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Ecoliteracy Competency Factors for Prospective Elementary School Teachers in Green Campus Policy

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Article Info

ABSTRACT

Purpose of the study: The purpose of this study is to identify and describe the structure of eco-literacy factors possessed by prospective elementary school teachers within the framework of green campus policy implementation. The study focuses on integrating cognitive, affective, and psychomotor dimensions.

Methodology: A descriptive quantitative approach was applied using Exploratory Factor Analysis (EFA). The study included 317 respondents. These respondents were students majoring in elementary school teacher education who had completed elementary school science education courses. The instrument was an eco-literacy questionnaire with 45 statements rated on a Likert scale. Data analysis was performed using SPSS with Principal Component Analysis and Varimax rotation.

Main Findings: The analysis results found a KMO value of 0.830 and a significant Bartlett test (Sig.=0.001). These results indicate that the data is suitable for further processing. Four factors were identified, accounting for 57.379% of the total variance, covering awareness and understanding of ecological concepts, attitudes and values of ecological literacy, environmentally conscious behavior, and the integration of ecological values into daily life.

Novelty/Originality of this study: The findings reveal a multidimensional and integrative structure of ecoliteracy skills. The results also show a clear connection among the cognitive, affective, and psychomotor domains. The resulting factor model can serve as a conceptual basis for strengthening sustainability-oriented didactic content knowledge in the design of green curricula for elementary school teacher education.

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1. INTRODUCTION

Global sustainability issues and increasingly complex environmental challenges demand a paradigm shift in education systems. The reality in Indonesia shows an urgent need to address environmental damage. Data from the national disaster management agency (BNPB) in 2023 shows that of a total of 5,400 disaster events, 99.35 percent were influenced by weather conditions and surface runoff. This challenge is complicated by development trends that still prioritize economic growth over ecological performance, which ultimately leads to environmental degradation. This situation emphasizes the importance of education as a strategic tool in building awareness, values, and sustainable behavior.

To comprehend the relationship between humans and the environment holistically, one must possess ecoliteracy. This literacy encompasses affective dimensions in the form of ecological attitudes and values, psychomotor dimensions in the form of tangible environmentally friendly actions, and cognitive knowledge in comprehending environmental concepts and principles. Students can adopt sustainable practices if ecological literacy is strengthened at the elementary school level. Education for Sustainable Development (ESD) teaches students to act for ecological balance, think critically, and show empathy. As a result, developing sustainable awareness at a young age is crucial for aspiring elementary school teachers. Therefore, it is the responsibility of educators to instill sustainable environmental values and practices through learning in addition to imparting knowledge [1].

In the context of higher education, the implementation of the Green Campus Policy provides a concrete framework for integrating sustainability principles across the three pillars of higher education. This policy creates a learning environment that promotes ecological awareness and sustainable practices among students. The implementation of green campuses in higher education institutions strengthens the community's commitment to the sustainable development goals (SDGs), particularly in quality education and climate change mitigation. For elementary school teacher education (PGSD) students, the implementation of the green campus policy is not only used as a physical program but also as a living laboratory to develop didactic content knowledge (DCK) with an eco-pedagogical perspective pedagogical content knowledge to integrate sustainability concepts into learning practices in primary schools [2]. Therefore, it is important to ensure that the ecological literacy skills of prospective elementary school teachers are tested in a structured and comprehensive manner in an environment guided by this policy. Teachers with a high level of ecological literacy are expected to not only understand environmental issues but also to integrate sustainability principles into their teaching practices and daily lives [3]. There is still a lack of empirical studies on the ability to integrate sustainability principles into teaching practices. Previous studies have generally assessed eco-literacy partially rather than holistically in terms of cognitive, affective, and psychomotor aspects in a continuous manner. Existing research has not found valid construct results. There is no strong consensus on the most valid and reliable dimensional structure for measuring the eco-literacy of prospective elementary school teachers, especially in the context of Green Campus policy implementation. Research shows that 67% of students in Indonesia understand the conceptual issues of sustainability but fail to demonstrate this understanding in their actual behavior on campus. Students often fail to apply it in their daily behavior, demonstrating the challenge of internalizing ecological values [4], [5]. In addition, the results of the 2023 UI greenmetric survey show that although 85% of universities in Indonesia have implemented green campus programs, only about 42% have succeeded in integrating sustainability principles into the curriculum and student activities. This fact shows that there is still a gap between institutional policies and the internalization of ecological values among individual students. Therefore, research is needed that can comprehensively identify and validate the structure of factors affecting the ecoliteracy of prospective elementary school teachers in the context of green campus policy implementation.

