Galore International Journal of Health Sciences and Research
[Indexed, Peer-Reviewed Journal]
Vol. 10; Issue: 3; July-Sept. 2025
Website: www.gijhsr.com
Original Research Article *P-ISSN: 2456-9321*

Implementing the FBEP Learning Model to Enhance Critical Thinking and Collaborative Learning in Environmental Education

Julhim S. Tangio[1], Ramli Utina[2], Frida Maryati Yusuf[3], Lukman Abdul Rauf Laliyo[4], Weny Musa[5], Masrid Pikoli[6]

[1,2,3,4,5,6]Postgraduate Program, Universitas Negeri Gorontalo, Indonesia

Corresponding Author: Julhim S. Tangio

DOI: https://doi.org/10.52403/gijhsr.20250306

ABSTRACT

This study seeks to examine the practicality and effectiveness of the Field-Based Environmental Problems (FBEP) learning model in enhancing students' socio-scientific reasoning skills and learning engagement in an Environmental Chemistry course. The research constitutes the implementation phase of a model development study, conducted through two stages of trials: a limited trial involving 10 students and a broader trial with 31 students from the Chemistry Education Program at Universitas Negeri Gorontalo. A quasi-experimental design was employed, specifically the One-Group Pretest-Posttest Design. Data were collected using observation sheets, student response questionnaires, and a socio-scientific reasoning skills test. Quantitative descriptive analysis was applied, supported by paired sample t-tests and Rasch model analysis. The results indicated that student engagement across the six phases of the FBEP model, including problem presentation, project briefing, field trip, field analysis, report writing, and reflection was consistently categorized as highly active in both trial phases. The improvement in pre-test and post-test scores on socio-scientific reasoning demonstrated the model's ability to foster critical and systematic thinking in analyzing socially grounded environmental issues. Student responses to the model's implementation were also categorized as highly positive, suggesting that FBEP is both practical and engaging for learners. Therefore, the FBEP learning model is well-suited for contextual and collaborative chemistry instruction at the higher education level.

Keywords: FBEP model, socio-scientific reasoning, collaborative learning, environmental chemistry, student engagement, contextual learning.

INTRODUCTION

In light of escalating environmental crises, ranging from ecosystem degradation and waste pollution to climate instability, educators face growing expectations to move beyond simply fostering awareness. They are increasingly expected to cultivate students' critical thinking and collaborative problem-solving abilities to support sustainable action. Environmental education, especially within science learning, aims to foster a sense of environmental responsibility among students. (Sabardila et al., 2019; Suryani, 2024). However, traditional instructional approaches often hinder the development of the cognitive and social competencies required to navigate and respond to complex, real-world environmental challenges (Presley et al., 2013; Ballantyne & Packer, 2009).

One of the primary shortcomings of traditional instructional practice is its tendency to prioritize content delivery over active, inquiry-based learning. Environmental issues are often presented to students in abstract and theoretical terms through textbooks, with minimal engagement in real-world contexts. As a result, students struggle to critically assess the causes and impacts of environmental problems and design realistic and collaborative solutions. Furthermore, classroom activities that emphasize individual work can hinder the development of shared understanding, the capacity to consider alternative perspectives, and teamwork, skills essential for 21st-century learning (Halim, 2022).

Contemporary educational discourse increasingly underscores the importance of integrating critical thinking and collaborative learning as core components of environmental education (Nurcahyani, 2024). Critical thinking involves analyzing evidence, reasoning logically, and questioning underlying assumptions, while collaborative learning fosters social interaction, communication, and shared responsibility in problem-solving (Lia et al., 2023). However, implementing both dimensions simultaneously within environmental education remains a pedagogical challenge. Educators often lack structured instructional models or strategies that effectively combine environmental content with real-world exploration and student-centered inquiry (Rickinson et al., 2004; Grooms, 2020).

In response to this gap, the present study implements the Field-Based Environmental Problems (FBEP) learning model, which integrates field activities, problem-based learning, and social interaction within a structured instructional framework. In contrast to conventional classroom strategies, the FBEP model positions students as active investigators of local environmental issues, encouraging direct engagement through field observations, collaborative analysis, and data-driven discussions. This model is based on the belief that critical and collaborative thinking skills are most effectively cultivated through authentic experiences supported by reflection and peer interaction.

