RESEARCH ARTICLE

The popular scientific book-based coastal gastropod's diversity as local potential: Practicality and effectiveness on student's critical thinking ability

Hery Fajeriadi[a,1,*], Muhammad Zaini[a,2], D. Dharmono[a,3], Bimo Aji Nugroho[b,4], F. Fahmi[c,5], Antung Fitriani[d,6]

[a] Study Program of Biology Education, Faculty of Teacher Training and Education, Universitas Lambung Mangkurat, Jl. Brigjend H. Hasan Basry Banjarmasin, South Kalimantan 70123, Indonesia

[b] Study Program of Biology Education, Faculty of Teacher Training and Education, Universitas Borneo Tarakan, Jl. Amal Lama Tarakan, North Kalimantan 77115, Indonesia

[c] Study Program of Natural Science Education, Faculty of Teacher Training and Education, Universitas Lambung Mangkurat, Jl. Brigjend H. Hasan Basry Banjarmasin, South Kalimantan 70123, Indonesia

[d] SMP Negeri 24, Jl. Sultan Adam Banjarmasin, South Kalimantan, Indonesia, 70122

[1]heryfaje@gmail.com*; [2]muhammadzaini@ulm.ac.id; [3]dhar66@ulm.ac.id; [4]bimoajinugroho29@borneo.ac.id; [5]fahmi@ulm.ac.id; [6]antungfitriani2811@gmail.com

For correspondence:
heryfaje@gmail.com

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Abstract: Developing learning tools based on local potential is necessary because it directly relates to students' daily lives. One of them is a Popular Science Book (PSB), which highlights the potential of gastropods in coastal areas as a subject for observing biodiversity. The implementation of assessments and the value of students' critical thinking abilities still need to be improved. This research aimed to implement the PSB based on its practicality and effectiveness in improving students' critical thinking abilities. The research method used formative evaluation, focused on testing the practicality and efficacy of valid development products. Practicality was analysed based on student response tests through the percentage of responses and the implementation of the learning plan (LP) through categorization. Furthermore, effectiveness was analysed based on student learning outcomes through the percentage of completeness and achievement of critical thinking ability indicators through the N-gain test. The research results prove that the PSB developed was practical and effective. Apperception and interpretation were two of the three stages of implementation of the LP that received the highest average, where students could provide theoretical ideas based on appreciation of environmental issues. This was also supported by the student's critical thinking ability tests, where the interpretation aspect obtained the highest N-gain. The development of local potential-based PSB shows positive impacts, especially ease of use, interest in learning, motivation, apperception, and interpretation. However, it is still necessary to study in more depth the causal factors and solutions for the differences in results between the implementation of the LP at the conclusion stage and the indicators of critical thinking in the inference aspect.

Keywords: coastal gastropods; development implementation; local potential; popular scientific books

Introduction

Local potential-based learning has been around for a long time, even more than the last ten years (Sarah & Maryono, 2014; Marlina et al., 2015; Amanda et al., 2016; Anisa, 2017; Kahar & Fadhilah,

2018; Setyaningsih et al., 2019; Suryanda et al., 2020; Sriyati et al., 2021; Busyairi et al., 2022; Rahmi et al., 2023). This learning in the 21st century is associated with higher-order thinking skills HOTS (Sriyati et al., 2021; Aprilia & Wulandari, 2022). Higher-order thinking skills, one of which is critical thinking, need to be mastered by students to face future challenges, both at the national and global levels (Zubaidah, 2016; Fahmi & Irhasyuarna, 2019). Unfortunately, the implementation of assessments (Lane & Oswald, 2016; Mukti & Istiyono, 2018) and the value of students' critical thinking skills is still relatively low (Amijaya et al., 2018; Agustine et al., 2020; Wangsa et al., 2021). Relatively low critical thinking skills are one of the educational challenges in producing graduates ready to face challenges as themselves, as members of society, and as part of work institutions.

