BIO-INOVED
Jurnal Biologi-Inovasi Pendidikan
Volume 4, Issue 1, February 2022 page. 75-82

P-ISSN : 2684-9062 | E-ISSN : 2714-9803
https://ppjp.ulm.ac.id/journal/index.php/bino
DOI: 10.20527/bino.v4i1.12205

The development of the popular scientific books on butterflies in the mangrove Sungai Bakau on student's critical thinking skills

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Article Information

Keyword:
Development research; Scientific book; Butterflies; Critical thinking skills

Kata Kunci:
Penelitian pengembangan; Buku ilmiah populer; Kupu-kupu; Keterampilan berpikir kritis

History:
Received : 15/12/2022
Accepted : 04/02/2022

Abstract

Innovative and easy-to-understand learning resources for students that contain materials based on local potentials that can improve students' critical thinking skills are still limited. This study aims to describe the validity, practicality, and effectiveness of popular scientific books on butterflies in the mangrove forest area of Sungai Bakau Village on students' critical thinking skills. Step by step of development includes self evaluation, expert trials, individual trials, small group tests, and field tests. Research subjects are 3 bioscientists, 3 students for individual trials and for small group tests, and 15 students for field Innovative learning resources that contain materials tests. The study shows that the popular scientific books that had been developed are highly valid for 96.3%, while individual testing discovered an excellent value to 88.1%. Popular scientific books are practical because students' responses to 94.7% with highly practicable criteria, the results of the publication of popular scientific books averaged 88.89% by excellent criteria. Popular scientific books that had been developed can be regarded as effective due to increment in students' learning outcomes with an average value to 88.30%. This is categorized as a very good criterion, especially supported by the increment in critical thinking skills up to 0.71 with high criteria.

Abstrak

Sumber belajar yang inovatif dan mudah dipahami mahasiswa yang memuat materi berbasis potensi lokal dapat meningkatkan keterampilan berpikir kritis mahasiswa masih terbatas. Penelitian ini bertujuan mendeskripsikan validitas, kepraktisan, dan keefektifan buku ilmiah populer kupu-kupu di kawasan hutan mangrove Desa Sungai Bakau terhadap keterampilan berpikir kritis mahasiswa. Tahap-tahap pengembangan menggunakan evaluasi formatif Tessmer yang meliputi evaluasi diri, uji pakar, uji perorangan, uji kelompok kecil, dan uji lapangan. Subjek penelitian adalah 3 pakar pembelajaran biologi, 3 mahasiswa untuk uji perorangan dan uji kelompok kecil dan 15 mahasiswa untuk uji lapangan. Hasil penelitian menunjukan BIP yang telah dikembangkan dinyatakan sangat valid dengan nilai 96,3%, sedangkan berdasarkan uji perorangan BIP ini dinyatakan sangat baik dengan nilai 88,1%. BIP dinyatakan praktis karena hasil respon mahasiswa sebesar 94,7% dengan kriteria sangat praktis, hasil keterlaksanaan BIP rata-rata 88,89% denga kriteria sangat baik. BIP yang dikembangkan dinyatakan efektif karena peningkatan hasil belajar mahasiswa dengan rata-rata nilai 88,30% dengan kriteria sangat baik dan peningkatan keterampilan berpikir kritis sebesar 0,71 dengan kriteria tinggi.

A. Introduction

Teaching materials are sets of learning tools that contains learning materials, methods, limitations, and evaluations that are designed systematically and attractively in order to achieve the expected goals, namely achieving competencies or sub-competencies with all their complexity (Lestari, 2016). Therefore, learning resources are everything designed to be used in learning activities and to facilitate the learning process at both high school and college levels, so it is necessary to develop learning resources that can be used to improve and bring up knowledge, attitudes and abilities. which can encourage success in the learning process. One of them is the development of BIP (Latifah et al., 2018).

BIP is a book that contains knowledge based on research results that are presented scientifically using simple, concise and clear language, so that it is easily understood by the public and students (Utami, 2017). The problem experienced by educators is the lack of teaching materials such as BIP based on local potential of an area that discusses butterflies, so it is necessary to study materials that contain local potential in the mangrove area of Sungai Bakau Village.

Various studies on the usage and development of local potential-based teaching materials in higher education institutions in the learning process and their effects on student learning outcomes have been carried out in various cities in Indonesia. Fithriyatur (2019) found that the development of teaching materials based on the local potential of the Baluran National Park mangrove forest can improve the critical thinking skills of students in natural resources courses. Hernawati (2018) in her research found that there was an effect of project-based learning assisted by local potential-based teaching materials on scientific literacy, science process skills and self-efficacy of prospective teacher students in the Vertebrate Zoology course.