This article investigates the role of the FBEP learning model in promoting critical thinking and collaborative learning in environmental education. Specifically, it explores how fieldwork, group projects, and authentic problem-solving tasks can enhance student engagement with environmental content while supporting cognitive and social development. Drawing on classroom observations, student reflections, and analysis of learning products, this study offers insights into the pedagogical potential of the FBEP model as an alternative approach to developing students' environmental awareness and sense of social responsibility.

MATERIALS & METHODS

This study constitutes a phase in developing the Field-Based Environmental Problems (FBEP) learning model, which had previously undergone expert validation. The primary aim of this phase was to evaluate the practicality, appeal, and effectiveness of the model in enhancing student learning engagement, socio-scientific reasoning skills, and student responses within the context of an Environmental Chemistry course. The research was conducted in two academic semesters: the second semester of the 2022/2023 academic year and the first semester of 2023/2024 at the Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Gorontalo.

Research Design

This study employed a quasi-experimental approach (Abraham & Supriyati, 2022) using a One-Group Pretest–Posttest Design (Marsden et al., 2012). In this design, a single group of students received instruction using the FBEP learning model. Measurements were taken both before and after the intervention to examine changes or improvements in learning outcomes. The structure of the design is illustrated as follows:

$\mathbf{X_1 \rightarrow O \rightarrow X_2}$

Description:

- **X_1**: Pre-test, initial assessment of socio-scientific reasoning skills
- **O**: Treatment, instruction using the FBEP learning model
- **X_2**: Post-test, final assessment of socio-scientific reasoning skills

Research Subjects

The study involved two groups of participants across separate trial phases. The limited trial included 10 students from the Chemistry Education Program enrolled in the Environmental Chemistry course during the second semester of the 2022/2023 academic year. The broad trial involved 15 students from the same program during the first semester of 2023/2024. Participant selection was based on their direct involvement in implementing the FBEP model and the relevance of the course content to the intervention.

Types and Sources of Data

Three main types of data were collected: (1) student engagement data based on the six instructional phases of the FBEP model, (2) socio-scientific reasoning skills data obtained through pretests and posttests, and (3) student response data regarding the implementation of the model. All data were derived directly from student participation during the instructional process and the results of assessment instruments administered throughout the study.

Data Collection Instruments

Three primary instruments were employed in this study. First, an observation sheet was used by observers to assess student engagement throughout each phase of the FBEP instructional model (problem presentation, project briefing, field trip, field analysis, reporting, and reflection). Second, a socio-scientific reasoning skills test was administered both before and after instruction. The test was developed based on four key indicators of socio-scientific reasoning and consisted of 10 items per indicator. Third, a student response questionnaire was designed using a five-point Likert scale to evaluate students' perceptions of the FBEP implementation.

Data Collection Techniques

Data were collected through direct observation of student activities by two independent observers trained using an observation guide aligned with the FBEP instructional syntax. The socio-scientific reasoning skills test was administered twice, once as a pre-test and as a post-test to measure changes in student abilities. Student perceptions of the learning model were assessed through questionnaires distributed after completing all instructional phases.

Data Analysis Techniques

Data in this study were analyzed using both descriptive and inferential quantitative approaches.

1. **Analysis of Student Engagement**
   Observation data on student engagement were analyzed descriptively to calculate the average percentage of student involvement across each phase of the FBEP learning model. The resulting percentages were then categorized as "active" or "highly active" based on established criteria ranges. These results were presented using pie charts, organized by learning phase and session.
2. **Analysis of Socio-scientific Reasoning Skills**
   Pre-test and post-test results for socio-scientific reasoning skills were analyzed using the Rasch Model approach (Uzun & Öğretmen, 2021). This analysis was conducted to evaluate the test instruments' reliability and validity and

identify the distribution of item difficulty and student ability using a Wright map. Skills were assessed across four indicators: (1) recognizing the complexity of issues, (2) analyzing problems from multiple perspectives, (3) identifying aspects requiring further investigation, and (4) critically examining biased information.

