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ANALYSIS OF THE NEED TO DEVELOP INNOVATIVE TEACHING MATERIALS BASED ON PROBLEM-BASED LEARNING (PBL) INTEGRATED WITH THE LOCAL WISDOM OF *MARPANGIR* BATAK TOBA ON THE TOPIC OF ELECTROLYTE AND NON-ELECTROLYTE SOLUTIONS

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ABSTRACT: The purpose of this study is to analyze the need for improvement of chemistry teaching materials for grade XI high school students on electrolyte and non-electrolyte solution topics, and the findings of this study are used as information in the development of chemistry teaching materials based on Problem Based Learning (PBL) integrated with Batak Toba local wisdom of *Marpangir*. A qualitative descriptive method was employed in this study. The research was conducted at SMA Negeri 12 Medan through interviews with a chemistry teacher and classroom observations in class XI-F3 involving 32 students. The results indicate that the teacher still mainly uses textbooks and limited learning resources in chemistry instruction, and learning activities have not yet integrated a structured learning model within teaching materials. The teacher also stated that students still experience difficulties in understanding electrolyte and non-electrolyte solution concepts because the material is abstract and not strongly connected to daily life. Furthermore, there are no teaching materials that integrate learning models with local wisdom in the learning process. Based on the student needs analysis, 88.13% of students expressed interest in and supported the development of Problem Based Learning (PBL)-based teaching materials integrated with Batak Toba local wisdom of *Marpangir*. Therefore, the development of such teaching materials is highly needed to provide meaningful and contextual learning experiences, enabling students to better understand abstract chemistry concepts and construct their own understanding independently.

Keywords: Electrolyte and Non-Electrolyte Solutions, Local Wisdom of *Marpangir*, Problem Based Learning (PBL).

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INTRODUCTION

Education is one of the key factors in improving the quality of a nation's human resources. High-quality human resources are developed through an educational process that emphasizes not only knowledge but also the development of character and individual skills, enabling individuals to compete in the global era. Competitiveness in the field of education can be defined as a country's ability to

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create an efficient, inclusive, and high-quality education system that produces individuals with the knowledge, skills, and ability to adapt to the needs of society and the workforce. In the context of learning, this can be achieved through contextual learning that connects the material to students' daily lives, including in chemistry education (Sanga & Wangdra, 2023). In line with Ki Hajar Dewantara's philosophy, education aims to give students the freedom to develop their potential and creative ideas without abandoning the cultural values that thrive in society (Firmansyah et al., 2021). Thus, education serves not only as a process of knowledge transfer but also as a means of character building and cultural preservation. In chemistry instruction, these cultural values can be integrated through the use of local wisdom as a learning context that is closely tied to students' daily lives (Devian et al., 2022).

Education and culture are two closely related and complementary elements. Education serves as a means of passing on values to future generations, while culture serves as an identity that must be preserved and studied by society. One form of culture with great potential for integration into learning is local wisdom. Local wisdom refers to a worldview, knowledge, and life strategies passed down from generation to generation and believed to embody wisdom in community life (Njatrijani, 2018). In Indonesia's multicultural society, understanding and passing down local wisdom are essential for strengthening a sense of community, cultural identity, and national unity. Therefore, education is viewed as an effective means of instilling the values of local wisdom through both formal and informal education (Iswatiningsih, 2019).

The integration of local wisdom into learning is considered relevant to the implementation of the Merdeka Curriculum, which emphasizes contextual learning and the strengthening of students' character. However, based on a preliminary survey, chemistry teaching materials that integrate local wisdom remain limited. In fact, the use of local cultural contexts can help students understand the material more tangibly while supporting the development of the Pancasila Student Profile. Previous research has shown that the integration of local culture into chemistry teaching materials has been applied to stoichiometry through the development of an electronic textbook based on Problem-Based Learning (PBL) that incorporates local wisdom related to betel leaf, demonstrating positive potential in learning (Silaban et al., 2025). These findings indicate that the development of locally-based teaching materials still holds broad potential for application to other chemistry topics.

