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Integration of Field Work Practices in Contextual Learning of Ecology in Biology Education Program Muhammadiyah Palangka Raya University

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Abstract: Ecology instruction in higher education often struggles to connect theoretical knowledge with real-world ecological complexity. Traditional, text-based learning limits students' conceptual understanding, critical thinking, and environmental awareness. This study investigates the impact of integrating Field Work Practices within a Contextual Teaching and Learning (CTL) framework on students in a Biology Education program. Using a quasi-experimental pretest-posttest non-equivalent control group design, the experimental group engaged in ecological learning across three local ecosystems: peat swamp forests, riverbanks, and sustainable agricultural areas. Instruments including concept tests, critical thinking rubrics, and environmental awareness questionnaires were validated and reliable (α = 0.82, 0.79, and 0.85, respectively). Results showed a notable improvement in ecological understanding (N-Gain = 0.63), contextual thinking (average score: 80.4 vs. 67.0), and environmental awareness (mean = 4.23), particularly in students' attitudes (4.4). These findings demonstrate that CTL-based fieldwork significantly enhances students' ecological competence holistically, supporting their cognitive, affective, and psychomotor development as future biology educators.

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Introduction

Ecology learning in higher education faces major challenges in connecting theoretical concepts with complex ecological realities in the real world (Patton, 2015) (Meng et al., 2024) Students often have difficulty understanding the dynamics of ecological systems only through classical learning based on lectures and textbooks. This has an impact on students' low contextual understanding and analytical skills in dealing with problems in the real environment. One potential approach to addressing this challenge is to integrate Field Work Practices into Contextual Teaching and Learning (CTL)-based learning (Oktaviani et al., 2023). CTL emphasizes the importance of linking learning materials to students' real-life contexts, so that there is active involvement, meaningful learning, and strengthening of problem-solving skills (Situmorang et al., 2019)(Nugroho & Kurniawan, 2017). Through field work practice activities, students can directly observe interactions between ecosystem components, evaluate environmental conditions, and apply theory in authentic situations, as emphasized by Patton (2015) (Koul, n.d.)(Johnson, 2017).

Previous studies have shown the success of integrating CTL with field-based activities. For example, Johnson's (2017) study reported a significant increase in mastery of the concepts of population dynamics and bird diversity through field observation-based learning (Nurlaela et al., 2020)(Shih et al., 2021). Meanwhile, a study by Wijaya & Hasudungan (2022) found that the use of local environmental issues as contextual learning resources can improve ecological awareness and student learning outcomes (Ardiansyah et al., 2023). Likewise, research by Nurlaela et al. (2020) emphasized that the experiential approach is very effective for ecological learning because it provides direct experience of the complexity of environmental systems (Wijaya & Hasudungan, 2022). However, the obstacle that is still faced is the lack of systematic implementation of Field Work Practice activities in the ecology curriculum structure in many universities. (Hanik et al., 2018). Learning tends to be theoretical, less project-based or real-world experience, and limited facilities and institutional support for field activities. This hinders the development of student competencies in dealing with environmental issues comprehensively (Suwandi, 2021)(Sukardjo & Djuarsa, 2017).

At Universitas Muhammadiyah Palangka Raya, local potential in the form of peatland biodiversity and tropical ecosystems has not been optimized as a source of contextual learning. Integration of field work practices in CTL-based ecology learning can be an innovative strategy to overcome the limitations of classical learning and maximize local potential (Hanik et al., 2018). Theoretically, this integration is also strengthened by Bronfenbrenner's Ecological Systems Theory, which emphasizes that the individual learning process is influenced by interacting environmental systems (Sari et al., 2022). Therefore, learning experiences that occur directly in the real environment have strategic value in forming a more complete ecological understanding (Yani et al., 2021) . Based on this, it is necessary to integrate field work practices into Contextual Learning in the Ecology Course in the Biology Education Study Program at Universitas Muhammadiyah Palangkaraya

Method

Types of research

This study uses a quasi-experimental approach with a pretest-posttest non-equivalent control group design. The main objective is to evaluate the impact of integrating Field Work Practices based on Contextual Teaching and Learning (CTL) on understanding of ecological concepts, contextual understanding, and environmental awareness of students.

