



Development of SETS-based modules for understanding zoological concepts on Lemukutan Island

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Article Information	Abstract
Keyword: SETS-based teaching module; Understanding; Zoological concepts; Invertebrate exploration; Lemukutan Island Kata Kunci: Modul ajar berbasis SETS, Pemahaman; Konsep zoologi; Eksplorasi invertebrata; Pulau Lemukutan History: Received : 20/11/2024 Revised : 10/04/2025 Accepted : 14/04/2025 Published : 19/04/2025	Zoology, as a branch of biology, not only focuses on theoretical aspects but also requires mastery of practical skills in observing, analyzing, and understanding the interactions between organisms and their environment. Observations during the field study on Lemukutan Island revealed that many students were still confused about identifying the names of species and body parts of invertebrate animals encountered during the field exploration. This study aims to determine the validity, student responses, and effectiveness of the SETS-based teaching module through invertebrate exploration on Lemukutan Island. This research is an R&D study using the ADDIE model. The data collection tools used in this study included validation sheets, student response questionnaires, and zoology concept understanding tests. Data analysis involved calculating validation scores, student questionnaires, and N-gain score results from the zoology concept understanding test. The results showed that the SETS-based module is valid, practical, and effective for enhancing students' conceptual understanding of zoology. It received an average validity score of 1.00, a student response percentage of 79%, and an N-gain score of 0.783 (high category). These findings suggest that the module is suitable for integration into the invertebrate systematics curriculum and can improve the relevance and engagement of learning by linking zoological content to local biodiversity contexts such as those on Lemukutan Island. <i>Abstrak. Zoologi sebagai salah satu cabang ilmu biologi tidak hanya menitikberatkan pada aspek teoritis saja, tetapi juga menuntut penguasaan keterampilan praktis dalam mengamati, menganalisis, dan memahami interaksi antara organisme dengan lingkungannya. Hasil observasi pada saat kuliah lapangan di Pulau Lemukutan menunjukkan bahwa banyak mahasiswa yang masih bingung ketika menyebutkan nama-nama spesies dan bagian tubuh hewan invertebrata yang ditemukan pada saat eksplorasi lapangan. Penelitian ini bertujuan untuk mengetahui validitas, respon mahasiswa, dan efektivitas modul ajar berbasis SETS melalui eksplorasi invertebrata di Pulau Lemukutan. Penelitian ini merupakan jenis penelitian R&D dengan menggunakan desain ADDIE. Alat pengumpul data yang digunakan dalam penelitian ini adalah lembar validasi, angket respon mahasiswa, dan tes pemahaman konsep zoologi. Analisis data menggunakan perhitungan skor validasi, angket mahasiswa, dan skor hasil N-gain tes pemahaman konsep Zoologi mahasiswa. Hasil penelitian menunjukkan bahwa modul berbasis SETS valid, praktis, dan efektif dalam meningkatkan pemahaman konsep zoologi mahasiswa. Modul ini memperoleh skor validitas rata-rata sebesar 1,00, persentase respons mahasiswa sebesar 79%, dan skor N-gain sebesar 0,783 (kategori tinggi). Temuan ini menunjukkan bahwa modul layak diintegrasikan ke dalam kurikulum sistematika invertebrata dan dapat meningkatkan relevansi serta keterlibatan pembelajaran dengan mengaitkan konten zoologi pada konteks keanekaragaman hayati lokal seperti di Pulau Lemukutan.</i>

A. Introduction

Zoology, as a branch of biology, encompasses the study of animals, their behavior, physiology, classification, and distribution. A comprehensive understanding of zoology requires an integration of various sub-disciplines, reflecting the complexity of biological processes and the interrelationships among different animal species (Koene, 2012). Invertebrate zoology, a critical subset of zoology, presents unique challenges for learners, particularly in educational contexts. Research indicates that pre-service teachers often struggle with conceptual understanding in this area due to the abstract nature of Invertebrate biology and the complexity of classification systems (Abza et al., 2023).

Several problems related to conceptual understanding in the field of zoology are highlighted in the following studies. Low student conceptual understanding is caused by a lack of student involvement in the learning process (Ashar & Nursikin, 2023). Research by Wakhidah (2021) revealed that students' understanding of the structure and properties of viruses, which are part of zoology, is still relatively low. The results showed that only 37.5% of students were able to demonstrate a good understanding of the structure of viruses. This shows that despite efforts to improve learning, understanding specific concepts still requires further attention. Research by Astuti and Haryadi (2023) showed that students in the low category had significant difficulty in understanding basic concepts, which can also be applied to the context of zoology. These difficulties are often related to inadequate understanding of the basic concepts needed to understand more complex material. To address these challenges, innovative educational strategies, such as guided inquiry-based models and hands-on practical experiences, have been proposed. For instance, the implementation of a "lab in a box" approach allows students to engage with physical specimens, thereby enhancing their comprehension of Invertebrate structures and functions (Novo et al., 2021). Such interactive frameworks are essential for fostering a deeper understanding of zoological concepts among students (Abza et al., 2023; Novo et al., 2021). Furthermore, the integration of technology in zoological education, such as augmented reality (AR), has shown promise in enhancing pedagogical practices. AR technology can facilitate inquiry-based learning, allowing students to visualize and interact with complex biological systems in a more engaging manner (Hsu et al., 2023).

