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Problem Solving and Phytopharmaceutical Based Animal Physiology Practicum Modules: Evidence Validity and Practicality

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Abstract

Animal physiology practicums at Universitas PGRI Pontianak are still dominated by recipe-based (cookbook) procedures and rarely make use of local resources, although West Kalimantan is rich in medicinal plants. This study aimed to develop an animal physiology practicum module based on problem solving and local phytopharmaceuticals and to determine its validity and practicality. A research and development design with the ADDIE model was used. The module was validated by three material experts and three media experts using a five-point Likert scale. Practicality was assessed with a student response questionnaire in a small-scale trial with 15 seventh-semester students and a large-scale trial with 34 fifth-semester students who used the module in four practicum sessions. The data were analyzed descriptively as percentages. The module was rated very valid by material experts (90%) and media experts (91%). Practicality reached 73.50% in the small-scale trial and 76.75% in the large-scale trial, both in the practical category. The lowest-rated aspect was the implementation of problem-solving steps (74%), indicating that students still need scaffolding to formulate hypotheses and analyze data independently. The module is therefore valid and practical as a supporting teaching material that links animal physiology experiments with local phytopharmaceutical knowledge. Its effectiveness in improving students' scientific and problem-solving skills has not yet been tested and should be examined in future experimental studies.

Keywords: Animal physiology practicum; Ethnoscience; Medicinal plants; Practicum module; Problem solving

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INTRODUCTION

Lab work is an integral part of higher education learning in biology, particularly animal physiology. Through lab work, students not only understand theoretical concepts but also develop science process skills such as observation, hypothesis formulation, experimentation, data analysis, and conclusion drawing. These skills form an essential foundation for building scientific literacy, scientific thinking skills, and problem-solving competencies required by prospective biology graduates. Therefore, animal physiology lab work should serve not only as a means of concept verification but also as a vehicle for developing higher-order thinking skills. Research shows that problem-solving and authentic assessment- based lab work significantly improve science process skills and student engagement compared to conventional lab work (Duda et al., 2019; Rokos & Zavodska, 2020). Several previous studies have demonstrated that problem-based learning models influence science process skills (Ilhami et al., 2023).

The application of PBL in physiology teaching is generally implemented in theoretical learning, while its application in physiology laboratory practicums is still relatively rare (Ding et al., 2023). Although the literature in human medicine is quite adequate in discussing the development of problem-solving skills for students, similar literature for learning animal

science and animal physiology is still very limited (Carr et al., 2022). The implementation of practicums in higher education, especially at developing private universities, still faces various obstacles (Choate et al., 2021). The implementation of practicums in animal physiology at Universitas PGRI Pontianak is still dominated by a recipe-based laboratory or "cookbook laboratory" approach, where students simply follow the provided work steps without actively engaging in further scientific investigation. This condition results in students' critical thinking and problem-solving skills not being optimally developed. Furthermore, limited laboratory facilities and the minimal connection of practicum materials to the local context also hinder the creation of meaningful and relevant learning (Griffin et al., 2025). This aligns with studies (Ramdiah et al., 2020; Suprapto et al., 2021), which state that local contexts can serve as effective learning materials to improve student learning outcomes. Davis and Choisy (2024) emphasized that an interdisciplinary approach integrating ethnopharmacology and indigenous knowledge has the potential to facilitate new scientific breakthroughs. In conventional practicum modules, experimental procedures are generally fully defined, leaving students solely responsible for implementing instructions. As a result, students receive fewer opportunities to design experiments, independently interpret data, or develop in-depth scientific reasoning (Agustian et al., 2022; Seery et al., 2024).

Various studies have attempted to address these issues through the application of problem-based learning models and contextual approaches. Research shows that Problem-Based Learning (PBL) can improve students' scientific skills and engagement in practicums (Duda et al., 2019). Furthermore, the application of problem-solving in science learning has also been shown to improve students' critical thinking, analytical reasoning, and science process skills (Kardoyo et al., 2020; Liu & Pásztor, 2022; Rahman, 2019). Furthermore, an ethnoscience approach has been shown to increase learning motivation, conceptual understanding, and scientific literacy through the integration of local knowledge into learning (Dewi et al., 2021; Sumarni & Kadarwati, 2020). Recent studies indicate that place-based laboratories and ethnoscience are emerging as more contextual and meaningful alternatives for science learning. Research by Duda et al. (2019) demonstrated that the use of a Problem-Based Learning (PBL) approach can significantly improve students' scientific skills and engagement in practicums. However, the application of PBL in the context of animal physiology practicums with a contextual approach is still minimally applied.

The problem-solving approach applied to practicums has been proven to improve students' science process skills and reasoning flexibility, including in Dayak and Malay ethnic groups in West Kalimantan (Duda et al., 2019; Sudarmin et al., 2019). PBL systematically builds higher-order cognitive abilities, including problem-solving, analytical reasoning, and metacognition (Liu & Pásztor, 2022; Mahanal et al., 2019; Thorndahl & Stentoft, 2020). However, its integration into practicum modules involving local phytopharmaceuticals remains largely unknown. This creates a gap that needs to be developed between practicum modules that integrate problem-solving strategies and the utilization of local resources (phytopharmaceuticals) to enrich scientific experiences and cultural relevance. However, previous studies still have limitations. Ethnoscience research primarily explores local wisdom and medicinal plants as cultural knowledge, but has not yet been designed in the form of a pedagogically structured animal physiology practicum module. Research on ethnoscience-based laboratories also generally does not integrate a problem-solving framework as the main structure of practicum activities. Thus, there are still research gaps in (1) the Problem-Based Learning model in animal physiology practicums, (2) ethnoscience-based laboratories or place-based laboratories, and (3) the integration of local phytopharmaceuticals as objects of physiological experiments.

West Kalimantan is rich in medicinal plants (phytopharmaceutics) such as kratom, yellow root, betel leaf, turmeric, and bajakah, which have been traditionally utilized by local communities (Supiandi et al., 2019, 2023; Susanti et al., 2023). Various studies have shown

that these plants contain bioactive compounds such as flavonoids, alkaloids, and tannins, which have the potential to affect the physiological systems of organisms (Fuloria et al., 2022; Ramadhan et al., 2019). This potential is highly relevant for use in animal physiology labs. However, the use of local phytopharmaceuticals in lab learning is still very limited and generally has not been developed into systematic, problem-solving laboratory activities. Most local plant utilization is still limited to ethnobotanical studies or the identification of active compounds, without being integrated into laboratory learning designs that support the development of students' scientific skills.