Research linking critical thinking skills based on local potential has been carried out for quite a long time (Fahmi, 2016; Aji, 2017; Fahmi, 2018; Budiarti & Airlanda, 2019; Fahmi et al., 2019; Muslimahayati, 2020; Suryani & Wilujeng, 2020; Fahmi et al., 2021; Agustinasari et al., 2021; Irhasyuarna et al., 2022; Hastuti & Alanis, 2022). These studies examine critical thinking skills from various points of view. These points of view include contextual learning, which can improve critical thinking through direct learning in the environment and is more relevant to students, training critical thinking using discovery learning models, apart from, using problem-based learning models, utilizing local potential, discussions about environmental issues, use of e-learning media, ethnoscience, and development of learning tools.

It is believed that learning based on local potential can be implemented in schools in Indonesia, considering its natural and cultural riches. Coastal areas, for example, have natural riches typical of wetland ecosystems (Fitriansyah et al., 2018; Hairiani et al., 2018; Irwandi et al., 2018; Misniyati et al., 2018), but not all of them are known to have benefited from the community, for example, gastropods. Gastropods are invertebrates that occupy many habitats, including the littoral or coastal zone (Fajeriadi et al., 2018a). Twenty-two gastropods were found in the littoral zone of Pulau Sembilan, Kotabaru Regency, of which 19 have been identified and published, 12 species from the Archaeogastropoda order (Fajeriadi et al., 2018b), five species from the Mesogastropoda order, and two species from the Neogastropoda order (Fajeriadi et al., 2019a). Several types of gastropods have been used as a side dish to replace fish, fishing bait, fish food, and handicraft materials (Fajeriadi et al., 2018a). Besides that, certain types of gastropods are also used as ingredients for wound healing, anti-microbial activity, skincare, and cosmetics (Liegertová & Malý, 2023; Rashad et al., 2023).

Utilizing local potential as a learning resource can be done using various methods or in multiple forms, such as PSB. At least 30 studies on the development of PSB based on local potential have been published and indexed in Google Scholar from 2019 to 2023. Some of them depart from local coastal potential. Zaini and Arsyad (2021) developed coastal biology PSB positively affects students' interpretation, analysis, evaluation, inference, and self-regulation skills, but not explanation. Astuti et al. (2021) developed a PSB for superior types of coastal water shrimp in terms of readability and inference aspects. Millianton et al. (2021) developed a PSB for mangrove shrubs, obtaining the highest student response in presenting attractive images and illustrating problems and concepts in everyday life. Fitriani et al. (2022) developed a PSB for mangrove aquatic plants as an attractive flipbook that is easy to understand and positively affects critical thinking skills, especially aspects of argumentation and inference. Suga et al. (2022) developed a PSB for coastal forest birds that achieved the highest implementation in the aspect of use in observation and analysis of observational data.

The results of the research above regarding the development of PSB based on local potential as an independent variable show difference. Some excel at the introductory stage, some at the core, and some at the end of learning. Apart from that, there are also differences in results on the critical thinking aspect, which is the dependent variable. This synthesis shows that the development of PSB based on local potential for critical thinking still needs to be studied further. These results become a reference for implementing PSB on coastal gastropod diversity and the students' critical thinking abilities in coastal schools. This implementation is also supported by the results of surveys at the coastal schools of Pulau Sembilan Kotabaru and Tanjung Dewa Pelaihari, namely the need for environment-based learning by bringing samples to class or bringing students to observe the natural habitat of coastal biodiversity. The PSB prototype for gastropod diversity that will be implemented has been validated and tested for readability by Fajeriadi et al., (2019b) with valid results based on the PSB preparation guidelines, which are interesting and easy to understand. Astuti et al. (2021) and Zaini and Arsyad (2021) stated that a valid PSB must be retested for its practicality and effectiveness. Specifically for testing critical thinking skills, Watson and Glaser (2002) divide critical thinking into five aspects: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments.

