

An Analysis of the Implementation of the Problem-Based Learning Model Integrated with the Toba Batak Ruma Bolon Philosophy among Students of SD Budi Murni 6 Medan in Science Learning

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Abstract

This study aims to describe the implementation of the Problem-Based Learning model integrated with the Toba Batak Ruma Bolon philosophy in science learning on the topic of states of matter and their changes among students of SD Budi Murni 6 Medan. This research employed a descriptive qualitative approach. The research subjects consisted of the classroom teacher and elementary school students involved in the learning process. Data were collected through classroom observation, interviews, and documentation. The data were analyzed through data reduction, data display, and conclusion drawing, while data validity was strengthened through source and technique triangulation. The results showed that the integration of the Ruma Bolon philosophy into the Problem-Based Learning model created a more contextual, collaborative, and meaningful science learning process. The values of togetherness, deliberation, responsibility, order, and harmony with the environment were reflected in the stages of problem orientation, group discussion, simple investigation, presentation, and learning reflection. Students were able to understand the concepts of solids, liquids, gases, melting, freezing, evaporation, condensation, and sublimation more easily when these concepts were connected to concrete objects, daily experiences, and local cultural contexts. However, several obstacles were found, including limited instructional time, differences in students' communication abilities, and the need for more systematic preparation of contextual problems and learning materials. The study concludes that the Problem-Based Learning model integrated with the Toba Batak Ruma Bolon philosophy is relevant to be applied as a local wisdom-based science learning strategy in elementary schools, particularly to strengthen students' conceptual understanding, collaboration, and appreciation of local culture.

Keywords: *Problem-Based Learning; Ruma Bolon philosophy; local wisdom; science learning;*

INTRODUCTION

Science learning in elementary school plays an important role in developing students' ability to understand natural phenomena through observation, reasoning, investigation, and communication. At the elementary level, science concepts need to be presented through concrete experiences because students are still in the stage of developing logical thinking based on objects and events that can be directly observed. One of the science topics that requires contextual and concrete learning is the topic of states of matter and their changes. Concepts such as solids, liquids, gases, melting, freezing, evaporation, condensation, and sublimation are closely related to students' daily experiences. However, in classroom practice, students often find it difficult to understand these concepts when learning is delivered only through verbal explanation, memorization, and textbook-based activities.

The topic of states of matter and their changes should be taught through active learning that encourages students to identify problems, conduct simple observations, discuss findings, and connect scientific concepts with real-life phenomena. Learning that is centered only on the teacher may limit students' opportunity to construct their own understanding. Therefore, an instructional model is needed to support students' active participation and critical thinking. One model that is considered relevant to science learning is Problem-Based Learning. Problem-Based Learning places real or contextual problems as the starting point of learning, allowing students to investigate, collaborate, analyze information, and present solutions based on evidence (Hmelo-Silver, 2004). Through this model, students are not positioned merely as recipients of information but as active learners who build knowledge through inquiry and problem solving.

Problem-Based Learning is also appropriate for elementary science learning because it allows students to relate scientific concepts to situations that are familiar to them. According to Arends (2012), Problem-Based Learning helps students develop thinking skills, problem-solving abilities, and collaborative learning habits through structured learning stages. These stages generally include orienting students to the problem, organizing students for learning, guiding investigation, developing and presenting work, and analyzing the problem-solving process. In the context of science learning, these stages can support students in observing objects, identifying changes, formulating explanations, and drawing conclusions based on simple scientific reasoning.

In addition to the need for an active learning model, science learning in elementary schools also needs to be connected to students' cultural environment. Local wisdom can become a meaningful learning resource because it reflects knowledge, values, practices, and ways of life developed by local communities. The integration of local wisdom into science learning can make learning more contextual and relevant to students' lives. It also helps students recognize that scientific concepts are not separated from social and cultural realities. According to Sumarni (2018), local wisdom-based science learning can strengthen students' conceptual understanding while also developing appreciation for cultural identity. In line with this, ethnoscience-based

learning emphasizes the connection between scientific knowledge and cultural practices found in society (Sudarmin, 2015).

