Development and Effectiveness of a Research-Based Pocketbook on Food Ethnobotany of the Batak Toba Ethnic Group

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Abstract. The limited availability of learning resources on Batak Toba food ethnobotany has resulted in low student understanding and threatens the preservation of local knowledge. This study aimed to develop and evaluate a research-based ethnobotany pocketbook as a supplementary learning medium. A research and development approach using the ADDIE model was employed, and the product was validated by experts with very good criteria. Effectiveness testing used a control–experimental design involving 56 university students (control class = 25; experimental class = 31). Learning outcomes were analyzed using the Mann–Whitney test and N-Gain analysis. The Mann–Whitney test revealed a significant difference between groups ($p < 0.05$). The experimental class achieved a high N-Gain score (76.11), while the control class showed a low gain (14.43). This study highlights the importance of integrating local ethnobotanical knowledge into higher education learning media to enhance both academic understanding and cultural sustainability.

Keywords: ethnobotany, food ethnobotany, Batak Toba, ADDIE model, learning effectiveness

1 Introduction

In higher education, students enrolled in biology and biology education programs often experience difficulties in understanding ethnobotanical concepts due to the limited integration of local research findings into learning materials. Existing textbooks and lecture resources generally emphasize theoretical explanations and lists of plant species without sufficiently contextualizing them within local cultural practices or field-based research data. As a result, students' understanding of ethnobotany tends to remain superficial, particularly in relation to plant morphology, processing methods, and ethnobotanical values relevant to everyday life.

Ethnobotany is a scientific discipline that examines the interactions between humans and plants, particularly in the context of cultural practices, traditional knowledge, and resource utilization

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[1-2]. In Indonesia, ethnobotanical knowledge plays a significant role in supporting food security, maintaining cultural identity, and conserving biodiversity due to the country's high biological and cultural diversity [3-4]. The Batak Toba ethnic group in North Sumatra possesses rich traditional knowledge regarding the use of local plants as food ingredients and spices, which is traditionally transmitted orally across generations [5]. However, reliance on oral transmission poses a risk of knowledge loss, particularly among younger generations, and may contribute to the erosion of cultural heritage and plant biodiversity [6].

Despite the increasing number of ethnobotanical studies, most research still focuses on documenting plant diversity and traditional uses, with limited efforts to transform such findings into structured instructional materials for formal education [7-8]. In Indonesia, ethnobotanical documentation continues to grow; however, its application in educational contexts remains limited, particularly in studies related to local ethnic groups such as the Batak Toba [11-12]. This condition creates a gap between ethnobotanical research and its utilization in teaching and learning processes.

From a pedagogical perspective, the use of contextual and research-based learning materials has been widely recognized as an effective approach to improve students' conceptual understanding. According to constructivist learning theory, meaningful learning occurs when new knowledge is actively connected to prior knowledge and real-life experiences [13]. In biology education, especially in topics involving plant identification and classification, the integration of visual elements plays an important role in reducing abstraction and supporting cognitive processes through dual coding mechanisms [14]. In addition, well-structured instructional materials facilitate knowledge organization and enhance students' ability to construct meaningful understanding [15]. Learning media that are designed systematically using instructional design frameworks, such as the ADDIE model, have been shown to improve learning effectiveness and accessibility [18-19].

However, learning resources that simultaneously integrate scientific accuracy, local cultural relevance, and effective instructional design remain limited, particularly in the form of concise and portable media such as pocketbooks. Therefore, the development of research-based ethnobotany learning media is necessary to bridge this gap, enhance students' understanding, and support the preservation of local knowledge.

This study aims to develop a research-based ethnobotany pocketbook focusing on food plants of the Batak Toba ethnic group and to evaluate its educational value in higher education. Specifically, this study seeks to (1) determine the validity of the developed pocketbook based on expert judgment and (2) evaluate its effectiveness in improving students' understanding of food ethnobotany through a control–experimental design using quantitative learning outcome measures.

2 Methods

2.1 Research Design

This study employed a research and development approach using the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. The ADDIE model is widely used in instructional design due to its systematic and iterative approach

in developing effective learning materials [18]. During the analysis stage, students' learning needs were identified through questionnaires and curriculum review of the ethnobotany course. The design stage focused on structuring the pocketbook content and layout based on field research findings. In the development stage, ethnobotanical data were compiled into a pocketbook format and refined through expert validation. The implementation stage involved classroom use of the pocketbook in an experimental class, while the evaluation stage assessed its validity and effectiveness through expert judgment and student learning outcomes.

