test scores, post-test scores, and ideal scores. The formula employed for this evaluation is as follows:

$$N - Gain = \frac{Posttest\ Score\ -\ Pretest\ Score}{Ideal\ Score\ -\ Pretest\ Score}$$

Table 5. Criteria for interpreting the N-Gain Index

N-Gain Value	**Category**
$0.7 \leq g \leq 1.00$	High
$0.3 \leq g \leq 0.7$	Medium
$g < 0.3$	Low

Source: (Meltzer, 2003)

2) Student and Teacher Activities.

The data from observations are analyzed by describing The engagements of both students and teachers throughout the learning procedure. To find the average frequency and percentage of time used by students and teachers for activities during the learning sessions, the following steps are taken:

Table 6. Criteria for Achieving Ideal Time Interval Activities for Students and Teachers.

No	**Category Aspect**	**Ideal Time**	**PWI Tolerance Interval**	**Criteria**
I. Lecturer Activities				
A	Explaining material. Providing information.	25% of the total WT	PWI falls between 20% and 30%	Two out of a, b, c must be fulfilled, and b must be fulfilled.
B	Observing student activities, motivating, giving guidance, guiding student activities.	75% of the total WT	PWI ranges from 70% to 80%	
C	Irrelevant behavior.	None of the total WT	PWI is within the range of 0% to 5%	

II. Aktivitas Mahasiswa				
A	Listening/paying attention to lecturer/friend explanations	25% of the total WT	PWI falls between 20% and 30%	Three out of a, b, c, d, e must be fulfilled, and c, d must be fulfilled.
B	Reading student books, LAM	15% of the total WT	PWI ranges from 10% to 20%	
C	Taking notes from lecturer explanations, taking notes from books or from friends, completing tasks in LAM, summarizing group work	30% of the total WT	PWI lies between 25% and 35%	
D	Discussing/asking questions between students and their peers, and between students and lecturers	30% of the total WT	PWI is within the range of 25% to 35%	
E	"Doing something irrelevant to learning	None of the total WT	PWI ranges from 0% to 5%	

Adapted from, (Sinaga, 2007)

3) Analysis of lecturer's ability in managing learning

The data from evaluating the lecturer's proficiency in implementing learning using the Realistic mathematics education based on Toba Batak culture Learning Model are examined by determining the category values derived from multiple assessment aspects provided by observers for three learning plans. The activities conducted to analyze the data on assessing the lecturer's competency in managing learning are as outlined below: a. summarizing the observer assessment results into a table that includes: aspects (Ai) and criteria (ki) for 8 learning plans, b. finding the category values (NK) from the average criteria value (NRKi) in ENRK, for each assessment aspect using the formula.

$$NK_j = \frac{\sum_{i-l}^{n} NRK_{ij}}{n}$$

With
NKi = the category value of aspect j.
NRKij = the average value of criteria i, aspect j and
n = the number of criteria in aspect j

The acquired results are subsequently recorded in the relevant columns of the table. "Determining NKD by computing the average category value using the formula;

$$NKD = \frac{\sum_{i=1}^{n} NK_i}{m}$$

With
NKD = the lecturer's ability value (average category value)
NKj = the category value of aspect j
m = the number of assessment aspects

Then, the average category value (NKD) is consulted to determine the interval for assessing the level of lecturer's proficiency in managing learning using the Realistic mathematics education based on Toba Batak culture Learning Model, as outlined in Table 7:

Table 7. With Level of Lecturer's Ability Model in Managing Realistic mathematics education based on Toba Batak culture Learning Model

Value Range	Description
1 ≤ NKD < 2	Extremely low
2 ≤ NKD < 3	Low
3 ≤ NKD < 4	Medium
4 ≤ NKD < 5	High
NKD = 5	Extremely high

Adapted from, (Sinaga, 2007)

4 RESULT

4.1. Effectiveness of the Realistic mathematics education based on Toba Batak culture Learning Model

The assessment data of the effectiveness of the Realistic mathematics education based on Toba Batak culture

Learning Model using learning tools (Teaching Materials, RPS, Student Guidebook, Student Instruction Book, Student Activity Sheet, HOTS Ability Test) rely on experts' theoretical expertise and practical experience. The average value of indicators for each assessment aspect from each expert and practitioner is presented in Table 8 below:

Table 8. Average Indicator Values from Experts and Practitioners for Each Assessment Aspect regarding the efficiency of the Realistic mathematics education based on Toba Batak culture Learning Model.