Conceptual understanding is a deep process involved in gaining a person's knowledge of an object. Understanding zoological concepts is an important foundation for biology students to understand the diversity of living things. However, during the learning process in higher education, a lack of direct experience with certain species can often hinder in-depth understanding. The results of observations during the

field lecture on Lemukutan Island showed that many students were still confused when identifying the names of species and body parts of invertebrate animals found during field exploration. In fact, these concepts are important to explore as preparation for prospective educators who will teach in schools in the future.

It is important to note that low conceptual understanding can occur at certain cognitive levels, such as applying, evaluating, and creating (Torre et al., 2023). Therefore, in developing the module, it is necessary to consider learning strategies that can improve students' conceptual understanding (Supena et al., 2021). To achieve this goal, a learning approach that emphasizes hands-on experience and field exploration is adopted. The developed learning module will integrate zoological concepts with the use of technology, understanding of environmental impacts, and its relevance in society. Practical steps will be considered to facilitate the use of this module in formal learning environments. This approach is supported by recent research findings in the field of biology learning and environmental education. For example, a recent study by Warouw et al. (2024) emphasized the important role of technology in facilitating environmentally oriented learning.

The development of teaching modules is a critical aspect of educational practice, as it directly influences the effectiveness of the learning process. Teaching modules can be defined as structured learning materials that encompass detailed instructional practices aimed at facilitating the acquisition of knowledge and skills in a specific subject area (Suratnu, 2023). The importance of aligning teaching modules with educational objectives cannot be overstated, as they serve as the backbone of curriculum development and instructional strategies (Azalia et al., 2023).

It is essential for curriculum developers to consider various factors, such as the philosophical, psychological, and socio-cultural foundations of education, to ensure that the curriculum meets the diverse needs of learners (Li-Sauerwine & King, 2019). For instance, the integration of modern educational theories and practices, such as competency-based education, has become increasingly relevant in the context of curriculum development, as it focuses on equipping learners with the necessary skills and competencies required for real-world applications (Thummaphan et al., 2022).

The intersection of science, environment, technology, and society (SETS) is increasingly critical in addressing contemporary environmental challenges. Public perception plays a pivotal role in shaping the acceptance and implementation of environmental technologies and policies (Abdullah et al., 2021). This aligns with findings from Huijts et al. (2012), who argue that public acceptance of

sustainable energy technologies, including CCS, is crucial for their successful integration into society. The interplay between public perception and stakeholder engagement is thus essential for fostering an environment conducive to the adoption of such technologies.

In rural contexts, the awareness and risk perception of environmental hazards, such as air pollution, further illustrate the complexities of public perception. A study in Kenya revealed how community members assess the risks associated with environmental hazards, indicating that their perceptions are influenced by personal experiences and community discussions (Omanga et al., 2014). This highlights the need for effective communication strategies that can bridge the gap between scientific knowledge and public understanding, as noted by Tov et al. (2022) who stresses the importance of science communication in shaping public perceptions of climate change and environmental issues.

Moreover, the role of media in shaping public perceptions cannot be understated. Research by Li-Ping et al. (2019) demonstrates that media coverage of environmental issues varies significantly across different language groups, which can lead to divergent public perceptions and attitudes towards environmental conservation. This is echoed in the work of Fitzgerald et al. (2021), who argue that media plays a crucial role in framing public views on novel environmental technologies, thereby influencing societal attitudes. The representation of environmental issues in mass media, as explored by Nasution et al. (2023), further illustrates how media narratives can shape public understanding and concern regarding sustainability issues.

Therefore, it is important to compile a teaching module based on the results of the Field Lecture on Lemukutan Island so that important concepts related to invertebrates can be effectively conveyed to support the learning outcomes of the Invertebrate Systematics course. This provides a strong theoretical basis for the approach proposed in this study. Thus, this study is expected to not only provide new insights into the development of SETS-based learning modules in the context of understanding zoological concepts, but also contribute to biology education practices that are more oriented toward field experiences and environmental awareness. By deepening students' understanding of zoology through exploration on Lemukutan Island, it is hoped that students will become more connected to biodiversity and the environment, and be better prepared to face complex scientific and social challenges in the future.

