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ThinkNature.Id: Enhancing Problem-Solving and Creative Thinking Skills through Integrated Learning Websites in Problem-Based Learning

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Abstract: *Sustainable Development Goals (SDGs)* telah menjadi tuntutan dalam kurikulum sekolah untuk membekali siswa dengan pengetahuan, keterampilan, dan sikap yang dibutuhkan agar dapat berkontribusi pada pembangunan berkelanjutan. Salah satu implikasinya dalam pembelajaran Biologi adalah perlunya pengembangan keterampilan abad ke-21, antara lain keterampilan pemecahan masalah dan keterampilan berpikir kreatif. Penelitian ini bertujuan mengembangkan ThinkNature.id, website pembelajaran berbasis *Problem-Based Learning* untuk meningkatkan keterampilan pemecahan masalah dan berpikir kreatif siswa pada materi keanekaragaman hayati. Penelitian ini menggunakan model pengembangan Lee dan Owens. Hasil penelitian menunjukkan bahwa *ThinkNature.id* memperoleh kategori sangat valid dan sangat praktis. Implementasi website meningkatkan keterampilan pemecahan masalah dengan nilai *N-Gain* sebesar 0,51, sedangkan keterampilan berpikir kreatif juga mengalami peningkatan sebesar 0,64. Hasil uji ANCOVA menunjukkan perbedaan yang signifikan antara kelas eksperimen dan kontrol ($p = 0{,}001 < 0{,}05$). Dengan demikian, *ThinkNature.id* berbasis PBL dinyatakan valid, praktis, dan efektif dalam mendukung peningkatan keterampilan pemecahan masalah dan berpikir kreatif siswa
Kata kunci: Keanekaragaman hayati; Keterampilan Pemecahan Masalah; Keterampilan berpikir kreatif; Problem-Based Learning; ThinkNature.id.

Abstract: The Sustainable Development Goals (SDGs) have become a requirement in school curricula to equip students with the knowledge, skills, and attitudes needed to contribute to sustainable development. One implication for biology education is the need to develop 21st-century skills, including problem-solving and creative thinking skills. This study aims to develop ThinkNature.id, a Problem-Based Learning based educational website designed to enhance students' problem-solving and creative thinking skills in the context of biodiversity. This study employed the development model proposed by Lee and Owens. The results indicate that ThinkNature.id was categorized as highly valid and highly practical. Implementation of the website improved problem-solving skills, with an N-Gain score of 0.51, while creative thinking skills also increased by 0.64. ANCOVA test results revealed a significant difference between the experimental and control classes ($p = 0.001 < 0.05$). Therefore, the Problem-based learning based ThinkNature.id platform is deemed valid, practical, and effective in

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supporting the improvement of students' problem-solving and creative thinking skills.
Keywords: Biodiversity; Creative Thinking Skills; Problem-Based Learning; Problem-Solving Skills; ThinkNature.id.

1. Introduction

The Sustainable Development Goals *(SDGs)* have become a requirement in school curricula to equip students with the knowledge, skills, and attitudes needed to contribute to development [1]. 21st-century skills, particularly problem-solving, are closely linked to the achievement of the SDGs, especially SDG 4 (quality education). The integration of learning that emphasizes creativity, skills, and innovation has proven effective in preparing the next generation to face global challenges and support sustainable development.

According to Greenstain, problem-solving skills are defined as the ability to identify and analyze problems, formulate various alternative solutions, select the best solution, and evaluate the results [2]. Greenstain emphasizes that problem-solving is not merely about finding the correct answer, but rather an iterative process that involves critical thinking, creativity, and adaptability in facing unstructured challenges. However, research findings reveal that high school students' problem-solving skills are often still very low [3].

Based on the results of a needs analysis at SMA Negeri 3 Putra Bangsa, Aceh Utara, regarding students' problem-solving skills in biology learning among 62 students. Based on the problem-solving skill indicators, the average score of 53 for in the Identifies the Problem category falls into the needs guidance category, Identifies Multiple Solutions with an average score of 52 in the needs guidance category, and Defends the Solution with an average score of 62 in the adequate category. Therefore, it can be concluded that the students' problem-solving skills at this school are still relatively low, and guidance is needed to improve their problem-solving skills.

Students' poor problem-solving skills can lead to apathy and an inability to actively contribute to conservation, as they may understand biodiversity issues but do not know how to translate that knowledge into practical solutions[5]. Problem-solving skills are crucial for students because they help foster creative thinking and the ability to analyze problem situations to make decisions in real life [7] therefore,

low problem-solving skills represent a critical issue that must be addressed through active approaches in the learning process.