Based on the synthesis above, this study aims to analyze the implementation of PSB on coastal gastropod diversity and its effect on students' critical thinking skills. The implementation of PSB in this study is a continuation of studies that include practicality and product effectiveness tests from previous publications regarding its validity. The analysis will strengthen the results of previous research, specifically, the use of local potential-based PSB for critical thinking skills and, more broadly, for higher-order thinking skills, which is a challenge for 21st-century education. This research is also the

basis for further studies on similar research regarding utilizing local potential as a learning resource and its effect on the quality of education, especially thinking skills.

Method

The implementation of the PSB for coastal gastropod diversity was researched through a formative evaluation of the Tessmer (1998) model with the flow as in Figure 1. SIPUT: Situs Tepi Laut Pulau Sembilan Kotabaru is the PSB implemented in this research. The results of this PSB validation can be seen in Fajeriadi et al. (2019b), and this PSB has been published through Lambung Mangkurat University Press. The preparation of this PSB follows the format from Hanum (2016) and is equipped with critical thinking aspects from Watson and Glaser (2002) in the form of instructions.
The PSB design is designed to be adaptive so that it can complement educators' LPs, as well as students' independent learning activities. The implementation of PSB was carried out at SMA (Senior High School), namely SMA Abdul Kadir Panyipatan, Tanah Laut Regency, whose location is similar to SMA Negeri 1 Pulau Sembilan, Kotabaru Regency as the initial location plan, namely close to the coast known as Tanjung Dewa Pelaihari Beach. The change in research location was caused by high waves in November-December, so the Sabuk Nusantara ship, used as a means of sea transportation, was not operating. This research was conducted in the classroom and on Tanjung Dewa beach for direct observation.

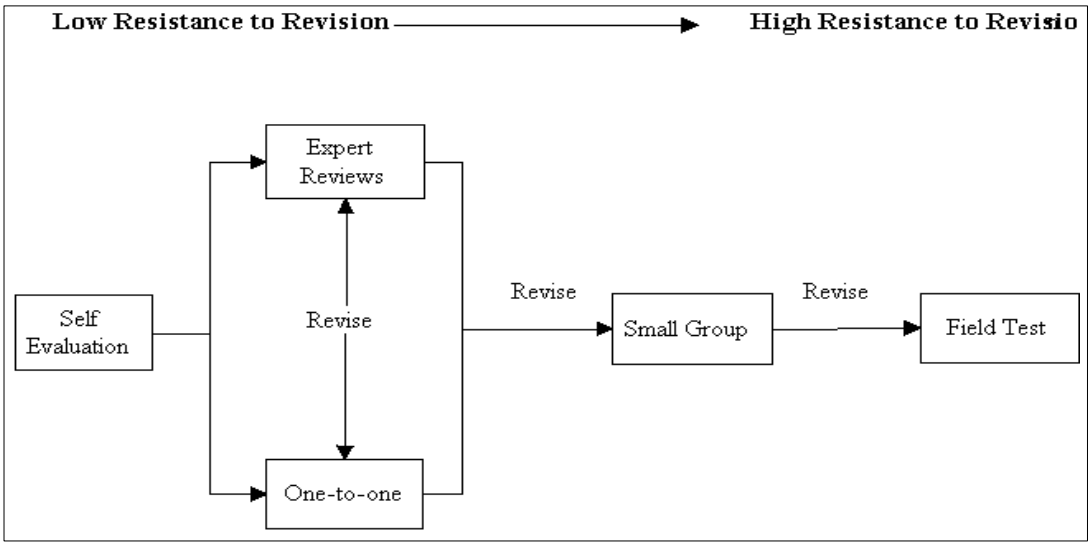

Figure 1. Tessmer (1998) formative evaluation flow

The research subjects, data collection techniques, and data analysis techniques in the practicality test are divided into two, including:

1) The biology teacher is the subject of the implementation of the LP, which is recorded using observation techniques. The observation technique is carried out by providing a checklist on the instrument containing details of the stages of learning activities, giving a score with a range of 1-4, and then analyzing descriptively in categories according to Table 1.
2) Five students were the subjects of student responses, which were recorded using questionnaire techniques. The questionnaire technique is carried out by asking questions, giving a score with the provisions Very Agree (VA) = 5, Agree (A) = 4, Undecided (U) = 3, Disagree (DA) = 2, and Strongly Disagree (SDA) = 1. The percentage of the data was then calculated and analyzed descriptively.

