Original Research Paper

Exploring the Role of Environmental Education in Promoting Sustainability Mindset: An Empirical Analysis using Forward and Hierarchical Regression Methods

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Abstract

This study employed Forward Regression Analysis and Hierarchical Regression Analysis to explore the connection between ecological literacy, ecological regulations, ecological awareness, ecological education, and the Sustainability Mindset. The study participants were higher education students from Pune who had received environmental education and could provide information on their ecological education, literacy, awareness, regulation, and sustainability mindset. The results indicate that elements such as knowledge levels among individuals and communities, alongside policies implemented for environmental protection measures and public awareness campaigns coupled with educational endeavours collectively account for a significant portion of the variations observed in fostering sustainable attitudes and behaviours. Ecological knowledge has become increasingly crucial in promoting development beyond the environment. Experts have emphasized the importance of understanding how these factors are interconnected. This study's findings have several implications. Could help shape tailored educational initiatives and policies that support sustainable growth. Moreover, the valuable insights from this research could greatly benefit decision makers and academics dedicated to enhancing sustainability. The results revealed that the strongest predictor of a Sustainability Mindset is Ecological literacy, followed by ecological regulations, ecological awareness, and ecological education. All four independent variables were significant predictors of Sustainability Mindset. This study remains a rich area for future exploration in education and sustainable development, with important implications for policymakers and sustainability professionals.

1. Introduction

In light of the current climate crisis, global initiatives towards sustainable development are crucial for a more sustainable future. This study uses forward and hierarchical regression analyses to investigate the connection between environmental sustainability and the promotion of the United Nations Sustainable Development Goals (SDGs). This study aims to better understand how ecological literacy, regulations, awareness, and education contribute to sustainable development by fostering a sustainable mindset by integrating sustainability principles into higher education institutions' curricula, research, and community engagement.

Universities emphasize sustainability by engaging in research and educational programs to support Sustainable Development Goals (SDGs). Education is crucial for promoting nations'shared goals. The Education for Sustainable Development (ESD) initiative by UNESCO is an approach to fostering a community and making progress towards achieving the SDGs by 2030. This study bridges the knowledge gap by demonstrating how these educational initiatives effectively contribute to achieving development outcomes and fostering enduring consciousness among students and alums from areas such as the Global South.

This study employs forward and hierarchical regression analyses to examine how various elements of education collaborate to enhance results in Higher Education Institutions by recognizing and elucidating crucial sustainability dimensions and obstacles. Addressing this gap in understanding and offering insights derived from the study's findings could potentially assist policymakers, educational institutions, and organizations to devise more effective sustainability education strategies and policies tailored to motivate students to embrace behaviors aligned with sustainability development goals (SDGs).

1.1 Background

This study highlights the importance of education in driving development and achieving the United Nations Sustainable Development Goals (SDGs). Many colleges and universities have incorporated sustainability values into their curricula and study initiatives as community engagement activities to recognize their contribution to promoting sustainable development (Asdlori & Yahya, 2023; Atthakorn et al., 2024).

The global significance of sustainability has led universities to play a role in contribute towards Development Goals (SDGs) through their focus areas of research efforts, educational initiatives, and community involvement (Saleh & Adly, 2024). UNESCO has strongly advocated Education for Sustainable Development (ESD) as a tool for establishing a society & accomplishing the SDGs by 2023 (Handayani, 2019. Higher education institutions are highly valued, as they shape students into individuals who

understand the importance of sustainability in balancing the environment, economy, and society (Handayani, 2019).

Incorporating sustainability into leadership and management is essential for instilling a culture of practice and achieving long-term objectives (Atthakorn et al., 2024). This goes beyond curriculum development to include implementing policies and encouraging leadership while actively involving stakeholders in supporting sustainable growth and addressing economic, environmental, and social issues. There is an emphasis on encouraging the industry to embrace responsibility and promote social entrepreneurship as part of this approach (Die Busto et al., 2022).

Adopting an educational approach that supports progress is crucial (Diab and Molinari, 2017). Universities must align their policies, funding, and course offerings with Sustainable Development Goals (Saleh & Adly, 2024). The advancement of development and management promotion depends heavily on education institutions cultivating human resources by incorporating ESD principles into their curricula (Handayani, 2019). This study is significant in advancing environmental development objectives. With the increasing focus on practices and the importance of responsible development and environmental care becoming a top priority for the public, this research is now more crucial than ever.