Location and Time of Research

This research was conducted in the Biology Education Study Program, FBIT, Muhammadiyah University of Palangka Raya. Data collection was carried out for one semester, namely in August 2024 - January 2025. Research activities include the preparation stage, implementation, field observation, and evaluation of results. Field Work Practice activities for the Ecology course were carried out in three different ecosystems: peat swamp forests, riverbanks, and sustainable agricultural areas around Palangka Raya.

Research Subject

The subjects of this study were all students taking the Ecology course, which were divided into 2 classes, namely the control and experimental classes.

Variables and Data Collected

Variables Data Types Instrument Understanding the concept of ecology Quantitative Objective test (multiple choice, expert validation, reliability $\alpha > 0.7$) Contextual Understanding Contextual Quantitative Essay-based contextual thinking rubric based on Facione (1990), scale 0–100, assessed through written field reports and group presentations; validated by expert review and tested for reliability with Cronbach's Alpha $\alpha = 0.79$ Environmental awareness Quantitative Likert scale questionnaire 1–5 (dimensions of ecological knowledge, attitudes, and behavior) Critical thinking skills Quantitative Critical thinking rubric based on Facione (1990), covering interpretation, analysis, inference, evaluation, and explanation.

Instrument Preparation and Validation

All research instruments underwent a validation process before being used in the field. Content validity was assessed by three experts in the field of ecology education and educational assessment from two different universities. The validation focused on the relevance, clarity, and alignment of each item with the intended learning outcomes. Based on their feedback, several items were revised for better clarity and content alignment. Furthermore, a pilot test was conducted with 20 students who were not part of the main study sample to assess the reliability of the instruments. The Cronbach's Alpha reliability coefficients were as follows: - Ecology Concept Test: $\alpha = 0.82$ -

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Contextual Thinking Rubric: α = 0.79 - Environmental Awareness Questionnaire: α = 0.85 These values indicate a high level of internal consistency, making the instruments suitable for use in the main study.

Data Collection Technique

Ecology Concept Test: Time of implementation: Pretest and posttest at the beginning and end of learning. Content: 25 multiple-choice questions covering basic ecology material (population, community, ecosystem, and biodiversity). Purpose: To measure the increase in concept mastery (N-Gain). Contextual Understanding Rubric (observation and report assignment). Time: After field activities and discussions. Indicators: Interpretation, Analysis, Evaluation, Inference, Explanation. Assessment: Field work practice report and group presentation. Critical Thinking Rubric. Time of implementation: After field-based learning sessions and discussions. The rubric, based on Facione's (1990) critical thinking framework, includes five core indicators: interpretation, analysis, inference, evaluation, and explanation. Student responses were collected through reflective essay tasks and group presentations. The instrument was validated by expert judgment and tested for reliability, yielding a Cronbach's Alpha value of α = 0.79. Environmental Awareness Questionnaire. The implementation time is during the pre and post activities. Content: 20 statements on a Likert scale (e.g., "I feel responsible for the sustainability of the local environment"). This instrument was adapted from a validated questionnaire developed by Wijaya & Hasudungan (2022), and it measures three main dimensions: ecological knowledge, environmental attitudes, and pro-environmental behavior (Wijaya & Hasudungan, 2022).