One form of local wisdom among the Toba Batak people that has the potential to be integrated into education is *Marpangir*. *Marpangir* is a bathing tradition that uses various natural ingredients, including kaffir lime, and is an integral part of Toba Batak culture. This tradition is not only viewed as a spiritual activity but also holds strong social value because it involves collective community participation. *Marpangir* reflects the values of mutual cooperation, togetherness, simplicity, and respect for nature and the ancestral heritage passed down through generations (Afifah & Ponidi, 2025; Siregar & Rusydah, 2025). From a chemical perspective, the ingredients used in *Marpangir* can serve as a context for discussing electrolyte and non-electrolyte solutions. Kaffir lime, for example, contains citric

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acid that can ionize in water and produce ions, making the solution capable of conducting electric current. This phenomenon can serve as a Problem-Based Learning (PBL) context to guide students in investigating the relationship between substance content, ion formation, and a solution's ability to conduct electricity. Thus, *Marpangir* can serve as a source of contextual learning that connects chemical concepts with the culture present in the students' environment.

Chemistry is a branch of natural science that studies the structure, composition, properties, and changes in matter, along with the energy associated with them. However, students often find chemistry difficult because its concepts are abstract, theoretical, and require logical thinking skills (Rostika, 2020). One topic that is still considered challenging is electrolyte and nonelectrolyte solutions. Difficulties with this topic arise because students are required to understand the concept of electrical conductivity, classify solutions based on their electrolyte properties, and understand the processes of ionization and dissociation that occur in solutions (Lela et al., 2023).

Furthermore, this topic also requires the ability to connect theory with real-world phenomena so that students do not merely memorize concepts but are able to understand their applications in daily life (Jayanti, 2018). Based on observations during the School Field Introduction (PLP) program, it was found that students still struggle to understand the concepts of electrolytes and nonelectrolytes. This is evidenced by students' limited ability to distinguish between types of solutions and their difficulty in connecting theoretical concepts to practical applications in daily life. These difficulties are believed to stem from a teaching approach that remains teacher-centered, as well as the limited use of engaging and contextually relevant learning materials tied to the local environment. Therefore, the development of Problem-Based Learning (PBL)-based instructional materials that integrate the local wisdom of the *Marpangir* Batak Toba community is essential to enable students to learn more actively and critically and to understand the concepts through experiences relevant to their daily lives.

To address these issues, innovative teaching methods that actively engage students are needed. One model considered appropriate is Problem-Based Learning (PBL). The PBL model encourages students to observe, ask questions, analyze, and solve problems through real-life situations, thereby making learning more meaningful (Saputri et al., 2022; Suswati, 2021). The use of this model is considered relevant because students can relate the learning material to their surroundings and gain firsthand experience in discovering the concepts being studied (Handayani & Muhammadi, 2021). Previous research also indicates that the instructional materials used by teachers remain conventional, so students require materials that are more practical, contextual, and capable of helping them understand the content in a more tangible way (Silaban et al., 2024).

Previous research shows that 85.5% of students expressed the need for the development of project-based e-modules integrated with ethnopedagogy on the topic of reaction rates. These findings indicate that students require innovative teaching materials that link chemical concepts to local wisdom. However, that study was limited to reaction rate material; therefore, an analysis of the need to develop innovative Problem-Based Learning (PBL)-based teaching materials that integrate

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the local wisdom of the *Marpangir* Batak Toba people into the topics of electrolyte and non-electrolyte solutions still needs to be conducted (Sianturi et al., 2026).

Based on the above discussion, a needs analysis is required as the initial stage in the development of innovative teaching materials based on Problem-Based Learning (PBL) that are integrated with the local wisdom of *Marpangir* Batak Toba regarding electrolytes and non-electrolytes. This study aims to analyze the needs of teachers and students for contextual teaching materials that integrate PBL and the local wisdom of the *Marpangir* Batak Toba.

