Assessing Biological Diversity Literacy Levels Among Students and Teachers at Teacher Training Colleges in the Eastern Region of Ghana

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Abstract
The biodiversity conservation concept is essential for literacy levels, as it provides the primary value of ecosystem life support, renewable resources, and ecological services. This research assesses the biological diversity literacy levels among students and teachers in the Eastern Region of Ghana. The research used the purposive sampling technique to select 515 students and 45 teachers from six (6) of the 46 public Colleges of Education in the Eastern Region of Ghana. Results showed that both students and tutors lacked adequate environmental awareness. Teacher trainees are expected to have adequate knowledge of responsible environmental behavior to influence their future students, as the training of teachers plays an important role in imparting the theme of Education for Sustainable Development. Results from the linear probability model indicate that being a female increases the probability of having perceived environmental knowledge by 10 percentage points, controlling other demographic characteristics. Also, being educated increases the probability of having perceived environmental knowledge by 5 percentage points, controlling other factors. Age was found to be significant at a 1% significant level. This research suggests policy recommendations for Ghana's Colleges of Education to develop and manage limited natural resources to promote environmental sensitivity, produce an in-depth knowledge of issues, teach students how to analyze and investigate issues, use citizenship to solve problems, and raise students' expectations of rewards for acting responsibly.

Keywords: Biological Biodiversity, Biodiversity Conservation, Environmental Education, Teacher Education, Environmental Abuse, Sustainable Development, Ghana

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1. Introduction

This paper explores the role of biological diversity literacy in Ghana's Teacher Training Institutions and its potential to contribute to sustainable development. It examines the relationship between instructors' and students' knowledge of biological diversity and their capacity to encourage sustainable behavior. The paper also explores the connection between Ghana's rich natural diversity and its cultural heritage, aiming to identify knowledge gaps and synergistic learning experiences. By examining the current state of biological diversity literacy within the framework of teacher training or education, we want to both uncover knowledge gaps and the potential for synergistic learning experiences. This is because, the Teacher Training Institutions serve as a thriving environment for the growth and training of prospective educators who are crucial agents to producing people who are environmentally conscious for a sustainable future (Adu et al., 2021; Adu et al., 2022; Yli-Panula et al., 2023). The purpose of the article is to clarify the connections that may be made between classroom instruction and sustainable development principles by utilizing biological diversity literacy. As we sort through the complexities of ecological education, we could get a deeper understanding of the subtleties of information transfer. Additionally, we may clear the way for a more tranquil coexistence of Ghana's natural ecosystems and its future stewards.

Human activity is mostly to be blamed for the about 1.0°C rise in global temperature above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. If global warming continues at its current rate, research predicts that it will hit 1.5°C between 2030 and 2052. The rate of rise during the pre-industrial period was claimed to be rising more slowly when compared to the trend for the decade 2006-2015, which was 0.87°C (possibly between 0.75°C and 0.99°C) greater than the average for the decade 1850-1900 (Adopted, 2014; Masson-Delmotte et al., 2021; Steiner & Engdaw, 2022). This circumstance is scary and troubling. All of these will have a disproportionately negative impact on the local populations that depend on agriculture or other agricultural activities for the provision of their basic needs.

2. Literature Review

2.1 Teacher Trainee as an Agent of Biodiversity Conservation

The field of education, particularly at the Teacher Training Institutions, has a complex task in the context of Ghana's efforts to achieve sustainable development and the entire world. There is a substantial knowledge gap regarding the level of instructors' and students' biological diversity literacy, despite the nation's rich ecological diversity and the urgent need for educated environmental stewardship. This information gap weakens the ability to develop environmentally conscious citizens and the incorporation of sustainable practices into educational settings (Adu et al., 2021).

The problem at hand is the incomplete integration of substantial biological diversity literacy in the curricula of teacher training institutes. This flaw prevents educators from properly educating succeeding generations about ecological awareness and responsibility, perpetuating the cycle of subpar environmental education. Furthermore, a poor understanding of biological diversity makes it difficult to combine educational programs with the need to save Ghana's natural resources and cultural heritage, which interferes with the more general goals of sustainable development.