Conventional learning, which tends to be rigid and focused on single correct answers [8], centers on the transfer of knowledge and leaves little room for students to fully develop their potential [9]. This often results in students lacking motivation and struggling to connect the concepts they learn with real-life applications, as well as a lack of opportunities to express new ideas and concepts [10]. Research indicates that students' creative thinking skills remain in the low category[11], primarily because school-based learning still focuses on assessment centered on right-or-wrong answers, thereby failing to adequately foster creative thinking and lacking creative stimulation in the learning process.

The results of a needs analysis at SMA Negeri 3 Putra Bangsa, Aceh Utara, regarding creative thinking skills in biology learning among 62 students. Based on the indicators, 71.1% of students scored Good for Curiosity , 61.3% for Originality in the Adequate category, 59.8% for Fluency in the Needs Guidance category, 55% for Elaboration in the Needs Guidance category, 55.8% for Flexibility in the Needs Guidance category, and 57.4% for Evaluation in the Needs Guidance category. Thus, based on the results of the observations and interviews above, it is evident that students at this high school need to improve their creative thinking skills. Research shows that a learning environment that facilitates experimentation and freedom of expression significantly enhances creative thinking skills [12].

The use of websites as a learning medium has proven effective in increasing students' interest, conceptual understanding, and skill development, as well as creating a more engaging and meaningful learning experience [13]. Their flexibility and supporting features make websites an ideal platform for dynamic content and active interaction [14]. Several studies have shown that web-based learning can effectively stimulate students' problem-solving [15] and creative thinking skills [16].

Given the existing challenges, there is a need for a website platform supported by learning models that not only develop problem-solving skills but also simultaneously stimulate and facilitate the development of creative thinking skills. One effective approach is Problem-Based Learning. Research shows that the

implementation of PBL significantly improves students' ability to identify, analyze, and find solutions to environmental problems at school [17]. It can empower students to improve their problem-solving skills [18] as well as their creative thinking skills and understanding of environmental issues [19].

The integration of Problem-Based Learning through a website is believed to create a learning environment conducive to the simultaneous development of these two crucial skills. Therefore, this study aims to bridge this gap by developing the ThinkNature.id website, which integrates Problem-Based Learning to enhance students' problem-solving and creative thinking skills in studying biodiversity-related material, while leveraging the potential of digital technology as an interactive learning medium relevant to the demands of the modern era.

2. Research Method

The research and development model used in this study is the Lee & Owens development model. The Lee & Owens model is specifically designed for the development of multimedia products, including educational media [20]. The stages of the Lee & Owens development model are presented in Figure 1

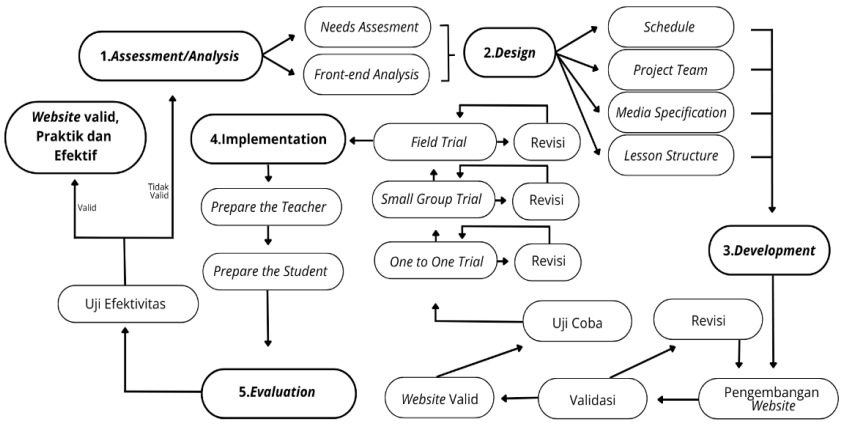


Figure 1 Research design modified from Lee and Owen stages (modified by researcher, 2026)