Accordingly, this study aims to develop a SETS-based teaching module specifically designed to improve students' understanding of zoological concepts. The focus of this study is the exploration of invertebrates on Lemukutan Island, a location with rich biodiversity in Indonesia. This study was

conducted to determine the validity of the SETS-based teaching module in enhancing students' understanding of zoological concepts through invertebrate exploration on Lemukutan Island, to assess students' responses to the developed module, and to evaluate the effectiveness of the teaching module.

B. Material and method

This is development research. The development model used in this study is the ADDIE model, originally developed by Dick and Carey. The ADDIE model is a systematic instructional design framework that includes five stages: Analysis, Design, Development, Implementation, and Evaluation. The research workflow can be seen in Figure 1.

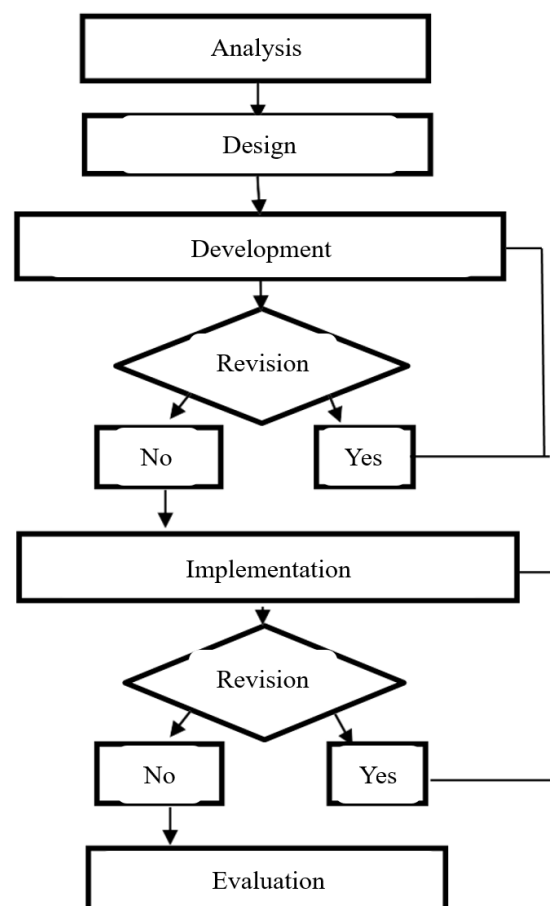


Figure 1 Research Flow of ADDIE

The ADDIE research model was chosen because of its flexibility, which allows for adjustments at each stage based on specific needs. The ADDIE model also focuses on achieving development goals, ensuring that learning modules are relevant and effective. The evaluation phase further ensures product quality. In addition, the ADDIE model includes evaluations that are conducted not only at the end (summative) but also during the development process (formative), ensuring that each step is carried out in accordance with the intended objectives.

The first stage begins with collecting information, analyzing materials, and reviewing literature related to students' needs for teaching materials. In the second stage, the researcher designed a teaching module based on the SETS learning model, incorporating native animals found during field exploration on Lemukutan Island. The third stage involves validation by two experts, followed by revisions based on suggestions and feedback. The fifth stage involves conducting trials and implementation with 38 third-semester students. The entire research process was conducted over one semester, from August 2024 to December 2024.

The population consisted of all students in the Biology Education Study Program at Universitas PGRI Pontianak. The research sample was selected using a purposive sampling technique based on several criteria: students who had taken the Invertebrate Systematics course and participated in the field lecture on Lemukutan Island. Therefore, the selected sample comprised third-semester students from the 2023/2024 intake, totaling one class with 38 students.

The instruments used in this study included a validation sheet, student response questionnaires, and pretest and posttest questions. The research instruments were first validated by two lecturers from the Biology Education Study Program. The validation sheet included indicators such as content suitability, language, presentation, and visual design. The student response questionnaire was filled out by third-semester students who had taken the Invertebrate Systematics course. It included indicators such as material presentation, language clarity, design quality, usefulness, and understanding of zoological concepts. The conceptual understanding test consisted of essay questions administered before and after the implementation of the SETS-based teaching module. The observed indicators were: interpreting, exemplifying, classifying, summarizing, drawing inferences, comparing, and explaining.

The data analysis techniques used in this study consisted of three types: expert validation analysis, practicality analysis, and effectiveness analysis of the teaching module. Data obtained from the validation results of the SETS-based teaching module were in the form of both qualitative and quantitative descriptive data. Qualitative data were derived from suggestions and comments from the validators, while quantitative data were obtained through assessment checklists ($\sqrt{}$).

Validity calculations were performed by two experts using the Formula 1 from Gregory (2011), as presented in Table 1, with criteria shown in Table 2. Data analysis conducted in this study involved calculating the assessment results from the validators and student responses.

The practicality analysis of the SETS-based teaching module was obtained from the student response questionnaire. The calculation of student responses was performed using the Excel application.