Studies on the development of PBL-based practicum modules and local phytopharmaceuticals are still limited. Most studies focus on a scientific approach without considering the local cultural context, or conversely, exploring local plants without integrating them into learning, providing a strong foundation for developing innovative research that goes beyond problem-solving and ethnobotany-based modules. Existing studies have shown that problem-solving- based modules are effective in improving students' higher-order thinking skills; the implementation of PBL modules in animal science programs positively impacts students' perceptions of their learning experience, although negative perceptions regarding module organization and the role of tutors have also been found (Broseghini et al., 2024). On the other hand, the ethnoscience approach as a foundation for place-based laboratories has developed significantly. Literature analysis shows that ethnoscience learning can be integrated with various other learning approaches and models, such as contextual learning, problem-based learning, and project-based learning , by connecting local knowledge and cultural wisdom to the surrounding environment (Sari et al., 2023). However, a significant gap has not been reported regarding the integration of local phytopharmaceuticals as objects of animal physiology experiments in a pedagogically structured laboratory module. Instructional innovation involves the use of a problem-solving framework not only as a teaching method but also as a module structure. Each laboratory unit is designed with an authentic problem scenario based on local phytopharmacologic phenomena that students must solve through a series of animal physiology experimental procedures. This model differs from conventional modules that merely present work procedures (recipe-based laboratories), but rather encourages students to formulate hypotheses, design procedures, analyze physiological data, and draw evidence-based conclusions.

The integration of problem-solving and the use of local phytopharmaceuticals in animal physiology practicums is an innovative approach to addressing current learning challenges. This module is designed not only as a means of exploring physiological concepts but also as a vehicle for strengthening students' scientific thinking and problem-solving skills. Through a problem-solving approach, students are encouraged to identify problems, formulate hypotheses, design experiments, and analyze data independently (Ding et al., 2023; Rokos & Zavodska, 2020). When connected to the use of local plants, the learning process becomes more contextual, meaningful, and relevant to students' lives (Ramdiah et al., 2020; Suryawati & Osman, 2018). The module was developed with an instructional design that actively builds students' scientific abilities. The novelty of this research lies not only in the use of local plants as practicum materials, but also in the development of a problem-solving- based animal physiology practicum module designed with an authentic laboratory activity architecture. This module uses a problem-solving framework as the main learning structure. Each practicum activity begins with a contextual problem scenario based on local phytopharmacological phenomena. Students are guided to identify problems, formulate hypotheses, design experimental procedures, analyze physiological data, and draw conclusions based on scientific evidence. Thus, this module serves not only as a procedural guide but also as a pedagogical tool designed to simultaneously develop students' scientific thinking skills, analytical reasoning, and cultural relevance.

The novelty of this module lies in its design architecture, which integrates three pillars:

problem-solving syntax, the physiological significance of phytopharmaceuticals, and authentic assessment. This module adopts a structured problem-solving model modified from Delisle's syntax, which is made explicit in the student instructions and assessment rubric. This approach differs from conventional practicum modules, which tend to be mechanical and oriented towards concept verification. By using local medicinal plants as test materials in physiology experiments, students are trained to build epistemological bridges between traditional knowledge and modern science. This is in line with Grundmann et al. (2023), who stated that ethnopharmacology education needs to be formally integrated into the life science curriculum. Students should not only understand the concepts of animal physiology in depth but also possess scientific skills, problem-solving abilities, and awareness of the potential and preservation of local biological resources in West Kalimantan. Therefore, this study aims to develop a valid and practical animal physiology practicum module based on problem-solving and local phytopharmaceuticals in West Kalimantan, to support students' scientific skills and problem-solving abilities.

METHOD

Research Design

This study was conducted at Universitas PGRI Pontianak, West Kalimantan, Indonesia, using a Research and Development (R&D) approach. The development process followed the ADDIE instructional design model, which consists of five interrelated stages: analysis, design, development, implementation, and evaluation (Figure 1). The ADDIE model was selected because it provides a systematic and iterative framework for developing instructional products and allows each stage to be evaluated and refined before progressing to the next stage (Branch, 2009; Spatioti et al., 2022). Rather than treating product development as a strictly linear process, the model supports continuous refinement based on evidence obtained from needs analysis, expert judgment, and user feedback.

