

Effectiveness of popular scientific books about the diversity of ornamental plants to train high school students' critical thinking skills

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Article Information	Abstract
Keyword: Validity; Practicality; Effectiveness; Popular scientific book; Ornamental plant Kata Kunci: Validitas; Kepraktisan; Keefektifan; Buku ilmiah populer; Tanaman hias History: Received : 11/04/2023 Accepted : 16/06/2023	No research has been conducted in the Pagat tourist area which has various types of ornamental plants that can be processed as teaching materials in the form of popular scientific books based on local potential to train high school students' critical thinking skills. The purpose of this study was to describe the effectiveness of popular scientific books. The research method uses formative evaluation based on Tessmer's design which consists of self-evaluation, expert validation (3 lecturers), individual test (3 students), small group test (5 students) and field test (10 students). The results of the research on the effectiveness of the BIP as a result of the development found that the criteria were very good for use by high school students because they had been fulfilled, which meant that the BIP was easy to use. This is supported by the positive response from students towards learning using the developed BIP. Students' critical thinking skills are included in the medium category with an average N-Gain of 0.5 so that they can be implemented in learning. In conclusion, the development of BIP development results is effectively used in an effort to train students' critical thinking skills. Abstrak Belum ada dilakukan penelitian di Kawasan objek wisata Pagat yang memiliki berbagai macam jenis tanaman hias yang dapat diolah sebagai bahan ajar berbentuk buku ilmiah populer berbasis potensi lokal untuk melatih kemampuan berpikir kritis siswa SMA. Tujuan penelitian ini untuk mendeskripsikan keefektifan buku ilmiah populer. Metode penelitian menggunakan evaluasi formatif berdasarkan desain Tessmer yang terdiri dari evaluasi diri, validasi ahli (3 dosen), uji perorangan (3 siswa), uji kelompok kecil (5 siswa) dan uji lapangan (10 siswa). Hasil penelitian keefektifan BIP hasil pengembangan mendapatkan kriteria sangat baik digunakan oleh siswa SMA karena telah terpenuhi yang artinya BIP mudah digunakan. Hal ini didukung oleh respon positif dari siswa terhadap pembelajaran menggunakan BIP hasil pengembangan. Kemampuan berpikir kritis siswa termasuk kategori sedang dengan rata-rata N-Gain sebesar 0,5 sehingga dapat diimplementasikan dalam pembelajaran. Kesimpulannya pengembangan BIP hasil pengembangan efektif digunakan dalam upaya melatih kemampuan berpikir kritis siswa.

A. Introduction

An effort to develop learning resources needs to be designed systematically by utilizing local wisdom, based on the needs of learning activities and student characteristics by developing learning resources by utilizing the environment as a learning resource (Dharmono et al. 2019). Like teaching materials in general, locally charged teaching materials include materials that can facilitate students and teachers in achieving a learning goal in class, but the difference lies in the material or learning methods that have been adapted to local conditions or local wisdom (Al Ghani et al., 2019). Good teaching materials are teaching materials that can help improve the learning process. According to Adi et al. (2020) it is estimated that there are 25 thousand to 35 thousand species of plants in Indonesia which are either scattered throughout the region or grow in groups that grow in an area. One of them is in the Pagat tourist area.

In the area of the Pagat Tourism object, various types of flora or plants are deliberately planted because they have advantages when viewed in terms of their beauty and have special benefits. Pagat Village or also known as a tourist village is a village that has great natural potential, because of this the village's potential can be used as an interesting educational object. The Pagat tourist attraction is located in the Meratus mountain region and is included in the wetland environment, namely the highland watershed which is well known to local and non-local tourists. In the Pagat tourist area, there are various types of ornamental plants that people deliberately plant to beautify tourist attractions with various forms such as shrubs, shrubs, vines, herbs, or trees. According to Marbun et al. (2022) ornamental plants are all types of plants grown for the aesthetic beauty of both flower plants, trees, fruits and vegetables.