After the calculation, the next step was to determine the criteria. The criteria are presented in Table 3.

Table 1 Tabulation of expert assessment

Tabulation of expert assessment	Judges I	
	Not relevant (score 1-2)	Relevant (score 3-4)
Judges II	Not relevant (score 1-2)	(A) (B)
	Relevant (score 3-4)	(C) (D)

(Source: Gregory, 2011)

$$V_c = \frac{D}{A + B + C + D} \dots \dots \dots \text{Formula 1}$$

Description:

- Vc = Contract validity
- A = Both judges disagree
- B = Judges 1 agree, judges II disagree
- C = Judges 1 disagree, judges II agree
- D = Both judges agree

Table 2 Validity criteria

Validity	Interpretation
Contract validity $\leq 0,4$	Less valid
$0,4 < \text{Contract validity} < 0,8$	Moderate valid
Contract validity $> 0,8$	Very valid

(Source: Gregory, 2011)

Table 3 Criteria of response questionnaire

Value (%)	Criteria
$80 < \text{Response value} \leq 100$	Very practical
$60 < \text{Response value} \leq 80$	Practical
$40 < \text{Response value} \leq 60$	Quite practical
$20 < \text{Response value} \leq 40$	Weak
$0 < \text{Response value} \leq 2$	Impractical

(Source: Riduwan, 2020)

The effectiveness analysis of the SETS-based teaching module (Invitation, Exploration, Solution, and Application) was obtained from the results of the students' conceptual understanding tests, which were administered before and after the use of the module. The scores were then calculated using the Normalized Gain (N-gain) Formula 2. The effectiveness criteria for the SETS-based teaching module are presented in Table 4.

$$N \text{ gain} = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Ideal score} - \text{pretest score}} \dots \dots \dots \text{Formula 2}$$

Table 4 N-gain score and its interpretation

Normalized gain	Interpretation
$g > 0,7$	High
$0,3 \leq g \leq 0,7$	Moderate
$g < 0,3$	Low

(Source: Hake, 1999)

C. Results and discussion

The developed SETS-based teaching module layout design can be seen in Figure 2. The module was designed using the Canva application and has been validated by experts, receiving a rating of "very valid". The components of the module include learning instructions, an introduction to the ecosystem of Lemukutan Island, a SETS-based learning approach, clearly defined learning outcomes, and a series of lecture materials with detailed content descriptions. The material descriptions in the module are organized according to the SETS learning stages, beginning with an introduction to the basic principles of invertebrate systematic classification.

The first SETS stage, Science, is implemented in the initial learning activity by utilizing data from the invertebrate inventory, specifically species found on Lemukutan Island. The second learning activity focuses on the characteristics of invertebrate classification and the nomenclature system. This activity integrates the second SETS stage, Environment, by linking the identified species from the inventory to their positive ecological impacts on the local environment. The third learning activity covers the Phylum Porifera and highlights the Technology stage of SETS, connecting certain Porifera species

found on Lemukutan Island to technological innovations derived from their biological features. The fourth learning activity discusses the Phylum Cnidaria and Phylum Ctenophora, emphasizing the Society component of SETS. In this activity, students explore the relationship between these organisms and local social conditions on Lemukutan Island. The fifth learning activity introduces the Phylum Platyhelminthes, continuing with the Society component by discussing the relevance of these species to community health and social practices in the area. The sixth activity covers the Phylum Nematoda and Phylum Annelida, integrating both the Science and Technology components of SETS. Students examine selected species from these phyla and their benefits for human health and technological development.

Subsequent learning activities address other major invertebrate groups, including the Phylum Arthropoda and Phylum Echinodermata, with each activity embedding one or more SETS components to ensure that scientific, environmental, technological, and social perspectives are holistically represented throughout the module. The developed module also includes student worksheets, evaluation questions, and answer keys to assess students' understanding of zoological concepts.