METHOD

This study employed a descriptive approach within the Research and Development (R&D) methodology. Research data were collected through interviews and questionnaires. Interviews were conducted to identify learning conditions, challenges faced by teachers and students, and the teaching materials used in the chemistry learning process. This study was conducted at State Senior High School 12 in Medan, involving chemistry teachers, students, and expert validators. Subjects were selected using purposive sampling. Teachers were involved in interviews and the distribution of questionnaires to analyze learning needs.

Data collection via questionnaires was carried out by providing respondents with a set of written questions or statements to answer. Questionnaires were chosen because they are an efficient data collection technique and can be used with a large number of respondents spread across a wide area, either in person or via the internet (Sugiyono, 2013). The questionnaire consisted of 15 items measuring three indicators: 1) learning challenges; 2) student characteristics and instructional materials; and 3) instructional material needs. The questionnaire used a dichotomous rating scale with two response options: “Yes” and “No.” Before use, the instrument was reviewed to ensure that the items aligned with the indicators being measured.

The data obtained were analyzed using quantitative descriptive techniques by calculating the percentage of “Yes” responses from all respondents. The percentage was calculated using the formula $P = (f/N) \times 100\%$, where P is the percentage, f is the frequency of “Yes” responses, and N is the total number of responses from all participants. From 32 students and 15 survey items, 423 “Yes” responses were obtained out of a total of 480 responses, resulting in an overall percentage of 88.13%. The percentage results were then interpreted based on the following categories: 81-100% = very high, 61-80% = high, 41-60% = moderate, 21-40% = low, and 0-20% = very low. Thus, the result of the students’ needs analysis 88.13% falls into the “very high” category.

RESULTS AND DISCUSSION

The results of this study aim to establish facts and identify the requirements necessary for the development of innovative teaching materials. At this stage, three types of analysis were conducted: an analysis of the needs of teachers and students, an analysis of the Learning Objective Sequence (LOS) used by teachers, and an analysis of the teaching materials or textbooks used in chemistry instruction. The

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researcher conducted observations and interviews with chemistry teachers at SMA Negeri 12 Medan to obtain information relevant to the study. This process was carried out using an interview instrument. Based on the results of the observations and interviews, it was found that the curriculum implemented at the school is the Merdeka Curriculum. An explanation of the results of the needs analysis is presented as follows.

Teacher Needs Analysis

The teacher needs analysis aims to identify the fundamental challenges faced in the chemistry learning process. At this stage, the researcher conducted observations and interviews with chemistry teachers at State Senior High School 12 in Medan using an interview instrument. Based on the results of the observations and interviews, it was found that the curriculum being implemented is the Merdeka Curriculum.

Based on the results of interviews with chemistry teachers at State Senior High School 12 in Medan, it was found that teachers have not yet utilized innovative teaching materials integrated with local wisdom in their instruction, particularly regarding the topics of electrolyte and non-electrolyte solutions. The learning process remains dominated by the use of printed textbooks, student worksheets, and PowerPoint presentations. The teacher explained that the topics of electrolyte and non-electrolyte solutions are still considered difficult for students to understand because the concepts are abstract and require observation and verification through laboratory experiments. However, the limited availability of contextual teaching media and materials has prevented the learning process from effectively connecting these concepts to students' real-world experiences.

The Merdeka Curriculum emphasizes the importance of contextual learning, character building, and the integration of cultural values into the learning process. However, based on interview results, Problem-Based Learning (PBL) integrated with local wisdom on the topic of electrolyte and non-electrolyte solutions has never been implemented during the teacher's tenure at the school. The teacher also noted that instruction still tends to be teacher-centered, resulting in students being less active in independently developing conceptual understanding.The teaching materials used to date are considered not to fully support interactive and meaningful learning.

Based on the analysis, students still struggle to distinguish between electrolyte and non-electrolyte solutions and to connect the concept of electrical conductivity with its applications in daily life. Therefore, there is a need for innovative teaching materials that can support chemistry learning in a more effective, interactive, and structured manner through the integration of the Problem-Based Learning (PBL) model with the local wisdom of the *Marpangir* Batak Toba. The teacher also explained that the development of teaching materials related to daily life and local culture is essential to make learning more contextual and to help students better understand chemistry concepts.