2.2 Biodiversity Conservation and Teacher Education

The successful implementation of innovations like environmental education, particularly biodiversity education, depends largely on pre-service teacher preparation. Recent international research shows that these teacher training programs place an extremely low priority on environmental and biodiversity teaching. The importance of this issue is underscored by the fact that each teacher educator has a significant impact on a sizable number of pupils, who in turn have a significant impact on the larger educational community and the educational experiences of countless children (Brandt et al., 2021; Robles-Moral et al., 2023).

The effectiveness of biodiversity education in education depends on policy, curriculum, staff qualifications, parental involvement, and school climate. Recent research has shown limited understanding of biodiversity among pre-service teachers, particularly at the organism level, and its relation to environmental sustainability. As indicated in research conducted in Poland and Turkey. Another research in Turkey looked at pre-service science teachers' perceptions on biodiversity and how it relates to environmental sustainability. Taking these studies as a whole, it is clear that pre-service teacher education programs must be improved in order to prepare future teachers to address biodiversity concerns in educational contexts (Id Babou et al., 2023). Essentially, pre-service teacher preparation plays a crucial part in preparing future teachers to act as change agents in society, advancing sustainability and biodiversity preservation. To provide future teachers with the required knowledge and abilities to handle biodiversity in the classroom, it is crucial that pre-service teacher education programs give priority to environmental education, particularly biodiversity education (Davis et al., 2010; Lim et al., 2009).

2.3 Educational and Development Theories

2.3.1 Macro Theory of Learning/Education

Education plays a significate role in the development process as shown by the macro theory of leaning by Blossfeld. The theory contend that education betters the fortunes of an individual and the community, and the country in general. Therefore, education could be said to be the main milestone that could provide the necessary ingredient for better development of society and hence, the protection of biodiversity. With the quality education received, the protection of biodiversity is assured.

The macro education theory aims at fulfilling the needs of everyone; the theory provides a depth education where everyone is expected to be included for the benefit of all (Blossfeld, 2023). The term “Macro” signifies the larger proportion of a socioeconomic system where education aims at making a positive change to the larger systems of communities (Blossfeld, 2023; Paldam, 2023). There are two theories under the macro education theory: functionalism and conflict theories.

2.3.2 Functionalism Education Theory

Functionalism education theory shows how education received can provide individuals with the capacity to contribute to better the community. The emphasizes the creation of individuals' ability to improve the fortunes of society, in other words, an individual is empowered not only for his advancement but that of the larger community. This kind of

education aims at changing the status of society by giving back to the same what an individual got through education (Nargiza et al., 2023; Paldam, 2023).

Furthermore, the functionalism education theory aims at producing protective individuals who could have at heart the development concerns of the community (Nargiza et al., 2023; Patoulioti & Nilholm, 2023) Therefore, an education system with a sense of biodiversity protection could achieve and promote biodiversity protection towards sustainable development. This type of holistic education cannot be complete without an emphasis on environmental education, especially biodiversity education.