1.2 Aim/Objective:

The main goal of this research was to analyze how "ecological literacy, regulations, awareness, and education" impact the sustainability mindset through forward and hierarchical regression analysis. The primary focus was to offer perspectives on the efficiency of environmental education initiatives and their influence on behavior by studying these associations. This analysis could assist decision-makers in refining their approaches to foster a culture of sustainability among individuals, while also aiding educators and environmental groups in enhancing their strategies for sustainability awareness.

1.3 Novelty:

We used the forward and hierarchical regression methods to analyze the environmental education variables in promoting the sustainability mindset, a unique and novel approach in sustainable development research.

1.4 Rationale:

This study aims to provide an understanding of how environmental education supports the achievement of development goals by investigating challenges that impede the implementation of environmental education programs and proposing solutions to overcome them while also exploring the enduring impact of "ecological literacy," "ecological regulations," "ecological awareness, and "ecological education" impacts sustainability mindset. Exploring the influence of awareness on attitudes and behaviors can offer perspectives for fostering a culture of sustainability across diverse populations. Understanding the impact of education could inspire strategies and programs to promote lasting behaviors and practices in communities.

This method supports the environmental education objectives of reshaping individuals' views and actions towards sustainability.

2 Literature Review:

Previous studies have shown that environmental education plays a crucial role in promoting sustainability; however, it does not explain the specific mechanism through which we can achieve sustainable development and the attainment of SDGs.

Various factors, such as demographics and shape attitudes towards sustainable development. Educational policies must understand the diverse needs and characteristics of different social groups, and be sufficiently flexible. (Concina, 2023; Fanea-Ivanovici & Baber, 2022). A comprehensive higher education approach is needed to address environmental issues proactively. However, this process requires not only understanding the concept of sustainability, but also implementing the process of sustainable development by educators and students (Gupta et al., 2023).

Higher education institutions currently focus on ecological education research. Highlighting the significance of cultivating a mindset in students' learning journeys, according to Barth et al. (2007), underscores the importance of environmental competence in achieving development goals. Existing education systems have not sufficiently incorporated education into their curricula, leading to a lack of awareness about development among future generations, as mentioned by Sterling in 2001.

2.1 Ecological Education and Sustainable Development

Ecological education encompasses concepts aimed at enhancing individuals' comprehension of ecosystems and functions, emphasizing the significance of acquiring knowledge to foster a mindset centered on sustainability and conscientious environmental actions (Ha et al. 2021). When people participate in environmental education programs, they learn about the importance of conserving resources for growth and development (Zevallos 2024). Integrating education into the Sustainable Development Goals framework aligns with the aim of promoting sustainability and increasing awareness of conservation (Boca and Saraçlı 2019). Environmental education also involves sharing knowledge on practices and encouraging behaviors such as conservation and sustainable economic development (Xu, 2023).

2.2 Ecological Literacy and Awareness

Understanding literacy entails understanding the relationship between nature and human conduct rather than just acquiring information; it involves nurturing principles and sentiments connected to the environment (Khanal et al., 2020). Ecological literacy contributes to improving our understanding of how human actions impact the planet's processes and outcomes, which is an element in promoting development (Prastiwi et al., 2019). Awareness of ecology is closely tied to knowledge, understanding the connection between humans and the natural world. Focusing on fostering connections with nature and encouraging activism is key here, as awareness is crucial in implementing actions that bolster conservation efforts and sustainability practices.

2.3 Ecological Regulation and Sustainability Mindset

Ecological regulations play a role in driving advancements by establishing standards and approaches that promote environmental preservation (Xus, 2023). Practices such as incentives help foster nature conservation by inspiring individuals and organizations to engage in conservation efforts (Xus 2023). Encouraging a mindset centered on sustainability involves embracing values and skills aimed at protecting the environment and working towards achieving Development Goals (Mulyadi, 2020). Having a commitment to sustainability inspires individuals to take steps towards meeting development goals by

reducing waste production and conserving resources while also supporting preservation efforts (Busin, 2023).

3 Research Design:

The study structure involved an analysis utilizing the forward and hierarchical regression methods to investigate the relationships between the different facets of environmental education and their combined impact on achieving a sustainability mindset. Through the application of forward and hierarchical regression analyses in this research endeavor, we revealed the channels by which ecological education levels and literacy awareness, alongside regulations and sustainability attitudes, play a role in promoting development. The results of this research have the potential to guide decision-making on policies and educational approaches directed towards building a sustainable tomorrow.

3.1 Research Method:

This research employs forward and hierarchical Regression Analysis as a method to explore the impact of Ecological literacy, ecological regulations, ecological awareness, and ecological education on Sustainability Mindset. Through an examination of data encompassing education and sustainable development indicators across regions and timeframes, this study sought to pinpoint factors and their contributions to attaining sustainable development outcomes using the forward and hierarchical Regression Methodology. In addition, the study analyses work dives into elements that might influence or interact with aspects of education to achieve a deeper understanding of how they all contribute to sustainability goals.