One form of local wisdom that can be integrated into science learning in North Sumatra is the philosophy of Ruma Bolon Batak Toba. Ruma Bolon is not only known as a traditional house of the Batak Toba community but also as a cultural symbol containing social, philosophical, and educational values. The structure, function, and meaning of Ruma Bolon reflect values such as togetherness, cooperation, order, responsibility, respect, and harmony with the environment. As a traditional house, Ruma Bolon represents the way the Batak Toba community organizes family life, social relations, and interaction with nature. These values are relevant to elementary education because they can support both cognitive and character development.

The integration of the Ruma Bolon philosophy into Problem-Based Learning can provide a contextual foundation for science learning. In the topic of states of matter and their changes, the physical and environmental aspects of Ruma Bolon can be used as learning contexts. For example, wooden pillars, floors, stairs, and roofs may be used to introduce the concept of solids; rainwater, drinking water, and other fluids around the house can be used to explain liquids; and air circulation inside the house can be used to introduce gases. Changes in matter can also be connected to daily phenomena such as water evaporating due to sunlight, dew forming in the morning, ice melting, or water freezing. Through these examples, students can understand science concepts more easily because the learning materials are connected to concrete objects and cultural contexts.

The values contained in the Ruma Bolon philosophy are also aligned with the principles of Problem-Based Learning. The value of togetherness supports group discussion, the value of deliberation supports decision-making during problem solving, the value of responsibility supports task completion, and the value of order supports systematic investigation. Thus, the integration of Problem-Based Learning and the Ruma Bolon philosophy does not only aim to improve students' understanding of science concepts but also to strengthen collaboration, communication, and cultural awareness. This is important because elementary science learning should not only focus on knowledge acquisition but also on the development of attitudes, skills, and values.

Based on initial classroom learning needs, science instruction at SD Budi Murni 6 Medan requires a learning approach that can make abstract concepts more concrete and meaningful for students. The diversity of students' learning abilities also requires teachers to design learning activities that involve direct observation, group interaction, and contextual problem solving. Therefore, the implementation of Problem-Based Learning integrated with the Toba Batak Ruma Bolon philosophy is considered relevant for science learning on the topic of states of matter and their changes.

This study is important because it attempts to describe how a problem-based learning model can be implemented together with local cultural values in elementary science learning. Previous studies have discussed the effectiveness of Problem-Based Learning and the importance of local wisdom in science education, but studies that specifically analyze the implementation of Problem-Based Learning integrated with the philosophy of Ruma Bolon Batak Toba in elementary

science learning are still limited. Therefore, this study focuses on analyzing the implementation process, students' learning responses, and the challenges found during the learning process.

Based on the background above, this study aims to analyze the implementation of the Problem-Based Learning model integrated with the Toba Batak Ruma Bolon philosophy among students of SD Budi Murni 6 Medan in science learning on the topic of states of matter and their changes. The results of this study are expected to provide theoretical and practical contributions to the development of local wisdom-based science learning in elementary schools.

MATERIALS AND METHODS

This study employed a descriptive qualitative research design. This design was selected because the study aimed to describe in detail the implementation of the Problem-Based Learning model integrated with the Toba Batak Ruma Bolon philosophy in elementary science learning. The focus of this research was not to measure statistical effects, but to obtain an in-depth understanding of the learning process, teacher strategies, student participation, cultural value integration, and obstacles encountered during the learning activities.

The research was conducted at SD Budi Murni 6 Medan. The research subjects consisted of one classroom teacher and students who participated in science learning on the topic of states of matter and their changes. The teacher was selected because the teacher was directly involved in designing and implementing the learning process. The students were involved as the main participants because they experienced the learning activities directly. The object of this study was the implementation of the Problem-Based Learning model integrated with the Toba Batak Ruma Bolon philosophy in science learning.