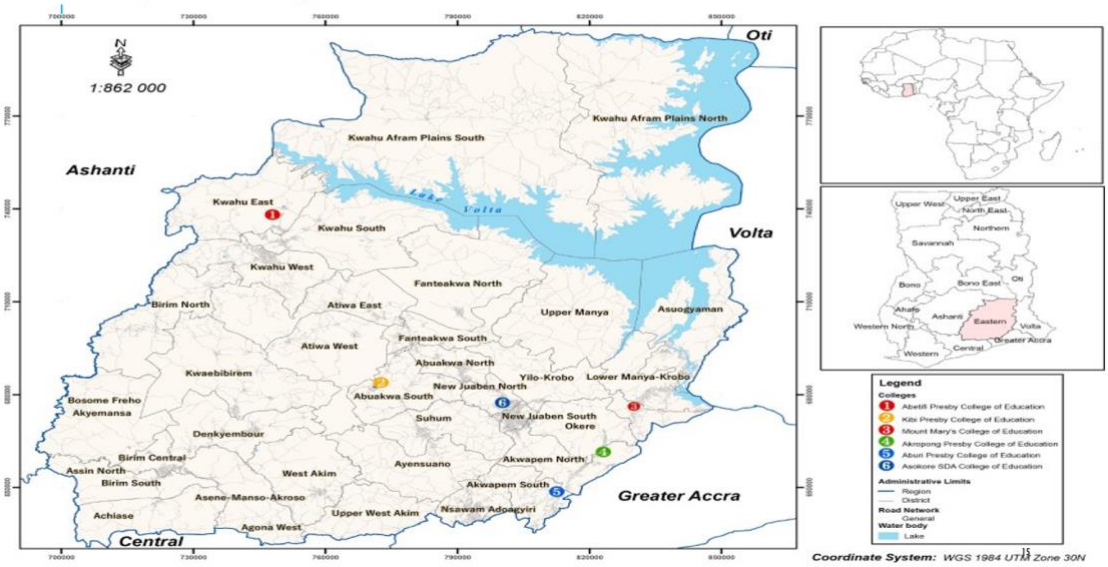
2.3.3 Conflict Education Theory

The conflict theory sees education as one that brings conflicts to society. The changing nature of education brings about structural changes in society which invokes a rise in injustice and inequality, which could breed violence among individuals in society. Educated individuals are likely to take advantage of the system and gain better socio-economic status, which causes the uneducated to be pushed away (Ferrare & Phillippo, 2023). The conflict theory looks at the other side of education that sees education as the cause of structural change in society due to the distinction between the educated and the uneducated (Ferrare & Phillippo, 2023; Isopahkala-Bouret et al., 2023).

3. Methodology

The students and tutors in this study serve as the main analytical subgroups for the data gathering. A purposive non-probability sampling technique was used to choose a total of 515 students and 46 tutors from the six institutions of education in the eastern region of Ghana with a total population(enrolment) of 10,588 students and 308 Tutors respectively. A same questionnaire survey consisting of both open ended and close ended were given to the sampled population to provide data for analysis for the survey. It was noted that among the 515 students, they were all studying different academic specialties that Ghana Tertiary Education Council (GTEC) had approved in the individual colleges or institutions. The 46 instructors were discovered to be teaching one or two of these approved subjects or courses concurrently at the various institutions. Excel, SPSS, and STATA statistical techniques were used to analyze the data collected. The study was conducted in the eastern region of Ghana. The locations of the study area is as shown below(figure 1). Participants in the survey were asked to rate their overall degree of knowledge on biodiversity genetic, biodiversity species, and ecosystem diversity using a Likert scale. The subsequent data analysis was performed using Microsoft Excel, SPSS, and STATA.

Figure 1: COUNTRY AND AREA OF RESEARCH: GHANA – EASTERN REGION



Author's own construct – 2023

3.1 Linear Probability Model: Equation and Definition of Variables

To ascertain the elements that shape the level of perceived biological diversity knowledge within the selected cluster, we employed the Linear Probability Model (LPM). The variables used in the Ordinary Least Square or the Linear Probability Model specification are perceived Biodiversity knowledge as the dependent variable and status, age, gender, level of formal education, marital status, mother tongue, Ghanaian language studied, religious denomination, ethnicity, and income as covariates as shown in Table 1. The dependent variables take the value of 1 if the pre-service teachers and teacher trainee tutors meet the acceptable score of perceived biodiversity knowledge and 0 otherwise. The OLS in the LMP equation used is as follows:

$$y_i = \beta_0 + \beta_1 x_i + \cdots + \beta_k \mathrm{X_i} + u_i \qquad (1)$$

where y_i is a dummy variable equal to 1 if pre-service teachers and teacher trainee tutors i meet the acceptable score of perceived biodiversity knowledge and 0 otherwise, while u_i is the error term.