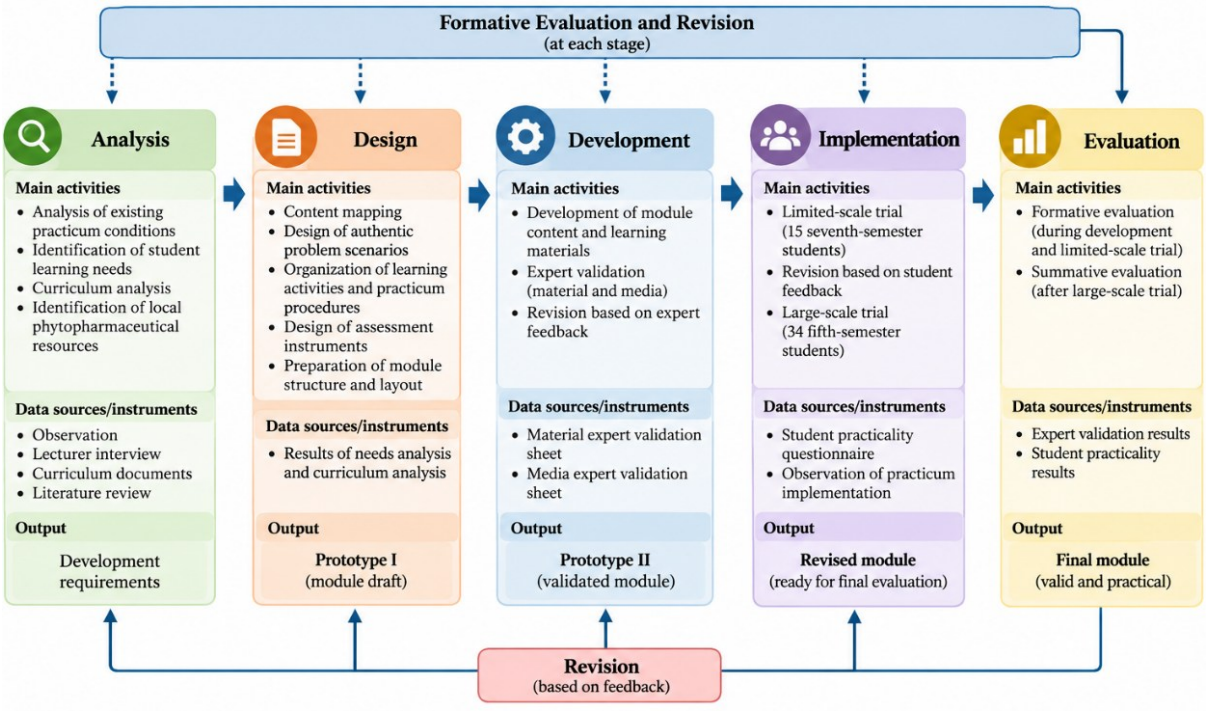


Figure 1. ADDIE-based research design

In this study, the ADDIE framework was applied to develop an animal physiology practicum module integrating problem-solving activities with local phytopharmaceutical resources from West Kalimantan. The development process began with an analysis of existing laboratory practices, student learning needs, curriculum requirements, and locally available phytopharmaceutical resources. The findings from this stage were then translated into the

instructional and structural design of the module. The initial prototype was subsequently developed, validated by experts, revised, and implemented through limited- and large-scale student trials. The final evaluation focused on two principal indicators of product quality: validity, as determined through expert assessment, and practicality, as determined through student responses after module implementation.

Analysis Stage

The analysis stage was conducted to identify the major instructional problems associated with the existing animal physiology practicum and to determine the learning requirements that should be addressed by the proposed module. Data at this stage were obtained through direct observation of animal physiology practicum activities, structured interviews with the course lecturer, and analysis of relevant instructional documents. The observations were intended to examine how practicum activities were currently implemented, the extent to which students were actively involved in scientific inquiry, and whether the existing practicum format provided sufficient opportunities for students to engage in problem identification, hypothesis formulation, experimental reasoning, data interpretation, and evidence-based conclusion drawing.

Structured interviews with the course lecturer were used to obtain additional information regarding difficulties encountered during practicum implementation and the competencies that students were expected to develop. Particular attention was given to identifying discrepancies between the expected characteristics of investigative laboratory learning and the actual implementation of existing practicum activities. Information obtained through the interviews complemented the observational data and helped clarify the instructional needs that could not be identified solely through direct observation.

Curriculum analysis was also conducted to ensure that the module development process was consistent with the formal requirements of the animal physiology course. The analysis included a review of the course learning outcomes, course syllabus, semester learning plan, practicum topics, and expected student competencies. The purpose of this process was to ensure that the proposed practicum activities did not function as additional or disconnected learning tasks but were directly aligned with the intended outcomes of the course. The results of the curriculum analysis were used to determine the animal physiology concepts, learning objectives, practical activities, and assessment components that needed to be incorporated into the module.

In addition to instructional and curricular needs, the analysis stage examined the potential use of local phytopharmaceutical resources as contextual materials for animal physiology experiments. Local medicinal plants from West Kalimantan were considered in relation to their potential physiological relevance, accessibility, and suitability for integration into laboratory activities. This analysis was important because the module was intended not only to facilitate scientific problem solving but also to connect physiological concepts with biological resources familiar to students in their local environment. The combined findings from observation, interviews, curriculum analysis, and identification of local phytopharmaceutical resources served as the empirical basis for developing the conceptual and instructional framework of the module.

Design Stage

The design stage translated the findings of the needs analysis into a detailed conceptual, instructional, and structural framework for the practicum module. At this stage, the relationship between animal physiology content, problem-solving activities, and local phytopharmaceutical resources was systematically organized. A module concept map was first developed to identify relevant connections between specific animal physiology topics and local medicinal plants that could be used as contextual experimental materials. This mapping process was intended to ensure that the selected phytopharmaceutical resources were pedagogically relevant to the

physiological concepts being investigated rather than being included merely as contextual examples.

Authentic problem scenarios were then designed for each practicum unit to provide students with a meaningful starting point for scientific investigation. Instead of presenting students only with predetermined laboratory instructions, each unit was structured around a contextual problem that required students to interpret a phenomenon, identify the scientific problem, formulate a hypothesis, conduct an experiment, analyze the resulting data, and formulate a conclusion. The problem scenarios were therefore designed to function as the central instructional element linking theoretical physiological concepts, experimental procedures, and the local phytopharmaceutical context.

The structural organization of the module was also developed during this stage. The module was designed to include learning outcomes and indicators, introductory information concerning relevant local phytopharmaceuticals, contextual problem scenarios, laboratory procedures, data recording and analysis worksheets, problem-solving questions, and assessment rubrics. These components were arranged in a logical sequence so that students could progress from understanding the context of the problem to carrying out scientific investigations and interpreting experimental evidence. Particular attention was given to the consistency of the learning sequence across practicum units to facilitate students' familiarity with the problem-solving process.

In addition, instruments for evaluating the quality of the developed product were prepared during the design stage. These instruments included a material expert validation sheet, a media expert validation sheet, and a student practicality questionnaire. The validation instruments were designed to assess the appropriateness of the module from scientific, pedagogical, and media-design perspectives, whereas the practicality questionnaire was intended to capture students' perceptions of usability, clarity, attractiveness, and contextual relevance. All components produced during the design stage were compiled into an initial version of the module, designated Prototype I, which was subsequently subjected to further development, validation, and revision.

Development Stage

The development stage involved transforming the conceptual design into a complete practicum module and evaluating the resulting product through expert validation. This stage comprised three interrelated activities: development of local phytopharmaceutical content, preparation of the complete module, and expert validation followed by product revision. The objective of this stage was to ensure that the module was not only scientifically accurate but also pedagogically coherent, visually usable, and appropriate for implementation in animal physiology laboratory instruction.