No	**Aspects Assessed**	**Average Value of Indicators for Each Assessment Aspect by Experts and Practitioners**					**Aspect Value**
		I	**II**	**III**	**IV**	**V**	
I	Students' Higher-Order Thinking Skills (HOTS) Abilities	4.3	4.5	4.3	4.3	4.3	4.3
II	Student and lecturer activities	4.3	4.3	4.3	4.3	4.3	4.3
III	Lecturer's ability in managing learning	4.3	4.5	4.3	4.5	4.3	4.3
IV	Students' and lecturers' responses to learning components and processes	4.2	4.4	4.4	4.2	4.2	4.3
IE Value or Total Average Value							4.3

Description:
Intended↔Experiential (IE from experts and practitioners)

The average indicator values in Table 8 above are obtained from the division of the sum of indicator values for each observation aspect provided by observers by the number of indicators in that aspect. Aspect values are obtained from the division of the sum of average indicator values provided by experts and practitioners for each assessment aspect by the number of experts and practitioners as assessors. Furthermore, the IE value or the total average aspect value is 4.3 obtained from the division of the sum of aspect values by the number of aspect criteria for determining the effectiveness level of the learning implementation model. The IE value is 4.3, if referred to the previously established criteria in Chapter II, it is concluded that the effectiveness level of the Realistic mathematics education based on Toba Batak culture learning model assessed The expertise in theory and practical experience of experts and practitioners is highly advanced.

4.2. Trial Results

The trial was conducted twice. The data analysis results for each trial along with the revision notes made on the model book and learning tools are outlined as follows.

1. Trial 1 Results

Trial 1 aimed to address the issues still found in the learning process. The trial was conducted by one of the lecturers teaching Mathematics learning courses for advanced elementary school classes in the PGSD Study Program. Before the trial, the researcher provided training to the lecturer to ensure that the trial was conducted in accordance with the development goals of the PGSD Study Program, which had 35 students. Through trial 1, the following data were obtained: 1) Findings from evaluating the execution of the Realistic mathematics education based on Toba Batak culture learning model, 2) Outcomes from assessing the efficiency of the Realistic mathematics education based on Toba Batak culture learning model, 3) Results from analyzing the activities of students and lecturers, 4) Findings from evaluating the lecturer's competence in managing learning, 5) Outcomes from analyzing the responses of students and lecturers.

1) Implementation of the Realistic mathematics education based on Toba Batak culture Learning Model

The observation findings from applying the Realistic mathematics education based on Toba Batak culture Learning Model using learning tools (RPS, Teaching Materials, Lecturer's Guidebook, Student Handbook, and Student Activity Sheets) for learning implementation can be seen in Table 10. The average value of indicators for each observation aspect by 3 observers is as follows:

Table 9. Indicator Values for Each Observation Aspect of the Implementation of the Realistic mathematics education based on Toba Batak culture Learning Model

Num	**Observed Aspects**	**Observer**			**Aspect value**
		I	**II**	**III**	
I	Syntax	3.50	3.38	3.50	3.46
II	Social system	3.33	3.50	3.33	3.33
III	Management reaction principle	3.33	3.33	3.50	3.50
	Average Total Score				3.43

Explanation:
IO stands for Intended ↔ Operation.

The average indicator values in Table 9 are calculated by dividing the total indicator values for each observation aspect, as provided by observers, by the number of indicators within that aspect. The aspect values are then derived by dividing the sum of average indicator values provided by observers for each aspect. Additionally, the IO value stands at 3.43.

2) Effectiveness of the Realistic mathematics education based on Toba Batak culture Learning Model

The effectiveness of the Realistic mathematics education based on Toba Batak culture Learning Model using the provided learning tools is reviewed from 4 measurement aspects, namely: 1) HOTS ability test, 2) achievement of the Percentage of ideal time for student and lecturer activities, 3) lecturer's ability in managing learning, and 4) student and lecturer responses to learning components and activities. Data analysis for each aspect is outlined as follows.

a) Students' HOTS Abilities

Data on students' HOTS ability test can be seen in Table 10. The average score of HOTS ability in advanced elementary school Mathematics learning courses is presented in the following Table 10.