3.2 The Cumulative Percentage of the Perceived Level of Biological Diversity Knowledge Performance

According to Al Rubaish (2010), when conducting assessment studies and experience surveys, the most suitable and practical method for handling ordinal scale data is the cumulative percentage (Al Rubaish et al., 2011). also advocated for the use of the cumulative percentage based on their deductions from assessment studies aimed at advancing academic programs. They drew inspiration from the practices of the National Commission for Assessment and Academic Accreditation (NCAAA) and well-regarded institutions worldwide. The cumulative percentage is a straightforward and easily comprehensible measure, making it particularly accessible to non-statisticians. It serves to quantify changes in performance over time and helps pinpoint areas where improvement is required (Al-Rubaish et al., 2011; Al Rubaish et al., 2011). In summary, the endorsement of the cumulative percentage as a tool for handling ordinal scale data is supported by Al Rubaish and his

collaborators, and it has been embraced in various assessment studies and experience surveys in the domains of education and environmental awareness (Al Rubaish et al., 2011; Campbell, 2021).

A variety of parametric and non-parametric metrics, such as the arithmetic mean, median, first quartile, and cumulative percentage, have been used as analytical tools in the evaluation in order to create a credible scoring system. But when the linear probability model was used for analysis, the "good" and "excellent" scores were combined and given the designation "acceptable score."

4. Results

4.1 Demographic Characteristics

The respondence completed a total of 560 survey questionnaires, 515 were from the students while 45 were completed by the tutors. Out of this total number, 63% (354) were females whiles 37.2% (206), were males. In all, 92.00% (517) were below age 30, 3.4% (19) were between the ages of 31 to 40, whiles 3.0% were also between the ages of 41 and 50, and the rest 1.6% (9) were above age 50. This suggests that most of the respondents are students, the actual target for the study. Since they are likely to work or impact knowledge to future generations for a long time, it is reasonable to assume that they are aware of how their labor affects the environment and biodiversity sustainability for sustainable development and vice versa. 531 representing 94.8% had SSCE/WASSCE certificates, 28 representing 5.0% had a master's degree, and 1 representing 0.2% had attained Ph.D. It is anticipated that respondents' perceived awareness of environmental concerns would be significantly influenced by their educational background. Most respondents (82.3%) are not married, with 84 (15.0%) being married. Akan, the mother tongue, is claimed by 72.14% of respondents. Ewe speakers make up 9.8% of the population, while Ga-Dangme speakers are present in 7.9%. Dagbani, Gonja, Wali/Dagaare, and Kasem have lower percentages, indicating lesser prevalence. 3.39% of respondents are classified as "Others," suggesting the presence of many minority languages. Most respondents are not married.

The study reveals that Akuapem Twi is the most frequently learned Ghanaian language among respondents, with 50.18% having studied it. Asante Twi is the second most learned language, followed by English at 30.54%. Ewe is the third most frequently learned language, with 6.96% of respondents studying it. Less frequently taught languages include Fanti, Ga, Dangme, Kasem, Nzema, and Dagbani. The data suggests that people from diverse linguistic backgrounds may desire to learn multiple Ghanaian languages for various reasons, including academic needs or personal curiosity. This information can help in educational planning and language preservation activities.

Table 1: General Environmental Knowledge of Teacher Trainees/Tutors Stratified by Demographic Characteristics

Parameter	Frequency	Percentage
Total respondent	**560**	**100**
Status: Pre-service teachers	515	91.96
Teacher trainee tutors	45	8.04
Age: Below 30	517	92.00
31-40	19	3.4
41-50	17	3.0
Above 50	9	1.6
Gender: Male	206	37.2
Female	354	63.2
Level of education: SSCE/WASSCE	531	94,8
Masters	28	5.0
Ph.D.	1	0.2
Marital Status: Single	461	82.3
Married	84	15.0
Divorced	11	2.0
Widow/Widower	4	0.7
Mother tongue: Akan (Akuapem, Asante, Fanti, Nzema)	404	72.14
Ewe	55	9.8
Ga-Dangme (Ga, Krobo)	44	7.9
Dagbani	4	0.71
Gonja	6	1.07
Wali/Dagaare	8	1.43
Kasem	14	2.5
Others	19	3.39
Ghanaian language studied at school:		
Akuapem Twi	281	50.18
Asante Twi	171	30.54
Fanti	27	4.825
Nzema	4	0.71
Ewe	39	6.96
Ga	11	1.96
Dangme	21	3.75
Dagbani	3	0.54
Kasem	3	0.54

