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Needs Analysis of Bioassay Course Teaching Materials Based on Rhizophoraceae Phytochemical Research to Strengthen Science Process Skills of Biology Education Students

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Abstract: The Bioassay course plays an important role in developing students' science process skills. However, its implementation still lacks structured and contextual learning resources that integrate local research-based content. This study aims to analyze students' needs for Bioassay learning resources as a basis for developing research-based textbooks integrating local Rhizophoraceae phytochemical studies. The research employed a descriptive quantitative method involving sixth-semester Biology Education students who had completed the course. Data were collected through structured questionnaires and interviews, then analyzed descriptively using percentages to identify students' needs for Bioassay teaching materials. The results revealed that students predominantly utilized journal articles (100%), lecturer slides (95%), and online textbooks (50%) as their primary sources of learning. However, these materials were fragmented and lacked contextual relevance to Bioassay learning. Although 70% of students showed high interest, 50% still experienced difficulties in understanding concepts and applying bioassay techniques appropriately. Furthermore, 85% of students expressed the need for systematic Bioassay textbooks, and 90% supported the development of textbooks based on local mangrove research. The findings indicate that students have a clear need for structured and contextual Bioassay learning resources that integrate local studies on the Rhizophoraceae mangrove family to enhance conceptual understanding and scientific process skills.

Keywords: Bioassay textbook; Contextual learning; Needs analysis; Rhizophoraceae; Science process skills

Introduction

The mastery of science process skills is a fundamental competence required of prospective biology educators and researchers. These skills include the ability to observe, classify, interpret data, control variables, and draw scientific conclusions, which are not only mandated by higher education curricula but also serve as prerequisites for students to engage in high-quality scientific research (Ekici & Erdem, 2020). To achieve these competencies, biology education programs incorporate several applied courses into their curricula. One of these is the Bioassay course, offered as an elective in the sixth semester at Universitas Samudra, which is designed to provide students with direct experience in understanding the principles, techniques, and applications of testing the biological activity of compounds or plant extracts. Consequently, Bioassay plays a pivotal role in equipping students not only with theoretical knowledge but also with the practical ability to integrate this knowledge into scientific inquiry.

Bioassay is generally defined as a method of measuring the biological potency of a substance by observing the responses it elicits in biological systems such as cells, tissues, microorganisms, or test animals, and comparing these responses with a reference

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standard (Indrayanto et al., 2021). In higher education settings, the scope of the Bioassay course covers fundamental principles, history, and objectives of bioassays; different types of bioassays, both qualitative and quantitative, including in vitro, in vivo, and ex vivo techniques; plant extraction methods using organic solvents; identification of secondary metabolites; bioactivity testing (e.g., IC_{50}, LC_{50}, antibacterial, antioxidant, cytotoxic); data analysis; and applications in biology, pharmacy, health, and environmental sciences (Erzinger et al., 2017; Harden & Lamb, 1970). Importantly, Bioassay also introduces students to the pathway of bioactive compounds from crude plant extracts to standardized medicines, thereby opening their perspectives toward bioprospecting (Sabotič et al., 2024).

Needs analysis in Bioassay learning is an important step to ensure that students achieve competencies optimally. Based on initial observations over two semesters of students taking the Bioassay course, although this course plays a strategic role, its implementation at Samudra University still faces various challenges. Ideally, Bioassay is designed so that students can understand concepts, conduct tests, and apply standard techniques that can be carried out in the laboratory. However, the reality in the field shows that learning outcomes have not been fully achieved, particularly in mastering the targeted competencies. This situation emphasizes the importance of needs analysis as the foundation for developing learning. Such analysis is based not only on theory and literature but also on the real problems experienced by students during the learning process (Herayanti et al., 2022; Khoirunnisa et al., 2024; Solihah et al., 2024).