2.2 Participants

The participants were undergraduate students enrolled in a biology education program at a public university in North Sumatra, Indonesia, who had taken or were taking an ethnobotany course. A total of 56 students participated in the effectiveness test, consisting of 25 students in the control class and 31 students in the experimental class. The classes were intact classes selected based on existing class groups (intact classes) considering practical and administrative feasibility. The experimental class used the developed pocketbook as a supplementary learning material, while the control class followed conventional learning without the pocketbook.

2.3 Development of the Ethnobotany Pocketbook

The pocketbook was developed based on field research conducted in Sionggang Village, North Sumatra, involving interviews with local traditional elders and direct observations. Eight plant species commonly used as food ingredients and spices by the Batak Toba ethnic group were selected based on their cultural significance, frequency of use, and continued practice in daily life. The pocketbook also included four traditional Batak Toba foods prepared using these plants. Each plant entry was accompanied by photographic documentation, morphological descriptions, ethnobotanical uses, and scientific identification, including local and Latin names. This approach ensured that the pocketbook content was scientifically valid while maintaining cultural authenticity.

2.4 Instruments

The pocketbook was validated by a panel of experts consisting of material experts, design/layout experts, language experts, and ethnobotany lecturers. Each expert evaluated the pocketbook using a Likert-scale instrument covering aspects such as content accuracy, relevance, layout design, and language clarity. The use of Likert-scale instruments is common in educational research to measure validation results and user responses [9-10]. Student responses were also collected using a similar instrument to assess readability, attractiveness, and clarity.

2.5 Data Analysis

Validation and student response data were analyzed using descriptive statistics to determine feasibility levels. Learning effectiveness was evaluated using pre-test and post-test scores from the control and experimental classes. Statistical analysis was conducted using SPSS software. The Mann–Whitney U test was used to examine differences in learning outcomes between the two groups because the data did not meet homogeneity assumptions. N-Gain analysis was used to measure the magnitude of learning improvement after treatment, with effectiveness categorized into high, medium, and low levels. The level of significance was set at 0.05 for all statistical tests.

3 Results and Discussion

3.1 Expert Validation Results

The developed ethnobotany pocketbook was evaluated by material, design/layout, and language experts to assess its feasibility as a learning medium. The validation results indicate that the pocketbook achieved a very good category across all assessed aspects.

Table 1. Results of material expert validation

Assessment Components	Average (%)	Criteria
Accuracy and strength of the material	93.75	Very Good
Presentation of material	95	Very Good
Overall	**94.38**	**Very Good**

Table 2. Results of design/layout expert validation

Assessment Components	Average (%)	Criteria
Book Size	80	Very Good
Cover Design	91.11	Very Good
Content Layout	91.43	Very Good
Overall	**87.51**	**Very Good**

Table 3. Results of language expert validation

Assessment Components	Average (%)	Criteria
Language clarity	93.3	Very Good

As shown in Tables 1–3, expert validation confirms that the pocketbook meets academic, visual, and linguistic standards. From a pedagogical perspective, materials that combine accurate scientific content, clear visual presentation, and accessible language are more likely to support meaningful learning. In ethnobotany education, this alignment is essential because students must integrate biological concepts with cultural context.

3.2 Student Response Results

Student responses were collected to evaluate the practicality and acceptability of the pocketbook as a learning resource. The results show that students responded positively to the pocketbook in terms of readability, attractiveness, and clarity.

Table 4. Student response results

No	Assessment Components	Average (%)	Criteria
1	Individual Test	83.51	Very Good
2	Small Group Test	87.72	Very Good
3	Limited Cohort Test	91.58	Very Good
	Total	**87.60**	**Very Good**

As shown in Table 4, students perceived the pocketbook as easy to use and visually engaging. The compact format and inclusion of photographs helped students understand plant morphology and ethnobotanical uses more effectively. These findings support the role of pocketbooks as

portable learning media that facilitate independent and field-based learning, which is particularly relevant for ethnobotany courses that emphasize direct interaction with plant resources.