Source: Authors' own construct (2023)

4.2 Independence Sampled T-test of Teacher Trainees and Tutors

An independent samples t-test was carried out as part of the statistical analysis to compare the means of two (2) distinct groups, namely male and female on ten environmental dimensions on which three were on biodiversity issues (Biodiversity species, biodiversity genetics and biodiversity ecosystems) to determine whether there is statistical evidence that the associated population means are significantly different. If the result of the observed t-test is greater than the critical values, the null hypothesis (H_0), which states that there is no significant difference between males and females, will be rejected. The outcomes of the independent T-tests for the two groups are shown in Table 2.

A. On biodiversity genetics, 354 female pre-service teachers and tutors, with an average score of 2.87 (with a standard deviation of 1.260). The 206 male participants, on the other hand, had a higher average score of 2.24 (with a standard deviation of 1.007). The findings revealed a statistically significant difference in perceptions across genders ($F(560) = 16.368$, $p = 0.000$), with Levene's test indicating equal variances. The independent samples t-test revealed that men had a statistically higher comprehension of biodiversity genetics than women ($t(560) = 6.103$, $p = 0.000$). Furthermore, Levene's test for variance equality ($F(560) = 16.368$, $p = 0.000$) indicated that the assumption was correct. The same interpretation was given to the others.

B. The study found a significant difference in awareness of biodiversity species between males and females, with males scoring higher on average (M=2.08). The t-test showed a t-value of 4.489 and a Cohen's D effect size of 0.41, indicating that males have a better understanding of this topic compared to females. However, the practical significance of this difference may be limited due to the relatively small effect size (Cohen's D = 0.41). Levene's test for equality of variances also showed a significant difference in awareness between the two groups, violating the assumption of equal variances. The study concludes that while the statistically significant difference is statistically significant, the practical significance of this difference is relatively modest.

C. The study found no significant difference in knowledge of ecosystem diversity between male and female groups, with an average score of 1.92. The Levene's Test and T-test for independent samples also showed no significant difference, indicating no practical significance. Cohen's D = 0.32 effect size suggests that there is limited practical significance associated with this difference. A similar interpretation is given to all the other dimensions.

Table 2: Independent Sample T-test of Teacher Trainees and Tutors

Dimension	*Levene's Test*		*Gender*	*Mean*	*Standard Deviation*	*P-value*	*T*	*Cohen D*
	F	*Sig.*						
Biodiversity Genetics	16.368	0.000	Female	2.87	1.260	.000	6.103	0.35
			Male	2.24	1.007		6.469	
Biodiversity Species	48.209	0.000	Female	2.63	1.506	.000	4.489	0.41
			Male	2.08	1.231		4.732	
Ecosystem Diversity	70.980	0.000	Female	2.55	1.579	.000	4.938	0.32
			Male	1.92	1.183		5.320	
Water Pollution	0.079	0.779	Female	3.17	1.285	.0568	0.572	0.52
			Male	3.10	1.301		0.570	
Air Pollution	73.667	0.000	Female	2.64	1.580	.000	5.406	0.37
			Male	1.95	1.192		5.814	
Biodiversity	0.245	0.621	Female	3.06	1.259	.001	3.378	0.61
			Male	2.69	1.234		3.396	
Sustainability	0.912	0.340	Female	2.92	1.300	.001	3.158	0.38
			Male	2.57	1.211		3.218	
Watershed management	0.276	0.599	Female	3.01	1.099	.265	1.095	0.61
			Male	2.90	1.022		1.116	
Conservation Of natural resources	2.603	0.107	Female	2.84	1.351	.000	5.163	0.42
			Male	2.24	1.271		5.247	
Wetland	0.235	0.628	Female	3.21	1.379	.704	0.380	0.31
			Male	3.17	1.449		0.375	