The local phytopharmaceutical content was developed by identifying medicinal plants traditionally used by communities in West Kalimantan and examining their relevance to animal physiology. Selection of the plants was informed by relevant ethnobotanical and scientific literature. Consideration was given to whether the plants contained reported bioactive compounds, whether their physiological effects could be meaningfully connected to the selected practicum topics, and whether these effects could be explored through feasible laboratory activities. This process was intended to ensure that the local context incorporated into the module remained scientifically grounded and directly related to the learning objectives of animal physiology.

The complete module was subsequently developed according to the framework established during the design stage. Each practicum unit followed a five-stage problem-solving sequence consisting of: (1) problem identification through an authentic contextual scenario, (2) hypothesis formulation based on relevant physiological and phytopharmaceutical information, (3) design and implementation of an animal physiology experiment, (4) analysis and interpretation of physiological data, and (5) formulation of evidence-based conclusions

followed by critical reflection. Through this sequence, students were expected to participate actively in scientific reasoning rather than simply execute a fixed series of laboratory instructions.

After completion of the initial module, expert validation was conducted to evaluate its quality before implementation with students. Six validators participated in the validation process and were divided into two groups: three material experts and three media experts. The material experts evaluated the accuracy and relevance of the animal physiology content, the integration of the problem-solving framework, the appropriateness of the local phytopharmaceutical content, the clarity of scientific terminology, and the alignment of practicum activities with the intended learning outcomes. The media experts, comprising two instructional design experts and one learning media expert, evaluated the visual design, layout, readability, consistency of presentation, illustration quality, and ease of use.

Expert validation produced both quantitative scores and qualitative comments. Quantitative scores were used to determine the validity level of the module, whereas qualitative comments were examined to identify components requiring revision. Recommendations from the validators were used to improve scientific explanations, clarify terminology, refine experimental procedures, improve the presentation of phytopharmaceutical information, and enhance the visual organization of the module. Following these revisions, Prototype I was refined into Prototype II, which was considered sufficiently developed for implementation in student trials.

Implementation Stage

The implementation stage was conducted to examine the practical use of the developed module by its intended users. Implementation was organized into two sequential phases: a limited-scale trial and a large-scale trial. This staged approach allowed the researchers to identify usability problems in a smaller group before the module was implemented under broader and more realistic instructional conditions. Data obtained during implementation were therefore used both to refine the product and to determine its practicality.

Limited Scale Trial

The limited-scale trial involved 15 seventh-semester students from the Biology Education Study Program who had previously completed the animal physiology course. These students were selected purposively to represent different levels of academic ability and to provide feedback from users who were already familiar with the fundamental content of animal physiology. Their previous learning experience was considered useful for identifying whether the module presented concepts, instructions, and experimental tasks in a sufficiently clear and coherent manner.

During the limited trial, students used the module in a restricted practicum setting and evaluated its usability after completing the assigned activities. The evaluation focused primarily on module readability, clarity of laboratory instructions, ease of following the sequence of activities, and comprehensibility of the problem-solving tasks. Students were also given opportunities to provide written comments regarding difficulties, ambiguities, or components they considered necessary to improve. Feedback obtained during this stage was reviewed and used to make minor revisions before the module was applied in the large-scale trial.

Large Scale Trial

The large-scale trial involved 34 fifth-semester students enrolled in the animal physiology course. In contrast to the limited-scale trial, this phase was conducted under regular instructional conditions to determine how the module functioned during actual practicum learning. The module was implemented during four practicum sessions, allowing students to experience the problem-solving sequence repeatedly across the developed laboratory activities.

At each practicum session, students engaged in a structured sequence consisting of

problem identification, hypothesis formulation, experimental implementation, data collection, data analysis and interpretation, and conclusion drawing. Students were expected to use the module as a guide for navigating these stages while actively making decisions regarding the scientific problem and the interpretation of experimental evidence. This implementation structure was intended to examine whether the module could support the organization of laboratory learning without requiring students to depend solely on step-by-step procedural instructions.

After completing the four practicum sessions, students completed a practicality questionnaire. The questionnaire was used to assess the ease of using the module, clarity of laboratory instructions, implementation of the problem-solving activities, attractiveness of the module presentation, and relevance of the local phytopharmaceutical context. The responses obtained from the large-scale trial constituted the primary data for determining the practicality of the developed module under actual instructional conditions.

Evaluation Stage

Evaluation was integrated throughout the development process and consisted of formative and summative evaluation. This approach is consistent with the ADDIE framework, in which evaluation functions not only as a final stage but also as a mechanism for continuous improvement during instructional development (Branch, 2009; Spatioti et al., 2022). Consequently, evaluation in this study was conducted at several points to determine whether revisions were necessary before the product proceeded to the subsequent stage.

Formative evaluation occurred during the analysis, design, development, and limited-scale implementation stages. At the analysis stage, the findings from observations, interviews, and curriculum review were evaluated to determine the instructional priorities to be incorporated into the module. During development, expert comments and validation scores were used to identify weaknesses in content accuracy, problem-solving integration, scientific terminology, experimental procedures, and media presentation. Student feedback from the limited-scale trial was then used to identify additional usability issues that might not have been detected during expert review. These successive sources of evaluation provided a basis for iterative improvement of the module.

Summative evaluation was conducted after large-scale implementation and focused on determining whether the final developed product met the predetermined criteria for validity and practicality. Module validity was determined from the assessments provided by material and media experts, whereas module practicality was determined primarily from students' responses after using the module in practicum activities. The combined results were used to determine whether the developed module was sufficiently appropriate and practical for use as a supporting instructional resource in animal physiology practicums.

This study was deliberately limited to the development, validation, and practicality assessment of the module. Therefore, no experimental comparison was conducted to determine whether the module improved students' learning outcomes, scientific skills, or problem-solving abilities compared with conventional practicum instruction. Evaluation of instructional effectiveness requires a separate experimental design and is therefore considered an appropriate direction for subsequent research.