Many groups of ornamental plants have not been identified, so this research has the potential to be used as a source of learning as well as an effort to preserve the diversity of flora, especially ornamental plants in the Pagat tourist area. According to Fajrin et al. (2021) local potential that can be used as a source of learning, namely the potential where the plants studied can be easily found in certain areas. Irwandi et al. (2019) states that local potential-based learning resources make the student learning process more interesting and efficient. According to Rahmah et al. (2021) books are better known as a source of knowledge from ancient times until now, not only for educational knowledge at schools or colleges but also for

ordinary people so that books developed into popular scientific books.

Popular scientific books are usually written by adapting, quoting, and processing information from several other people's writings rather than writing purely on main ideas, opinions, and expressions (Yunizarrakha et al., 2018). Popular scientific books are developed based on local potential in an effort to train students' critical thinking skills. The pressure for future curriculum is higher to improve critical thinking skills in the learning process in class (Surahman & Surjono, 2017). The ability to think critically encourages students to think using logic in analyzing and evaluating the information obtained so that it will produce solutions to problems that will occur. The ability to think critically is very important to be able to live successfully and be able to face all the challenges that will occur now and in the future (Kumalasari & Putra, 2021). Therefore, students' critical thinking skills can be trained using the developed BIP that utilizes the school environment or student residence.

The school environment can help students develop positive character and train critical thinking skills (Irwandi et al., 2019). Students' critical thinking skills can be trained through learning Biology, especially those associated with the environment. Utilizing the surrounding environment as a learning resource, students get a varied learning atmosphere and avoid boredom (Ardyati et al., 2022). Teaching materials developed must be contextual, meaning that they come from the surrounding environment and are closely related to everyday life (Aisyi et al., 2013). The popular scientific book on the diversity of ornamental plant species in the tourist area of Pagat village which was developed is a local potential contained in a teaching material in an effort to train high school students' critical thinking skills. According to Sarpani et al. (2020) this locally charged learning product is very helpful in giving students an understanding of ethnobotany and adding insight into the use of local plants in their area.

Research has never been conducted in the Pagat tourist area so researchers are interested in conducting research by developing BIP based on local potential in an effort to train high school students' critical thinking skills.

B. Material and Method

This type of research is development research. Development research begins with preliminary research to produce an initial product, namely BIP

"Ornamental Plant Species Diversity". The next stage is evaluation using the Tessmer (1998) model, including (1) self-evaluation; (2) expert review; (3) individual test (one-to-one); (4) small group test; and (5) field tests (field tests). In the formative stage testing of popular scientific books is carried out to gain effectiveness.

Expected effectiveness data were obtained from the results of LKS and evaluation questions by SMA class XI IPA students in the Small Group test consisting of 5 students and actual effectiveness was obtained from the results of LKS and evaluation questions by students in the Field test consisting of 10 students. Students' critical thinking skills include five indicators, namely interpretation, analysis, evaluation, inference and explanation and then calculated using the formula for the normalized n-gain value (N-Gain or g) adapted from Facione (2011) as Formula 1.

$$g = \frac{S_{\text{posttest}} - S_{\text{pretest}}}{S_{\text{maximum}} - S_{\text{pretest}}} \dots \dots \dots \text{Formula 1}$$

Information:

g = gain value

S Post-test = KBK score meeting 3

S Pre-test = KBK score meeting 1

Critical thinking can be identified with high or low criteria based on N-gain, namely the classification in Table 1.

Table 1 N-Gain Classification

Category g value	Category g value
$g \geq 0,7$	High
$0,7 > g \geq 0,3$	Moderate
$g \leq 0,3$	Low

(Source: Adaptation by Hake, 1999)

Students' critical thinking skills are obtained from the results of focusing on five indicators of critical thinking according to Facione (2011) including 1) interpretation, 2) analysis, 3) evaluation, 4) inference, and 5) explanation as well as making and determining the results of consideration by students based on the answer key question. Student scores are obtained by looking at the results of the LKS in groups and individual student evaluation questions. This assessment uses a rubric with a score of 1-4, then calculated by the Formula 2.

$$\text{Student scores} = \frac{\text{Total score obtained}}{\text{Max amount}} \times 100\% \dots \dots \text{Formula 2}$$

The value range in Table 2 serves to determine the difference between the high and low levels of students' critical thinking skills.