Source: Author's own from fieldwork (2023)
Level of significance $p<0.05$

4.3 Perceived Biodiversity Knowledge Performance as a Cumulative Percentage

Using a five-point Likert scale with 1= strongly agree, 2= agree, 3= neutral, 4= disagree, and 5= strongly disagree, the 515 teacher trainees and the 45 teacher trainee tutors were asked to assess their own level of familiarity or knowledge on the issue of biodiversity. The survey reviewed that Pre-service teacher, comprising 66.99% of the population, are classified as "Improvement Required (Poor)," while 19.81% are "Acceptable (Good)," and 13.20% are "High Quality (Excellent). Teacher trainee tutors, on the other hand, are classified as 26.67% - Improvement Required (Poor), 51.11% - Acceptable (Good), and 22.22% - High Quality (Excellent) category respectively (See Table 3). This is a bad recipe for the achievement of the SDG 14 and 15 and its subsequent effects on sustainability development of Ghana. This is because, for the ecological and sustainable utilization of biodiversity, education has a crucial role to play in ensuring the protection and sustainable utilization of biodiversity. The knowledge and deeds of present and future generations will determine the fate of biodiversity in the event of sustainable development. In addition to this, a survey by (Solveig Marie, 2023), reviewed that acquiring knowledge in educational program by students in Ngorongoro district, Tanzania on Biodiversity and ecosystem systems changed student's perceptions on biodiversity conservation and ecosystem services as indicated by the pre-test and the post-test results findings reported by the researchers. Therefore, this study also supports the positive effect of biodiversity knowledge for biodiversity sustainability for sustainable development through education.

Table 3: Assessment of the Level of Biological Diversity Literacy, Interest, and Skills of Teachers Trainees/Tutors Stratified by Four (4) Demographic Characteristics

Parameter	Improvement Required (Poor)	Acceptable (Good)	High Quality (Excellent)
Status: Pre-service teachers	345(66.99)	102(19.81)	68(13.20)
Teacher trainee tutors	12(26.67)	23(51.11)	10(22.22)
Age: Below 30	303(63.79)	114(24.00)	58(12.21)
31-40	11(57.89)	3(15.79)	5(26.32)
41-50	7(43.75)	1(6.25)	8(50.00)
Above 50	4(57.14)	11(4.29)	22(8.57)
Gender: Male	100(48.54)	53(25.73)	53(25.73)
Female	225(63.56)	66(18.64)	63(17.80)
Level of education: SSCE/WASSCE	303(57.06)	116(21.85)	112(21.09)
Masters	22(41.51)	28(52.83)	3(5.66)
Ph.D.	0(0)	0(0)	1(100)

Source: Author's own from fieldwork (2023)

4.4 Linear Probability Model (LPM)

Table 4 shows the results from the Ordinary Least Square (OLS) in the Linear Probability Model (LPM) estimates of perceived environmental knowledge of pre-service teachers and teacher trainee tutor. Among the pre-service teachers and teacher trainee tutor, mother tongue, marital status, religious denomination and income are unrelated to their perceived environmental knowledge score. This means that mother tongue, marital status, religious denomination, and income are not important factors in predicting the household head's perceived environmental knowledge score. The results indicate that being a female increases the probability of having perceived environmental knowledge by 10 percentage points,

controlling other demographic characteristics. Also, being educated increases the probability of having perceived environmental knowledge by 5% points, controlling other factors. Age was found to be significant at a 1% significant level. The coefficient of the Ghanaian language studied at school was found to be significant at 10% significant level.