In addition, data collection techniques and data analysis techniques in the effectiveness test involving twenty students include:

1) Assessment of classical completeness of cognitive learning outcomes, assessed based on the results of answering pretest and posttest questions. Students are declared complete if they get a minimum score of 70. The percentage of correct answers is calculated using Formula 1 and then analyzed descriptively.
2) Students' critical thinking abilities are assessed based on groups of questions in the pretest and posttest according to aspects of critical thinking. Students' critical thinking progress was analysed using the N-gain test between pretest and posttest scores using Formula 2, then analysed

descriptively by categorization according to Table 2.

$$\text{Classical completeness} = \frac{\text{Number of students who completed}}{\text{Total number of students}} \times 100\% \quad (1)$$

$$\text{gain} = \frac{\text{Postest score} - \text{Pretest score}}{\text{Maximum score} - \text{Pretest score}} \quad (2)$$

Table 1. LP implementation score categories

Score	Category
3.6-4.0	Very good (performed according to procedure)
2.6-3.5	Good (partially carried out according to procedure)
1.6-2.5	Less good (done a small part)
1.0-1.5	Not good (not carried out according to procedure)

(Source: Ratumanan & Laurens, 2011)

Table 2. N-gain value categories

g value	Category
g > 0.7	High
0.3 < g < 0.7	Medium
g < 0.3	Low

(Source: Hake, 1999)

Results and Discussion

The development product in this research was a popular scientific book based on the results of the exploration of local potential in biodiversity material. The local potential referred to in this research was the diversity of gastropods in the coastal area of Pulau Sembilan, Kotabaru Regency. This book is entitled "SIPUT: Situs Tepi Laut Pulau Sembilan Kotabaru". The name for this work was later shortened to PSB SIPUT. Based on the results of the implementation of PSB SIPUT, practicality data, which includes the implementation of the LP, can be seen in Table 3, while student responses are in Table 4. Furthermore, effectiveness data, which provides for classical completeness, can be seen in Table 5, while critical thinking skills are in Table 6.

Table 3. Implementation of the learning plan (LP)

Activity	Stage	LP implementation score		Average	Category
		Observer 1	Observer 2		
Initial	Apperception	4	4	4.0	Very good
	Motivation	3	3	3.0	Good
Core	Interpretation	4	4	4.0	Very good
	Assumption	3	4	3.5	Good
	Deduction	4	3	3.5	Good
	Inference	3	3	3.0	Good
Closing		4	4	4.0	Very good
Average				**3.6**	**Very good**

Table 4. Student responses

No	Questions	Score
1.	Learning Biology has made me have a high desire to take part in the lessons	23
2.	Learning Biology has made me have a high desire to make good use of my study time	23
3.	Learning Biology makes it easier for me to understand the lesson	25
4.	Biology learning is exciting and not boring	23
5.	Learning Biology allows me to eliminate my misconceptions	20
6.	If Biology learning is carried out like this, I can remember the concepts from the lesson material longer	20
7.	Biology learning can help solve problems in everyday life related to learning topics	20
8.	Learning Biology has broadened my horizons	22
9.	If Biology learning is carried out using a PSB, it can improve learning achievement	20
10.	If biology learning is carried out like this, it can increase group work enthusiasm	21
11.	Learning Biology can improve my reasoning in studying lesson topics	22
12.	Learning Biology can help me think more critically	20
13.	Learning Biology can increase my creativity	21
14.	Learning Biology can make me feel more respected in expressing my opinions	22

No	Questions	Score
15.	The biology learning that was carried out gave me the courage to express my opinion	20
Total		**322**
Maximum score		**375**
Percentage (%)		**85.9**

The objectives of developing PSB include facilitating students to learn independently (Fitriansyah et al., 2018; Latifah et al., 2020), being structured interestingly, using popular language, and sometimes containing humor to arouse readers' interest (Hanum, 2016). The level of practicality shows that the development product is easy for teachers and students to use (Setiawan et al., 2017; Mudiartana et al., 2021). Referring to the analysis results based on Table 3 and Table 4, the PSB SIPUT developed was categorized as very practical. This PSB SIPUT makes it easier for students to understand and develop critical thinking.