3. **Analysis of Student Responses**
   Student responses to implementing the FBEP model were analyzed descriptively using percentage scores, categorized into two levels: good (75%–85%) and very good (86%–100%). The results were illustrated in pie chart format for both the limited and broad trial groups.

RESULTS AND DISCUSSION

Analysis of Students' Socio-scientific Reasoning Skills

This study evaluated the effectiveness of the Field-Based Environmental Problems (FBEP) learning model by assessing students' socio-scientific reasoning (SSR) skills to determine its impact on their critical thinking abilities. The analysis was conducted using four core indicators: (1) the ability to recognize the complexity of socio-scientific issues through cause and effect, (2) the ability to analyze problems from multiple perspectives, (3) the ability to identify aspects of a problem that require further investigation, and (4) the ability to critically and skeptically evaluate potentially biased information.

Students were administered a socio-scientific reasoning (SSR) test consisting of 10 items, both prior to (pre-test) and following (post-test) the implementation of the FBEP learning model to assess these skills. Scoring was conducted using a standardized rubric designed to measure student performance on each indicator objectively. The resulting pre-test and post-test data were analyzed using the Rasch Model approach, allowing for a quantitative evaluation of instrument quality and student ability based on logit (log-odds unit) measurements.

Instrument reliability was examined through the Summary Statistics, which provided information on person reliability (the consistency of responses across participants) and item reliability (the ability of each item to measure the intended indicators consistently). The analysis revealed high levels of reliability for both respondents and items, indicating that the SSR instrument was appropriate and valid for measuring socio-scientific reasoning skills in this context.

Further analysis of instrument validity was conducted using the Wright Map. This map presents student ability (on the right side) and item difficulty (on the left side) along a shared logit scale, allowing for a direct comparison between student performance distribution and each test item's relative challenge. The Wright Map generated in this study demonstrated a positive shift in student ability following the implementation of the FBEP model, indicated by an overall movement toward higher logit values. For instance, the number of students classified as having very high ability increased from 4 (pre-test) to 7 (post-test), positioned at a logit score of +3.51. Conversely, the number of students in the very low ability category decreased, reflecting an overall improvement in socio-scientific reasoning skills.

Additionally, item B1 was identified as the most challenging question, with a logit value of +1.17, while item C2 was the least difficult, with a logit value of –3.22. Students who correctly answered item B1 typically demonstrated above-average ability, reinforcing the item's function as a strong discriminator of higher-level reasoning. In contrast, item C2 was answered correctly by nearly all participants, indicating its role as a baseline item for detecting minimum competence. Overall, the results of the Rasch analysis support the conclusion that the FBEP model not only enhances students' academic performance but also significantly strengthens their socio-scientific reasoning skills, particularly in the context of environmental education.