Table 4: Linear Probability Model (LPM) Estimates of Perceived Environmental Knowledge Pre-service Teachers and Teacher Trainee Tutor

Variables	Perceived Environmental Knowledge Score
Age	**0.201*** **
	(0.154)
Female	**0.1003** **
	(0.138)
Education	**0.0555* **
	(0.115)
Mother tongue	0.000850
	(0.00720)
Marital Status	0.108
	(0.101)
Religious Denomination	0.0221
	(0.00245)
Ghanaian language studied at school	**0.0201* **
	(0.0288)
Income	-0.0001
	(0.00137)
Constant	0.7118**
	(0.2001)
Observations	560
R-squared	0.4032

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Created by the Author from fieldwork, 2023

5. Discussion

The study reveals that demographic variables such as mother tongue, marital status, religious denomination, and income do not significantly influence the perceived environmental knowledge of pre-service teachers and teacher trainee tutors. However, gender and education play more significant roles in shaping environmental knowledge, with females showing a 10 percentage point increase in perceived environmental knowledge. This suggests that gender-specific patterns in environmental awareness may be present, and targeted approaches to environmental education could benefit both male and female individuals.

The positive correlation between education and perceived environmental knowledge emphasizes the importance of formal education in shaping individuals' awareness and understanding of environmental issues. Age also plays a significant role in predicting

perceived environmental knowledge, suggesting generational differences in environmental awareness. The Ghanaian language studied at school has a modest impact on perceived environmental knowledge, prompting further exploration into the role of language in environmental education.

The study also highlights the need for tailored educational strategies to enhance environmental awareness among diverse populations. However, the current situation in education, particularly for pre-service teachers, raises questions about the effectiveness of the current system in fostering knowledge and abilities needed to conserve biodiversity. Most pre-service teachers' assessments of their performance are classified as "Improvement Required (Poor)," raising concerns about the sustainability of terrestrial and marine ecosystems.

The study concludes that education is essential to the ecological and sustainable use of biodiversity, and immediate action is needed to improve the educational quality of this group. Cooperation between legislators, educational institutions, and the community is crucial to change Ghana's educational system and prepare the country for a more sustainable and ecologically aware future. The findings underscore the interconnectedness of education, biodiversity awareness, and sustainable development, emphasizing the need for immediate action to enhance the effectiveness of the educational system in fostering responsible biodiversity management and environmental consciousness.

6. Conclusion

This study emphasizes the importance of education in increasing biodiversity awareness and supporting its sustainable management. To secure a better future for Ghana's biodiversity, several actions can be implemented, including enhancing the curriculum, providing teacher training, promoting public awareness, and integrating biology, ecology, environmental science, and social sciences into biodiversity education.

Investing in teacher education, curriculum reform, and public awareness initiatives is crucial for Ghana to secure its ecological heritage, which is essential for sustainable development and achieving SDGs 14 and 15. Teacher trainees, when motivated, can enhance their knowledge on biodiversity issues, serving as a foundational understanding of the environment and its natural interactions. This indirectly makes them willing to learn more to become an environmentally conscious generation.

The study also advocates for differentiation in environmental education at every educational level to achieve specific goals at every educational level. By focusing on biodiversity education and awareness, the study contributes to the body of previous knowledge by highlighting the potential benefits of decreasing human-related activities that endanger genetic and species functioning and sustainability. This could improve ecosystem services and well-being, increase the chances of a sustainable future for future generations, and impact future clients, such as students.

In conclusion, investing in teacher education, curriculum reform, and public awareness initiatives is essential for Ghana's sustainable future. By addressing biodiversity issues and raising environmentally conscious generations, Ghana can work towards achieving its Sustainable Development Goals (SDGs 14 and 15).

References

Adopted, I. (2014). Climate change 2014 synthesis report. *IPCC: Geneva, Szwitzerland*, 1059-1072.

Adu, I. K., Puthenkalam, J. J., & Antwi, K. E. (2021). Environmental Generation Framework: A Case of Environmental Awareness Among farmers and Senior High School Students for Sustainable Development. *Journal of Environmental and Agricultural Studies*, *2*(1), 62-78.