Table 3 shows that the average LP implementation score reached 3.6 and is included in the very good category. This indicates that, overall, the learning process observed by the two observers has gone well. However, consideration still needs to be taken to adjust the motivation strategy to reach the same level as the other stages. Apart from that, aspects of deduction, inference, and assumptions still need to be given more attention to ensure a balance between each aspect of learning. This analysis is supported by Table 4, which shows the percentage of students' positive responses to learning activities at 85.9%. These results indicate that students assess biology learning positively. However, follow-up is needed through concept understanding tests and evaluations to ensure a better understanding of students through learning activities using PSB SIPUT based on local potential.

Biology learning based on local potential encourages students to build their understanding and relationship with reality or phenomena they experience in everyday life (Situmorang, 2016; Nurmalasari, 2019; Sriyati et al., 2021). This activity can increase interest in learning (Irwandi & Fajeriadi, 2019; Aroyandini et al., 2020; Sriyati et al., 2021), motivation (Situmorang, 2016; Aroyandini et al., 2020; Ule et al., 2021), and enthusiasm for learning (Irwandi & Fajeriadi, 2019; Aroyandini et al., 2020; Ule et al., 2021). So that learning becomes more meaningful (Nofiana & Julianto, 2018; Irwandi & Fajeriadi, 2019; Sudirgayasa et al., 2021). Using PSB based on local potential helps students understand the material better.

Table 5. Student cognitive learning outcomes

No.	Student class score	Pretest	Posttest
1.	Total	666.7	1650
2.	Highest score	66.7	91.7
3.	Lowest score	16.7	75
4.	Average	33.3	82.5
5.	Classical Completeness	0%	100%

Table 6. Results of evaluation of students' critical thinking

Indicator	Score percentage (%)		N-gain	Category	Average	Category
	Pretest	Posttest				
Interpretation	25.0	91.7	0.9	High	0.8	High
Assumption	55.0	91.7	0.8	High		
Deduction	33.3	83.3	0.8	High		
Inference	20.0	63.3	0.5	Medium		

The effectiveness analysis supports the results of the practicality analysis. Based on Table 5 of cognitive learning results, it is known that the average student score was initially 33.3 obtained at the pretest, then increased to 82.5 at the posttest. Students receive 100% classical completeness. Then, the results of N-gain critical thinking ability received the high category with an average score of 0.8, according to Table 6. These results prove that PSB SIPUT, developed based on local potential, effectively improves cognitive learning outcomes and students' critical thinking abilities. Based on these results, the analysis is complete, and implementing PSB SIPUT based on local potential can increase learning interest, motivation and enthusiasm for learning, and student learning outcomes.

Learning using PSB SIPUT becomes higher quality because biological material is integrated with students' everyday local potential and can be used independently. The observation instructions and evaluation questions are also integrated with critical thinking indicators. Not only that but PSB SIPUT is also equipped with 77 self-photographed images from observations on Pulau Sembilan Kotabaru, which are presented attractively. The benefits of this content are to make it easier for students to understand the material, easy for students to use for independent learning and for teachers to test critical thinking skills, attract students' interest, increase motivation, enthusiasm for education, and student achievement.