Based on these statements, it is clear that this study aims to identify and validate the most appropriate and consistent factor structure of elementary school teacher education students' ecoliteracy abilities in the context of the green campus policy. This valid and reliable environmental literacy model can serve as a foundation for strengthening the competence of prospective elementary school teachers and making a real contribution to the implementation of sustainable environmental learning [10], [11]. Therefore, the results of this study not only confirm the hypothesized dimensions but also have transformative implications for the elementary school teacher education curriculum.

2. RESEARCH METHOD

The research approach used was a quantitative method [12]. This approach was chosen to measure students' environmental literacy skills in elementary school teacher education programs and to identify the underlying factor structure of this construct. A correlation survey design was considered appropriate for mapping the patterns of interrelationships between indicators without subjecting respondents to experimental treatment.

The research subjects were 317 students of elementary school teacher education programs who had taken natural science courses and were actively involved in the implementation of the green campus policy [13]. Purposive sampling was determined by considering that the respondents had relevant learning experiences and contexts for the research objectives [14]. This technique was selected by adjusting the research objectives that emphasized the relationship between the characteristics of the respondents and the phenomena being studied.

Research data were collected using a questionnaire with a Likert scale. Each question was designed to measure ecoliteracy and student involvement in the implementation of green campus policies. This instrument was developed based on the conceptual framework of ecoliteracy, which includes cognitive, affective, and psychomotor dimensions [15], [16]. In addition, each of the three main dimensions consisted of five indicators, as shown in the following table 1.

The data were analyzed using exploratory factor analysis (EFA). This technique was chosen to discover and map the structure of relationships among the indicators into a small number of underlying factors (latent factors), which had not been rigorously tested in the context of green campus policies [17] [18]. The stages of testing assumptions and feasibility include a) the Kaiser-Meyer-Olkin (KMO) test to measure sample adequacy (MSA), which assesses the adequacy of the sample for factor analysis. The KMO value must be above 0.50; b) The Bartlett's Sphericity test, which tests whether the correlations between variables are significant enough to form factors. The results of this test must be significant (Sig. < 0.05) [19].

Table 1. Research Questionnaire Instruments

Dimension	Indicator	Code
Cognitive	Students are able to explain the basic concepts of eco-literacy	K1
	Students can mention the principles of sustainability.	K2
	Students can recognize the green campus policy of State University of Malang.	K3
	Students can explain the impact of human activities on the environment	K4
	Students can relate the concept of eco-literacy to everyday life.	K5
Affective	Students feel a need to protect the campus environment.	A1
	Students have empathy for other living things.	A2
	Students believe that a green campus should be implemented at State University of Malang	A3
	Students are motivated to encourage others to protect the environment.	A4
	Students feel proud to be part of the green campus policy	A5
Psychomotor	Students can sort waste on campus	P1
	Students bring environmentally friendly equipment to campus.	P2
	Students participate in campus resource management.	P3
	Students participate in environmental conservation activities.	P4
	Students use environmentally friendly transportation when going to campus.	P5

3. RESULTS AND DISCUSSION

This section presents empirical findings on the structure of elementary school teacher education students' ecoliteracy abilities in the context of Green Campus policy implementation. The results show a multidimensional factor structure that describes how prospective elementary school teachers integrate ecological awareness, values, and actions in a sustainability-oriented learning environment.

3.1. Data Feasibility Test

The data feasibility tests showed that the research data met the statistical requirements for Exploratory Factor Analysis (EFA). The Kaiser–Meyer–Olkin (KMO) value was 0.830, which exceeded the minimum limit of 0.50, indicating a high level of sample adequacy. In addition, Bartlett's Test of Sphericity showed significant results (p = 0.001), indicating adequate correlation between variables so that factor analysis could be continued [20][21]. Data related to the KMO and Bartlett's test are displayed in Table 1 as follows.

Tabel 2. KMO and bartlett's test

Test	Description	Value
Kaiser-Meyer-Olkin (KMO)	Measure of Sampling Adequacy	0,830
Bartlett's Test of Sphericity	Approx. Chi-Square	1284,581
	df	105
	Sig.	< 0,001

Furthermore, the results of the Measure of Sampling Adequacy (MSA) in Table 2 show that all indicators have values above 0.50, with the highest value in the indicator of integration in daily life (0.903) and

the lowest value in the indicator of empathy toward the environment (0.601). These findings confirm that each indicator contributes significantly to factor formation and that no indicators need to be eliminated [22]. Thus, all indicators are deemed feasible and consistent for use in forming the factor structure of elementary school teacher education students' ecoliteracy abilities.