Table 10: Students' Higher-Order Thinking Skills (HOTS) Abilities After Being Taught with the Realistic mathematics education based on Toba Batak culture Learning Model

Respondent Number	Proportion		Level of Students' Higher Order Thinking Skills
	U1	U2	
Average	0.20	0.63	Moderate

According to the data analysis in Table 10, it's evident that traditionally, the proficiency level of students' Higher-Order Thinking Skills (HOTS) in the Elementary School Teacher Education Program, particularly in the advanced elementary school Mathematics course focusing on plane geometry material, is notably deficient, with a HOTS ability proportion of 0.20. In comparison, the results indicate that the students' HOTS abilities following instruction with the Realistic mathematics education based on Toba Batak culture learning model are still relatively low, with a HOTS ability proportion of 0.63 or 63%. Specifically, there are 9 prospective teachers demonstrating a low mastery level and 26 prospective teachers exhibiting a moderate mastery level.

b) Lecturer's Ability in Managing Learning

Data from observations on lecturers' ability in managing learning through the implementation of the Realistic mathematics education based on Toba Batak culture Learning Model in trial 1 are presented in the following Table 11.

Table 11. Data on Lecturers' Ability in Managing Learning in the Elementary School Teacher Education Program

Trial Number	Phase				Mean	Description
	1	2	3	4		
1	3.33	3.50	3.00	3.00	3.21	Moderate

Based on the data in Table 11 above, It's evident that the lecturer's proficiency in overseeing learning via the implementation of the Realistic mathematics education based on Toba Batak culture Learning Model in trial l is 3.21, positioning it within the moderate range.

c) Student Activities

The data from observations of student activities in trial 1 are presented in the following Table 12.

Table 12. Student Activity Data of Primary School Teacher Education Study Program

Phase				Mean	Description
1	2	3	4		
2.33	3.00	3.00	3.00	2.58	Low

In Table 13 above, the average student activity in each phase can be observed as follows: the cultural apperception phase has an average of 2.33, the Problem Solving Discussion phase has 3.00, the Social Interaction Pattern *Suhi Ni Ampang Na Opat* with Representation and Problem Solving phase has 3.00, and the Work Results Reflection phase has 3.00. All phases have student activities at a moderate level.

d) Lecturer Activities

The observations regarding activities throughout the learning process in trial 1 of implementing the Realistic mathematics education based on Toba Batak culture Learning Model are outlined in Table 13 below.

Table 13. Lecturer Activity Data in the Implementation of the Learning Model

Phase	Observer			Mean
	1	2	3	
1	3.67	4.00	3.67	3.78
2	3.50	3.50	4.00	3.67
3	3.00	4.00	4.00	3.67
4	3.00	4.00	4.00	3.67
Average				3.70

In Table 13 above, it can be seen that the level of lecturer activity in each phase is as follows: the cultural apperception phase has an average of 3.78, the Problem Solving Discussion phase has 3.67, the Social Interaction Pattern *Suhi Ni Ampang Na Opat* with Representation and Problem Solving phase has 3.67, and the Work Results Reflection phase has 3.67. All phases of lecturer activity are at a moderate level.

4.3. Trial Results 2

The instructional model book, teaching materials, and all research instruments developed in trial 1 are referred to as Prototype-3. Prototype-3 has not met the criteria for the practicality and effectiveness of the Realistic mathematics education based on Toba Batak culture learning model established previously. The next activity is to conduct a re-trial (trial 2) while paying attention to the indicators of practicality and effectiveness of the model that have not been met. Trial 2 is conducted with the same students as in trial 1. This is done because these students already have experience from trial 1, so it is expected that the introduction to the learning steps will be easier to understand. The development results of the tools and the analysis of trial 2 data, along with the revisions made to the teaching materials, are outlined as follows:

1) Implementation of the Realistic mathematics education based on Toba Batak culture Learning Model

Observations were conducted on the utilization of the Realistic mathematics education based on Toba Batak culture learning model within advanced elementary school mathematics courses for third-semester students in the Elementary School Teacher Education Study Program at the Faculty of Education, Catholic University of Santo Thomas. The implementation involved the use of teaching materials such as RPS, Teaching Books, Lecturer's Guidelines, Student Handbooks, and Student Activity Sheets to facilitate learning. The table below presents the average indicator values for each observation aspect.