Research Participants

The participants in this study consisted of expert validators and students involved in the two stages of product trials. Six experts participated in product validation, including three material experts and three media experts. The material experts were responsible for evaluating aspects related to animal physiology content, scientific accuracy, problem-solving integration, local phytopharmaceutical content, language, and alignment with learning outcomes. The media experts evaluated aspects related to module design, visual presentation, layout, readability, format consistency, illustrations, and ease of use.

Student participants were drawn from the Biology Education Study Program at Universitas PGRI Pontianak. The limited-scale trial involved 15 seventh-semester students who had previously completed the animal physiology course. Their participation was intended primarily to provide preliminary feedback concerning module readability, clarity, and usability. The large-scale trial involved 34 fifth-semester students enrolled in the animal physiology course who represented the principal target users of the module.

Participants were selected through purposive sampling based on their relevance to the objectives of each product-trial stage. Students in the limited trial were selected because they had prior experience with animal physiology learning and were therefore able to provide informed feedback regarding the content and usability of the module. Students participating in the large-scale trial were selected because they were currently engaged in the animal physiology course and represented the population for whom the instructional product was developed.

Data Collection Techniques and Instruments

Data were collected using observation, interviews, document analysis, expert validation questionnaires, and student response questionnaires. The use of multiple data collection techniques enabled the study to obtain both qualitative and quantitative information regarding the development and quality of the module. Qualitative data were obtained from observations of practicum activities, structured interviews with the course lecturer, comments and suggestions from expert validators, and written responses provided by students during the product trials. These qualitative data were used primarily to identify instructional problems and to guide revisions of the developed product.

Quantitative data were obtained from expert validation scores and student practicality questionnaire scores. The expert validation data were used to determine the level of validity of the module from material and media perspectives, whereas student responses were used to determine its practicality. The quantitative data therefore served as the principal basis for classifying the quality of the module according to the predetermined interpretation criteria.

The research instruments consisted of a material expert validation sheet, a media expert validation sheet, and a student practicality questionnaire. The validation instruments employed a five-point Likert-type scale consisting of very good (5), good (4), sufficient (3), poor (2), and very poor (1). The use of a uniform response scale was intended to facilitate consistent scoring across the evaluated indicators.

The material expert validation sheet assessed six dimensions: appropriateness and accuracy of animal physiology content, integration of problem-solving activities, integration of local phytopharmaceutical content, language and scientific terminology, organization and presentation of learning materials, and alignment between practicum activities and intended learning outcomes. These dimensions were selected to ensure that the developed module was evaluated not only for scientific content but also for its instructional relevance.

The media expert validation sheet assessed five dimensions: visual design, layout and readability, consistency of format and presentation, quality of illustrations and images, and ease of use. These dimensions focused on whether students could navigate and use the module effectively during laboratory activities. Because the module functioned as both a source of learning content and a guide to experimental activities, the clarity and organization of its visual presentation were considered important components of product quality.

The student practicality questionnaire assessed five aspects: ease of module use, clarity of practicum instructions, implementation of problem-solving activities, attractiveness of module presentation, and relevance of the module to the local context of West Kalimantan. These indicators were designed to capture students' direct experiences with the developed product during laboratory learning. Before the instruments were administered, their content was reviewed by experts to determine whether the individual items were appropriate for the intended constructs and evaluation objectives. Revisions were made according to expert

recommendations before the instruments were used for data collection.

Data Analysis Technique

The validity and practicality data were analyzed descriptively. The percentage of validity was calculated with the following formula:

$$\text{Validity } (\%) = \frac{\text{Total score obtained}}{\text{Maximum possible score}} \text{X } 100\%$$

The validity percentage was then interpreted using the criteria in Table 1. The module was considered valid if it reached at least the "valid" category (> 60%).

Table 1. Product Validity Level Criteria

Interval	Criteria
81–100	Very valid
61–80	Valid
41–60	Quite valid
21–40	Less valid
0–20	Invalid

Practicality was calculated from the student questionnaire using the following formula:

$$Practicality\ (\%) = \frac{\text{Total score obtained}}{\text{Maximum possible score}} x100\%$$

The practicality percentage was interpreted using the criteria in Table 2. The module was considered practical if it reached at least the "practical" category (> 60%).

Table 2. Criteria for Product Practicality Level

Interval	Criteria
81–100	Very Practical
61–80	Practical
41–60	Quite practical
21–40	Less practical
0–20	Not practical

RESULTS AND DISCUSSION

The results of the development of the animal physiology practicum module integrating problem-solving activities and local phytopharmaceutical resources from West Kalimantan are presented according to the five stages of the ADDIE model: analysis, design, development, implementation, and evaluation. Each stage generated specific findings that contributed to the refinement of the module and provided evidence regarding its validity and practicality.

Step 1: Analysis

The analysis stage revealed that the existing animal physiology practicum was still largely procedural and reflected a recipe-based laboratory approach. Students generally followed predetermined instructions and had limited opportunities to engage in scientific reasoning processes such as identifying problems, formulating hypotheses, designing experiments, analyzing relationships among variables, and drawing evidence-based conclusions. Interviews with lecturers and students also indicated that practicum activities were more strongly oriented toward completing laboratory procedures than toward developing higher-order thinking and independent scientific inquiry.

This condition suggests that the existing practicum structure provided insufficient opportunities for students to develop problem-solving and scientific investigation skills. A similar concern was reporte (Rokos and Zavodska, 2020), who found that highly procedural laboratory activities may limit students' engagement in inquiry and reduce opportunities to develop scientific reasoning. Therefore, the findings of the needs analysis provided a strong

basis for restructuring practicum activities so that students could assume a more active role in the scientific process.

The analysis also showed that local phytopharmaceutical resources from West Kalimantan had not been systematically incorporated into animal physiology practicums. This represented an important missed opportunity because several locally available medicinal plants possess biological properties that are relevant to physiological investigation. Kratom, turmeric, yellow root, and betel leaf, for example, have been reported to contain bioactive compounds associated with various physiological and pharmacological effects (Ahmad et al., 2022; Biswas et al., 2022; Fuloria et al., 2022). Their incorporation into practicum activities therefore offered the possibility of connecting animal physiology concepts with biological resources familiar to students in their local environment.