The mangrove forest of Sungai Bakau Village is an area that provides productive natural resources both as a source of food and education and is a habitat for many flora and fauna. This area will also have the potential as a tourist attraction. Based on preliminary research by researchers, in the mangrosve forest area of Sungai Bakau Village, Kurau District, Tanah Laut Regency, there are several types of butterflies that live in the area. Several types of butterflies can be used as students' learning materials with the aim of enriching insight, as enrichment and knowledge.

Butterflies which are the local potential of the area can be included in a teaching material, namely BIP in an effort to improve students' critical thinking skills in the learning process. The development of BIP that leads to the implementation of knowledge and life experience is very important, especially in understanding the surrounding environment and in improving critical thinking skills.

Research conducted by Latifah et al. (2018) showed that there was a significant increase in students' critical thinking skills using BIP. Popular scientific books that can be used to improve critical thinking skills are books that fulfill several criteria. This is in line with research by (Plomp & Nieveen, 2007) which states that these criteria include valid, easy to use (practical), and have broad benefits and are effective in learning.

Research The development of local potential-based teaching materials to improve critical thinking has been carried out by Irwandi et al. (2019) in his research, it was found that students' responses to popular scientific books (BIP) scored 88.5% which indicated that students responded positively to BIP (BIP). A similar study by Latifah et al. (2018) showed that there is a significant increase in students' critical thinking skills using BIP for species diversity in the Anacardiaceae family. A similar study was also reported by Fajrin et al. (2021) in his research, which showed a significant increase in students' critical thinking skills after using BIP about the Avicennia genus and was declared eligible for use in learning.

Based on those research, it encourages the researcher to conduct research on the development of popular scientific books on butterfly diversity in Mangrove Forests as subject matter for Invertebrate Zoology in an effort to improve students' critical thinking skills.

B. Method

The type of research used in this research is development research which is tested using Tessmer's formative evaluation. The research model that chosen to develop teaching materials is the Tessmer model. Tessmer's formative evaluation design was chosen because it was systematic and considered suitable for testing

the use of teaching materials in the form of BIP. The stages of its development consist of 5 steps: self-evaluation, expert test, individual test, small group test and field test with a limited number of subjects. This formative evaluation is used to produce a valid, practical and effective BIP. Preliminary research was conducted to obtain the initial product, namely the BIP of the Sungai Bakau mangrove forest.

Data collection techniques are carried out for obtain a valid, practical and effective BIP by:

1) The validity of the BIP is carried out through an expert test and supported by an individual test to obtain data on the practicality of the contents of the BIP.
2) The practicality of expectations and actuals was obtained through the opinions of students in the small group test (consist of 3 students), using student response instruments as users and implementation instruments by observers.
3) The effectiveness of the expectations obtained from the small group test includes: critical thinking skills obtained from the results of working on the Practicum Guide and BIP-based evaluation questions using a practicum guide validation instrument.
4) The actual effectiveness obtained from field testing includes: critical thinking skills obtained from the results of working on practicum guides and BIP-based evaluation questions using the critical thinking ability rubric. Critical thinking skills obtained from student answers on test questions and practical guides. Adapted from Watson (1980), assessments in this study include five indicators, namely, formulating questions, identifying assumptions, making problem solutions, evaluating arguments and drawing conclusions.

C. Results and Discussion

1. Validation of Popular Scientific Book

a. Expert Validation

BIP validation "Butterfly in the Mangrove Forest Area of Sungai Bakau Village" was obtained from expert validation which was strengthened by individual tests. The following are the results of the validation by 3 experts in Table 1.

BIP validation assessment "Butterfly in the Mangrove of Sungai Bakau Village" based on Table 1 shows that the average percentage result is 96.3% with a very valid category or can be used without revision, which means the Popouler Scientific Book "Butterflies in the Mangrove Village Mangrove River" is ready for use.