The research and development procedure follows the model proposed by Lee & Owens (2004), which consists of five stages: Assessment/Analysis, Design, Development, Implementation, and Evaluation. The Assessment/Analysis stage is conducted through needs analysis and front-end analysis to identify student characteristics, technology, context, tasks, problems, objectives, media, supporting data, and costs. The Design stage involves scheduling, assigning team tasks, and

specifying the ThinkNature.id. The Development stage includes creating storyboards, interface design, production, quality review, expert validation, formative evaluation through individual, small-group, and field testing, as well as product packaging. The Implementation stage is carried out by applying ThinkNature.id based on Problem-Based Learning in the classroom and testing its effectiveness using a non-randomized control group pretest-posttest design. Next, the Evaluation phase is conducted to assess user responses, improvements in problem-solving and creative thinking skills, and to analyze data on validity, practicality, and effectiveness through prerequisite tests, One-Way ANCOVA

a. Population and sample

The population in this study consisted of 131 students, or the entire tenth-grade student body enrolled at SMAN 3 Putra Bangsa in North Aceh. From this population, 66 students from classes X-3 & X-4 were selected as the research sample.

b. Instrument

The research instruments used in this study included validation questionnaires for a panel of media experts, teaching materials, learning modules, and biology education practitioners, as well as instruments to assess students' problem-solving and creative thinking skills. These instruments were developed and validated to ensure their validity and suitability for the students' circumstances.

c. Data analysis

The data analysis procedures in this study were conducted systematically to evaluate the validity, practicality, and effectiveness of the ThinkNature.id website, as well as to test the research hypotheses. The validity and practicality tests aimed to assess the quality of the developed ThinkNature.id website. The validation process involved four experts: a media expert, a content expert, a learning instrument expert, and an education practitioner. Validators and practitioners were selected based on their expertise and alignment with the specified criteria. Data on the website's validity and practicality were collected using a Likert-scale questionnaire. The data were analyzed descriptively in the form of percentages and aligned with the validity and practicality criteria in Table 1. The formula used is as follows:

$$V.ah = T.se/T.sh \times 100\%$$

Note:
V.ah : Expert validation
T.se : Total score achieved
T.sh : Expected total score

Table 1 Expert validation criteria

Value Range	Validation Criteria
100	Highly valid, or the product can be used without modification.
85.00 ≤ X ≤ 99.99	Highly valid, or the product can be used with minor modifications.
70.00 ≤ X ≤ 85.00	Valid, or the product can be used with moderate repairs.
55.00 ≤ X ≤ 70.00	Less valid, or the product can be used with major improvements.
40.00 ≤ X ≤ 55.00	Invalid, or the product cannot be used
X ≤ 40.00	Highly invalid, or the product cannot be used.

Source: adapted from Sulisetijono (2018)

d. Hypothesis Testing

Hypothesis testing used a *one-way* ANCOVA at a 5% significance level. In the ANCOVA analysis, a *p-value* <0.05 indicates that the null hypothesis is rejected. Before the ANCOVA was conducted, prerequisite tests were performed, including a normality test (*One-Sample Shapiro-Wilk*) and a homogeneity test (*Levene's Test of Equality of Error Variances*), with significance levels of >0.05 for each. If the calculated significance value exceeded 0.05, the data were considered normally distributed and homogeneous.

3. Results and Discussion

1. Results

a. ThinkNature.id Validation Results

The ThinkNature.id validation results are shown in Figure 2

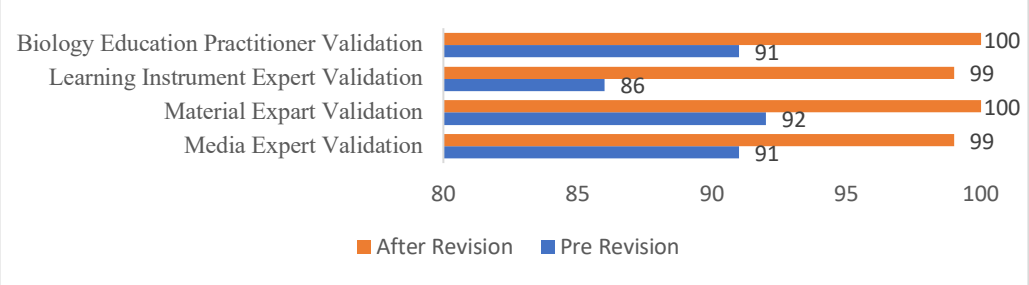


Figure 2 Results of the website validation

Based on Figures 2, the validation results for the learning products and instruments after revision achieved an average score of 99–100% and fell into the "highly valid" category. Expert validation indicated that the aspects of relevance, appropriateness, accuracy, content, instruments, and usability met the established criteria. These results are consistent with previous studies stating that expert validation is important for ensuring content appropriateness, instrument quality, and the effectiveness of media in supporting e-learning-based instruction [21], Therefore, it can be concluded that the ThinkNature.id website is suitable for use in biodiversity education to enhance problem-solving and creative thinking skills.