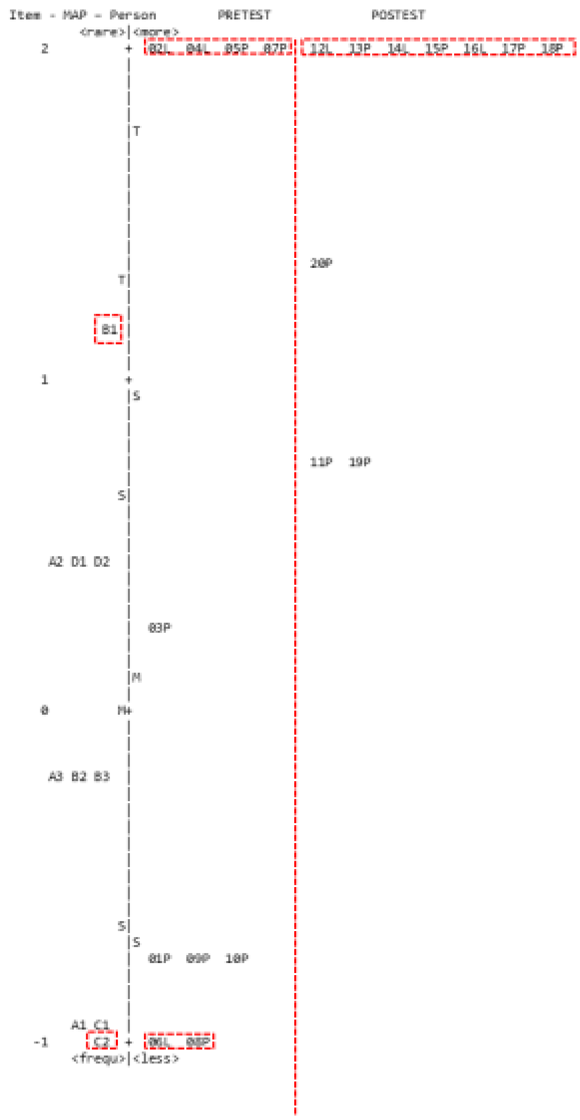


Figure 1. Wright Map of Limited Trial Data

Analysis of Student Activities During the Implementation of the FBEP Learning Model

Student engagement throughout the implementation of the FBEP learning model was examined across six core instructional phases, observed over six class sessions. These phases encompassed the entire learning trajectory, from problem identification to final reflection and assessment. The data were gathered through direct classroom observations involving Chemistry Education students from two academic year groups: those enrolled in 2020 and 2021 during the even semester of the 2022/2023 academic year, and those from the 2021 and 2022 intakes during the odd semester of 2023/2024. In total, the analysis included responses from 57 students.

In the first phase, involving problem presentation, students were guided to identify and formulate socio-scientific issues based on selected videos, articles, and reference materials. Their engagement during this stage was notably high, with an average participation rate of 90.38%, which qualifies as the 'very active' category. Students demonstrated strong enthusiasm in following the lecturer’s explanation and identifying relevant issues. However, activities related to formulating complex problem questions and describing cause-and-effect relationships showed relatively lower percentages, indicating areas where further improvement is needed.

In the second phase, which focused on preparation and project planning, students received foundational briefings on core ecological concepts, water pollution, sampling techniques, and water quality testing methods. Following this, they worked collaboratively to design a mini research project. The average participation rate during this stage was 87.1%, reflecting a strong level of student engagement. Activities such as listening to concept explanations and presenting project designs scored the highest. However, components like action planning and detailed project design fell within the 60% to 80% range, indicating a need for more structured guidance and facilitation.

In the third phase, emphasizing fieldwork or site visits, students were directly involved in conducting observations, interviews, sample collection, and field documentation. The overall participation rate during this phase was remarkably high, averaging 95.74%. Nearly all student groups successfully executed core activities such as field preparation, research implementation, and data verification. These outcomes affirm the effectiveness of a contextual, field-based learning model in enhancing student engagement and fostering collaborative work.

The fourth phase focused on laboratory analysis of the water samples collected during fieldwork. Student engagement during this stage was also strong, with an average participation rate of 90%. Most students were actively involved in preparing equipment and materials, conducting laboratory tests, compiling results, and presenting their findings. However, data analysis and interpretation activities remained at approximately 70%, indicating the need for additional support to strengthen students' scientific data processing and reasoning skills.

In the fifth phase, marked by project report writing, students were responsible for compiling and articulating the outcomes of their mini research projects in a final report. The average level of student participation at this stage was 86.05%. Activities involving the drafting and presenting the report were carried out exceptionally well, with completion rates reaching 100%. However, tasks requiring epistemological reasoning, such as responding to experiment-based questions and conducting analytical discussions, remained within the range of 60–83%, highlighting the need to strengthen students' argumentative and reflective skills.

The final phase, covering assessment and reflection, recorded the lowest level of student engagement, with an average participation rate of 79.6%, although still categorized as active. Students adequately reflected on the learning process and discussed areas for improvement. Nonetheless, activities involving the articulation of personal experiences (40–74%) and the identification of novel findings (50–67%) were less optimal. These findings suggest a need for targeted strategies to enhance students' metacognitive awareness and open inquiry during the closing stages of the learning process.