Table 2 Range of Critical Thinking Skills

Category Score	Category Score
85,00 – 100	Very good
70,00 - < 85,00	Good
60,00 - < 70,00	Enough
50,00 - < 60,00	Not enough
0 - < 50,00	Less

(Modification Kunandar, 2015)

C. Results and Discussion

The Popular scientific books developed can be seen in Figure 1. Data on the effectiveness of BIP "Diversity of Ornamental Plants" was obtained from data analysis of students' critical thinking abilities in working on student worksheets (LKS) and evaluation questions. At the stage of testing the effectiveness of expectations, 1 meeting was carried out to see the results of learning using the BIP as a result of the development, exercises were carried out in working on worksheets and evaluation questions by being accompanied and directed by researchers.

In the actual effectiveness testing stage, 3 meetings were held. The second and third meetings were carried out in independent field tests using the developed BIP as teaching materials for working on student worksheets (LKS) containing direct observations and using BIP products and answering evaluation questions in the field tests.

The BIP expectations effectiveness obtained an average value of 64.16. This shows that the BIP developed in Biology learning in high school is expected to be able to train students' critical thinking skills in the sufficient category (see Table 3). The actual effectiveness of the BIP at meeting 1 was scored 66.23 and increased to 86.27 at meeting 3. These shows that the BIP resulting from the development of Biology learning in high school can train students' critical thinking skills in a very good category (see Table 4). Improving students' critical thinking skills includes 5 indicators of critical thinking skills, namely interpretation, analysis, evaluation, inference and explanation can be seen in Table 5.

The actual effectiveness result is 0.5 with the medium N-Gain category. N-Gain currently means that the BIP resulting from the development can help students in terms of practicing critical thinking skills. However, there are still deficiencies in the developed BIP so that it does not get high N-Gain values and less repetition so that further research is strengthened by journals. The effectiveness of the BIP developed includes 1) expected effectiveness with sufficient criteria, and 2) actual effectiveness with very good criteria.



Figure 1 Front and Rear BIP Covers (in Indonesian)

Table 3 Expectations Effectiveness of the BIP

No	Indicator	Meeting 1			
		LKM	Evaluation	Amount	Average
1	Interpretation	75.00	66.67	142	70.8
2	Analysis	75.00	50.00	125	62.5
3	Evaluation	66.67	66.67	133	66.7
4	Inference	75.00	66.67	142	70.8
5	Explanation	66.67	33.33	100	50.0
Amount		358,34	283,34	642	320,8
Average		64,16			
Category		Enough			

Table 4 Actual Effectiveness of the BIP

No	Indicators	Meeting 1 Meeting 3				Meeting 1 Meeting 3			
		LKM	Evaluation	Amount	Average	LKM	Evaluation	Amount	Average
1	Interpretation	65,00	70,00	135	67,50	80,00	86,67	167	83,34
2	Analysis	65,00	66,67	132	65,84	95,00	83,33	178	89,17
3	Evaluation	55,00	66,67	122	60,84	95,00	86,67	182	90,84
4	Inference	75,00	63,33	138	69,17	85,00	80,00	165	82,50
5	Explanation	75,00	60,00	135	67,50	90,00	80,00	170	85,00
Amount		335	326,33	661	331,16	445	416,67	862	431,33
Average		66,23				86,27			
Category		Enough				Very Good			

Table 5 N-Gain Test Results for Students' Critical Thinking Ability

No	Critical Thinking Skills Indicator	N-Gain Field Test
1	Interpretation	0,5
2	Analysis	0,6
3	Evaluation	0,6
4	Inference	0,5
5	Explanation	0,5
Average		0,5
Category		Moderate

Data for testing the effectiveness of BIP as a result of the development were divided into two stages, namely the expected effectiveness in the small group test and the actual in the field test as seen from student learning outcomes. Several studies of BIP have been conducted by Fajeriadi, (2018); Fitriansyah et al. (2018) stated that BIP was very effective in increasing critical thinking skills. This is reinforced by Ridhana et al. (2021) that developing BIP can improve students' critical thinking skills.