Research Implementation Stages

The learning implementation followed a structured process using a contextual learning model integrated with field work practices. The ecology course was conducted over one semester and covered four main topics: ecosystem dynamics, biodiversity, population interactions, and environmental issues. Each topic was contextualized through activities in different ecosystems: peat swamp forests, riverbanks, and sustainable agriculture zones in Palangka Raya. The learning was problem-based and project-oriented. For example: - In the peat swamp forest, students identified types of flora-fauna and evaluated the impact of water table changes. - In the riverbank area, students conducted water quality assessments and examined community-waste relationships. - In the agricultural area, students analyzed sustainable farming practices and soil health. Each student group worked on a mini-project aligned with these ecosystems. They were tasked to formulate environmental questions, collect field data, analyze findings, and present solutions. This flow helped build critical thinking, scientific reasoning, and ecological awareness. The overall learning flow included the following stages: 1. Orientation and Planning: Introduction to CTL, learning goals, field safety briefing. 2. Classroom Preparation: Pretest and basic ecology concept discussion. 3. Field Work Activities: Visits to three ecosystem sites with structured observation, data collection, and interaction with local stakeholders. 4. Reflection and Discussion: Group-based interpretation and evaluation using rubrics. 5. Presentation and Reporting: Students compiled field reports and presented findings in class. 6. Posttest and Feedback: Concept test, awareness survey, and reflective evaluation. All field visits were coordinated with local authorities and planned in advance to ensure accessibility, student safety, and ecological sensitivity.

Data Analysis Techniques

The data analysis in this study involved both descriptive and inferential statistical techniques. For the ecology concept test, the increase in student understanding was measured using the normalized gain score (N-Gain), following the formula proposed by Hake (1998): (Posttest Score - Pretest Score) / (100 - Pretest Score). The classification used was: high ($g > 0.7$), medium ($0.3 < g \leq 0.7$), and low ($g \leq 0.3$). The results of this study are organized based on the three core variables: understanding of ecological concepts, contextual and critical thinking skills, and environmental awareness (Ramadhan, 2019). These results are further supported by field observations conducted across three local ecosystems: peat swamp forests, riverbanks, and sustainable agricultural areas in Palangka Raya.

Results

During the field work, students made direct observations of ecological interactions and environmental conditions at each site: - Peat Swamp Forests: Students observed unique adaptations of flora (e.g., pandanus, pitcher plants) and fauna (e.g., long-tailed macaques) to acidic and waterlogged conditions. They also recorded signs of peatland degradation such as canalization and fire scars. - Riverbanks: Students measured physical-chemical properties of river water (pH,

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turbidity, dissolved oxygen) and identified sources of anthropogenic pollution such as domestic waste and agriculture runoff. - Sustainable Agriculture Area: Students analyzed crop diversity, use of organic fertilizers, and traditional ecological knowledge shared by local farmers. These observations were documented in individual field journals and triangulated through group discussions and local stakeholder interviews. The observation findings enriched students' understanding of real-world ecological systems and served as data sources for their project-based assignments.

Understanding the concept of ecology

Table 1. Results of Pretest and Posttest of Understanding Ecological Concepts

Group	Pretest Average	Posttest Average	N-Gain	Category
Experiment (PKL + CTL)	58.2	84.5	0.63	Medium-High
Control (Lecture)	59.4	70.3	0.27	Low

Table 1. The experimental group's normalized gain (N-Gain) of 0.63, based on Hake's (1998) criteria, indicates a substantial learning gain. This score surpasses the threshold for medium effectiveness ($0.3 < g \leq 0.7$), suggesting that contextual and experiential learning environments significantly promote deeper conceptual acquisition in ecological content areas. Meanwhile, the control group's N-Gain of 0.27 reflects limited advancement, likely constrained by the abstract nature of ecological concepts when taught via conventional lectures.

These findings align with constructivist learning theory, which posits that meaningful learning is best achieved through active construction of knowledge in authentic settings. The CTL-based integration of fieldwork provided situated learning experiences, enabling students to encounter ecological phenomena firsthand—an approach grounded in Vygotsky's Zone of Proximal Development (ZPD), wherein scaffolding through real-world exposure optimizes cognitive development (Purwanti & Ardiansyah, 2019).