Table 1 Expert Validation

Aspect	Average
1. Coherence	3.88
2. Readability	4.00
3. Vocabulary	4.00
4. Active and passive sentences	4.00
5. Protecting value: words that mean uncertainty	3.50
6. Applications, implications	3.92
7. Definition and explanation	4.00
8. Other styles of devices: narration, humor and analogy	4.00
Average	**3.75**
Percentage	**96.3**
Criteria	**Very Valid**

(Source: Results of data processing)

Some of the advantages possessed by BIP "Butterfly in the Mangrove Area of Sungai Bakau Village" which can improve students' critical thinking skills, such as cover design. The cover design is very influential on someone's reading interest, because an eye-catching cover can gives the impression that the contents of the book are interesting to read. This is in line with the results of Agustina's research (2015) that the influence of book cover design on one's reading interest, the better the book cover design, the more it attracts the attention of readers and one's reading interest grows. Therefore, the BIP cover design has these advantages so that students are interested to reads it in an effort to improve students' critical thinking skills.

The pictures shown in the BIP "Butterflies in the Mangrove of Sungai Bakau Village" are pictures with the same colors as the real butterflies. This is to make it easier for students or other readers to easily recognize the types of butterflies in the mangrove forest area so that students' critical thinking skills could increase. BIP is very easy to understand because the presentation of the material is accompanied by pictures (Rahmawati et al., 2019). This is also reinforced by (Behnke, 2018) which states that students can easily investigate or research through visual attention or images rather than through text.

The preparation of the BIP which is done in such a way will make it easier for students to learn Invertebrate Zoology. The statement above is in line with Suwarni (2015) that the coherence of the content of teaching materials ease the students to learn and guides students to get used to thinking coherently. This is reinforced by Suherli (2008) that the

presentation of material in a book must be done in a systematic, task, and easy-to-understand manner so that it can encourage the motivation of readers to find out more about the material presented.

b. One-to-one evaluation

The second stage is an one-to-one evaluation which aims to conduct an assessment by students who are BIP users. The assessment is reviewed from several components: readability, interactiveness and ease of use. The results of the one-to-one evaluation can be seen in Table 2.

Table 2 One-to-one evaluation

No.	Validated Indicators/Aspects	Average
1	Easy to learn and understand	3.67
2	Instructions for using the book and how to carry out tasks are clear.	3.67
3	The entire contents of the book are complete in a logical order.	3.67
4	The words used in the book are easy to understand.	3.67
5	The picture quality is good and the meaning is understandable.	3
6	No typos or grammar errors found.	3
7	The photo on the cover is clear and understandable	4
Average (%)		**88.1**
Criteria		**Very good**

(Source: Results of data processing)

Based on the data obtained at the individual test stage (readability components, interactive components, ease of use components) compiled and analyzed to revise the BIP. The results of student responses to BIP are included in the very good category in terms of readability, interactiveness and ease of use. At this stage, the assessments using students who have taken the Invertebrate Zoology course, which as the users assessment criteria. Nurhidayati et al. (2017) stated that the purpose of this one-by-one trial was an attempt to obtain empirical evidence about the feasibility of a limited initial product. Individual testing is focused on emphasizing more on process factors than on learning outcomes. This is in line with Setiawan (2017) who argues that BIP will get very good results if the process of designing and developing the material in the book is carried out very well. This is in line with Fajrin et al. (2014) which states that individual tests are carried out so that the message or content of the reading can be accepted by the reader as intended by the author.

The presentation of BIP butterflies in the mangrove forest with clear pictures that are the same as the original butterflies ease the students to identify and understand the diversity of butterfly species. This is in line with Dharmono et al. (2019) which states that the presentation of material in teaching materials accompanied by pictures associated with knowledge and adapted to student experience can improve students' critical thinking skills in learning. Therefore, the results of students' positive responses to learning using BIP are expected to improve critical thinking skills of students who use it.

2. Practicality and Implementation of BIP

a. Expected and Actual Practicality

The practicality of the butterfly BIP in the mangrove area is divided into 2 parts: the practicality test of the contents obtained from the results of student responses and those obtained from the implementation test assessed by the observer. Based on the data from student responses and implementation tests, the expected and actual practicality are obtained in Table 3 and Table 4.

Based on these data, it can be seen that students' opinions on the use of BIP in studying Invertebrate Zoology are easier to learn and understand with the material presented. They consider that studying butterflies using BIP aim which contains descriptions and pictures can ease them to determine the characteristics and identification process of butterflies. This is also expressed by several studies, including by Abadi et al. (2017) which explained that scientific papers must be easy to use with the aim of motivating students not to be lazy, not bored, and more enthusiastic in the teaching and learning process.