Table 14. Indicator Scores for Each Aspect of Observing the Implementation of the Realistic mathematics education based on Toba Batak culture Learning Model.

No	Observed Aspects	Observer			Aspect Scores
		I	II	III	
I	Syntax	4.50	4.38	4.50	4.46
II	Social system	4.33	4.50	4.33	4.39
III	Management reaction principles	4.33	4.33	4.33	4.33
	IO Value" or "Total Mean Score				4.39

Explanation:

IO stands for Intended Operation

The average indicator scores in Table 14 above are obtained by dividing the sum of indicator scores for each observation aspect provided by the observer by the number of indicators in that aspect. Aspect scores are obtained by dividing the sum of average indicator scores provided by the observer for each aspect by the number of observers for each aspect. Furthermore, the IO score is 4.39.

2) Effectiveness of the Realistic mathematics education based on Toba Batak culture Learning Model

The effectiveness of the Realistic mathematics education based on Toba Batak culture learning model using the provided teaching materials is assessed based on 4 measurement aspects: 1) students' HOTS test, 2) achievement of the ideal percentage of time for student and lecturer activities, 3) Lecturer's capacity for overseeing learning, and 4) Feedback from students and lecturers regarding learning elements and activities. The data analysis for each aspect is delineated below.

a) Students' HOTS Test
Data on students' HOTS test scores can be seen in Table 15. The average HOTS skill scores in the Advanced Elementary School Mathematics Learning course are presented in the following table:

Table 15. Students' Higher-Order Thinking Skills (HOTS) After Being Taught with the Realistic mathematics education based on Toba Batak culture Learning Model

Number of Respondents	Proportion U1	U2	Level of Students' Higher Order Thinking Skills.
Average	0.63	0.85	High

According to the analysis results presented in Table 15, it can be deduced that traditionally, the proficiency level of Higher-Order Thinking Skills (HOTS) among students in trial 1 of the Elementary School Teacher Education Study Program, particularly in the advanced elementary school mathematics course, focusing on plane geometry, is moderate, with a HOTS skill mastery proportion of 0.63. However, upon evaluating the implementation of the Realistic mathematics education based on Toba Batak culture learning model, there is notable improvement, with the proportion of HOTS skill mastery increasing to 0.85 or 85%, indicating a high level of mastery. Specifically, among the prospective teachers, one demonstrates moderate mastery level, 25 exhibit high mastery level, and 9 showcase very high mastery level.

b) Lecturer's Ability to Manage Learning
Data from observations on the lecturer's ability to manage learning through the implementation of the Realistic mathematics education based on Toba Batak culture learning model in trial 2 are presented in the following table:

Table 16. Data on the Lecturer's Ability to Manage Learning in the Study Program

Trial Number	Phase				Average	Description
	1	2	3	4		
2	4.67	4.00	4.00	4.00	4.17	High

Based on Table 16 above, It's apparent that the lecturer's proficiency in overseeing learning has advanced from trial 1 to trial 2, transitioning from a moderate level to a high level. This serves as evidence of the effectiveness of the Realistic mathematics education based on Toba Batak culture learning model experiencing improvement.

c. Student and Lecturer Activities
Data from observations on student activities in trial 2 are presented in the following table.

Table 17. Information regarding Student Engagements in the Elementary School Teacher Education Study Program using the Realistic mathematics education based on Toba Batak culture Learning Model Implementation.

Phase				Average	Description
1	2	3	4		
4.33	4.00	5.00	5.00	4.58	High

In Table 17 above, the average student activity level for each phase can be observed: the cultural apperception phase has an average of 4.33, the Problem Solving Discussion phase has 4.00, the Social Interaction Pattern *Suhi Ni Ampang Na Opat* with Representation and Problem Solving phase has 5.00, and the Work Results Reflection phase has 5.00. All phases show that student activities are at a high level.

d. Lecturer Activities
The data from observations on activities during the learning process in trial 1 of implementing the Realistic mathematics education based on Toba Batak culture Learning Model are presented in Table 18.