Table 2. Students' Contextual Thinking Skills Scores

Group	Interpretation	Analysis	Evaluation	Inference	Explanation	Average Total
Experiment	78	82	80	79	83	80.4
Control	65	68	67	66	69	67.0

Table 2. All five sub-indicators of contextual thinking measured through the Facione Critical Thinking Rubric (1990) show marked improvement in the experimental cohort, with scores consistently exceeding 78. This 13.4-point differential (80.4 vs. 67.0) illustrates that students engaged in contextualized fieldwork were more adept at data interpretation, systemic analysis, and evaluative reasoning.

This enhancement is theoretically underpinned by Bloom's Taxonomy (revised version), where activities like ecological assessment, hypothesis formulation, and inference mapping engage higher-order cognitive skills (analysis, evaluation, and creation). Students utilized actual environmental data (e.g., pH, DO, turbidity) as stimuli for evidence-based reasoning—an approach that mirrors scientific inquiry models emphasized in STEM pedagogy. Moreover, the hands-on interaction with ecosystem complexity promotes systems thinking, a critical capacity in environmental education that enables learners to identify feedback loops, interdependencies, and ecological causality (Sterling, 2010).

Table 3. Students' Environmental Awareness Scores

Group	Knowledge	Attitude	Behavior	Average Total
Experiment	4.2	4.4	4.1	4.23
Control	3.5	3.6	3.4	3.5

Table 3. The experimental group exhibited significantly higher affective engagement across all dimensions of ecological awareness. The greatest increase was observed in attitudinal change (M = 4.4), indicating that contextual exposure to real environmental challenges such as peat degradation, water pollution, and agricultural sustainability has a transformative effect on ecological empathy and personal environmental responsibility.

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These outcomes are consistent with Bronfenbrenner's Ecological Systems Theory (1979), which emphasizes the importance of proximal processes—recurring, real-world interactions between individuals and environmental systems—in shaping development. By immersing students within the mesosystem of local ecosystems, the intervention fosters personal meaning-making and a sense of stewardship. Additionally, the results support Ajzen's Theory of Planned Behavior, wherein increased ecological knowledge and positive attitudes are precursors to behavior change. The elevation in the behavior dimension (4.1) suggests a transition from awareness to action, vital for the cultivation of environmental citizenship.

Discussion

The results of this study clearly show that the integration between Field Work Practice and the Contextual Teaching and Learning (CTL) approach has a positive impact on three main aspects of ecological learning, namely: conceptual understanding, critical thinking skills, and students' environmental awareness.

1. Improving Understanding of Ecological Concepts

The data shows that the average posttest score of students in the experimental group increased significantly compared to the control group, with an N-Gain of 0.63 which is classified as medium-high, based on the interpretation criteria by Hake (1998). This shows that direct experience in the field can strengthen the transfer of abstract ecological concepts such as interactions between species, population dynamics, and ecosystem processes (Wahyuni & Hadi, 2020). This conclusion is based on the analysis of students' written field reports and group presentations, which reflected their ability to connect realworld observations with theoretical ecological concepts. This finding is consistent with previous studies by Johnson (2017) and Nurlaela et al. (2020), which emphasized that direct observation in nature helps students understand concepts through concrete experiences that are difficult to represent only through textbooks or lectures (Oktaviani et al., 2023). In theory, these results can be explained through the theory of constructivism and the situated learning approach, which states that knowledge is constructed more strongly when learned in the context in which it will be used. Local contexts such as peat ecosystems, rivers, and sustainable agriculture in Palangka Raya become "living laboratories" that allow students to understand concepts by connecting them to the ecological reality around them.