Integrating these local resources was expected to make practicum activities more contextual and meaningful while simultaneously strengthening students' awareness of local biodiversity. This approach is particularly relevant because laboratory learning should not only provide technical experience but also help students connect scientific concepts with observable phenomena and authentic contexts. The needs analysis further indicated that animal physiology learning should provide greater opportunities for students to develop scientific skills, scientific literacy, experimental design abilities, and competence in interpreting observational data (Bretz, 2019).

Taken together, the findings from the analysis stage indicated the need for a practicum module that combines a structured problem-solving approach with locally relevant phytopharmaceutical resources. This combination was considered appropriate for transforming the practicum from a predominantly procedural activity into a more contextual and investigative learning experience.

Step 2: Design

Based on the findings of the analysis stage, the practicum module was designed to integrate problem-solving activities with the use of local phytopharmaceutical resources from West Kalimantan. The instructional structure was developed so that students would not merely follow laboratory procedures but would actively participate in a sequence of scientific activities, including phenomenon identification, problem formulation, hypothesis development, experimental planning, data collection, data analysis, and conclusion drawing.

Each practicum topic was connected to a physiological phenomenon and a locally relevant phytopharmaceutical context. For example, practicum activities related to the respiratory and nervous systems incorporated kratom extract as an experimental material for observing physiological responses in test organisms. In another activity, turmeric extract was incorporated into an immune-system-related practicum to examine observable physiological responses. These contextual links were intended to help students understand that animal physiology concepts are not isolated theoretical constructs but can be investigated through biological materials found in their surrounding environment.

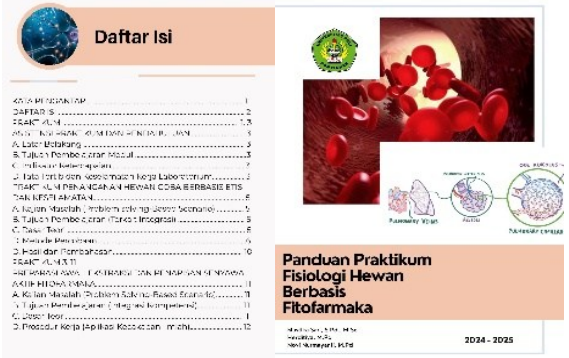
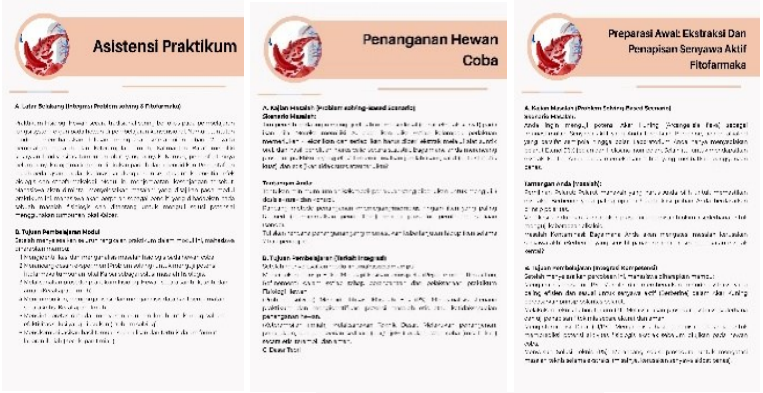
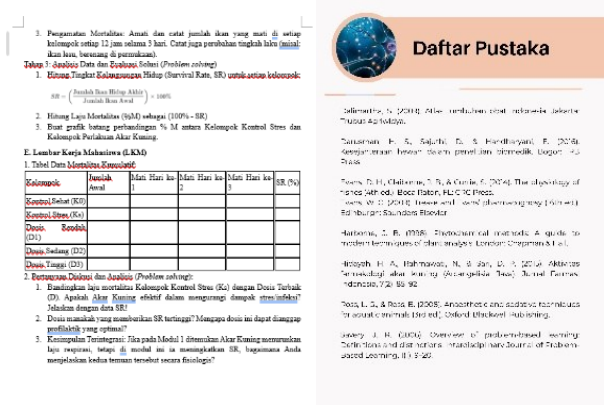
The incorporation of local context into practicum design may also increase the relevance of learning by connecting scientific concepts with students' everyday environment. Previous studies have shown that context-based science learning can contribute to stronger learning motivation, more positive attitudes toward science, and deeper conceptual understanding when compared with learning experiences that are disconnected from students' real-life contexts (Hüfner et al., 2026; Sevian et al., 2018). In the present module, local phytopharmaceutical resources therefore served not only as laboratory materials but also as contextual anchors for scientific investigation.

The module was organized into several main components, including practicum identity, learning outcomes, contextual phenomena, problem formulation, hypothesis development, tools and materials, experimental procedures, observation tables, data analysis activities, and scientific reflection. These components were arranged sequentially to guide students from

initial problem recognition to evidence-based interpretation of experimental findings. Visual markers such as "Phenomenon," "Hypothesis," "Experiment," and "Data Analysis" were also included to make the sequence of problem-solving activities more explicit and easier to follow.

In addition to the instructional components, evaluation instruments were developed during this stage to assess the quality of the module. These instruments included expert validation sheets and student response questionnaires, which were subsequently used to evaluate the validity and practicality of the developed product. The complete structure of the initial module design is presented in Table 3.

Table 3. Initial Product Design

Part	Content	Design
Opening	Cover, Foreword, List of contents	
Contents	Practical Assistance, Practical Events consisting of 9 practical activities	
Closing	Student Worksheet, Bibliography	

Step 3: Development

The development stage produced the complete module, which was then validated by material and media experts to obtain suggestions and to determine the quality of its content, presentation, language, integration of problem solving and local phytopharmaceuticals, and media design (Puspita, 2019). The material expert validation instrument consisted of 24 items and was completed by three validators with backgrounds in animal physiology, biology education, and ethnobotany. The results are presented in Table 4.

Table 4. Results of Material Expert Validation

Rated aspect	Number of Items	Percentage (%)	Validator Score Range	Category
Content suitability	8	90	88–92	Very Valid
Linguistics	5	88	85–90	Very Valid
Presentation	6	91	89–94	Very Valid
Integration of problem solving and phytopharmaceuticals	5	90	87–93	Very Valid
Average	24	90	86–94	Very Valid

The module was rated very valid by the material experts, with an average of 90%. The presentation aspect received the highest score (91%) because the module was considered to have a systematic flow of activities, an attractive display, and problem-solving activities that were easy to follow. The language aspect received the lowest score (88%) because the validators found several scientific terms that needed to be adjusted to standard animal physiology terminology. Revisions based on the validators' suggestions are presented in Table 5.