The learning material used in this study was the topic of states of matter and their changes. The main concepts included solids, liquids, gases, melting, freezing, evaporation, condensation, and sublimation. The cultural material used as the contextual basis was the philosophy of Ruma Bolon Batak Toba. The Ruma Bolon philosophy was integrated into the learning process through values such as togetherness, deliberation, responsibility, order, cooperation, and harmony with the environment. These values were connected to the stages of Problem-Based Learning and to examples of objects and phenomena related to the topic of states of matter.

The learning instruments consisted of a teaching module, student worksheets, observation sheets, interview guidelines, and documentation guidelines. The teaching module was prepared based on the stages of Problem-Based Learning, namely orienting students to the problem, organizing students for learning, guiding individual and group investigation, developing and presenting the results, and evaluating the problem-solving process. The student worksheets contained contextual problems related to Ruma Bolon and the topic of states of matter and their changes. The observation sheets were used to record teacher activities, student activities, student collaboration, and the integration of Ruma Bolon values during learning. Interview guidelines were used to obtain information from the teacher and students regarding their experiences, responses, and difficulties during the learning process. Documentation guidelines were used to

collect supporting data such as teaching materials, student worksheets, photographs of learning activities, and students' written work.

The research procedure consisted of three main stages: preparation, implementation, and data analysis. In the preparation stage, the researcher identified the learning objectives, analyzed the science topic, prepared the teaching module, developed contextual problems, and designed the student worksheets. The contextual problems were developed by connecting the topic of states of matter and their changes with the physical and philosophical aspects of Ruma Bolon Batak Toba. For example, wooden structures in Ruma Bolon were used as examples of solids, water around the house environment was used as an example of liquids, air circulation inside the house was used as an example of gases, and daily phenomena such as evaporation, condensation, melting, and freezing were used to explain changes in states of matter.

In the implementation stage, the learning process was carried out using the Problem-Based Learning model. The first stage was orienting students to the problem. At this stage, the teacher introduced contextual problems by showing pictures or descriptions of Ruma Bolon and asking guiding questions related to states of matter and their changes. The second stage was organizing students for learning. Students were divided into small groups, and each group received a worksheet containing problems and investigation tasks. The third stage was guiding investigation. Students observed examples of solid, liquid, and gas objects and discussed changes in states of matter using simple materials such as water, ice cubes, glass containers, spoons, and pictures of Ruma Bolon. The fourth stage was developing and presenting the results. Each group discussed its findings and presented the results of its investigation to the class. The fifth stage was evaluating the problem-solving process. The teacher guided students to reflect on the science concepts learned and the values of the Ruma Bolon philosophy that appeared during group work and discussion.

Data were collected through observation, interviews, and documentation. Observation was conducted during the learning process to examine how the teacher implemented the Problem-Based Learning stages and how students participated in learning activities. The observation focused on students' involvement in identifying problems, discussing in groups, conducting simple investigations, presenting findings, and reflecting on learning outcomes. Interviews were conducted with the teacher and selected students after the learning process. The teacher interview focused on the planning, implementation, benefits, and obstacles of integrating the Ruma Bolon philosophy into Problem-Based Learning. Student interviews focused on their understanding of the material, learning experiences, group collaboration, and responses to the use of local cultural contexts in science learning. Documentation was used to support the observation and interview data. The documents included lesson plans or teaching modules, worksheets, students' answers, photographs, and researcher field notes.

The data analysis technique used in this study consisted of data reduction, data display, and conclusion drawing. Data reduction was conducted by selecting, simplifying, and organizing data related to the implementation of Problem-Based Learning, the integration of Ruma Bolon philosophy, student responses, and learning obstacles. Data display was carried out by presenting the findings in the form of descriptive narratives based on the research focus. The data were

grouped into several themes, including the implementation of Problem-Based Learning stages, the form of Ruma Bolon philosophy integration, student participation, teacher strategies, and challenges in the learning process. Conclusion drawing was conducted by interpreting the patterns found in the observation, interview, and documentation data.

To ensure data validity, this study used triangulation of sources and triangulation of techniques. Source triangulation was conducted by comparing data obtained from the teacher, students, and learning documents. Technique triangulation was conducted by comparing data from observation, interviews, and documentation. The consistency of data from these different sources and techniques was used to strengthen the credibility of the research findings. In addition, the researcher reviewed the field notes and interview results repeatedly to ensure that the interpretation was consistent with the data collected during the learning process.