Table 18. Lecturer Activities Through the Implementation of the Realistic mathematics education based on Toba Batak culture Learning Model.

Phase	Observer			Average
	1	2	3	
1	4.67	4.67	4.33	4.56
2	4.50	4.50	4.50	4.50
3	4.00	5.00	5.00	4.67
4	4.00	5.00	5.00	4.67
Average				4.60

In the table above, the level of lecturer activity for each phase is as follows: the cultural apperception phase has an average of 4.56, the Problem Solving Discussion phase has 4.50, the Social Interaction Pattern *Suhi Ni Ampang Na Opat* with Representation and Problem Solving phase has 4.67, and the Work Results Reflection phase has 4.67. Overall, the lecturer activity level in all phases is at a high level.

3) Lecturers' Ability to Manage Learning

Data from observations on lecturers' ability to manage learning through the implementation of the Realistic mathematics education based on Toba Batak culture Learning Model in trials 1 and 2 are presented in the following table:

Table 19. Summary of Data on Lecturers' Ability to Manage Learning in the Elementary School Teacher Education Program

Trial Number	**Phase**				**Mean**	**Description**
	1	**2**	**3**	**4**		
1	3.33	3.50	3.00	3.00	3.21	Moderate
2	4.67	4.00	4.00	4.00	4.17	High

From the data provided in Table 19, it's evident that there has been a progression in teachers' capability to oversee learning within the Primary School Teacher Education Program, moving from a moderate level to a high level.

5 DISCUSSION

This research starts from the problem of the low quality of the process and the ability of Higher Order Thinking Skills (HOTS) of students in advanced level elementary mathematics learning in the Elementary School Teacher Education Study Program, especially the inability of students in mastering mathematical concepts to be taught in a more effective understanding form. In fact, the orientation of the lectures focuses on mastering as much material as possible, and lectures proceed through a final form of knowledge transfer process. This issue is receiving more attention in line with the demands of 21st-century learning, which require learners to have skills, one of which is HOTS ability. HOTS ability is needed in learning, especially for prospective teachers, because with this skill, prospective teachers are expected to be able to create learning that has HOTS ability and learners who have HOTS ability.

The lectures currently held in the Elementary School Teacher Education Study Program implement learning by applying models that are less relevant to the characteristics and objectives of mathematics learning. The implementation of mathematics learning in lectures has not yet applied constructivist-based learning and has not paid attention to the aspects of HOTS ability in the mathematics learning process in an effort to provide scientific experiences in fostering students' HOTS abilities.

Efforts to address these issues involve developing a Realistic mathematics education based on Toba Batak culture learning model that meets the criteria of validity, practicality, and effectiveness. This model is designed so that lecturers do not deliver material to students in final form. The Realistic mathematics education based on Toba Batak culture learning model will serve as a guide for lecturers to assist students in improving their HOTS abilities. The achievement of research objectives based on the conclusions of data analysis and the discussion of research weaknesses based on problems in the design, process, and results of developing the Realistic mathematics education based on Toba Batak culture learning model, as well as how to accommodate/eliminate these weaknesses, will be discussed and discussed.

5.1. Syntax of the Realistic mathematics education based on Toba Batak culture Learning Model Enhances Students' HOTS Abilities

Improving students' HOTS abilities by implementing the Realistic mathematics education based on Toba Batak culture learning model, which includes the syntax of (1) cultural apperception; (2) problem-solving discussions; (3) the pattern of social interaction suhi ni ampang na opat with representations and problem-solving; (4) reflection on work results is a learning stage that students must go through. In the cultural apperception phase, students need to experience contextual-based learning to enhance their HOTS abilities. Students acquire deeper knowledge when they engage in activities similar to those of professionals working in a discipline (Sawyer, 2014). Numeracy education calls for students to engage in problem-solving: formulating explanations and preparing arguments to communicate and justify these explanations (National Research Council, 1996). Based on these two opinions, during the cultural apperception phase, students will engage in problem-solving discussions and formulate explanations to be discussed in the next phase. Piaget proposed that schemas emerge from learners' interactions and experiments with the physical world. Schemas initially appear as concrete actions and gradually develop into more conceptual mental entities.