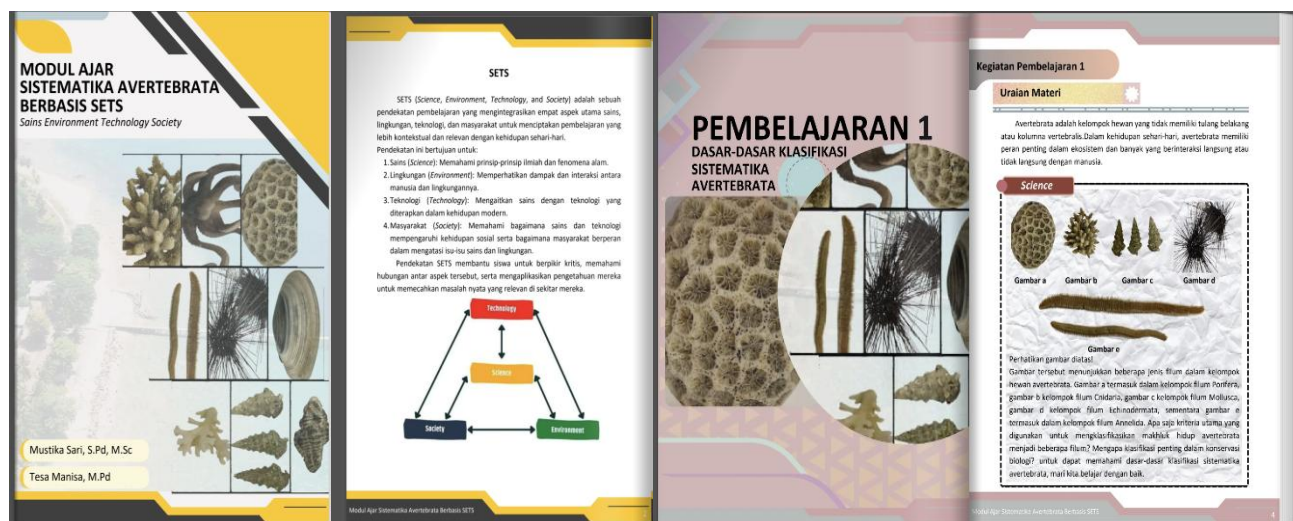


Figure 2 SETS-based teaching module for students' understanding of zoology concepts through invertebrate exploration on Lemukutan Island (in Indonesian)

Validation of the SETS-based teaching module was carried out by two validators, namely lecturers from the Biology Education Study Program at Universitas PGRI Pontianak. This activity was conducted to assess the level of product validity and to provide suggestions for improvement. Validation by the two validators evaluated four aspects of the developed teaching module: content suitability, language, presentation, and graphics. The results of the validation, calculated using Gregory's formula (2011), are presented in Table 2. The selection of two

validators was based on Gregory's (2011) analysis, which allows for the use of two raters in content validity testing. The table below outlines the interpretation of the validation results. A "very valid" criterion is achieved if the construct validity value assessed by both validators is greater than 0.8. A "moderately valid" criterion applies if the value is between 0.4 and 0.8. A "less valid" criterion is applied if the construct validity value is less than 0.4 (Retnawati, 2016).

Table 5 Results of validation of the SETS-based teaching module

Aspects	Indicators	Validator score		Vc	Criteria
		1	2		
Content suitability	Material content suitability with learning outcomes of graduates	3	4	1	Very valid
	Suitability with student needs	4	4	1	Very valid
	Suitability with teaching material needs	4	4	1	Very valid
	Truth of material substance	3	4	1	Very valid
	Module conforms to SETS syntax (Invitation, Exploration, Solution, & Application)	4	4	1	Very valid
Language	Readability	3	3	1	Very valid
	Clarity of information	4	4	1	Very valid
	Suitability with Indonesian language rules	4	4	1	Very valid
	Effective and efficient use of language	4	4	1	Very valid
Presentation	Clarity of purpose	4	4	1	Very valid
	Presentation sequence	3	4	1	Very valid
	Providing motivation	3	3	1	Very valid
	Completeness of information	3	4	1	Very valid
Graphics	Use of fonts (type and size)	3	4	1	Very valid
	Layout	4	4	1	Very valid
	Images/photos	4	4	1	Very valid
	Display design	4	4	1	Very valid
Average				1	Very valid

Table 5 shows that the SETS-based teaching module is considered highly valid for use as teaching material, with an average score of 1.00 for each aspect, based on Formula 1. Validation of the SETS-based teaching module is an important step in ensuring that the developed teaching materials are not only relevant, but also effective in improving students' understanding and skills.

Previous research shows that teaching modules validated by experts tend to exhibit high levels of validity, reflecting their quality and effectiveness in instructional settings. In the context of teaching module development, several studies have demonstrated significant validation outcomes. For example, Indariani et al. (2018) reported that the digital module they developed received assessments of 83.33% from media experts and 85.57% from material experts, indicating a very valid classification for use in mathematics education. Similarly, Zinnurain (2021) reported that an e-module developed for management courses received validation from material experts of 92%, also indicating a very valid category. These results reinforce the notion that expert validation is a key indicator of the quality of a developed teaching module. Furthermore, Ulum et al. (2019) showed that the module developed for a Natural Resource Management course received validation scores of 88.42% from teaching material experts and 92.35% from subject matter experts. This aligns with the findings of Fatihah et al. (2021), who found that the contextual-based textbook they developed also received a high validation score, reaching 87.5%.

Based on suggestions from validators, several improvements were made. Initially, the teaching module did not yet contain the specific SETS stages.