Table 5. Product Revisions Based on Validator Input

Validator Input	Before Revision	After Revision
– The explanation of the physiological mechanisms is too brief.	The explanation is only a general definition.	Added explanation of the relationship between bioactive compounds and physiological responses.
– Scientific terms are not yet consistent.	Mixed use of terms.	Standardized according to animal physiology terms.
– The experimental procedure is less detailed.	Observation steps are not specific.	Added treatment duration and observation parameters.
– Phytopharmacological information is incomplete.	Only use local plant names.	Added Latin name and phytochemical content.
– The image display is less attractive.	Some black and white pictures.	Replaced with high resolution color image.

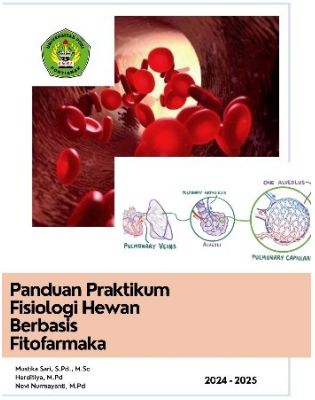
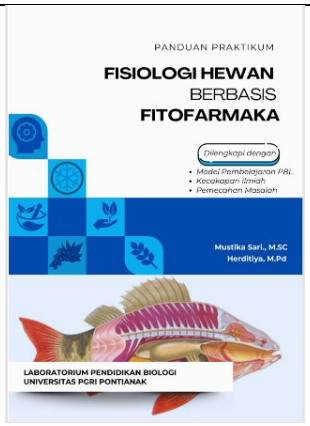
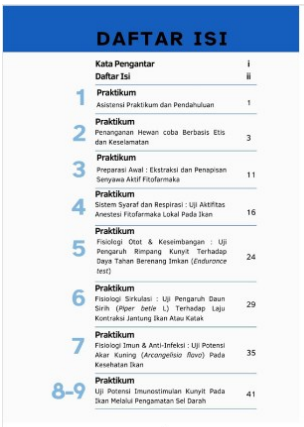
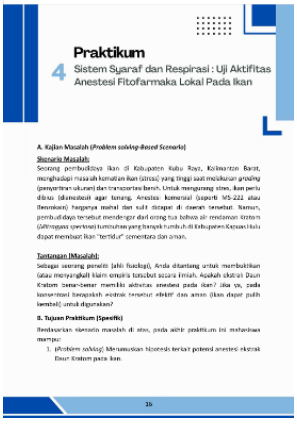
The module was also validated by three media experts to assess its display, layout, readability, visual consistency, and ease of use. The results are presented in Table 6.

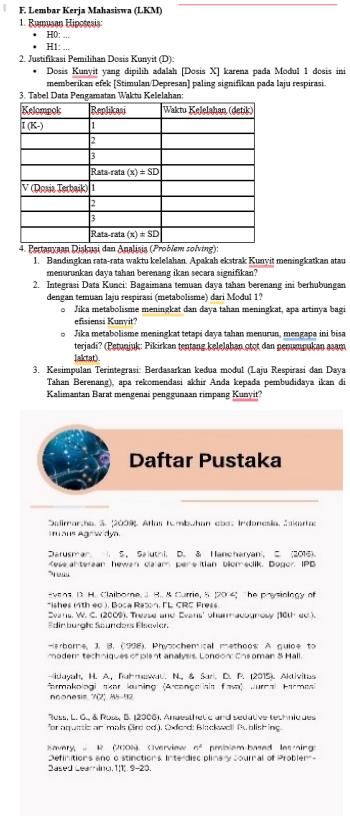
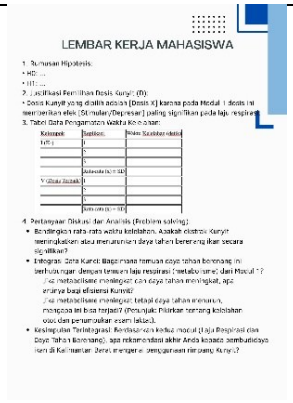
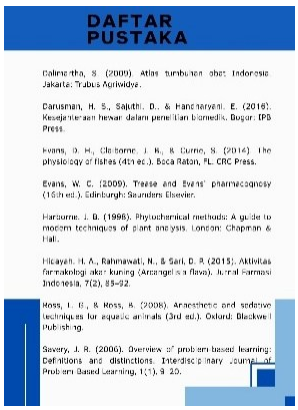
Table 6. Media Expert Validation Results

Rated aspect	Percentage (%)	Category
Layout and readability	96	Very Valid
Display design	87	Very Valid
Content design and user-friendliness	91	Very Valid
Average	91	Very Valid

The media experts rated the module very valid, with an average of 91%. Layout and readability received the highest score (96%) because the placement of text, images, icons, and workspace was proportional and easy to read, and the icons helped students follow the learning stages. Display design received the lowest score (87%) because the validators suggested that some illustrations be made more attractive and colorful; varied colors in learning media can increase students' reading interest (Wijarini & Zulfadli, 2018). The revisions are shown in Table 7. After revision, the module was declared very valid and suitable for the implementation stage.

Table 7. Initial product and final product results

Repair Section	Before	After
Cover 1. The cover section does not include the integration of Scientific Skills, PBL, and Problem Solving. 2. The cover image does not yet show contextual animal physiology. 3. No phytopharmaceutical symbol		
Foreword The foreword is written in an untidy manner and still uses a different font.		
List of contents The table of contents does not include all the practical activities and is too long, it is better to make it concise and clear.		
Contents 1. The practical activity section does not show the practical events, 2. The font and visualization of the initial part of the page are made attractive and different.		

Repair Section	Before	After
LKM LKM is created on a different page from the previous section		
Bibliography Adjust the bibliography writing to APA 7 format		

Step 4: Implementation

The small-scale trial was conducted with 15 seventh-semester students who had completed the animal physiology course. The results are presented in Table 8.