They consider that learning using BIP is advantageous and fosters interest to participate in Invertebrate Zoology learning activities. The pictures contained in the butterfly BIP make learning in the Invertebrate Zoology course, especially for material about butterflies, more interesting. BIP can foster a positive attitude for Invertebrate Zoology courses so that students strongly agree to use BIP as teaching material for Invertebrate Zoology learning.

Table 3 Expected and Actual Practical Test Results

No.	Statement	Average	
		Small test	Field test
1	BIP provides motivation to learn.	5.00	5.00
2	Can learn actively and independently.	4.67	4.67
3	The material presented can be understood easily.	4.67	4.60
4	The book is very interesting and not boring.	4.67	4.60
5	The concepts of the lesson material can be remembered easily and longer.	4.33	4.13
6	Help solve problems in everyday life related to learning topics.	4.67	4.67
7	Broaden your horizons.	4.33	4.33
8	Can understand the material with the help of pictures with good quality.	4.33	4.53
9	Can learn according to the needs of independent study.	4.33	4.33
10	Can help me develop critical thinking skills.	4.33	4.47
Amount		**45.33**	**45.33**
Percentage		**90.67**	**90.67**
Average (%)		**90.67**	
Criteria		**Very Practical**	

(Source: Results of data processing)

Table 4 BIP Implementation Test Results

No	Student Activities	Average Score	
		Small group	Field test
1	Reading the front (table of contents, instructions and explanation of contents)	3	3
2	Read the introductory information	3	3
3	read the description of general information	1	2
4	Look at the pictures and descriptions in popular scientific books	3	3
5	Paying close attention to the explanation of the characteristics of butterflies	3	2
6	Read facts about Butterflies	3	3
7	Reading the glossary	2	2
8	Using BIP when making observations	3	3
9	Using BIP when doing data analysis	3	3
Amount		**24**	**24**
Percentage		**88.89**	**88.89**
Average (%)		**88.89**	
Criteria		**Very good**	

(Source: Results of data processing)

The advantages of the developed BIP make this teaching material very practical because the BIP that had developed contains the characteristics and benefits of butterflies accompanied by the pictures displayed in the BIP are images with the same colors as the real butterflies, making it easier to identify the species of butterfly studied. The developed BIP presentation is structured in such a way as to make it easier to understand and learn. This statement is also strengthened by Fitriansyah (2018) which states that the developed BIP is in a very practical category which means that it is very easy to use and be utilized in learning.

3. Effectiveness of BIP

The butterfly BIP effectiveness test data is divided into two stages: the expected effectiveness obtained from the test results on the Small Group, and the actual effectiveness obtained from the Field Test. The effectiveness of expectations is carried out to determine whether the BIP developed is in accordance with what is expected by the researcher, while the actual effectiveness is carried out to determine the reality in the field whether or not the indicators to be developed are achieved. The following are the results of the expected and actual effectiveness tests as set out in Tables 5 and 6 below.

Table 5 Expectation Effectiveness Test Results

No	Indicator	Average	Criteria
1	Interpretation	87.50	Very good
2	Assumption	92.50	Very good
3	Deduction	87.50	Very good
4	Argument Analysis	85.00	Very good
5	Inference	90.00	Very good
Average		**88.50**	**Very good**

(Source: Results of data processing)

Based on the results of the expected and actual effectiveness test from the table above, it

can be proven that between the expectations of butterfly BIP efficacy and its implementation in learning is matched and appropriated. Based on the data in Table 5, the results of the effectiveness of expectations are in the very good category. Meanwhile, the actual effectiveness test in Table 6 shows that at the initial meeting it was in the good category and at the final meeting it was in the range with the very good category. The results of the scores for each meeting shows that BIP containing butterflies in mangrove forests can be effective in learning for students' critical thinking skills.

Table 6 Actual Effectiveness Test Results

No	Indicator	Meeting I		Meeting III	
		Average	Criteria	Average	Criteria
1	Interpretation	59.83	Enough	88.00	Very good
2	Assumption	59.50	Enough	90.83	Very good
3	Deduction	60.33	Good	88.33	Very good
4	Argument Analysis	59.50	Enough	84.00	Very good
5	Inference	61.17	Good	90.33	Very good
Average		**60.07**	**Good**	**88.3**	**Very good**

(Source: Results of data processing)