Quality learning can be realized using PSB based on local potential (Astuti et al., 2021; Zaini & Arsyad, 2021; Millianton et al., 2021; Fitriani et al., 2022; Suga et al., 2022). The use of learning resources based on local potential not only improves the quality of learning in the classroom (Nuralita, 2020; Sriyati et al., 2021) but also outside the classroom (Kahar & Fadhilah, 2018; Irwandi & Fajeriadi, 2019)The learning process becomes higher quality because students learn more actively. Students' activities in the learning process influence their learning achievement (Ebele & Olofu, 2017; Tokan & Imakulata, 2019; Theobald et al., 2020). Learning achievement reflects mastery and understanding of subject matter, independence, tenacity, skill development, and provisions for facing future challenges.
Students' critical thinking abilities increase by implementing local potential-based PSB in this research. Generally, similar results were obtained in previous studies, but the specifics differed. A comparative sample of the results from these studies can be seen in Table 7 as a basis for implications for future research follow-up. The indicators listed in Table 7 come from two references, Watson and Glaser (2002), explained previously, and Facione (1990), which include interpretation, analysis, evaluation, inference, explanation, and self-regulation.

Table 7. N-gain critical thinking previous research as a comparison sample

No.	Researchers	Average score	Category of critical thinking indicators								
			1	2	2	4	5	6	7	8	9
1.	Harlinson et al. (2023)	0.50	*	-	-	-	*	*	*	*	*
2.	Rusmana et al. (2023)	0.50	*	-	-	-	*	*	*	*	-
3.	Fitriani (2022)	0.53	*	*	**	**	**	-	-	-	-
4.	Rahayu et al. (2022)	0.71	**	**	**	*	**	-	-	-	-
5.	Astuti et al. (2021)	0.80	*	*	*	*	**				

Note: 1 = Interpretation; 2 = Assumption; 3 = Deduction; 4 = Argumentation; 5 = Inference; 6 = Analysis; 7 = Evaluation; 8 = Explanation; 9 = Self-regulation; * = medium; ** = high; - = not recorded/different reference

Based on a comparison between Table 6 and Table 7, the average N-gain scores and critical thinking indicator categories obtained are different. Still, the effectiveness of the increase is in the medium to high range. This proves that implementing PSB based on local potential effectively increases students' critical thinking, but the specific improvements differ for each indicator. Assumptions regarding the factors that influence these differences are based on references, including variations in learning methods (Ennis, 2016), student characteristics (Hastuti et al., 2018), learning styles (Samsudin & Hardini, 2019), learning environment (Jou et al., 2016), different local potential characteristics (Putri & Aznam, 2019), measurement instruments (Stupple et al., 2017), or time management (Santoso et al., 2021).
Based on these findings, it can be seen that PSB, based on local potential, still has research opportunities in the future. However, it is not only oriented toward producing valid, practical, or effective products but also requires further study of other factors that influence implementation results, especially each indicator of critical thinking. The effectiveness of implementing PSB based on local potential to improve students' critical thinking skills is considered to positively impact the development of HOTS in the 21st century. It is not limited to critical thinking skills, but other ability or skill indicators included in HOTS are essential for further study if the situation is similar. As previously explained, HOTS is needed by students to face challenges, both as themselves, as members of society, and as part of work institutions.

Conclusion

The development of SIPUT PSB based on local potential can be concluded to be practical and effective in improving students' critical thinking skills, especially for students in schools in coastal areas. The implementation of the LP received a very good category, and 85.9% of students gave a positive response as evidence of the practicality test. Based on the learning outcomes assessment, students obtained 100% classical completeness at the posttest stage, and the N-gain increase in critical thinking skills was 0.8 with a high category as evidence of the effectiveness test. It is proven that local potential-based PSB can be implemented well in learning activities, get positive responses, and improve learning outcomes and students' critical thinking skills as part of HOTS. However, specifically, there is still an opportunity to get different results on each critical thinking ability indicator. Several factors that can influence the differences in these results need to be studied further in development research, not only oriented toward producing valid, practical, and effective development products.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

H. Fajeriadi, M. Zaini, and **D. Dharmono:** methodology. **H. Fajeriadi, B. A. Nugroho,** and **F. Fahmi:** analysis**. H. Fajeriadi** and **A. Fitriani:** writing original draft preparation. **H. Fajeriadi, F. Fahmi,** and **A. Fitriani:** review and editing.

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