b. Thinknature.id Practicality Results

The ThinkNature.id practicality results are shown in Figure 3

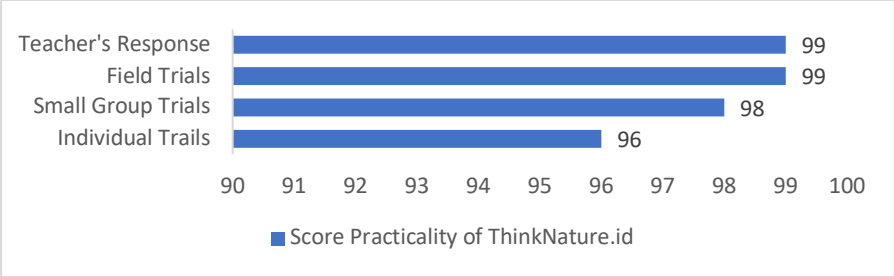


Figure 3 Score Practicality of ThinkNature.id

Based on Figures 3, the results of the ThinkNature.id website trials showed an excellent response rate, with individual trial scores of 96%, small-group trial scores of 98%, field trial scores of 99%, and teacher response rates of 99%. These results indicate that ThinkNature.id is practical, easy to use, and has received a positive response from both teachers and students. This demonstrates that the developed ThinkNature.id website received a positive response from students and can support the learning process. This aligns with research indicating that digital media can enhance 21st-century skills [22]. Therefore, it can be concluded that the ThinkNature.id website is practical for use in learning.

c. The Effectiveness of ThinkNature.id on Problem-Solving and Creative Thinking Skills

Analysis of students' problem-solving skills showed a significant improvement in the experimental class (X-3) compared to the control class (X-4). A

bar chart illustrating the results of the application of students' problem-solving skills is presented in Figure 4.

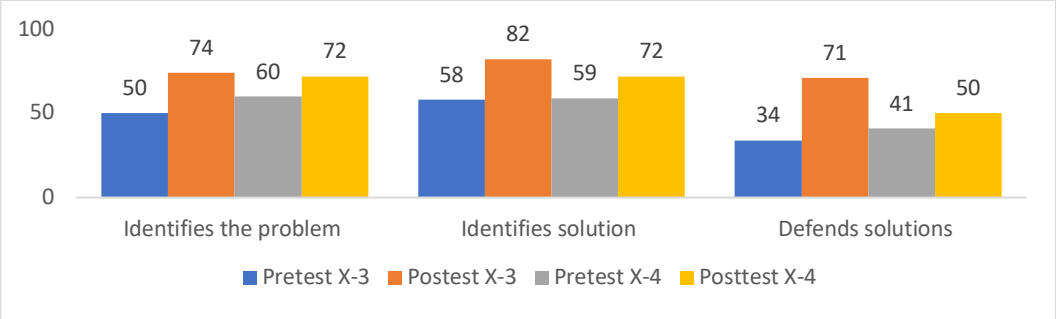


Figure 4 Results of students' problem-solving skills

Overall, Class X-3 showed an improvement in scores from pre-test to post-test on all indicators compared to Class X-4. This indicates that the PBL-integrated ThinkNature.id website successfully improved students' problem-solving skills. These findings are consistent with research at , which suggests that structured PBL supported by digital media can enhance problem-solving skills [23].

An analysis was also conducted on students' creative thinking skills. A bar chart illustrating the results of the application of students' creative thinking skills is presented in Figure 5.