3.2 Application of Forward and Hierarchical Regression Analysis in Environmental Education Research

Forward and hierarchical Regression Analysis is a technique used in environmental education research to explore how different independent variables are simultaneously affected by variables. This method allows researchers to investigate the relationships between education levels, literacy rates, awareness levels, practices, and sustainability mindsets to comprehend their effects on development outcomes. By studying the interactions among these factors, a hierarchical Regression Analysis highlights the significance of education in promoting a Sustainability Mindset.

3.3 Data Collection

Data were collected through a survey questionnaire that assessed participants' ecological education, literacy, awareness, regulation, and perception of the sustainability mindset. Four hundred higher education students majoring in environmental science in Pune city were approached for data collection.

3.4 Statistical Analysis

Statistical analysis involves the application of forward and hierarchical regression analyses to identify the relationships between dependent and independent variables.

3.5 Reliability and validity

Reliability is the ability of a scale to produce consistent results and is the extent to which a scale is trustworthy. The five variables under study, ecological literacy, ecological awareness, ecological regulations, ecological education, and sustainability mindset, are single-item scale variables. The reliability

of the measuring instrument was examined using the test-retest method. The results of the test-retest method showed high consistency among the data collected on two occasions. Validity refers to the ability of a scale to produce accurate results. This is the extent to which a scale measures what it is supposed to do. Validity is examined by computing the content validity index and content validity ratio, as suggested by C H Lawshe (1975). The content validity ratio and content validity index for all five variables were above the threshold of 0.741 for the seven experts.

Model	Parameters	B	Std. Error	Beta	T	Sig.	R Square	R Sq Changed	F	Sig.
1	(Constant)	2.287	0.105		21.718	p<0.001	0.364	0.364	119.8	p<0.001
	Ecological Literacy	0.318	0.029	0.604	10.947	p<0.001				
2	(Constant)	2.03	0.106		19.098	p<0.001	0.459	0.095	88.35	p<0.001
	Ecological Literacy	0.23	0.031	0.436	7.52	p<0.001				
	Ecological Regulations	0.17	0.028	0.351	6.042	p<0.001				
3	(Constant)	1.912	0.108		17.624	p<0.001	0.491	0.032	66.5	p<0.001
	Ecological Literacy	0.193	0.031	0.367	6.149	p<0.001				
	Ecological Regulations	0.138	0.029	0.285	4.816	p<0.001				
	Ecological Awareness	0.101	0.028	0.212	3.594	p<0.001				
4	(Constant)	1.796	0.113		15.856	p<0.001	0.512	0.021	54.04	p<0.001
	Ecological Literacy	0.16	0.033	0.304	4.89	p<0.001				
	Ecological Regulations	0.128	0.028	0.264	4.505	p<0.001				
	Ecological Awareness	0.085	0.028	0.179	3.034	0.003				
	Ecological Education	0.089	0.03	0.174	2.977	0.003				
a. Dependent Variable: Sustainability Mindset										

Table 1: Model summary and coefficients

It is hypothesized that "ecological literacy," "ecological regulations," "ecological awareness," and "ecological education" are significant predictors of a "sustainability mindset." Forward regression analysis was used to validate this hypothesis. Forward regression analysis is an entry-based method for developing a predictive model. We had a continuous dependent variable and several continuous independent variables. A forward regression approach begins with a null model (an empty model with only a constant in the model)

and then sequentially adds independent variables to the model to improve it until the stopping criterion is met. Unlike the backward method, which employed a significance level of 0.1, the level of significance used in the forward method was 0.05. The analysis produced four models of current data.

Model 1 (F = 119.8***) includes the most meritorious predictor, "ecological literacy," with an R square of 0.36, indicating that ecological literacy can explain 36% of the variance of the Sustainability Mindset. Model 2 (F = 88.3***) includes two predictors, "ecological literacy" and "ecological regulation," with an R square of 0.4,5, indicating that ecological literacy and ecological regulations can explain 45% of the variance in the Sustainability Mindset. Model 3 (F = 66.5***) includes three predictors, "ecological literacy," "ecological regulations," and "ecological awareness," with an R square of 0.49 indicating that ecological literacy, ecological regulations, and ecological awareness can explain 49% of the variance of Sustainability Mindset. Finally, model 4 (F =54.04***) includes four predictors: "ecological literacy," "ecological regulations," "ecological awareness," and "ecological education," with an R square of 0.51 indicating the ecological literacy, ecological regulations, ecological awareness, and ecological education can explain 51% of the variance of Sustainability Mindset, "***" significant at 0.1% level of significance.