The success of a learning process is influenced by various factors, including the quality of material delivery, lecturer competence, student motivation, availability of facilities and infrastructure, and adequate teaching resources (Bakar & Quah, 2023; Dahri et al., 2024; Superi & Naqshbandi, 2022). Among these factors, the presence of relevant and well-structured teaching materials holds a crucial position, as they serve as the primary guide for mastering both concepts and scientific process skills (Abad & Hattie, 2025; Iroh & Onyinyichi, 2024; Maria & Paidi, 2024). Several studies have also emphasized that the lack of specific teaching materials can hinder students' conceptual understanding and practical skills (Martin-Alguacil et al., 2024; Suryandari et al., 2022). Based on this context, the results of this needs analysis are expected to serve as a reference for researchers as well as course instructors in improving the quality of learning. Specifically, the needs analysis focuses on providing a foundation for the development of teaching materials in the form of textbooks tailored to students' needs. With the availability of relevant, structured, and contextual textbooks, it is expected that students' mastery of concepts and scientific process skills in the Bioassay course can be significantly enhanced (Chakraborty & Kidman, 2022; Erzinger et al., 2017).

The potential of local mangrove resources in Langsa can be incorporated as contextual content in Bioassay learning, considering that Samudra University is located near coastal areas dominated by the family Rhizophoraceae (Rhizophora, Bruguiera, and Ceriops). Plants from this family are known to contain secondary metabolites such as flavonoids, tannins, alkaloids, and triterpenoids, which exhibit various biological activities, including antibacterial, antioxidant, anticancer, and antihypertensive properties (Bibi et al. 2019; Indriaty et al., 2023a; Ramalingam & Rajaram 2018; Seepana et al. 2016). Phytochemical and bioactivity studies conducted by the authors have also confirmed the presence of these secondary metabolites, demonstrating antibacterial and antioxidant activities in local Rhizophoraceae species (Indriaty et al., 2023a, 2023b, 2022). Integrating these findings into Bioassay learning not only enriches students' knowledge but also broadens their understanding of biodiversity exploration as a source of important bioactive compounds. These findings open opportunities to design research-based teaching materials that not only strengthen conceptual understanding but also develop students' scientific skills. In this context, students are positioned not merely as recipients of information but as active contributors who provide feedback on the content of teaching materials. They assess the importance of integrating local mangrove research findings into the Bioassay textbook. Information obtained from students represents a crucial part of the needs analysis, as it reflects real conditions and provides a strong foundation for researchers in developing Bioassay textbooks that are relevant, systematic, and based on Rhizophoraceae research tailored to students' needs.

The novelty of this study lies in a needs analysis approach that not only describes the learning conditions of students but also evaluates the urgency of integrating phytochemical and bioactivity research of local mangroves into the Bioassay textbook. This novelty differs from previous studies, which generally highlight textbook needs in a general sense, without emphasizing the role of research-based, locally sourced materials as primary learning resources. Systematic needs analysis identifies the gap between current teaching practices and students' expectations for more structured, contextual, and research-based learning resources (Lim et al., 2023; Maisarah & Nirwanto, 2024; Tomlinson et al., 2023). Therefore, this study aims to analyze the needs of biology education students at Samudra University regarding teaching materials for the Bioassay course.

The results are expected to provide a foundation for designing interactive electronic textbooks that not only enhance the acquisition of scientific process skills but also contribute to the sustainable utilization of local biodiversity through phytochemical research on Rhizophoraceae.

Method

This study employed a descriptive quantitative survey design to analyze students' needs for Bioassay course teaching materials. The descriptive survey method was chosen because it enables systematic collection and analysis of quantitative data to describe current educational phenomena and students' perceptions (Oktaviani et al., 2023; Sugiyono, 2020).

The research was conducted on July 21, 2025, at the Biology Education Study Program, Samudra University. The research subjects consisted of sixth-semester Biology Education students at Samudra University who had completed the Bioassay course. The participants were selected through purposive sampling, as they had direct experience with the course content and were therefore able to provide relevant and informed feedback regarding the teaching materials required. This course has only been implemented for two semesters, so the selected participants represented the first cohorts who had completed and experienced the learning process of the Bioassay course.