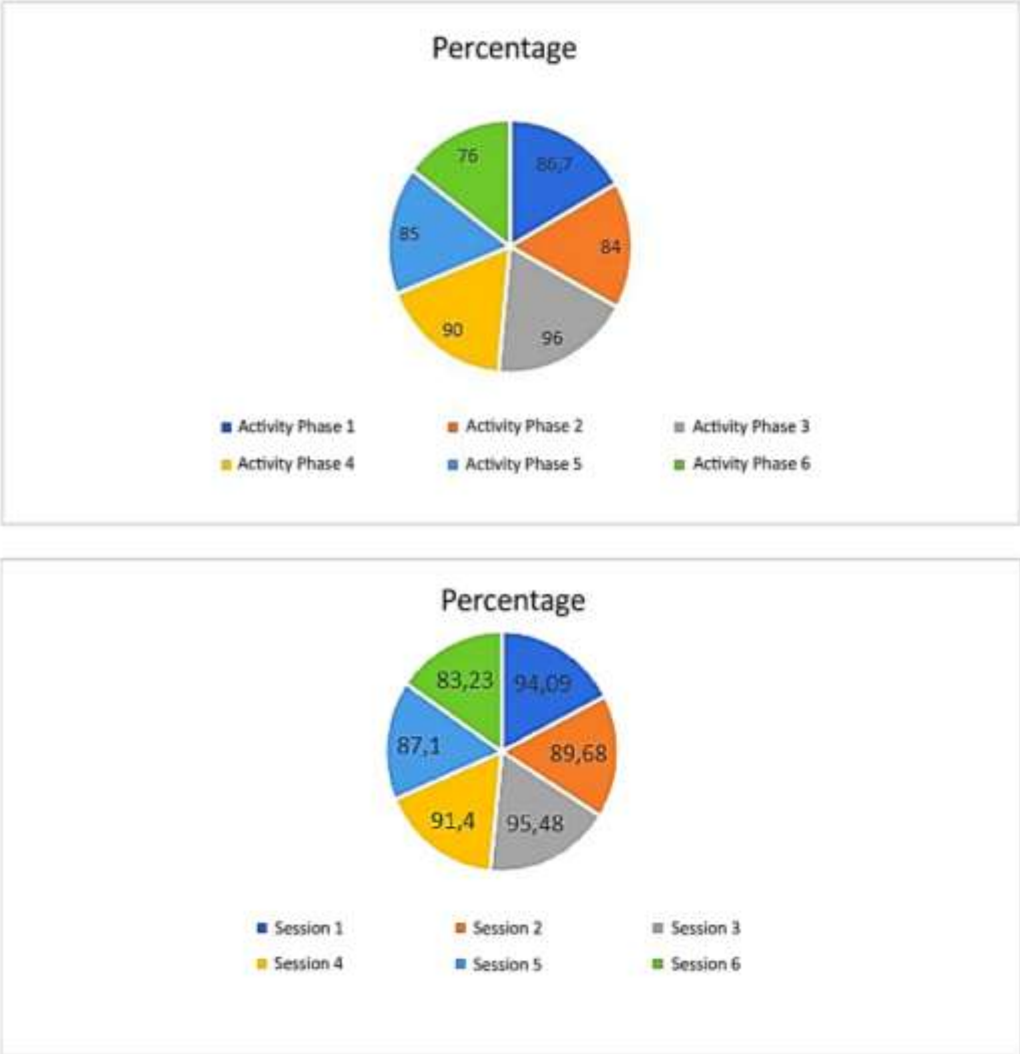
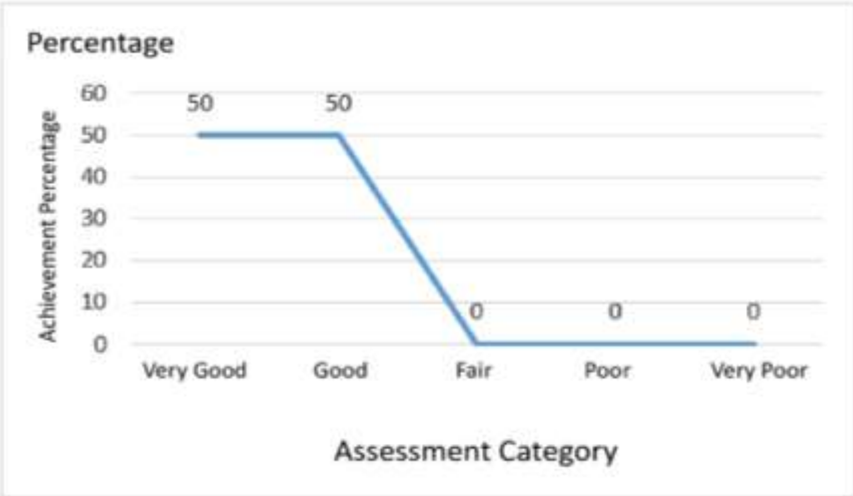