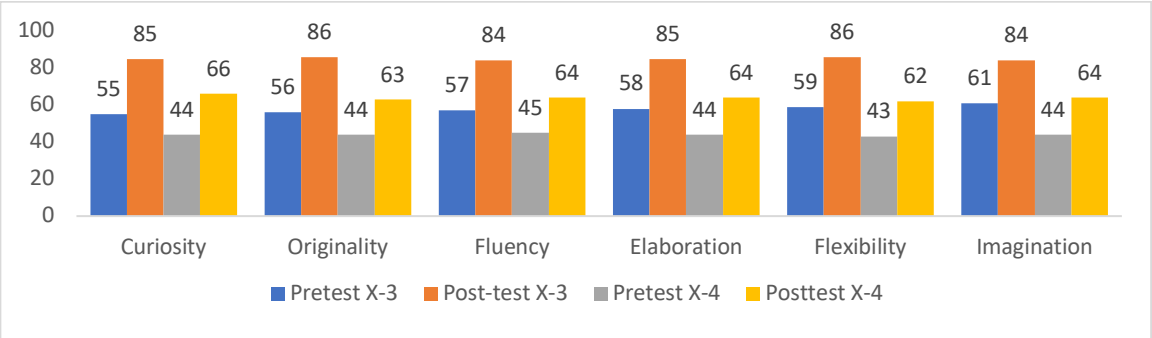


Figure 5 Results of students' creative thinking skills

Overall, Class X-3 showed an improvement in scores from pre-test to post-test on all indicators compared to Class X-4.. This indicates that the ThinkNature.id website used was highly effective in stimulating the generation of new, unique, and varied ideas. This finding aligns with research showing that structured problem-based learning supported by digital media can enhance creative thinking skills [24].

d. hypothesis testing results

The results of the prerequisite tests and hypothesis tests designed to measure problem-solving skills skills are presented in table 2.

Table 2. Prerequisite tests for student problem-solving skills

Prerequisite		Significance level	Description
Saphiro-Wilk	Pretest Experiment (X-3)	0.210	Normal
	Post-test Experiment (X-3)	0.105	Normal
	Pre-test Control (X-4)	0.069	Normal
	Post-test Control (X-4)	0.076	Normal
	Levene's Test	0.063	Homogeneous
	ANCOVA	0.001	Statistical Significance

The results of the prerequisite tests and hypothesis tests designed to measure students' creative thinking skills are presented in Table 3.

Table 3 Prerequisite tests for students' creative thinking skills

Prerequisite		Significance level	Description
Saphiro-Wilk	Pretest Experiment (X-3)	0.070	Normal
	Post-test Experiment (X-3)	0.072	Normal
	Pretest Control (X-4)	0.064	Normal
	Posest Control (X-4)	0.082	Normal
	Levene's Test	0.064	Homogeneous
	ANCOVA	0.001	Statistical Significance

Tables 3 and 4 show the results of the ANCOVA analysis for the variables of problem-solving skills and creative thinking, which yielded a significance value (Sig.) of 0.001. Since the significance value is less than 0.05 (0.001 < 0.05), it can be concluded that there is a significant difference in problem-solving and creative thinking skills, and that the ThinkNature.id website is effective in improving students' problem-solving and creative thinking skills.

2. Discussion

a. A study on the Development of the ThinkNature.id Biodiversity Website

The ThinkNature.id website was developed using the WIX platform because it can integrate various digital learning resources, such as Google Forms, Google Drive, Canva, YouTube, and others, thereby supporting interactive and easily accessible learning. The integration of these various media aligns with the concept of digital learning, which emphasizes flexibility of access, interactivity, and the integration of learning resources [25].

The Home page is designed as the main page that introduces the website's identity through a nature-themed layout and simple navigation. Based on the Cognitive Theory of Multimedia Learning, relevant visual presentations help direct

students' attention and build initial understanding of the material before the learning process begins [26]. The About page provides information on the website's objectives, concepts, and development background so that users understand the platform's functions before using it. Providing this information aligns with the principles of User-Centered Design, which emphasizes the importance of transparency and ease of understanding a digital system's functions [27].

The learning materials page is organized into six progressive sessions featuring summaries, illustrations, and instructional videos. This presentation aligns with the Advance Organizer theory and the Cognitive Theory of Multimedia Learning, which help students connect prior knowledge with new concepts [28]. The website also provides a discussion forum and worksheets as an implementation of the Problem-Based Learning approach. These features provide students with opportunities to discuss, exchange ideas, and solve problems collaboratively. The development supported by Vygotsky's theory of social constructivism, which emphasizes that knowledge is constructed through social interaction [29].

The assessment page provides pre-test and post-test instruments to measure problem-solving and creative thinking skills. These concepts align with Assessment for Learning, which enables teachers to monitor students' competency development throughout the learning process. [30]. The News page on the ThinkNature.id website presents a variety of information and current issues regarding biodiversity, conservation, and environmental problems to connect learning materials with real-world phenomena. This approach supports the principle of user-centered learning, which helps students relate biological concepts to environmental issues and improves their problem-solving skills [32]

b. A Study on the Effectiveness of the ThinkNature.id Biodiversity Website in Developing Problem-Solving Skills

The effectiveness of a learning medium is one of the key indicators of the extent to which that medium can improve problem-solving skills. The ANCOVA results showed a significance value of 0.001 ($p < 0.05$), indicating a significant difference in problem-solving skills between students who used the Problem-Based Learning based ThinkNature.id website and those who used conventional learning methods.