Table 7 Students' Critical Thinking Skills

Critical Thinking Indicator	*Field Test*		*N-Gain*	Criteria
	Meeting I	Meeting III		
Interpretation	59.83	88.00	0.70	High
Assumption	59.50	90.83	0.77	High
Deduction	60.33	88.33	0.71	High
Argument Evaluation	59.50	84.00	0.60	Medium
Inference	61.17	90.33	0.75	High
Average score			**0.71**	
Average criteria				**High**

(Source: Results of data processing)

The efficacy data is obtained from student learning outcomes when learning using BIP. The result that has been obtained shows that the reliability is not much different, which means the reliability of the developed BIP is good. These data indicate that the BIP was developed to be used as an enrichment material for the Invertebrate Zoology course in an effort to improve students' critical thinking skills in an effective category. Several studies on BIP have been carried out by Fajeriadi (2017), Fitriansyah et al. (2018), and Ardiansyah (2017) state that BIP is very effectively used to improve learning outcomes.

Based on the average results of all indicators of critical thinking skills there is a high change, this is inseparable from the ability to work in groups in solving problems. The research results of Winarti et al. (2019) shows that problem solving activities in learning, in addition to improving problem solving skills, students' critical thinking skills also increase along with increasing problem solving skills, especially if these activities are carried out collaboratively.

The use of BIP developed in Invertebrate Zoology learning based on the results of its implementation (expected and actual) can improve students' critical thinking skills. The factor causing the increase in critical thinking skills is thought to be the advantages possessed by BIP butterfly diversity in the mangrove forest area. The statement put forward by Wulandari et al. (2018) on critical thinking skills, students are trained to investigate problems, and provide direct experience through experiments by utilizing learning resources both from books and from the surrounding environment.

Student learning outcomes when viewed from each indicator, the argument analysis indicator is lower than the other indicators. This is because at the time of the field test some students were able to assess the statements or opinions received both from themselves and others, but there were also some students who were less thorough and focused in assessing the opinions or statements of solving a problem. Students who are able to analyze or know the level of understanding and mastery of a person in a subject or competency will be able to easily grow their critical thinking skills.

The results of this argument analysis must be studied more deeply in its overall meaning with an understanding of the concepts possessed, so that it takes quite a long time, because some students do not have time to give the assessment. This time limitation makes some students become anxious, lose focus and lose concentration. This is in line with Cowden's (2011) statement that anxiety often makes students view their abilities negatively, lose control, and result in not understanding the situation at hand. As a result of the inability of students to control their anxiety, they cannot write down any answers so they cannot complete the questions given.

In this study, students were directed to complete collaborative learning. This is in accordance with the results of Isjoni (2012) which explains that cooperative or group learning can foster critical thinking skills because students can be actively involved in the learning process. The improvement of students' critical thinking skills cannot be separated from the learning process. This illustrates that the BIP has been effectively implemented in learning. This BIP has several advantages so that it gets very good effectiveness results.

The following are the advantages of the developed BIP: (1)Have an attractive appearance; (2)Make it easier for students and other readers to introduce species of butterfly species in the mangrove area because of the pictures shown in the picturesbeep"Butterfly in the Mangrove of Sungai Bakau Village" is an image with colors that match the original butterfly; (3) Facilitate the learning of Invertebrate Zoology because of the presentationbeeparranged in such a way that it is easily understood by students.

D. Conclusion

Development research with the Tessmer design has succeeded in producing a BIP (BIP) entitled "Butterflies in the Mangrove of Sungai Bakau Village" with the following criteria:

1) The BIP that has been developed is stated to be very valid based on the results of expert validation with a score of 96.3%, while based on the BIP individual test, the score is 88.1% with a very good category.
2) The BIP that has been developed is stated to be practical to use based on student responses that get results of 94.7% with the criteria of strongly agreeing and the implementation of the use of BIP which gets an average of 88.89% with very good criteria.
3) The BIP that has been developed is stated to be effective to use based on increasing student learning outcomes with an average score of 88.30% with very good criteria and increasing critical thinking skills getting an average N-Gain of 0.71 which was in high criteria. The value of each indicator of critical thinking ability is: Interpretation in high category, Assumption in high category, Deduction high, Argument analysis in medium and Inference with high category.

E. Acknowledgments

The completion of the writing of this journal cannot be separated from the help of several parties; therefore the authors are very grateful to:

1. Author's husband and parents.
2. Supervising lecturer from ULM's Master of Biology Education.
3. Administrative staff Master of Biology Education
4. Research team

Without the help of the parties above, the writer would not be able to complete the research properly, therefore, with all due respect, the author would like to thank you.

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