Student Needs Analysis (Survey)

The student needs analysis in this development study aims to identify students' needs regarding the development of innovative teaching materials integrated with local wisdom in accordance with their learning needs. At this stage,

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the researcher explained the instructional materials to be developed to the students of Class XI-F3 at SMA Negeri 12 Medan, who had already studied the topic of electrolyte and non-electrolyte solutions. This was done so that the students could provide insight into their needs for Problem-Based Learning (PBL)-based instructional materials integrated with the local wisdom of *Marpangir* Batak Toba.

The data were collected through the distribution of a needs analysis questionnaire to 32 10th-grade students at State Senior High School 12 in Medan. The results of the questionnaire analysis indicate that the students' need for the development of innovative teaching materials based on Problem-Based Learning (PBL) integrated with the local wisdom of *Marpangir* Batak Toba falls into the "very high" category, with an overall percentage of 88.13%. This percentage was derived from 423 "Yes" responses out of a total of 480 responses to the 15 survey items, calculated using the formula $P = (f/N) \times 100\%$. The questionnaire covered three indicators: learning challenges, student characteristics and instructional materials, and instructional material needs. Based on each indicator, the percentages of "Yes" responses were 88.54%, 87.50%, and 88.54%, respectively.

These results indicate that students need instructional materials that can relate chemistry concepts to daily life and local culture so that the concepts of electrolyte and non-electrolyte solutions can be understood in a more contextual and meaningful way. Furthermore, the use of the PBL approach is necessary to encourage students to be more active in problem-solving, discussing, and exploring concepts independently. Therefore, the needs analysis results indicate a high need for the development of innovative PBL-based teaching materials integrated with the local wisdom of the *Marpangir* Batak Toba.

ATP Analysis

The Learning Objectives Flowchart (ATP) analysis phase is conducted to determine a focused, systematic instructional design that aligns with the learning outcomes in the Merdeka Curriculum. This analysis is crucial to help researchers develop and adapt instructional materials to meet students' needs and learning objectives for the topic of electrolyte and non-electrolyte solutions. The ATP used in this study was developed by subject teachers in accordance with the curriculum implemented at the school.

The results of the ATP analysis serve as a reference for the design and development of innovative, Problem-Based Learning (PBL)-based instructional materials that integrate the local wisdom of the *Marpangir* Batak Toba. Through this analysis, content, learning objectives, and learning activities can be systematically organized so that the developed instructional materials align with students' characteristics and support the achievement of learning objectives.

Textbook Analysis (BSNP Standards)

At this stage, the material was analyzed according to the research topic so that it could be systematically reorganized. The analysis of material on electrolyte and non-electrolyte solutions was conducted using the *Kurikulum Merdeka* teaching modules as well as several chemistry textbooks by different authors. The selection of textbooks was based on the chemistry textbooks currently used at State Senior High School 12 in Medan. Consequently, two textbooks were selected for analysis based on the standards of the National Education Standards Agency (BSNP),

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covering aspects of content appropriateness, language, presentation, contextual relevance, and graphics as the basis for the content and design requirements of innovative teaching materials based on Problem-Based Learning (PBL) integrated with the local wisdom of *Marpangir* Batak Toba, as outlined in Table 1.

Table 1. Textbook Analysis (BSNP Standards).

No.	Book Title	Author	Publisher	Year
1	Dasar-dasar Kimia : Teori dan Prinsip	Arsayd *et al.*	Azzia Karya Bersama	2025
2	Kimia Dasar 1	Sulastri & Rahmadani	Syiah Kuala University Press	2017

The average results of the analysis of the three books based on the standards of the National Education Standards Agency (BSNP) are shown in Table 2.

Table 2. Results of an Analysis of Chemistry Textbooks Based on BSNP Standards.