This indicates that integrating the website with PBL effectively improves students' problem-solving skills [33] , therfore supporting the research hypothesis.

Students' answers to the essay questions under the identifying problems indicator initially focused only on the difficulties of getting to school and disruptions to learning caused by flooding. After accessing the ThinkNature.id website, students were able to identify the problems more comprehensively, including the causes of flooding, damage to agriculture, losses suffered by the community, and water pollution. This skill was developed through the problem-based learning in problem-orientation phase, which used contextual environmental issues drawn from news articles, enabling students to connect the concept of biodiversity to environmental issues in their surroundings.[34]

Students' answers to the essay questions on the "identifying initial solutions" indicator tended to offer general solutions, such as reforestation and providing evacuation boats; however, after using the ThinkNature.id website, students were able to generate more diverse solutions tailored to the root causes of the problems, such as restoring river function, building levees and drainage systems, and cleaning up trash. This ability was developed through the guided inquiry phase of Problem-Based Learning, supported by contextual information on the website that helped students compare alternatives and determine solutions based evidence. [35]

Students' answers to the essay questions assessing the maintaining solutions indicator provided only simple justifications; however, after using the ThinkNature.id website, students were able to construct more comprehensive arguments by linking the causes of flooding, solutions, and supporting scientific rationale. This ability was developed through the phases of developing and presenting work in Problem-Based Learning, with the support of information on the website that helped students construct evidence-based arguments and make decisions more systematically.[36]

c. A Study on the Effectiveness of the ThinkNature.id Biodiversity Website in Developing creative thinking skills

The effectiveness of a learning medium is one of the key indicators of the extent to which that medium can improve creative thinking skills. The results of the

ANCOVA analysis showed a significance value of 0.001 ($p < 0.05$). This indicates that improvements in creative thinking skills are influenced by the use of the PBL-based ThinkNature.id website, which encourages students to explore ideas, discover alternative solutions, and generate creative thinking [37]

The curiosity indicator shows that before the lesson, students were less interested in exploring the causes of extinction, whereas after using the PBL-based website, they were more motivated to seek information, ask questions, and explore environmental phenomena. This indicates that the integration of the website and PBL can enhance curiosity through more active and meaningful learning [2]. The indicator of idea originality shows that before the lesson, students tended to generate general and similar ideas, whereas after the lesson, they were able to generate more creative and original ideas for introducing and conserving biodiversity. This indicates that a PBL-based website provides students with the opportunity to develop new and innovative thinking. [38]

Indicators of fluency in thinking show that before the lesson, students tended to have difficulty generating many ideas and were passive in discussions, whereas after the lesson, they were able to propose more ideas and alternative solutions through information exploration and group discussions. This indicates that PBL-based websites help students generate a variety of ideas fluently and relevantly[39]. The elaboration indicator shows that before the lesson, students had difficulty developing their ideas into detailed and systematic plans, whereas after the lesson, they were able to expand their ideas into more structured and realistic solutions. This indicates that a PBL-based website, through discussion and the presentation of results, helps students develop their ideas more thoroughly [40].

The flexibility indicator shows that before the instruction, students tended to produce monotonous and less varied solutions, whereas after the instruction, they were able to view problems from various perspectives and generate a wider range of alternative solutions. This indicates that integrating PBL with creativity-development strategies can enhance students' flexibility [41]. The imagination indicator shows that before the lesson, students tended to be less interested in creating solutions, whereas after the lesson, they were better able to imagine various possibilities, develop ideas, and visualize alternative solutions. This suggests that integrating PBL with creativity

strategies can enhance students' creativity through activities that involve generating and developing various alternative solutions [42].

3. Conclusion

The ThinkNature.id websiteon biodiversity through Problem-Based Learning, has been found to be valid, practical, and effective in improving high school students' problem-solving and creative thinking skills.

4. Limitation

This study has limitations in terms of its scope, which is limited to biodiversity; its limited measurement of problem-solving, manual assessment of essays and the lack of a "live discussion" feature. Future research is recommended to expand the subject matter, supplement the problem-solving indicators, implement automated assessment, and add a live discussion feature to enhance student interaction and collaboration.

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