The research results were reported descriptively. The findings were presented in relation to the research objective, namely to analyze the implementation of the Problem-Based Learning model integrated with the Toba Batak Ruma Bolon philosophy in science learning on the topic of states of matter and their changes. The description included the learning implementation process, the integration of local wisdom values, student responses, and the obstacles encountered during the learning activities.

RESULTS AND DISCUSSION

The implementation of the Problem-Based Learning model integrated with the Toba Batak Ruma Bolon philosophy in science learning on the topic of states of matter and their changes showed that local cultural values could be used as a meaningful context to support students' conceptual understanding. The results were obtained through classroom observation, teacher and student interviews, and documentation of learning activities. The findings are presented based on four main aspects: the implementation of Problem-Based Learning stages, the integration of Ruma Bolon philosophical values, students' learning responses, and obstacles encountered during the learning process.

The learning process was carried out by following the stages of Problem-Based Learning. The teacher began the lesson by presenting contextual problems related to Ruma Bolon Batak Toba and the phenomena of matter around students' daily lives. The use of Ruma Bolon as a cultural context helped students connect science concepts with concrete objects, such as wood, water, air, sunlight, and environmental conditions around traditional houses. The implementation of each learning stage is presented in Table 1.

Table 1. Implementation of Problem-Based Learning integrated with Ruma Bolon philosophy

PBL Stage	Learning Activity	Integration of Ruma Bolon Philosophy	Observed Result
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Orienting students to the problem	The teacher presented pictures and contextual questions related to Ruma Bolon and states of matter	Ruma Bolon was introduced as a cultural symbol containing values of order, togetherness, and harmony with nature	Students showed interest and began to connect science concepts with familiar objects
Organizing students for learning	Students were divided into small groups and given worksheets	The value of togetherness was emphasized through group work	Students discussed examples of solids, liquids, and gases in groups
Guiding investigation	Students observed objects and phenomena related to changes in states of matter	The value of responsibility appeared through task division in each group	Students identified melting, freezing, evaporation, and condensation through simple examples
Developing and presenting results	Each group presented its findings to the class	The value of deliberation appeared during discussion and presentation	Students communicated their findings, although some still needed teacher guidance
Evaluating the learning process	The teacher guided students to reflect on science concepts and cultural values	The value of order and reflection was connected to systematic learning	Students concluded that science concepts can be found in daily life and local culture

As shown in Table 1, the learning process was not limited to delivering science concepts but also involved cultural meaning-making. The teacher used Ruma Bolon as a contextual entry point to explain the characteristics of solids, liquids, and gases. For example, the wooden structure of Ruma Bolon was used to represent solid objects because it has a fixed shape and volume. Water around the house environment was used to represent liquid objects because it follows the shape of its container. Air circulation inside and around the house was used to introduce gas because it occupies space even though it cannot be seen directly.

The integration of Ruma Bolon philosophy also appeared in students' group activities. During discussion, students were encouraged to cooperate, listen to others' opinions, and make decisions together. These activities reflected the cultural values of togetherness and deliberation. This finding is consistent with the idea that Problem-Based Learning supports collaborative inquiry and problem-solving skills because students are actively involved in discussing problems, investigating information, and constructing explanations (Arends, 2012). Recent studies also indicate that Problem-Based Learning in elementary science can strengthen critical thinking, reflective thinking, and student engagement when it is implemented through contextual problems (Surya, 2025; Mooduto, 2025).

The second finding concerns the forms of Ruma Bolon philosophical integration in science learning. The integration was carried out through cultural objects, cultural values, and environmental phenomena. The teacher did not treat Ruma Bolon merely as a visual illustration but as a contextual and philosophical learning source. This integration is summarized in Table 2.