3.6 Predictor importance

The strongest predictor of a Sustainability Mindset is Ecological literacy (beta = 0.304, t = 4.89***), followed by ecological regulations (beta = 0.264, t = 4.5***), ecological awareness (beta = 0.179, t = 3.03***), and environmental education (beta = 0.174, t = 2.97***). The inclusion of ecological regulation has improved the model by 9.5%, the inclusion of environmental awareness has improved the model by 3.2%, whereas the inclusion of ecological education has improved the model by 2.1%, "***" significant at 0.1% level of significance.
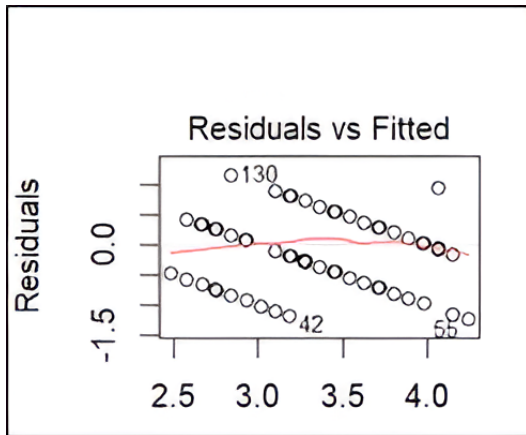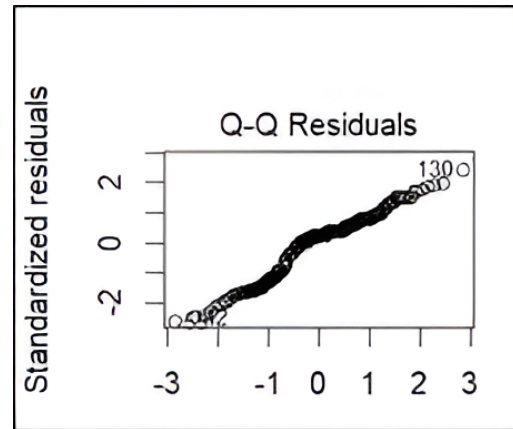

Fig:1 Assumption of linearity

Fig:2 Assumption of residual normality

The accuracy of the results of multiple regression analysis is based on four assumptions: linearity, residual normality, homoscedasticity, and no outliers. If these assumptions are not supported, multiple regression analysis (MRA) results can be misleading and the MRA model can be misspecified. Figure 1 shows that the red line is close to the horizontal axis, supporting the Assumption of linearity and ruling out the possibility of the nonlinear relationship between the "sustainability mindset" and our predictors, "ecological literacy," "ecological regulations," "ecological awareness" and "ecological education"

A standard QQ residual plot is a graphical technique used to assess whether residuals are approximately normally distributed. The residuals are plotted against a theoretical normal distribution such that the points form an approximately straight line. Departures from this straight line indicate departure from normality. The error terms were close to the diagonal line of normality, supporting the assumption of residual normality, as shown in Figure 2.
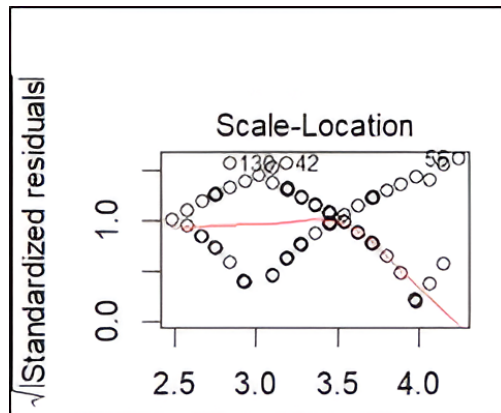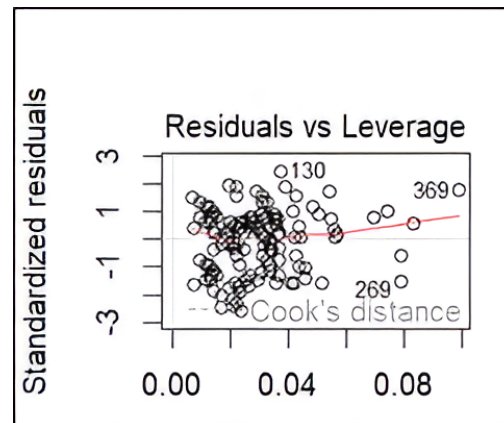

Fig:3 Assumption of homoscedasticity

Fig:4 Assumption of outliers

The third important assumption was homoscedasticity. That is, the error terms are constant across the regression line, that is, the size of the error terms is independent of the four predictors. Figure 3 shows that the error terms were constant across the regression line. These results are also supported by an insignificant (p>0.05) Breusch and Pagan test ($\chi 2$ = 1.085, p =0.298)

Fig:5 Breusch-Pagan Test

The final assumption is that there are no outliers, that is, the data are free from outliers (abnormal values). Figure 4 shows that there are no potential outliers because no cases are beyond the Cook's distance threshold.