No.	Assessment Aspect	Average (%)
1	Content Suitability	90,71
2	Presentation Suitability	89,00
3	Graphics	90,59
4	Language	90,00
Average		90,19
Category		Very Suitable

The average results of the chemistry textbook analysis based on BSNP standards are shown in Figure 1.

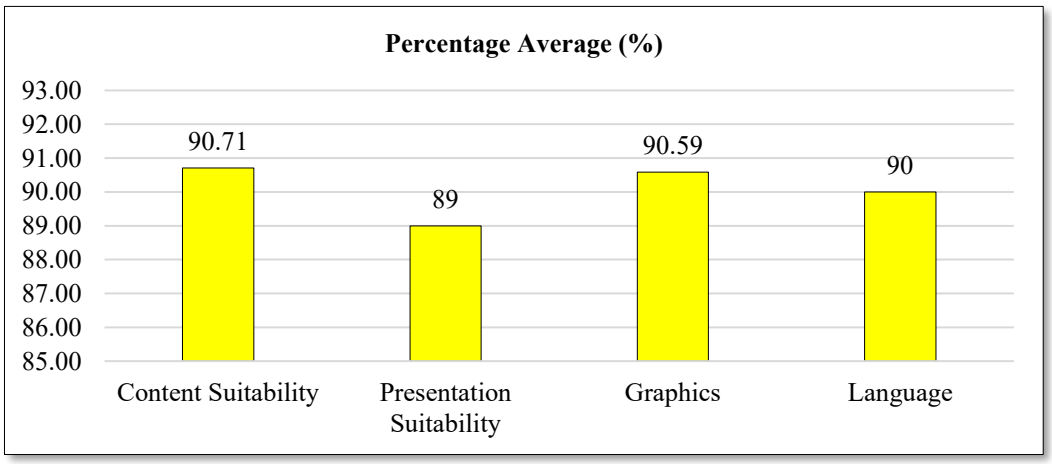


Figure 1. Graph of the Results of the Chemistry Textbook Analysis Based on BSNP Standards.

Neither of these books has been designed as a module based on the Problem-Based Learning (PBL) model, nor have they been integrated with local wisdom. This finding serves as the basis for the need to conduct this research to produce innovative Problem-Based Learning (PBL)-based teaching materials integrated with the local wisdom of the *Marpangir* Batak Toba people on the subject of electrolyte and non-electrolyte solutions, in accordance with the feasibility criteria established by the BSNP.

CONCLUSION

Based on the results of a needs analysis of instructional materials on electrolytes and non-electrolytes, it can be concluded that teaching still relies on conventional materials such as textbooks and has not yet fully implemented learning models that encourage active student engagement. The analysis of two textbooks also shows that the instructional materials used have not yet integrated the Problem-Based Learning (PBL) model and local wisdom. Students need teaching materials that are more practical, contextual, easy to understand, and relevant to their daily lives and cultural environment.

The results of the needs analysis survey of 32 students showed an overall percentage of 88.13%, which falls into the "very high" category. Students expressed a need for instructional materials that can help them understand concepts through contextual problems and encourage activities such as problem-solving, discussion, and independent exploration of concepts. Thus, the results of the needs analysis indicate the need to develop innovative Problem-Based Learning (PBL)-based instructional materials that integrate the local wisdom of the *Marpangir* Batak Toba people into the subject matter of electrolyte and non-electrolyte solutions.

RECOMMENDATION

Based on the results of the needs analysis, several recommendations can be proposed. First, innovative teaching materials based on Problem-Based Learning (PBL) integrated with the local wisdom of *Marpangir* Batak Toba should be developed to support meaningful and contextual chemistry learning, particularly on the topic of electrolyte and non-electrolyte solutions. Second, chemistry teachers are encouraged to utilize local wisdom as a learning resource to enhance students' engagement, critical thinking skills, and appreciation of their cultural heritage. Finally, future researchers are expected to develop, validate, and evaluate the effectiveness of these teaching materials in improving students' learning outcomes, problem-solving skills, and learning motivation.

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