Table 2. Forms of Ruma Bolon philosophy integration in science learning

Integrated Aspect	Example in Learning	Related Science Concept	Educational Meaning
Wooden structure of Ruma Bolon	Pillars, stairs, walls, and floors	Solid objects	Students understood that solids have fixed shape and volume
Water around the house environment	Rainwater, water containers, and daily water use	Liquid objects	Students understood that liquids follow the shape of their containers
Air circulation	Air inside and around the house	Gas objects	Students understood that gases occupy space even though they are not visible
Sunlight and environmental temperature	Drying water and warming objects	Evaporation and heat influence	Students connected changes in matter with environmental conditions
Group discussion values	Cooperation, responsibility, and deliberation	Scientific communication	Students learned to solve problems through collaborative reasoning

Table 2 indicates that the use of Ruma Bolon philosophy created a bridge between cultural knowledge and scientific concepts. Students were able to identify examples of states of matter through objects that were culturally and environmentally meaningful. The use of cultural context helped reduce the abstractness of science concepts, especially for elementary students who require concrete learning experiences. This finding is in line with ethnoscience-based learning, which emphasizes the relationship between scientific concepts and local knowledge found in society (Sudarmin, 2015). Local wisdom-based science learning can make learning more relevant because students are encouraged to understand science through familiar cultural practices, objects, and values (Sumarni, 2018).

The third finding concerns students' responses during the learning process. Based on classroom observation, students became more active when the teacher connected the topic of states of matter with concrete examples. Students asked questions, mentioned examples from daily life, and participated in group discussions. Some students explained that they understood the difference between solids, liquids, and gases more easily after observing objects and discussing them with

their peers. However, students' ability to communicate their ideas varied. Some students were confident in presenting group results, while others still needed prompts from the teacher.

Table 3. Students' learning responses during the implementation of PBL integrated with Ruma Bolon philosophy

Observed Aspect	Description of Student Response	Interpretation
Attention to learning	Students paid attention when the teacher showed pictures and asked questions about Ruma Bolon	Cultural context increased students' initial interest
Participation in discussion	Most students contributed examples of solids, liquids, and gases	Group work encouraged student involvement
Conceptual understanding	Students connected wood, water, and air with states of matter	Concrete examples helped students understand science concepts
Communication	Some students presented results confidently, while others needed guidance	Students' communication skills developed gradually
Cultural awareness	Students recognized that local culture can be connected to science learning	Learning supported both science understanding and cultural appreciation

As presented in Table 3, students' responses were generally positive. The use of local culture made the learning process more meaningful because students did not learn science as an isolated subject. They were encouraged to see that scientific concepts exist in their environment and cultural heritage. This finding supports recent studies showing that local wisdom-based learning can improve students' cultural awareness, scientific literacy, and critical thinking because it connects formal science content with students' lived experiences (Wahyudi, 2025; Fitriyah, 2025).

The fourth finding relates to the obstacles encountered during the implementation. The first obstacle was limited instructional time. Problem-Based Learning required students to understand the problem, discuss in groups, investigate examples, prepare answers, and present findings. These activities took more time than conventional teacher-centered instruction. The second obstacle was the difference in students' communication abilities. Some students were active in discussion, while others were passive and tended to follow their friends' answers. The third obstacle was the teacher's need to prepare contextual problems carefully. The integration of Ruma Bolon philosophy required appropriate examples so that cultural elements were not used superficially.

Table 4. Obstacles in implementing PBL integrated with Ruma Bolon philosophy

Obstacle	Description	Possible Solution
Limited instructional time	Group investigation and presentation required longer learning time	The teacher should prepare focused worksheets and limit the number of problems
Unequal student participation	Some students dominated the discussion, while others were passive	The teacher should assign specific roles in each group
Difficulty in communicating ideas	Some students had difficulty presenting their findings	The teacher should provide guiding questions and simple sentence starters
Preparation of contextual problems	The teacher needed to connect science concepts and Ruma Bolon philosophy accurately	The teacher should develop a structured local wisdom-based teaching module
Risk of superficial cultural integration	Ruma Bolon could be treated only as an image or decoration	The teacher should integrate both cultural objects and philosophical values

The obstacles presented in Table 4 show that the implementation of Problem-Based Learning integrated with local wisdom requires careful planning. Teachers need to design problems that are relevant to science concepts, appropriate to students' cognitive development, and meaningful in relation to local culture. Without proper preparation, cultural integration may become merely decorative. Therefore, the teacher's understanding of both scientific content and cultural values is essential.