The results that have been obtained on the BIP development results are able to improve students' cognitive learning outcomes. This popular scientific book can improve student learning outcomes because it is written in an easy-to-understand way so that readers more easily grasp the intent of the author's thoughts. Improving students' cognitive learning outcomes is also influenced by the good critical thinking skills of these students. This is reinforced by Wicaksono (2014) who states that critical thinking is one of the factors that influence cognitive learning outcomes. This is clarified by Page & Mukherjee (2006) that critical thinking is related to higher-order cognitive skills such as analysis, evaluation and synthesis. Facione (2011) also states that critical thinking is the result of a process of interpretation, analysis, evaluation.

Students' critical thinking skills were analyzed based on assessments of filling out student worksheets and answering evaluation questions. Evaluation questions in the form of multiple choices aim to determine student success in learning. This is in accordance with Achadah (2019) explaining that evaluation is an assessment process to describe student achievement based on predetermined criteria. Meanwhile, to assess students' critical thinking skills, it can be seen from the five indicators of critical thinking skills, namely interpretation, analysis, evaluation, inference and explanation.

The following is an indicator of critical thinking skills for students' critical thinking skills in BIP used in Biology lessons.

1. Interpretation

The interpretation ability indicator obtained the N-Gain value in the field test of 0.5. In the interpretation ability when doing practicum students are required to read the discourse on the LKS to be able to examine a problem from the discourse so that they can formulate the problem correctly.

Students' ability to interpret obtains a moderate score because students in the learning process are oriented to identify problems to be solved and students are directly involved in determining the problems to be resolved. Another reason why interpretation has increased is because in the developed BIP there are questions that invite students to think critically so that it makes it easier for students to understand what is meant by interpretation. The ability of students' interpretation will make it easier for them to determine problems regarding the diversity of ornamental plant species. If students determine the problem correctly, then students will also make a hypothesis correctly. This is in accordance with Sari et al. (2018) interpretation is the ability to understand, explain and interpret data and information. In addition, Dewi et al. (2017) explains that indicators of interpretation ability can be seen from students who have started to train to predict and make data presentations.

2. Analysis

The analysis indicator for critical thinking skills in the field test obtained a value of 0.6. This shows that students can put forward an analysis of the formulation of the problem that has been stated before. Students' ability to analyze can be seen when these students can identify actual problem solving very precisely. This is in line with Sari et al. (2018) analysis is the ability to identify links from information used to express thoughts or opinions.

Increased students' ability in analysis because students are guided to give their opinion on the problems that exist in the interpretation. Students with good analytical skills will have problem solving correctly. This is in accordance with Azizah et al. (2018) stated that critical thinking skills are students' cognitive processes in systematically and specifically analyzing the problems they face, being able to distinguish these problems carefully and thoroughly, and identifying and studying information to plan strategies for solving these problems. This opinion is reinforced

by Stobaugh (2013) who explains that critical thinking is deep reflective thinking in decision making and problem solving to analyze situations, evaluate arguments, and draw appropriate conclusions. People who think critically are people who are able to conclude what they know, know how to use information to solve problems, and are able to find relevant sources of information to support solving the problems they face.

3. Evaluation

The evaluation indicator in the field test obtained a value of 0.6. Students' ability to evaluate can be seen when students can assess the statements or opinions received very precisely. This is in line with Sari et al. (2018) stated that evaluation is a person's capacity to test a fact.

Students' ability in evaluating has increased because students are guided in assessing the statements or opinions received. Students with good evaluation skills will have an assessment of the information received. This is in line with Pratiwi et al. (2015) explained that evaluation is related to questions about a problem, specifically one's ability to evaluate the credibility of one's statement of opinion or draw conclusions based on the relationship between information and concepts. Agnafia (2019) evaluation ability is used to assess the strengths and weaknesses of arguments.

4. Inference

The inference indicator gets an N-Gain value in the field test of 0.5. These results can be seen when students can make hypotheses based on problems that exist in the interpretation process. Facione (2011) inference is identifying every argument needed to draw a reasonable conclusion, to form conjectures and hypotheses, and to consider relevant information. This is in line with Pratiwi et al. (2015) on the inference aspect, students can draw a conclusion in problem solving. The conclusions drawn should be the answer to the problems that are made, so that they can prove the truth. This is reinforced by the opinion of Benjamin et al. (2021) after discovering the concept, students are expected to be able to match the conclusions with the hypotheses that have been made. Also Edi & Rosnawati (2021) stated that inference ability can be developed based on the results of hypothesis testing that has been done by students.