Tabel 3. MSA value

| No	Indicator Code	Indicator	MSA Value
1	K1	Ecoliteracy concept	0.883
2	K2	Sustainable education	0.858
3	K3	Green campus policy	0.703
4	K4	Impact on daily life	0.878
5	K5	Integration into daily life	0.903
6	A1	Environmental responsibility	0.790
7	A2	Empathy toward the environment	0.601
8	A3	Policy urgency awareness	0.897
9	A4	Motivation to influence others	0.783
10	A5	Policy implementation commitment	0.867
11	P1	Waste sorting behavior	0.620
12	P2	Use of sustainable tools	0.830
13	P3	Resource management practices	0.830
14	P4	Environmental conservation activities	0.648
15	P5	Sustainable transportation use	0.799
1	K1	Ecoliteracy concept	0.883

3.2. Factoring results

Based on the results of the principal component analysis, four main factors with eigenvalues > 1 were identified, which cumulatively explained 57.379% of the variance in the ecoliteracy abilities of elementary school teacher education students. These findings confirm that the ecoliteracy abilities of elementary school teacher education students consist of several interrelated dimensions, thus providing a clear empirical answer to the research question. Details on the contribution of each factor are presented in the following table.

Table 4. Factor formation results

Factor	Eigenvalue	Percentage of Variance (%)	Factor Meaning
Factor 1	4,506	30,042	Ecological Awareness and Knowledge (Cognitive Awareness)
Factor 2	1,795	11,968	Environmental Values and Empathy (Affective Dimension)
Factor 3	1,201	8,004	Pro-Environmental Actions and Behaviors (Behavioral Engagement)
Factor 4	1,105	7,365	Integration of Sustainability in Learning (Sustainability Integration)

Collectively, the findings of this study reinforce the conceptual model of ecoliteracy as a multidimensional competency that integrates cognitive, affective, and psychomotor domains. The four-factor structure that emerged shows that ecoliteracy development cannot be done partially but must integrate environmental knowledge, internalization of values, and concrete actions in educational practice. These findings are in line with the environmental education perspective that emphasizes a balance between thinking, feeling, and acting as the foundation for sustainable learning [23]. Thus, the results of this study confirm that a comprehensive environmental education approach is necessary to effectively foster ecoliteracy in the context of teacher education. Furthermore, the Scree Plot visualization confirms the robustness of the four-factor structure, indicating that the resulting factor model is representative and valid as follows.
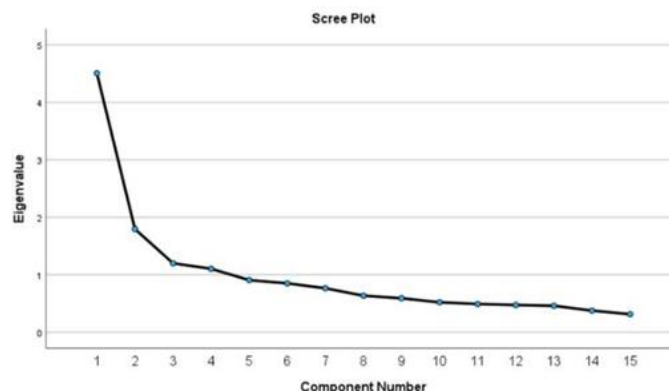
Graphic 1. Scree plot result

The four-factor structure formed in the graph shows that the dimension of ecoliteracy competence is built through the integration of conceptual understanding, internalization of values, and the manifestation of concrete actions in the context of education. Therefore, the resulting factor model can be viewed as representative and theoretically consistent with the ecological literacy framework that emphasizes the interconnection between awareness, attitudes, and sustainable practices [24][25]. The integration of these three aspects confirms the essence of sustainable environmental education, namely the integration of reflective thinking, ecological concern, and responsible behavior towards the environment.

3.3 Consistency and Validity of Factor Structure

All indicators in this study have factor loadings above 0.35, indicating a significant relationship between the indicators and the factors formed. The emergence of several negative loading values does not indicate a weak relationship between indicators, but is caused by the existence of statements that are formulated negatively, so that the direction of the correlation is opposite. The findings presented in Table 5 confirm that, substantially, the indicators used still represent the construct measured consistently.