After revision, the final version integrates the full SETS syntax. The revised module incorporates the local potential of Lemukutan Island, including its biodiversity, environmental conditions, potential for developing local-based technologies, and the social relationships embedded within the island's natural and cultural resources (see Figure 3).

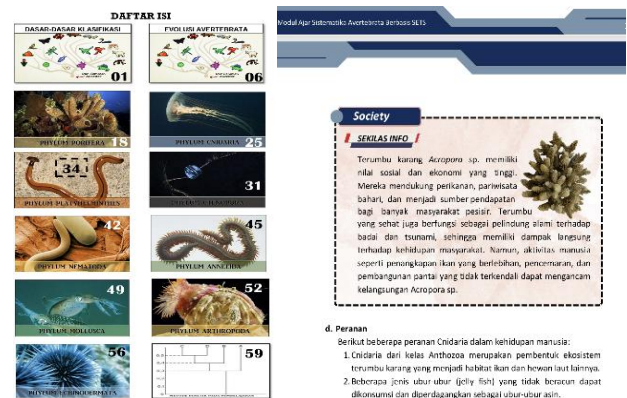


Figure 3
Teaching module before (right) and after revision (in Indonesian)

The second suggestion from the validators was that the results of the invertebrate inventory on Lemukutan Island had not yet been included. Therefore, the validator recommended that the results of the invertebrate inventory found on Lemukutan Island be displayed and integrated into the teaching module (see Figure 4). The third suggestion from the validators was that the questions designed to measure students' conceptual understanding should be included in the developed module (see Figure 5).

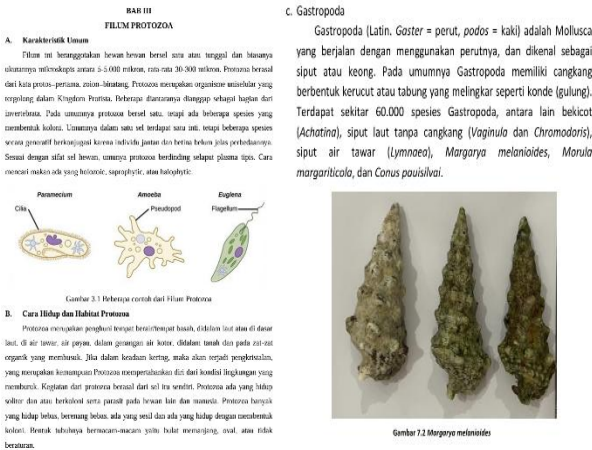


Figure 4
Teaching module before (right) and after revision (left)
(in Indonesian)

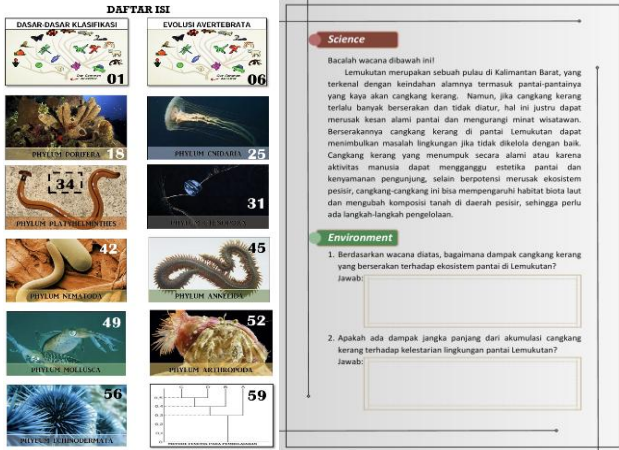


Figure 5
Teaching module before (right) and after revision (left)
(in Indonesian)

Table 6 Results of the student response questionnaire analysis

Aspects		Indicators	Student response results	
			% Score	Score category
Presentation of material	Clarity of material delivery	84	Very practical	
	Ease of understanding the material	76	Practical	
	Understanding the stages of the work procedure according to the learning model	79	Practical	
	Effectiveness in remembering the material	76	Practical	
Language	Ease of understanding the language and terms used	80	Very practical	
	Ease of understanding the information conveyed	79	Practical	
Design	Use of type, size and color of letters	81	Very practical	
	Clarity of layout placement	80	Very practical	
	Clarity of images presented	86	Very practical	
	Clarity of captions on each image	80	Very practical	
	Clarity of sentences presented	76	Practical	
	Ease of using icons or buttons presented	81	Very practical	
Benefits	Easy to use as learning resource material	78	Practical	
	Easy to understand instructions for use	71	Practical	
	Easy to access anywhere and anytime	81	Very practical	
	Increase learning motivation	83	Very practical	
	Benefits in increasing insight	80	Very practical	
Understanding the concept of zoology	Interpreting	81	Very practical	
	Exemplifying	81	Very practical	
	Classifying	77	Practical	
	Summarizing	77	Practical	
	Drawing inferences	79	Practical	
	Comparing	81	Practical	
	Explaining	82	Practical	
Average		79	Practical	

Overall, the results of the validation of the SETS-based teaching module show that the development of teaching materials involving both expert review and student feedback can produce modules that are not only valid, but also practical and effective for use in learning. This is essential to ensure that students receive a high-quality learning experience that is relevant to their needs in the modern era.