Data were collected using structured questionnaires and structured interviews. The questionnaire consisted of two types of items: Likert-scale questions (1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree) designed to measure students' perceptions and needs; and multiple-response questions that allowed students to select more than one option, used to explore the variety of learning resources and expectations for Bioassay teaching materials.

Structured interviews were conducted to provide contextual information that complemented the quantitative data (Kvale, 2019). Questionnaire responses were analyzed using a percentage score formula, which is appropriate for describing the proportion of responses in needs analysis studies (Cohen et al., 2017; Riduwan, 2013).

$$\text{Score} = \frac{\text{Obtained Score}}{\text{Maximum Score}} 100\% \quad (1)$$

The results were interpreted based on predetermined criteria to categorize the level of need as low, moderate, or high. The findings were then presented descriptively in tables and charts to illustrate frequencies, distributions, and overall trends, while interview data were summarized to strengthen and enrich the quantitative results.

Result and Discussion

Based on student information, four types of teaching materials were used in learning: web-based texts, journal articles, online textbooks, and lecturer PowerPoint (PPT) slides (Figure 1). The highest use was for journal articles (100%), followed by lecturer PowerPoint slides (95%), online textbooks (50%), and web-based texts (40%). This indicates that all students use research articles as their primary learning resource. However, interviews revealed that some students reported difficulty understanding international journal articles due to the language and complexity of the material presented. This difficulty was exacerbated by the abundance of scientific terms, units of measurement, and numerical data that are difficult to understand without adequate scientific and numerical literacy (Fitrianingrum & Murtiyasa, 2023; Prihatiningtyas et al., 2025; Santia & Handayani, 2023). This finding aligns with Rosida et al. (2024) and Taye et al. (2024), who stated that students often face challenges in understanding English-language scientific literature when they lack a strong conceptual foundation.

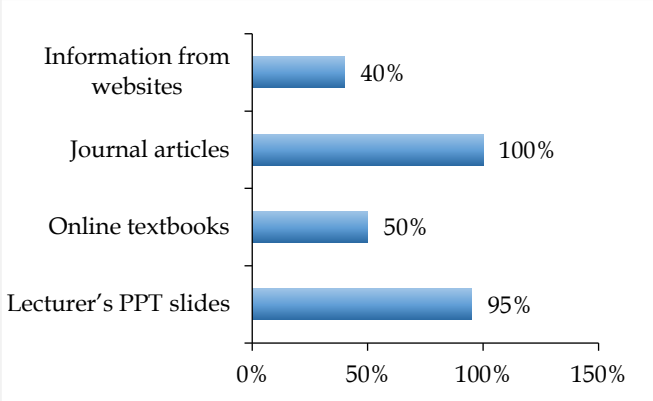

Figure 1. The teaching materials used by students in the Bioassay course

Lecturers' PowerPoint slides were also widely used, but they were deemed too concise and insufficient to explain the complex and relatively new bioassay concepts. Consequently, they had to seek additional resources to fully understand the material. This aligns with previous research showing that visual teaching materials need to be accompanied by sufficient narrative explanations to support conceptual understanding (Fiorella, 2022; Müller-Brauers et al., 2020; Thyberg et al., 2024). Meanwhile, accessed online textbooks were generally less relevant, as they primarily discussed medicinal plants rather than bioassay testing techniques, making them less relevant to the lecture material. These results indicate a gap between the availability of learning resources and students' actual learning needs. This finding aligns with Haleem et al. (2022) and Zannah

et al. (2023), who highlighted the limited availability of digital teaching materials suitable for applied sciences.