Tabel 5. Rotated component matrix

	Component			
	1	2	3	4
Ecoliteracy's Concept	.563	.149	.253	.304
Principal of Sustainable	.701	-.003	.163	.160
Green Campus Policy	-.093	.417	.579	.190
Human Environment Impact	.667	.032	-.136	.315
Ecoliteracy Integration in Daily Life	.513	.269	-.133	.346
Environmental Responsibility	.739	.082	.148	-.403
Environmental Empathy	.103	.071	.103	.836
Green Campus Belief	.550	.056	.387	.022
Pro-Environmental Motivation	.198	.760	.010	.007
Student Participation in Green Campus Policy	.596	.351	.169	.058
Waste Sorting Behavior	.500	.096	.497	-.059
Eco-Friendly Equipment Use	.331	.698	-.089	.060
Campus Resource Management Participation	.748	.049	.064	-.045
Environmental Conservation Participation	-.129	.790	.149	.058
Sustainable Transportation Use	.187	-.109	.730	.010

In addition, the correlation values between components in Table 5. Component Transformation Matrix are in the range of 0.860 to 0.892, indicating a strong internal relationship between the four factors[26], [27]. This condition shows that the factors formed do not stand alone but are interrelated in representing the overall ecoliteracy abilities of PGSD students.

Table 6. Component transformation matrix

Component	1	2	3	4
1	.860	.379	.300	.163
2	-.423	.873	-.023	.242
3	-.244	.011	.892	-.380
4	-.149	-.307	.337	.878

Based on goodness-of-fit criteria, the resulting factor structure can be considered valid and stable. This is supported by the fulfillment of three main requirements, namely: (1) adequate communalities extraction values, (2) significant and consistent relationships between indicators and factors, and (3) the model's ability to explain total variance above 50% [28], [29]. The total variance proportion of 57.379% indicates that the resulting factor model is able to explain most of the indicator diversity, thus having a strong explanatory power in describing the structure of PGSD students' ecoliteracy abilities in the context of the Green Campus policy. Thus, the resulting factor structure not only meets statistical validity but also provides a strong empirical basis for understanding ecoliteracy as an integrated construct relevant to the context of teacher education.

3.4 Multidimensional structure of ecoliteracy competence

The study identifies four interrelated dimensions that shape prospective elementary school teachers' ecoliteracy competence. This finding reinforces the perspective that authentic ecological understanding requires balancing knowledge, emotion, and action in relation to life systems.

Factor 1: Ecological Awareness and Knowledge (Cognitive Awareness)

The first factor represents PGSD students' ecological awareness and understanding of the concept of ecoliteracy, Green Campus policies, and sustainability principles. This dimension shows that students who have a good understanding of the relationship between humans and the environment are better able to recognize the impact of human behavior on ecosystem sustainability. The results of this study indicate that environment-based learning experiences gained through the implementation of the Green Campus policy contribute to strengthening the ecological understanding of prospective elementary school teachers.

This study is in line with previous studies showing that ecological understanding developed through contextual and experience-based learning plays an important role in shaping the environmental literacy of education students [30]. Furthermore, other studies confirm that environmental education integrated into institutional policies, such as sustainable campuses, is more effective in improving ecological understanding than learning approaches that are separated from the real context [31], [32]. Therefore, these findings indicate that the Green Campus context as an authentic learning environment plays an important role in bridging the gap between conceptual understanding and sustainability practices among prospective elementary school teachers.

Factor 2: Environmental Values and Empathy (Affective Dimension)

This dimension reflects the affective values and emotional sensitivity of elementary teacher education students toward environmental issues, as reflected in their concern for living things, ecological empathy, and sense of responsibility in maintaining environmental balance. The results of this study indicate that aspects of values and emotional sensitivity are an integral part of the eco-literacy competence of prospective teachers, who not only understand environmental issues rationally but also internalize concern as the basis for attitudes and actions.

The results of this study are in line with previous studies that state that emotional connectedness to nature plays a significant role in encouraging individual participation in pro-environmental behavior [33]. Empathy for the environment and living things is an important mediator between environmental understanding and involvement in sustainable actions [34]. In the context of education, learning that builds an emotional connection with nature has proven to be more effective in fostering long-term concern and commitment to the environment than approaches that only emphasize knowledge transfer.

For prospective elementary school teachers, the affective dimension has special significance because the role of teachers is not only as conveyors of concepts but also as role models who demonstrate ecological values through their attitudes, concerns, and daily responsibilities. Thus, strengthening the affective dimension in teacher education is key to shaping authentic and sustainable environmental learning practices from elementary education onwards.