Figure 2. Percentage of Student Activity Observations Across Each Phase and Session

Analysis of Student Responses

The implementation of the Field-Based Environmental Problems (FBEP) learning model was trialed with Chemistry Education students through two main phases: a limited trial and a broader field implementation. The limited trial involved 10 students, while the broader trial engaged 15 participants. Subsequently, during the full implementation phase, 47 students were involved. Student responses were measured using a questionnaire consisting of 20 statements in order to assess the effectiveness of the FBEP learning model. The instrument adopted a five-point Likert scale with the following response options: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), and Strongly Agree (SA). Scoring was conducted such that for positively worded items, SD = 1 to SA = 5, while for negatively worded items, the scoring was reversed (SA = 1 to SD = 5).

The analysis of student responses from both trial phases indicates that the FBEP learning model was well received. As shown in Figure 3, student responses were predominantly within the "good" (75%–85%) and "very good" (86%–100%) categories. During the limited trial phase, most students fell into these two categories, suggesting that implementing the FBEP model effectively fostered student engagement, comprehension, and enthusiasm toward environmentally focused problem-based learning. A significant increase was observed in the broader trial phase, with 93.55% of students rating their experience in the "very good" category and the remaining 6.45% in the "good" category. These findings indicate that the FBEP model met the established success criteria, as reflected by the positive student responses. Therefore, it can be concluded that the FBEP learning model is effective and well-suited for implementation in environmental education contexts.



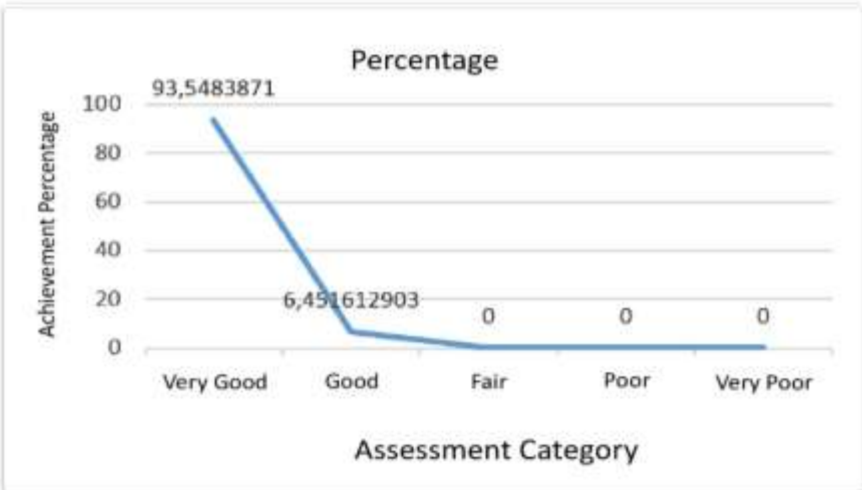


Figure 3. Average Percentage of Responses from Chemistry Education Students

CONCLUSION

This study demonstrates that the Field-Based Environmental Problems (FBEP) learning model is effective in enhancing students' socio-scientific reasoning skills and engagement in the Environmental Chemistry course. Observational data indicated a high level of student participation across all stages of the learning process, both in the limited and broader implementation trials. Furthermore, the results of the pre-test and post-test analyses revealed a significant improvement in students' socio-scientific reasoning following the implementation of the FBEP model. Student responses toward the model were also highly positive, suggesting that FBEP is pedagogically effective and engaging and contextually relevant to real-world environmental learning.