Adu, K., Puthenkalam, J. J., & Kwabena, A. E. (2022). Agricultural and Extension Education for Sustainability Approach. *British Journal of Environmental Studies*, *2*(1), 20-37.

Al-Rubaish, A. M., Rahim, S. I. A., Abumadini, M. S., & Wosornu, L. (2011). Academic job satisfaction questionnaire: Construction and validation in Saudi Arabia. *Journal of Family and Community Medicine*, *18*(1), 1.

Al Rubaish, A., Wosornu, L., & Dwivedi, S. N. (2011). Using deductions from assessment studies towards furtherance of the academic program: An empirical appraisal of institutional student course evaluation.

Blossfeld, P. N. (2023). How do macro and micro level changes interact in the emergence of educational outcomes? *Sociology Compass*, *17*(2), e13042.

Brandt, J.-O., Barth, M., Merritt, E., & Hale, A. (2021). A matter of connection: The 4 Cs of learning in pre-service teacher education for sustainability. *Journal of Cleaner Production*, *279*, 123749.

Campbell, M. J. (2021). *Statistics at square one*. John Wiley & Sons.

Davis, H., Hartshorne, R., & Ring, G. (2010). Being an innovative teacher: preservice teachers' conceptions of technology and innovation. *International Journal of Education*, *2*(1), 1.

Ferrare, J. J., & Phillippo, K. (2023). Conflict theory, extended: A framework for understanding contemporary struggles over education policy. *Educational Policy*, *37*(3), 587-623.

Id Babou, A., Selmaoui, S., Alami, A., Benjelloun, N., & Zaki, M. (2023). Teaching Biodiversity: Towards a Sustainable and Engaged Education. *Education Sciences*, *13*(9), 931.

Isopahkala-Bouret, U., Tholen, G., & van Zanten, A. (2023). Introduction to the special issue: positionality and social inequality in graduate careers. In (Vol. 36, pp. 1-8): Taylor & Francis.

Lim, C. P., Cock, K., Lock, G., & Brook, C. (2009). Innovative Practices in Pre-Service Teacher Education. *Sense Publication.–2009*.

Masson-Delmotte, V., Zhai, P., Pirani, S., Connors, C., Péan, S., Berger, N., Caud, Y., Chen, L., Goldfarb, M., & Scheel Monteiro, P. M. (2021). Ipcc, 2021: Summary for policymakers. in: Climate change 2021: The physical science basis. contribution of working group i to the sixth assessment report of the intergovernmental panel on climate change.

Nargiza, N., Zhao, W., & Fazal, K. (2023). Investigating the Practicality of Implementing Structural Functionalism Theory in the Teaching Practices of Basic Education Teachers in Tashkent, Uzbekistan. *Open Journal of Social Sciences*, *11*(4), 271-283.

Paldam, M. (2023). The transition of education a cross-country macro analysis. *European Journal of Political Economy*, 102362.

Patoulioti, E., & Nilholm, C. (2023). What is meant by 'community'in different theoretical traditions? An analysis of influential educational research. *European Journal of Special Needs Education*, 1-15.

Robles-Moral, F. J., Fernández-Díaz, M., & Ayuso-Fernández, G. E. (2023). A Study of the Usefulness of Physical Models and Digital Models for Teaching Science to Prospective Primary School Teachers. *Education Sciences*, *13*(4), 343.

Solveig Marie, W. (2023). *Decolonising Medieval Fennoscandia: An Interdisciplinary Study of Norse-Saami Relations in the Medieval Period*. De Gruyter.

Steiner, A. K., & Engdaw, M. M. (2022). Climate change, its impacts, and attribution of causes: Current status and challenges. Climate Change, Responsibility and Liability,

Yli-Panula, E., Jeronen, E., Vesterkvist, S., & Mulari, L. (2023). Subject Student Teachers' Perceptions of Key Environmental Problems and Their Own Role as Environmental Problem Solvers. *Education Sciences*, *13*(8), 779.