Student responses in this study were assessed based on five aspects: material presentation, language, design, usefulness, and understanding of zoological

concepts. These responses were measured using a questionnaire administered after the students had used the SETS-based teaching module. The results of the student response questionnaire analysis are presented in Table 6.

Table 6 shows that the overall average percentage of student responses is 79%, indicating that the developed SETS-based teaching module is practical for use in learning. The module has passed the validation stage conducted by expert validators and was declared highly valid for student implementation.

The trial was carried out at Universitas PGRI Pontianak, with the participants being third-semester students. This trial aimed to assess student responses after using the SETS-based teaching module. The instrument used was a student response questionnaire. Student responses in this study were measured across five aspects: material presentation, language, design, usefulness, and understanding of zoological concepts.

The development of a SETS-based teaching module to improve students' understanding of zoological concepts through Lemukutan Island invertebrate exploration represents an innovative approach in biology education. This approach not only aims to enhance conceptual understanding in zoology, but also to connect scientific knowledge with relevant environmental and social contexts. Conceptual understanding is a key element in science education, including zoology. A strong conceptual understanding enables students to explain, connect, and apply the knowledge they acquire in broader contexts. Research has shown that the use of structured teaching modules can significantly enhance students' conceptual comprehension. For instance, Adnan et al. (2025); Anfa et al. (2023); Firdani et al. (2024) emphasize the importance of using modules to improve conceptual understanding in specific subject areas.

Zoology, as a branch of biology that studies animals, encompasses various approaches in the teaching and understanding of its concepts among students. The importance of developing teaching materials designed to enhance critical thinking and problem-solving skills, which are highly relevant in the context of zoology. In line with this, Fatiqin and Herniadi (2023) conducted an analysis of biology education students' understanding of invertebrate zoology concepts, finding that factors influencing this understanding include teaching methods and classroom interactions. This study demonstrates that conceptual understanding depends not only on the content delivered but also on the method of instruction and student engagement in the learning process.

Another study by Rusyana (2021) also highlighted the use of cladistic tables as a tool to improve students' understanding of invertebrate zoology, showing that visual aids can significantly enhance the comprehension of complex concepts. In the broader context of education, the importance of zoological museums as educational tools should not be overlooked. Yuniati et al. (2024) explained that zoological museums provide accessible scientific collections, which serve as valuable learning resources for both students and the general public. This aligns with efforts in biodiversity conservation, where understanding species and their habitats is essential for promoting sustainable conservation practices.

The application of an appropriate learning model can have a positive impact on students' conceptual understanding. Direct exploration of

invertebrates on Lemukutan Island provides a contextual and applicable learning experience. Through field activities, students do not only learn theoretical concepts, but can also observe and analyze species firsthand. This is consistent with the findings of Kaenuwihanulah et al. (2021), who emphasize the importance of zoological collections in education as a means of enhancing student comprehension. By connecting classroom learning with real-world field experiences, students can better appreciate the relevance of zoology within environmental and societal contexts.

To ensure the effectiveness of the developed learning module, it is important to carry out a systematic evaluation of students' conceptual understanding following the implementation of the SETS-based module. This evaluation is essential for verifying the achievement of learning objectives. Several indicators were used to assess students' understanding of zoological concepts, including: interpreting, exemplifying, classifying, summarizing, drawing inferences, comparing, and explaining.

Table 7 N-gain score result

Average score		N-gain	Criteria
Pretest	Posttest		
40	87	0.783	High

Table 7 shows the results of students' conceptual understanding in zoology based on pre-test and post-test scores. The pre-test results indicated that 100% of students failed, with scores ranging from 11 to 58. In contrast, the post-test results showed that 100% of students passed, with scores ranging from 79 to 95. The poor pre-test performance was attributed to students' limited understanding of zoological concepts, as evidenced by their confusion in identifying species names during the exploration activity on Lemukutan Island. Based on the comparison of pre-test and post-test scores, there was a significant improvement in students' understanding of zoological concepts. The average pre-test score before the implementation of the SETS-based teaching module was 40, which falls into the low category. After the implementation, the average post-test score increased to 87, classified as high. These results indicate that the SETS-based teaching module has a positive effect on improving students' understanding of zoology concepts.

There are several factors that influence students' conceptual understanding in zoology. These include pedagogical approaches, cultural contexts, interdisciplinary integration, and the overall educational environment. Each of these elements plays a critical role in shaping how students engage with and comprehend zoological content. One of the most important factors is the pedagogical approach used. The adoption of the SETS model is considered an appropriate strategy in developing this teaching

module, as it integrates SETS. This finding is also supported by several relevant studies.