Factor 3: Pro-Environmental Actions and Behavior (Behavioral Engagement)

The third factor represents the actual ecological actions of PGSD students as reflected in their daily behavior, such as sorting waste, using reusable products, conserving energy and water, and participating in

environmental conservation activities. This dimension shows that ecoliteracy skills do not stop at understanding and concern but are concretely reflected in sustainable practices in daily life. The results of this study confirm that environmentally friendly behavior is the most tangible indicator of the internalization of ecological values in prospective elementary school teachers [35].

In the context of teacher education, the dimension of ecological action plays a strategic role because behavioral involvement encourages experiential learning. Prospective teachers who consciously choose environmentally responsible behaviors not only build personal competencies but also develop pedagogical capacities to transform sustainability values into learning practices [36].

Furthermore, this dimension includes students' ability to apply sustainability principles to learning, which is at the core of didactical transformation [37]. Teachers with ecological literacy are required to be able to transform sustainability values and practices into meaningful learning experiences for students. In this case, the results of this study reinforce the view that the development of eco-pedagogical Didactical Content Knowledge (DCK) cannot be separated from students' real experiences in practicing sustainability on campus.

The use of the Green Campus policy as a living laboratory allows students to reflect on real experiences and relate them to the learning context in the classroom. Unlike previous studies that separated campus environmental policies and learning practices, the results of this study show that the integration of the two contributes significantly to shaping prospective teachers who think systemically, act ecologically, and are able to instill sustainability values from elementary education [38]. Thus, the dimension of real action is key in building the profile of elementary school teachers who are ecologically literate and oriented towards long-term sustainability.

3.5 Relevance to the green campus polic

The results of the study show that implementing the green campus policy a set of institutional strategies promoting sustainable practices in State University of Malang (UM) significantly strengthened students' eco-literacy skills, defined as knowledge, attitudes, and behaviors required to understand and act on environmental issues, particularly in the affective and psychomotor domains (factors 2, 3, and 4). This success is due not only to physical development but also to the internalization of the policy as a learning context.

Environmental policies at universities work only if paired with pedagogical transformation not just physical changes or symbolic programs [27], [28]. Factors 3 (concrete actions) and 4 (learning integration) show that the green campus program supports experiential learning. Through hands-on sustainability practices, such as waste sorting and energy conservation, students complete a learning cycle: they have concrete experiences, reflect on them, conceptualize abstractly, and actively experiment [29]. This deepens understanding and builds ecological responsibility. For PGSD UM students, the Green Campus serves as a living laboratory to observe, join, and reflect on sustainable activities [30].

Overall, the results of this study confirm the hypothesized dimensions and have transformative implications for the elementary teacher education curriculum. The valid and reliable ecopedagogical model developed in this study can be incorporated into coursework, student teaching, and assessment strategies within elementary teacher education to strengthen future teachers' competencies as agents of ecological change. These teachers will be able to think systemically and foster sustainability awareness in their students. This enhancement focuses on developing action-based ecopedagogical Didactical Content Knowledge (DCK).

4. CONCLUSION

This study shows that the eco-literacy skills of Elementary School Teacher Education (PGSD) students consist of four main components, namely ecological awareness, affective values, concrete actions, and sustainable learning integration. These four components form an interrelated structure of abilities and represent the integration of understanding, internalization of values, and sustainable practices. These findings confirm that the Green Campus policy does not only function as a physical or symbolic policy but also plays an effective role as a contextual learning space that supports the holistic development of prospective teachers' ecoliteracy.

Based on these findings, this study provides several important recommendations. First, elementary teacher education programs are advised to integrate the resulting ecoliteracy model into the curriculum, particularly through strengthening experience-based learning, environmental projects, and reflective practices that link sustainability issues to elementary school learning. Second, higher education institutions need to strengthen the implementation of Green Campus as part of a pedagogical strategy, not just as an environmental management policy, so that campuses truly function as living laboratories for prospective teachers. Third,

teacher education needs to be directed towards the development of ecopedagogical Didactical Content Knowledge (DCK), which emphasizes the ability of prospective teachers to transform sustainability values and practices into contextual and applicable learning activities.

This study also has limitations, particularly in the context of a sample limited to one institution and the use of Exploratory Factor Analysis (EFA) as an initial stage of construct testing. Therefore, further research is recommended to test this model using the Confirmatory Factor Analysis (CFA) approach, involving a more diverse institutional context, and examining the relationship between prospective teachers' eco-literacy and sustainable learning practices in elementary schools. Overall, this study provides a strong empirical basis for the development of a sustainability-oriented teacher education curriculum and is an important first step in building a school culture and basic education that cares about the environment.

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