Overall, although students actively used various learning resources, the available teaching materials did not fully support bioassay learning. Therefore, there is a need for more relevant, research-based teaching materials that are appropriate to students' ability levels. Effective teaching materials must be oriented to students' actual learning needs, both in terms of content, language, and the context in which they are used (Bremner et al., 2022; Choppin et al., 2022; Goyibova et al., 2025; Purnamasari et al., 2024; Utami et al., 2023).

The next analysis focuses on students' interest and conceptual understanding of the Bioassay course, as presented in Figures 2 and 3. Figure 2 represents data on students' learning interest and conceptual understanding of the Bioassay course. The diagram shows that most students (70%) reported a high level of interest in the course, 20% showed a moderate level of interest, and only 10% expressed no interest. This indicates that, in general, students have strong enthusiasm and motivation to study Bioassay. Meanwhile, Figure 3 presents a different condition from the perspective of conceptual understanding. As many as 50% of students reported experiencing difficulties in understanding Bioassay concepts, 35% showed a moderate level of understanding, and only 15% found the material easy to comprehend. This finding suggests that although the majority of students have a high interest in learning, most of them still face challenges in mastering the fundamental concepts of Bioassay, which are inherently complex and multidisciplinary. This indicates a gap between the students' high interest in learning and their relatively low level of conceptual understanding. Logically, this phenomenon can be explained by the fact that, although students show strong enthusiasm for learning Bioassay concepts, they are still at the early stage of studying material that is complex and new to them. At this stage, they need enough time and proper guidance to build a clear understanding of the basic terms, principles, and scientific reasoning behind bioassay. Therefore, their high enthusiasm has not yet been followed by a deep conceptual mastery. Several studies have also revealed that a high level of students' learning interest does not always correspond to better comprehension. In some cases, students with high interest still exhibit low understanding due to difficulties in grasping complex or unfamiliar learning materials (Anggalya & Dianti, 2023; Harackiewicz et al., 2016; Purnama et al., 2023; Ramanda & Sunarti, 2024).

The high level of student enthusiasm for the Bioassay course can also be explained by its project-based learning activities. This method allows students to engage directly in research activities relevant to the fields of biology, biotechnology, and pharmacy. According to the Self-Determination Theory (Deci et al., 2009), intrinsic motivation arises when learning activities are perceived as meaningful and connected to academic or professional goals. In this context, bioassay is appealing because it provides practical research experience, particularly in biological activity testing and tracing bioactive substances from natural materials. Therefore, although students' conceptual understanding is still developing gradually, their engagement and motivation remain high.