Students learn better when they express their evolving knowledge. Students need problem-solving discussions with the issues faced so that lecturers can assess the accuracy of the material acquisition. In this phase, students will engage in an important activity: problem-solving through group discussions. Next is the pattern of social interaction suhi ni ampang na opat phase. This phase is conducted classically. During presentation, students present problem-solving material based on group discussions conducted in the problem-solving discussion phase. By articulating their evolving knowledge, students learn more effectively (Bransford, Brown, & Cocking, 2000). Furthermore, the entire class is given the opportunity to respond and provide feedback on the presentations made by students presenting the results of their group discussions. As the end of this phase, students, along with lecturers, reflect on the process and material acquisition achieved in the learning process. The articulation process overview as a learning application (adapted from Ash & Clayton, 2004): a) Describing goals based on service; b) Analyzing experiences sequentially from the perspective of each category of learning goals: personality, people, and academic; c) Identifying the core of important learning from each category; d) Articulating learning by transforming core ideas into well-developed statements using articulation learning: four outline-guiding questions and a program, extensive services, learning goals for guidance/counseling in learning development; e) Applying critical thinking standards to articulation learning concepts; f) Finally, aiming to meet all learning goals in each category and meet critical thinking standards; g) Having new experiences. This includes, if possible, taking action toward set goals/testing conclusions reached in articulation learning; and h) Continuing the reflection process outlined here. This includes reflecting on experiences in setting goals/testing conclusions reached in previous articulation learning, when that has been done, and articulating additional complexity according to learning.

The value of reflection in experience to enhance learning has increased over the decades (Ash & Clayton, 2004). Dewey (1934) and Schon (1983) proposed the idea that reflection is a crucial foundation for growth and learning. Reflection lies behind direct quality. The use of reflective methods in higher education is based on adult learning theory (Knowles, 1980; Mezirow, 1998; Rogers, 1982). Kolb (1984) acknowledges that reflection is an integral part of engaging learners, thus suggesting that reflective writing can result in meaningful or purposeful learning. Rogers (1982) also compiled ideas supporting the use of reflective writing as a tool for learning, personal growth, and professional development. According to Rogers, "The only learning that significantly influences behavior is self-discovered, self-appropriated learning." Vygotsky highlights the relationship between thought, feeling, and action, emphasizing the importance of reflection in learning. Boud (2001); Brookfield (1998); Goldsmith (1996); Moon (1999) identify reflection methods as highly successful strategies for encouraging students to sharpen and practice reflective skills and to develop introspective skills. Hatton and Smith (1995) identify four levels of reflection revealed through writing: descriptive writing, descriptive reflection, dialogic reflection, and critical reflection. Chua (2016) demonstrates the significant contribution of reflective methods as pedagogical approaches in values education and in achieving meaningful and enduring educational outcomes. In reflection, thinking involves seeking similarities, differences, and connections beyond their superficial elements.

This phase is conducted collectively. The agreed-upon reflection outcomes in learning refer to HOTS abilities, namely the ability to analyze, evaluate, and create. In this phase, students' HOTS abilities are absolutely necessary because this is where HOTS abilities truly come into play. Students are expected to produce something entirely new based on their own ideas. The improvement of students' HOTS abilities is at a moderate level. This is suspected because the subjects of the research are third-semester students. The courses they take are mostly university and faculty courses. The courses related to their expertise are fundamental courses. Thus, students' HOTS abilities only develop to a limited extent through the implementation of the Realistic mathematics education based on Toba Batak culture learning model.

5.2. Constructivism Can Enhance HOTS Abilities

The Realistic mathematics education based on Toba Batak culture learning model is built upon the constructivist paradigm. Learning is a set of processes that are internal to each individual as a result of transforming stimuli originating from external events in the individual's environment (conditions) (Gagne, 1965). To understand how the learning process takes place, several scholars have put forward theories about learning. One such learning theory is constructivism.