Problem-based learning (PBL) has been shown to enhance student engagement and conceptual understanding by promoting active participation and critical thinking. This method stands in contrast to traditional instructional approaches that often emphasize rote memorization, which can result in only superficial learning. Moreover, incorporating culturally responsive pedagogies—such as contextualizing local Aboriginal fauna stories into the zoology curriculum—has been found to increase students' learning potential and foster a sense of cultural pride (Rioux & Ewing, 2022). This approach not only enhances the relevance of the subject matter, but also enriches the educational experience by linking students' cultural backgrounds to scientific content.

Interdisciplinary integration is another key factor influencing students' understanding of zoology. The ability to connect zoology with other disciplines—such as botany, ecology, and genetics—is essential for fostering a comprehensive grasp of biological concepts (Elliott-Kingston et al., 2021). For instance, integrating statistical methods into zoology courses has been shown to improve students' quantitative skills, which are increasingly critical in contemporary biological research (Colon-Berlinger & Burrowes, 2011).

In addition, incorporating fieldwork and hands-on experiences, such as outdoor schoolyard instruction, has been associated with increased content knowledge and positive attitudes toward environmental science. These experiential learning opportunities enable students to apply theoretical knowledge in real-world contexts, thereby deepening their understanding of zoological concepts.

The educational environment also plays a crucial role in shaping students' understanding of zoology. Factors such as classroom dynamics, teacher expertise, and resource availability significantly influence the learning process. For example, teachers' ability to effectively implement a curriculum is often determined by their perceptions of its efficacy and their level of preparedness to teach the material (Fink et al., 2024). Additionally, access to laboratory equipment and field study opportunities can enhance students' engagement and support a deeper conceptual understanding of zoology (Davis-Berg & Kocot, 2021).

The results of the N-gain analysis from the student trial showed an average score of 0.783, which falls under the "high" category. The N-gain test was conducted to assess the increase in students' learning outcomes before (pre-test) and after (post-test) the use of the teaching module. Thus, it can be concluded that there was a significant improvement in students' understanding of zoological concepts following the application of the SETS-based teaching module, with the results falling into the high category. The module can therefore be considered effective, as it positively

influenced students' conceptual understanding of zoology (Soeprapto et al., 2020). This finding aligns with the research of Shinysheroova et al. (2018), who emphasized that active learning strategies enhance the professional training of biology students, indicating that cognitive-practical activities play a vital role in effective zoology education.

Overall, the development of SETS-based teaching modules that integrate invertebrate exploration on Lemukutan Island has shown great potential to enhance students' understanding of zoological concepts. By combining theoretical knowledge with practical field experience, and applying active learning strategies such as the SETS model, students are expected to gain a more meaningful and contextually relevant understanding of the subject matter.

The development of a SETS-based zoology teaching module not only enriches instructional content but also contributes significantly to the pedagogical advancement of zoology education in Indonesia. This module fosters students' connection with local biodiversity, promotes awareness of conservation, and equips students with the skills needed to critically address environmental and social challenges. The integration of technology, environmental perspectives, and societal applications makes this module innovative and well-aligned with the evolving needs of Indonesian education.

D. Conclusion

The SETS-based teaching module was declared highly feasible for use as instructional material, with an average score of 1.00 for each assessed aspect. Overall, the module was found to be practical, as indicated by students' positive responses during the trial, which yielded an average percentage score of 79%. The effectiveness test, based on N-gain score analysis, showed a result of 0.783, falling into the "effective" category after its implementation in the Invertebrate Systematics course. Based on these findings, it can be concluded that the SETS-based module designed to enhance students' conceptual understanding of zoology meets the criteria of being valid, practical, and effective, making it appropriate for use in the Invertebrate Systematics curriculum. There are several practical implications. Educators can utilize the SETS-based module to connect zoological concepts with local contexts on Lemukutan Island, such as through case studies on marine fauna and terrestrial fauna. This contextualization can make the learning process more relevant and engaging for students. Additionally, educators may integrate project-based learning activities, such as field explorations, fauna documentation projects, or simulations of environmental degradation using appropriate technology aligned with the SETS framework. There are also several recommendations for further research. Future studies could focus on developing and adapting

SETS-based modules for other regions in Indonesia with diverse biodiversity—such as Kalimantan, Papua, or Sumatra—to evaluate their effectiveness in different ecological contexts. Further research may also explore the application of the SETS-based module at different educational levels, such as in elementary schools, secondary schools, or higher education, with appropriate content adjustments.

E. Acknowledgement

The Community Service Team would like to thank LPPM Universitas PGRI Pontianak as the funding provider for this research.

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