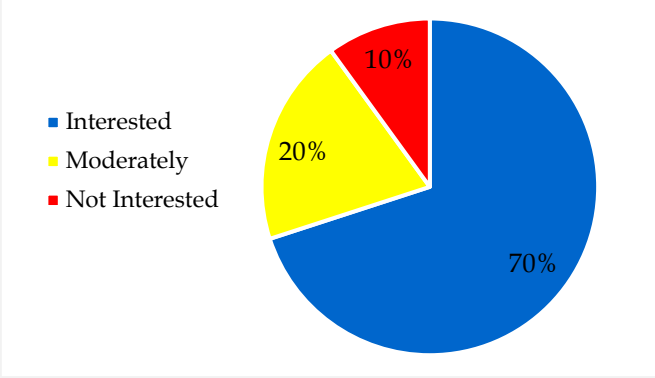

Figure 2. Students' level of interest in the Bioassay course

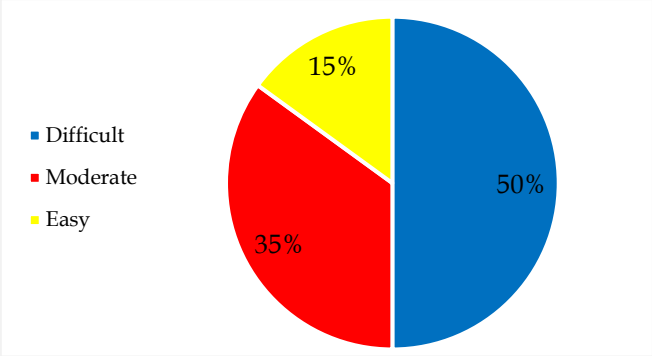

Figure 3. Students' level of comprehension of Bioassay

Further analysis revealed that students experienced difficulties in understanding and applying Bioassay concepts systematically. This condition indicates a gap between students' learning needs and the availability of adequate learning materials. The current Bioassay learning process has not fully supported the development of scientific process skills such as observing, interpreting data, thinking critically, and conducting experiments independently. Based on student feedback, they expect learning materials that not only explain theoretical concepts but also help them apply these concepts within a research-based learning context (Andini et al., 2018; Sufriyah et al., 2025).

To examine these aspects in greater depth, Table 1 presents an analysis of students' learning needs observed by the researchers, covering six main aspects:

learning resources, textbook availability, students' understanding, practical activities, relevance to local potential, and accessibility of learning materials. These aspects reflect students' perceptions of the current Bioassay learning conditions and their expectations for ideal teaching materials. In terms of learning resources, students reported that the current materials used in the course are still fragmented, consisting of lecturer slides, online articles, and digital books. They stated that these sources do not provide sequential and easy-to-understand explanations. Therefore, most students suggested developing research-based Bioassay teaching materials. They considered this idea both realistic and relevant, especially when linked to lecturers' research findings that explore local potential, such as studies on medicinal plants or the bioactivity of mangrove species from the Rhizophoraceae family. For students, such an approach would make the material easier to understand by connecting scientific content with the local environmental context (Bello et al., 2023; Kamila et al., 2024; Yemini et al., 2025). Regarding textbook availability, students reported that there is currently no Bioassay textbook aligned with the curriculum and directed toward real research contexts. This lack has affected their procedural understanding, particularly in designing and conducting experiments.

From the perspective of conceptual understanding and laboratory practice, students stated that they still find it difficult to understand technical terms and Bioassay laboratory procedures. This difficulty is compounded by the absence of standardized experimental guidelines, which makes it challenging for them to follow the correct steps during Bioassay experiments. Therefore, students expect the development of a Bioassay learning book that not only explains theoretical concepts but also provides clear descriptions of experimental implementation supported by visual illustrations, diagrams, and examples of research findings. Such a textbook would help them connect theoretical knowledge with practical applications in a more systematic and meaningful way (Finby et al., 2021; Kamila et al., 2024). This finding is consistent with Dah et al. (2024), who stated that visual and research-based approaches can enhance students' analytical abilities and conceptual understanding in science. In terms of accessibility, students indicated the need for learning materials that are easily available in various formats, both printed and digital. The availability of interactive learning materials is believed to increase learning motivation and facilitate independent study (Alshammary & Alhalafawy, 2023; Syahfitri & Safitri, 2024).

In the previous analysis, various challenges faced by students were discussed, including the condition of learning resources, the level of interest and understanding of the learning materials, as well as their expectations regarding the ideal form and content of the instructional materials. Based on these findings, Figure 4 and Figure 5 illustrate the overall expectations of students toward the development of a Bioassay learning book. The majority of respondents (85%) stated that such a learning book is necessary, while 15% considered its existence to be very important. Furthermore, 90% of students agreed and 10% strongly agreed that the Bioassay learning book should be developed based on local research findings. This indicates that students expect learning materials that are not only aligned with the curriculum but also relevant to real research contexts at the local level.

Table 1. Current Conditions and Students' Expectations for Bioassay Textbooks

Aspects	Current condition without a specific textbook	Students' expectations for a research-based Bioassay textbook
Learning resources	Lecturer PPT, random articles, internet, general books	Structured textbooks, based on local research (mangroves), equipped with the latest references
Textbook availability	Absence of a Bioassay Textbook	A systematic and curriculum appropriate Bioassay textbook
Student comprehension	Often experience difficulty in understanding the material	It contains structured explanations, diagrams, illustrations, and example images from research findings
Practical activities	Limited, no specific guidelines yet	The textbook contains procedures and research findings that support practical activities.
Relation to local potential	It has not yet been integrated with local biological resources	The textbook presents research findings derived from local biological resources as a basis for learning.
Accessibility	Learning resources rely on internet-based materials, while the available literature is often irrelevant to the needs of students	The textbook is provided in print and e-book versions, offering interactive features and easy accessibility for students.