Constructivism is a relatively new branch in cognitive psychology that has had a significant impact on the thinking of instructional designers. The main concept in constructivist thinking is the view of learning as the product of construction by the learning individual.

Constructivism stems from the English word "to construct," which means to build. Constructivism originates from a philosophical standpoint that views the knowledge one possesses as the result of one's own construction process. Knowledge is acquired when learners actively engage in the process of discovering knowledge, and formation occurs within the learner. Constructivist scholars view knowledge as an individual acquisition through active engagement in the learning process (Julaeha & Asandhimitra, 2004). Learning outcomes are a combination of new knowledge with previously acquired knowledge or experiences. One can be said to have learned when they have constructed or constructed new knowledge by interpreting or interpreting their social, cultural, physical, and intellectual environment where they live. Learning in the constructivist view is related to the experiences one possesses.

In understanding the world actively, children use schemas (cognitive frameworks or reference frameworks). A schema is a concept or framework that exists in an individual's mind and is used to organize and interpret information. Piaget in Santrock (2007) states that there are two processes responsible for how children use and adapt their schemas, namely assimilation and accommodation. Assimilation occurs when a child incorporates new knowledge into existing knowledge. That is, in assimilation, children assimilate the environment into a schema. Accommodation occurs when a child adjusts to new information. That is, children will adjust their schemas to their environment.

Piaget (1952) states that to understand their world, children cognitively organize their experiences. Organization is a concept of Piaget (1952) that means the effort to group separate behaviors into a more orderly sequence, into cognitive functions. Equilibration is a mechanism proposed by Piaget (1952) to explain how children move from one stage of thinking to the next stage of thinking. This shift can only occur if the child experiences cognitive conflict (this is referred to as disequilibrium). Piaget (1952) believed that strong movement between cognitive equilibrium and disequilibrium during assimilation and accommodation leads to cognitive change.

Good learning is learning that is able to produce something genuinely new or new for the learners themselves. Learner engagement in learning has a significant influence on learner learning outcomes. One effort to increase learner engagement is by enhancing learners' curiosity. Curiosity is the starting point for learners' HOTS abilities. HOTS abilities begin with curiosity, and tasks of exploration and investigation can enhance the development of students' HOTS thinking abilities (Panaoura & Panaoura, 2014). Learning that applies a constructivist approach is facilitated by giving students the opportunity to explore the environment and learning-supporting factors. Davies et al. (2013) state that factors influencing the learning environment in schools support the development of HOTS abilities in children and adolescents. The supporting factors mentioned include the use of flexible space and time, availability of appropriate materials, working outside the classroom/school, a "playful" or game-based approach with student autonomy, opportunities for peer collaboration, and awareness of students' needs. To create or enhance the conditions for students' HOTS abilities, including through physical and pedagogical environments.

HOTS abilities will grow if students can interact directly with real events with the teaching material. Through interaction with the environment and learning-supporting factors, students are given the opportunity to construct their own knowledge. Ernest (1994) states that learning can be seen as a process of HOTS abilities where meaning is constructed by the learner.

Learning based on real experiences through direct interaction with the environment sometimes causes students to face unexpected problems. These problems require students to take initiative in solving contextual problems. The emergence of new ideas through problem-solving triggers students' HOTS abilities (Jones, Svejenova, Pedersen, & Townley, 2016). The greater the interaction of students with contextual environments or experiments, the more their HOTS abilities will improve.

5.3. Collaboration Enhances HOTS Abilities

Gregory et al. (2013) state that collaboration is beneficial for solving complex problems. To foster collaboration in the learning process, attention should be paid to the placement of students in discussion groups. What needs to be considered is the diversity among students. By leveraging the diverse backgrounds and experiences of students, it is hoped that through this approach, students will have more opportunities to share experiences. The socio-cultural assumption about HOTS abilities is that differences can trigger the work of HOTS abilities (Glaveanu, 2020). There are several differences that affect HOTS abilities within groups, including: ranging from individual differences (for example, in personality profiles and cognitive orientations; Coursey et al., 2018) and demographic differences (Martins & Shalley, 2011), to differences in social roles within groups (de Bono, 2017). It is generally assumed that, beyond surface-level diversity within groups, it is cognitive diversity or differences in types of knowledge, skills, and worldviews, in other words, perspectives that are most important for the group's potential for HOTS abilities (Paulus, 2000).