Based on these findings, it is recommended that the FBEP model be applied more extensively to other relevant courses, particularly those requiring active student involvement with environmental and socio-scientific issues. Faculty members and program administrators are encouraged to consider integrating this model into the curriculum as part of a project-based and context-driven instructional strategy. Future research should involve experimental designs with control groups to provide stronger empirical evidence regarding the model's effectiveness in fostering students' higher-order thinking skills.

Declaration by Authors

Acknowledgement: None

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Abraham I, Supriyati Y. Desain kuasi eksperimen dalam pendidikan: literatur. Jurnal Ilmiah Mandala Education. 2022; 8(3). http://dx.doi.org/10.36312/jime.v8i2.3127
2. Ballantyne R, Packer J. Introducing a fifth pedagogy: Experience-based strategies for facilitating learning in natural environments. Environmental education research. 2009; 15(2):243–262. https://doi.org/10.1080/13504620802711282
3. Grooms J. A comparison of argument quality and students' conceptions of data and evidence for undergraduates experiencing two types of laboratory instruction. Journal of Chemical Education. 2020; 97(8): 2057-2064. https://doi.org/10.1021/acs.jchemed.0c00026
4. Halim A. Signifikansi dan implementasi berpikir kritis dalam proyeksi dunia pendidikan abad 21 pada tingkat sekolah dasar. Jurnal Indonesia Sosial Teknologi. 2022; 3(3). https://doi.org/10.36418/jist.v3i3.385
5. Lia A, Rumbenium DN, Sihasale IJ, et al. Penguatan profil pelajar Pancasila bernalar kritis melalui karya tulis ilmiah. DIDAXEI. 2023; 4(1):551–564. oai:ojs.e-journal.iaknambon.ac.id:article/761
6. Marsden E, Torgerson CJ. Single group, pre-and post-test research designs: Some methodological concerns. Oxford Review of Education. 2012; 38(5):583–616. https://doi.org/10.1080/03054985.2012.731208
7. Nurcahyani ND. Upaya meningkatkan kemampuan berpikir kritis peserta didik menggunakan model problem-based learning (PBL) berpendekatan lingkungan. In Proceeding Seminar Nasional IPA. 2024; 808–814. https://proceeding.unnes.ac.id/snipa/article/view/3814
8. Presley ML, Sickel AJ, Muslu N, et al. A framework for socio-scientific issues-based education. Science Educator. 2013; 22:26–32. https://eric.ed.gov/?id=ej1062183
9. Rickinson M, Justin D, Teamey K, et al. A review of research on outdoor learning. 2004. https://research-information.bris.ac.uk/en/publications/a-review-of-research-on-outdoor-learning
10. Sabardila A, Budiargo AD, Wiratmoko G, et al. Pembentukan karakter peduli lingkungan melalui kegiatan penghijauan pada siswa MIM Derasan Sempu, Boyolali. Buletin KKN Pendidikan. 2019; 35–41. https://doi.org/10.23917/buletinkkndik.v1i2.11349
11. Suryani Y. E-LKM berbasis PJBL terintegrasi etno-STEM pada materi IPA dalam menumbuhkan karakter peduli lingkungan pada mahasiswa. Harmoni Media Dan Metode Dalam Pembelajaran IPA. 2024; 99. https://repository.radenintan.ac.id/31888/
12. Uzun Z, Öğretmen T. Test equating with the Rasch model to compare pre-test and post-test measurements. Journal of Measurement and Evaluation in Education and Psychology. 2021; 12(4):336–347. https://doi.org/10.21031/epod.957614

How to cite this article: Julhim S. Tangio, Ramli Utina, Frida Maryati Yusuf, Lukman Abdul Rauf Laliyo, Weny Musa, Masrid Pikoli. Implementing the FBEP learning model to enhance critical thinking and collaborative learning in environmental education. *Gal Int J Health Sci Res*. 2025; 10(3): 53-61. *DOI: https://doi.org/10.52403/gijhsr.20250306*

******