The desire for a research-based learning book arises because students believe that such an approach can help them understand the connection between theoretical concepts and practical applications in the laboratory. A learning book equipped with empirical data, illustrations of research results, and examples highlighting local potential is considered more contextual and easier to understand. This view is consistent with Lidiawati et al. (2021) and Mukhlishin (2024) who stated that contextually developed learning materials are more effective in meeting students' learning needs. Similarly, Anriani et al. (2019) found that research-based learning materials can enrich the learning experience and foster higher-order thinking skills. In the same vein, Asrizal et al. (2018) highlight that integrating research findings into instructional materials can enhance students' scientific literacy and strengthen their ability to connect theory with practice.

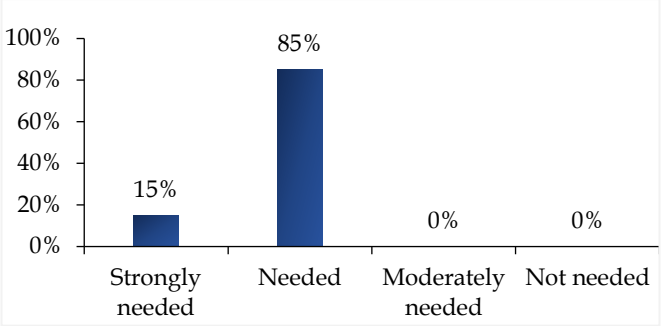

Figure 4. The avaibility of Bioassay textbooks

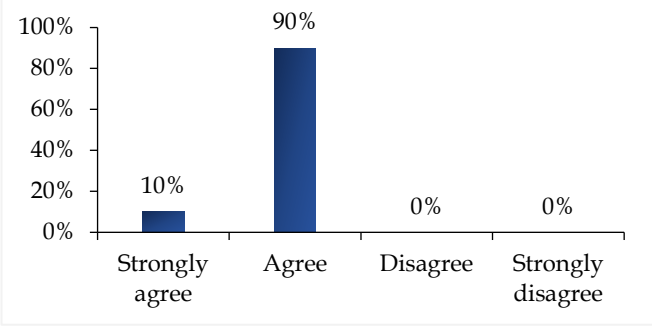

Figure 5. Agreement on the need to develop a Bioassay textbook based on local research findings

Overall, the findings indicate that developing a research-based Bioassay learning book integrating local mangrove phytochemical studies is both a real and urgent need. Such a learning book can serve as a strategic tool to strengthen conceptual understanding, improve scientific process skills, and foster scientific attitudes among biology education students. Furthermore, this model of learning book development can function as a replicable framework for science education that bridges the gap between scientific.

Conclusion

Based on the results of the needs analysis, this study identifies that students of the Biology Education Study Program at Samudra University require structured and contextual learning resources for the Bioassay course. The findings reveal a gap between students' strong interest and their ability to fully understand and apply Bioassay concepts, suggesting that the existing materials do not yet support optimal learning. These results provide a foundation for future development of Bioassay textbooks aligned with local research findings, particularly studies on the phytochemistry and bioactivity of mangroves from the Rhizophoraceae family, to better support contextual and research-oriented learning.

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Author Contributions
In this study, each author contributed as follows: I: conceptualization, methodology, project administration, funding acquisition, and writing original draft preparation; S.J.: validation, supervision, resources, and writing review and editing; M.K.: formal analysis and methodology; A.W. and H.W.A.: investigation and data curation.

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Conflicts of Interest
The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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