The first socio-cultural assumption about HOTS abilities is that differences can trigger the work of HOTS abilities. These differences can be of various types: between oneself and others; between symbols and the objects they denote; between past, present, and future; between expectations and reality, and so on (Glaveanu & Gillespie, 2015). Each of these differences presents a need for solutions in problem-solving. This is because they confront us with dissonance or tension in our experiences that require new meanings, objects, values, or practices to help us understand these "gaps," sometimes solving the problems they pose, at other times maintaining them, further developing our thinking (Perret-Clermont et al., 2004).

When looking at an issue, everyone will have a different perspective, depending on their experiences and thoughts. Different life backgrounds will result in different perspectives. Differences in perspectives are very important in this regard, considering that perspective is the orientation of action, and thus, being aware of or holding multiple perspectives means being able to direct one's thinking and actions in various different ways for the linkage between different thoughts and creative potential (Runco & Acar, 2012). Newton & Beverton (2012) state that to apply HOTS abilities in learning, teachers must understand that HOTS abilities are related to opportunities for action and interaction. Teachers provide opportunities for students to engage in physical activities and social interactions. Bull, Montgomery, and Baloche (1995) recommend that social interaction can also support in promoting the performance of students' HOTS abilities.

5.4. Providing Facilitation Enhances HOTS Abilities

In implementing contextual learning as one of the characteristics of constructivist learning, students often directly encounter problems that are often unresolved. This constraint arises due to the lack of experience and the accessibility of students' minds. The role of adults, in this case teachers as facilitators, is very necessary. Teachers are expected to be able to act as scaffolding for students' cognitive limitations so that they can climb the stairs to reach higher cognitive levels. With proper scaffolding, learning experiences in the context of providing experiences that can be reflected upon to learn skills and intentional repetitions of important skills gradually lead to becoming more proficient in executing them (Lee, 2011).

Ideally, a learning process that occurs in the classroom has clear targets for each domain of learning. It is common for the achievement of learning to reach the highest level of learning targets. Developing HOTS abilities through learning can be achieved. The selection of the right approach in learning is expected to provide maximum results. Providing appropriate scaffolding and other tools to help them obtain the targeted content and skills from students' experiences (Lee, 2011). The role of the teacher as scaffolding in this regard needs to be strengthened.

6 CONCLUSION

From the analysis of the research data and discussion, conclusions about the development of the learning model can be drawn. The Realistic mathematics education based on Toba Batak culture learning model has achieved levels of effectiveness in enhancing students' HOTS abilities. The components of this model include: Syntax, comprising: cultural apperception, problem-solving discussions, the social interaction pattern "*suhi ni ampang na opat*" with representation and problem-solving, work result reflection, Social system built on collaboration principles, Management reaction principle where teachers act as facilitators, Supporting system including: semester lesson plans, teaching materials, teacher guidebooks, student handbooks, and student activity sheets, Instructional impact in the form of students' HOTS abilities, and accompanying impact in the form of scientific attitude, collaboration, and realistic thinking.

The Realistic mathematics education based on Toba Batak culture learning model is complemented by a set of books, semester lesson plans, teaching materials, teacher guidebooks, student handbooks, and student activity sheets that have met the criteria of effectiveness. More specifically, the conclusions obtained are as follows: a. The effectiveness level of the Realistic mathematics education based on Toba Batak culture learning model is influenced by four aspects: teacher's ability to manage learning obtains a value of NKD = 4.17 (high category), students' HOTS abilities have a proportion value = 0.85 (high category), active student activities have a value of 25% (active category), b. The level of HOTS ability through the application of the Realistic mathematics education based on Toba Batak culture learning model has increased from a moderate category to a high category, with an N-Gain value of 0.81 (high category), c. The level of active student activities through the application of the Realistic mathematics education based on Toba Batak culture learning model has a value of 25% (active category), d. The level of student response to the learning process in implementing the Realistic mathematics education based on Toba Batak culture learning model obtains a value of 93 (high category).

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