Table 8. Results of small-scale practicality tests

Practical Aspects	Percentage (%)	Category
Legibility	73	Practical
PBL Integration	76	Practical
Skill 21	72	Practical
Material and content suitability	73	Practical
Average	73.50	Practical

The small-scale trial showed that the module was practical, with an average of 73.50%. The highest score was for PBL integration (76%) and the lowest for 21st-century skills (72%). Students' feedback was used to make minor revisions before the large-scale trial.

The large-scale trial was conducted with 34 fifth-semester students taking the animal physiology course, who used the module in four practicum sessions. In each session, students went through the problem-solving stages from problem identification to analysis of experimental results. Practicality was then measured with the student response questionnaire; the results are presented in Table 9.

Table 9. Results of large-scale practicality tests

Practical Aspects	Percentage (%)	Category
Ease of use	78	Practical
Clarity of practical instructions	80	Practical
Module view	75	Practical
Implementation of problem solving	74	Practical
Integration of local context	77	Practical
Average	76.75	Practical

The module was practical in the large-scale trial, with an average of 76.75%. Clarity of practicum instructions received the highest score (80%), as students found the experimental steps and observation procedures easy to follow. The implementation of problem solving received the lowest score (74%), as some students still needed time to adapt to formulating hypotheses and analyzing data independently. This pattern is consistent with the view that students moving from guided to problem-based activities benefit from explicit scaffolding of the inquiry process; a meta-analysis showed that scaffolding in problem-based STEM learning has a positive effect on cognitive outcomes (Kim et al., 2018). Students also stated that integrating local phytopharmaceuticals made the practicum more engaging and relevant to their surroundings. The slightly higher score in the large-scale trial (76.75%) than in the small-scale trial (73.50%) may reflect the revisions made after the small-scale trial, although the two trials involved different groups and partly different questionnaire aspects, so they cannot be compared directly.

Step 5: Evaluation

Formative evaluation during development resulted in several revisions, including a more detailed explanation of physiological mechanisms, the addition of Latin names and phytochemical information on local phytopharmaceuticals, standardization of scientific terms, more specific observation parameters, and improvements to the visual design. Such iterative revision is a core feature of the ADDIE model, which ensures that the product meets learners' needs before it is implemented (Spatioti et al., 2022). The summative evaluation showed that the module met the criteria of very valid according to material and media experts and practical according to students. Therefore, the module is suitable for use as a supporting teaching material for animal physiology practicums.

The findings show that integrating problem solving and local phytopharmaceuticals can produce a contextual practicum module that experts consider valid and students consider practical. Using plants such as kratom and turmeric, which are familiar in students' environment, brings the practicum closer to students' lives and supports the principle of place-based education, which connects learning to the local community and environment (Yemini et al., 2025). This is consistent with the evidence that contextual learning supports students' scientific attitudes and science performance (Suryawati & Osman, 2018) and with recent calls to integrate ethnopharmacology into life science education (Grundmann et al., 2023).

In terms of learning design, the problem-solving structure gives students the opportunity to carry out scientific investigations in stages, from identifying problems and formulating hypotheses to conducting experiments and interpreting data. These activities support student-centered learning and represent a shift from verification-oriented laboratories toward investigative ones (Agustian et al., 2022; Rokos & Zavodska, 2020). Previous studies have shown that problem-based practicums improve science process skills (Duda et al., 2019; Ilhami et al., 2023) and that problem-solving practicums can encourage students to reason using the scientific method, so that biology is experienced as a process of discovery and not only as a collection of facts (Rahmawati et al., 2022). The relatively low practicality score for the implementation of problem solving suggests that future versions of the module should provide more scaffolding, such as worked examples of hypothesis formulation and guided data-analysis templates.

This study has several limitations. First, it focused only on the development, validity, and practicality of the module; its effectiveness in improving students' learning outcomes, scientific skills, and problem-solving abilities was not tested. Second, practicality was measured only by students' self-reported questionnaires, without lecturer responses or observation data. Third, validity was based on percentage scores from three validators per group, without an index of expert agreement. Fourth, the trials were conducted at a single institution with small samples, and the small-scale and large-scale questionnaires assessed partly different aspects.

CONCLUSION

This study produced an animal physiology practicum module based on problem solving and local West Kalimantan phytopharmaceuticals through the ADDIE model. The module was very valid according to material experts (90%) and media experts (91%), indicating that its content, language, presentation, integration of problem solving and local phytopharmaceuticals, and media design are appropriate. The module was also practical according to students in the small-scale trial (73.50%) and the large-scale trial (76.75%), with clear practicum instructions as its strongest aspect and the implementation of problem-solving steps as the aspect most in need of further support. The module can be used as a supporting teaching material that links animal physiology experiments with local phytopharmaceutical knowledge, and its design can be adapted for other courses that use local biological resources.

RECOMMENDATION

Based on the results and limitations of this study, the following recommendations are proposed:

1. Future research should test the effectiveness of the module on students' learning outcomes, science process skills, and problem-solving abilities using an experimental or quasi-experimental design with a control group.
2. Future studies should involve more participants from several institutions, include lecturer responses and observation data, and report inter-rater agreement and instrument reliability.
3. The module could be expanded to include more types of local phytopharmaceuticals and more scaffolding for hypothesis formulation and data analysis.

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AUTHOR CONTRIBUTIONS STATEMENT

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Mustika Sari	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Herditiya	✓	✓		✓	✓	✓				✓	✓		✓	
Novi Nurmayanti		✓		✓		✓	✓	✓		✓				

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all student participants included in the small-scale and large-scale product trial evaluations of this study.

ETHICAL APPROVAL

The research and educational evaluations involving student participants were conducted in accordance with institutional policies and national educational research regulations. The animal handling procedures integrated into the practicum design complied with ethical guidelines for animal care and educational use, as approved by the Faculty Ethics Committee of Universitas PGRI Pontianak.

DATA AVAILABILITY

The authors confirm that the data supporting the findings of this study (expert validation scores and student practicality evaluation datasets) are available within the article, and additional supplementary materials are available from the corresponding author, [MS], upon reasonable request.

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