2. Contextual and Critical Thinking Skills.

The results also indicated a notable improvement in contextual and critical thinking skills among students in the experimental group, with an average rubric score of 80.4 compared to 67.0 in the control group. This improvement was measured using an essay-based rubric adapted from Facione (1990), which included indicators such as interpretation, analysis, inference, evaluation, and explanation. These indicators are aligned with established critical thinking constructs, although they were embedded within contextual assignments such as field reports and presentations (Astuti & Pratama, 2021). Activities such as analyzing water pollution, interpreting species interactions, and evaluating local environmental problems required students to apply critical reasoning in authentic situations. In particular, during water monitoring tasks, students used simple testing kits to measure pH, turbidity, and dissolved oxygen levels from river samples. The results were recorded in structured worksheets and served as the basis for discussion and report writing. This finding suggests that CTL-based field learning supports the development of higher-order thinking skills in a natural and applied context, even if not measured through a standalone critical thinking test.

3. Increasing Environmental Awareness and Attitudes

In terms of environmental awareness, the results of the study showed that the experimental group had an average score of 4.23 on the Likert scale (maximum 5), much higher than the control group (3.5). The attitude dimension had the highest score (4.4), followed by knowledge (4.2) and behavior (4.1). This shows that direct interaction with the environment - such as witnessing habitat destruction or changes in water quality - encourages students' affective reflection on the importance of environmental conservation and sustainability. These results are in line with the findings of Wijaya & Hasudungan (2022) (Toskey & McKay, 2024), that a learning approach that raises local issues and is based on real experiences can foster ecological empathy and increase students' commitment to being involved in real environmental action. In theory, this is also supported by the Bronfenbrenner model (Ecological Systems Theory), where direct interaction with the real environment can form a deeper understanding and stronger attitudes towards ecological systems (Wijaya & Hasudungan, 2022).

Figure 1. student are learning ecology in field work practices measure pH, turbidity, and dissolved oxygen levels from river samples

4. **Implications for Curriculum and Institutions.**
   These findings reveal the importance of restructuring the paradigm of ecological learning from a classical, theoretical approach to a contextual and applied approach (Adhikari et al., 2021). This shift is not merely pedagogical, but also strategic for fostering 21st-century ecological literacy. Contextual-based learning, especially when implemented through field work practices, provides students with the opportunity to engage directly with complex environmental systems, formulate problems, and develop authentic solutions based on scientific inquiry (Nuroniah et al., 2021). For universities in regions with rich biodiversity such as Palangka Raya, integrating local ecosystems into the curriculum offers enormous potential. Field-based modules can be embedded in multiple courses not only Ecology, but also Conservation Biology, Environmental Education, and even Education for Sustainable Development. These modules may include continuous observation activities, long-term ecological monitoring, or even service-learning programs in collaboration with local communities. By transforming peatlands, rivers, and agricultural landscapes into open laboratories, institutions empower students to bridge the gap between knowledge and action. This approach also encourages the development of interdisciplinary skills such as teamwork, communication, digital reporting (e.g., through GIS-based mapping or environmental logs), and environmental ethics. At the institutional level, this model promotes a place-based curriculum that is responsive to local ecological challenges and fosters sustainable campus-community partnerships (Smith & Doe, 2024).

Conclusion

Based on the research results, it can be concluded that the integration of Field Work Practices based on the Contextual Teaching and Learning (CTL) approach in ecology learning has a significant positive impact on students' conceptual understanding, contextual understanding, and environmental awareness. Students who take part in learning with this approach show a significant increase in mastery of ecological concepts, as reflected in the N-Gain value and higher posttest scores compared to the control group. In addition, direct involvement in field activities also strengthens students' contextual understanding, especially in the aspects of analysis, evaluation, and drawing conclusions based on real data. No less important, contextual learning that utilizes the potential of local ecosystems has succeeded in building students' environmental awareness, both in terms of knowledge, attitudes, and ecological behavior. Thus, ecological learning integrated with CTL-based field work practices has proven effective in connecting theory with real practice, as well as forming holistic and applicable ecological competencies for prospective biology educators.

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