The discussion of these findings shows that the integration of the Problem-Based Learning model and Ruma Bolon philosophy has pedagogical relevance. Problem-Based Learning provides a structured learning process that encourages inquiry, collaboration, and problem solving. Meanwhile, the Ruma Bolon philosophy provides cultural meaning and contextual examples that make science learning more concrete. The combination of these two elements supports the development of students' conceptual understanding, learning participation, and appreciation of local culture.

The findings also indicate that science learning in elementary schools should not be separated from students' social and cultural environment. The topic of states of matter and their changes is suitable for local wisdom-based learning because the concepts can be observed in daily life. Objects and phenomena related to Ruma Bolon, such as wood, water, air, sunlight, and

environmental temperature, can be used as learning resources. This approach helps students understand that science is not only found in textbooks but also in the surrounding environment. In relation to previous research, the results of this study are consistent with studies reporting that Problem-Based Learning can support students' critical thinking and problem-solving abilities in elementary science learning (Surya, 2025; Aripin, 2025). The findings also support research on ethnoscience and local wisdom-based learning, which states that cultural contexts can strengthen students' understanding by connecting scientific concepts with local practices and community knowledge (Fitriyah, 2025; Wahyudi, 2025). In the context of Ruma Bolon, local wisdom is not only represented through the physical form of the traditional house but also through values such as cooperation, order, responsibility, and harmony with nature. These values are relevant to the collaborative and reflective nature of Problem-Based Learning.

Based on the results, the implementation of the Problem-Based Learning model integrated with the Toba Batak Ruma Bolon philosophy can be considered effective as a qualitative learning practice to create contextual science learning. The model helped students identify examples of solids, liquids, and gases, understand changes in states of matter, and relate science concepts to cultural and environmental contexts. Nevertheless, the success of this implementation depends on the teacher's ability to design contextual problems, manage group discussions, guide investigation, and connect cultural values with science concepts appropriately.

Overall, the results show that the integration of Problem-Based Learning and Ruma Bolon philosophy can enrich elementary science learning. This approach not only supports students' understanding of states of matter and their changes but also strengthens collaboration, communication, responsibility, and cultural appreciation. Therefore, this model can be recommended as an alternative strategy for local wisdom-based science learning in elementary schools, particularly in regions where Batak Toba cultural values are relevant to students' social environment.

CONCLUSION

Based on the research results, the implementation of the Problem-Based Learning model integrated with the Toba Batak Ruma Bolon philosophy in science learning on the topic of states of matter and their changes was carried out through five main stages: orienting students to contextual problems, organizing students into groups, guiding investigation, developing and presenting group findings, and evaluating the learning process. The integration of the Ruma Bolon philosophy was reflected through the use of cultural objects, environmental phenomena, and local values such as togetherness, deliberation, responsibility, order, cooperation, and harmony with nature.

The implementation of this learning model helped students understand the concepts of solids, liquids, gases, and changes in states of matter more easily because the material was connected to concrete objects and daily experiences. The use of Ruma Bolon as a cultural context also made science learning more meaningful and encouraged students to recognize that scientific concepts can be found in their local environment and cultural heritage.

The research results also showed that students became more active in observing, discussing, asking questions, and presenting their findings during the learning process. Group activities supported collaboration and communication among students, although some students still required teacher guidance to express their ideas confidently. Several obstacles were found, including limited instructional time, unequal student participation, differences in communication ability, and the need for more systematic preparation of contextual problems and learning materials.

In conclusion, the Problem-Based Learning model integrated with the Toba Batak Ruma Bolon philosophy is relevant to be applied as a local wisdom-based science learning strategy in elementary schools. This model can support students' conceptual understanding, collaborative skills, communication skills, responsibility, and appreciation of local culture in science learning.

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