3. 7 Hierarchical regression analysis

The above results were reinforced using a hierarchical regression analysis. Hierarchical regression analysis is a type of multiple regression analysis that allows us to examine the impact of an independent

variable on a dependent variable after accounting for other variables. In this method, predictors are entered into a block. The evaluated variable is entered next (last) to check the predictive ability of the variable to be assessed over and above the covariates. The results of the hierarchical regression analysis with four block variables ("ecological literacy," "ecological regulations," "ecological awareness, and "ecological education") are presented below.

Variable to be evaluated	R square BEFORE	R square AFTER	R square changed
Ecological Education	0.491	0.512	0.021
Ecological Literacy	0.455	0.512	0.057
Ecological Awareness	0.490	0.512	0.021
Ecological Regulations	0.464	0.512	0.048

Table 2: hierarchical regression analysis

It is interesting to note that Ecological Education contributes 2.1% to the model over and above ecological literacy, ecological awareness, ecological regulations; Ecological Literacy contributes 5.7% to the model, over and above ecological education, ecological awareness, ecological regulations; ecological awareness contributes 2.1% to the model over and above ecological literacy, ecological education, ecological regulations, whereas ecological regulations contributed 4.8% to the model over and above ecological literacy, ecological awareness, ecological education.

3. 8 Study Participants:
The study participants were higher education students from Pune City who had received environmental education and were able to provide information on their ecological education, literacy, awareness, regulation, and sustainability.

3.9 Inclusion Criteria:
Participants were included in the study if they had received environmental education and were able to provide information on the five key variables of ecological education: literacy, awareness, regulation, and sustainability mindset.

3.10 Exclusion Criteria:
Participants were excluded from the study if they were unable to provide information on the five key variables or had not received any environmental education.

4 Application/ Implications
The findings of this study provide insights into how environmental education programs can contribute to achieving sustainable development objectives by exploring the mechanisms involved in promoting the acceptance and implementation of these goals. Furthermore, it delves into the factors that could enhance or hinder the efficacy of efforts in advancing Sustainable Development Goals (SDGs) through a stainability mindset and offers valuable insights for designing impactful educational initiatives within the realm of sustainability.

5 Limitations and Future Research Directions

This research has its constraints due to data accessibility and the depth of the investigation, which concentrates on five aspects of education. The importance of this study goes beyond presenting proof; it could also lay the groundwork for future studies that delve into how environmental education can impact sustainable development in the long term. The repercussions of these discoveries might have an impact on shaping programs and policies at the administrative level, ranging from community schools to national educational frameworks. Although the study focuses on a context that has its limitations, it also offers a chance for researchers to conduct studies across various regions or cultures to confirm and build upon these findings further. The unique methodology employed in this study might motivate researchers to delve into approaches for evaluating the effects of sustainability parameters on development goals. Subsequent studies could explore integrating variables or investigating how environmental education intersects with educational fields to gain a broader insight into their combined impact on the SDGs.

Moreover, research studies could be planned to follow the lasting impacts of education on people's perspectives, actions, and involvement in growth over their lifetimes. Expanding on this understanding, it is clear that this research not only adds insight to the field but also paves the way for many potential research directions and real-world applications in environmental education and sustainable development.

5.1 Future Scope

In the future, researchers could explore how adding more environmental education factors affects developmental outcomes. To confirm the results of this study, a comparison of data from different regions and cultures would be beneficial. Moreover, the forward and hierarchical regression techniques used in this study could be helpful in exploring aspects of development and revealing new perspectives. Future research should also consider long-term evaluations to understand how education influences the achievement of Development Goals (SDGs).

This study emphasizes the role of ecological literacy, ecological regulations, ecological awareness, ecological education, and sustainability mindset in reaching development objectives. It also sets the stage for broader and more varied research across different regions of the world in the future. The unique forward and hierarchical regression approach utilized in this study has the potential to be used in areas of development and could uncover new perspectives and connections. Moreover, the results indicate that conducting long-term studies to explore how environmental education impacts the sustainability mindset over time may offer knowledge to decision-makers and education professionals.

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