3.3 Effectiveness Test Results

The effectiveness of the pocketbook was evaluated by comparing learning outcomes between the control and experimental classes using pre-test and post-test scores.

Table 5. Pre-test and post-test mean scores

Class	Mean	
	Pre-test	Post-test
Control	52.50	61.58
Experiment	49.53	91.06

As shown in Table 5, both classes showed improvement; however, the experimental class demonstrated a substantially higher increase in post-test scores. Statistical analysis using the Mann–Whitney U test indicated a significant difference between the two groups ($p < 0.05$), confirming that the use of the pocketbook had a significant effect on learning outcomes.

To measure the magnitude of learning improvement, N-Gain analysis was conducted.

Table 6. N-Gain comparison between classes

Class	N-Gain Mean	Category
Control	14.43	Low
Experiment	76.10	High

As shown in Table 6, the experimental class achieved a high N-Gain score, while the control class remained in the low category. This result indicates that the pocketbook was effective in improving students' understanding of food ethnobotany.

3.4 Discussion

The significant difference in learning outcomes between the experimental and control classes indicates that the research-based ethnobotany pocketbook plays an important role in facilitating deeper conceptual understanding. This finding is consistent with constructivist learning theory, which emphasizes that knowledge is actively constructed when learners connect new information with prior knowledge and real-life contexts [13]. In this study, students were not only introduced to abstract ethnobotanical concepts but were also provided with contextualized examples derived from field-based data on Batak Toba food plants.

The high N-Gain score achieved by the experimental class (76.10) suggests that the pocketbook effectively supports conceptual change and knowledge restructuring. This effectiveness can be attributed to several key characteristics of the developed learning media. First, the integration of local cultural context enables students to relate scientific concepts to their everyday experiences, thereby enhancing cognitive relevance and engagement. The representation of plant uses within Batak Toba culinary traditions provides authentic learning experiences that strengthen students' understanding of ethnobotany [5-6].

Second, the inclusion of visual elements such as photographs and morphological descriptions significantly supports students' understanding. Visual representation is essential in biology learning, particularly in plant identification and classification, as it helps reduce cognitive load and facilitates dual coding processes [14]. By combining textual explanations with visual documentation, the pocketbook enables students to construct more accurate mental representations of ethnobotanical concepts.

Third, the concise and portable format of the pocketbook enhances accessibility and supports independent learning. Students can easily use the material both inside and outside the classroom, including during field activities. This aligns with principles of instructional media design, where structured and accessible learning resources contribute to improved learning outcomes and student engagement [19-20].

Furthermore, the findings highlight the importance of transforming ethnobotanical research into instructional media. Many ethnobotanical studies, both globally and in Indonesia, remain focused on documentation rather than educational application [7-8, 16-17]. This finding is consistent with previous studies that emphasize the effectiveness of contextual and research-based learning media in improving students' conceptual understanding and engagement [20].

In addition, integrating ethnobotanical knowledge into formal education contributes to the preservation of local wisdom. By incorporating culturally relevant content into the learning process, students develop greater awareness and appreciation of local biodiversity and traditional knowledge systems. This is particularly important in the context of globalization, where local knowledge is increasingly at risk of being marginalized.

Overall, the developed pocketbook is pedagogically effective, culturally relevant, and scientifically grounded. It not only improves cognitive learning outcomes but also fosters cultural awareness and learning motivation. These findings emphasize the importance of integrating locally grounded scientific knowledge into higher education learning materials to enhance both academic understanding and cultural sustainability.

4 Conclusion

This study demonstrates that the developed research-based pocketbook on Batak Toba food ethnobotany is valid and highly effective in improving students' understanding in ethnobotany courses. Expert validation results confirmed that the pocketbook meets academic, visual, and linguistic standards, while student responses indicated high levels of readability and attractiveness. The effectiveness test showed a significant difference in learning outcomes between the experimental and control classes, with the experimental class achieving a high N-Gain score, indicating substantial learning improvement. The effectiveness of the pocketbook can be attributed to its integration of visual documentation, culturally relevant content, and concise explanations that support meaningful and contextual learning. This study contributes to the integration of ethnobotanical research into contextual learning media in higher education, bridging the gap between scientific documentation and educational practice. Future studies should explore the application of similar media in other ethnic contexts or across different educational levels to strengthen the role of ethnobotany in culturally responsive science education.

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