5. Explanation

The explanation indicator gets an N-Gain value in the field test of 0.5. Explanation results can be seen when students can explain or state their

thoughts based on evidence, methodology and concepts. This is in line with Sari et al. (2018) stated that explanation is the ability to explain or express ideas based on evidence, methodology and context. This is reinforced by Pratiwi et al. (2015) that explanation, namely one's ability to express one's reasoning when giving reasons for the justification of an evidence, concept, methodology, and logical criteria based on information received or existing data. Ilaah & Yonata (2015) explained that critical thinking can help students understand material and concepts can be remembered for a longer period of time because these concepts were discovered by students themselves. Antika (2015) states that increasing students' critical thinking skills in learning is one of the variables to improve cognitive learning outcomes.

Based on the overall average value of N-Gain, the results obtained in the field test were 0.5 in the medium category. This shows that the developed BIP can train students' critical thinking skills so that it can be concluded that the developed BIP has been effectively implemented in Biology learning in high school. This research is in line with Fajrin et al. (2021) concerning the development of a popular scientific book on the ethnobotany of mangroves of the *Avicennia* genus in an effort to improve students' critical thinking skills, obtained an average N-gain effectiveness of 0.4 in the medium category. N-Gain in the moderate category is affected by the repetitions carried out during the study, where at the time of the research the researchers carried out only up to 3 repetitions, while it was only carried out up to 3 repetitions. This indicates that if the repetition is done only 3 times, the N-gain that will be obtained is only up to the moderate criterion, but if it is carried out more than 3 times, it is likely that the N-gain value will be high.

Improved critical thinking skills can occur in accordance with the implementation of the use of BIP. This happened because during the learning activities students made observations and answered evaluation questions very well. This is in line with Antika (2015) that increasing critical thinking in learning is one of the variables to improve cognitive learning outcomes. This statement is reinforced by Purnaningsih et al. (2019) stating that student learning outcomes are influenced by increased critical thinking skills.

Improving critical thinking skills is inseparable from the advantages of BIP as a result of the development because the material content of this BIP is complete, such as an overview of the Pagat tourist attraction, types of ornamental

plants in the Pagat tourist area, and the important role of ornamental plant species for the environment. Then, an attractive cover design and the pictures displayed are in accordance with the original ornamental plants to facilitate identification of the species of ornamental plants being studied. In addition, the presentation and appearance of the BIP material is in accordance with the level of education so that it is easily understood by students, as well as there are questions for critical thinking skills in the developed BIP. Therefore, the BIP diversity of ornamental plants in the tourist area of Pagat is effective for use in learning, especially in Biology subjects and can train students' critical thinking skills.

Noorhidayati et al. (2022) stated that based on an analysis of the results of observations made and through direct interviews with school principals, biology teachers and students at school, there were still schools with very limited and insufficient enrichment teaching materials. This is due to the limited ability of teachers to develop the preparation of teaching materials as enrichment of existing learning materials in the environment. This is in line with Irianti & Mahrudin (2022) that contextual learning is highly expected in the development of education in the 21st century, which requires teachers to be more creative in developing learning tools, including teaching materials. This is what underlies the researchers to develop teaching materials in the form of BIP based on local potential that is effectively used in Biology learning in schools.

The scientific impact on education is as follows: teachers obtain references for the development of teaching materials based on effective local potential which can facilitate students in understanding learning and practicing critical thinking skills because the material is in the surrounding environment. The weakness of this research is that the material developed is only in the form of ornamental plant species, not all of the plant families so that it can only be used on certain materials. Therefore, there is a need for more extensive material development.

D. Conclusion

Based on the results of the research and discussion of the conclusions, the BIP was declared effective based on the results of the LKS (Student Worksheets) and evaluation questions by ten students using popular scientific books developed by doing three repetitions so that an N-Gain score was obtained with moderate criteria.

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