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Exploring the Impact of Education for Sustainable Development on Global Climate Action Awareness

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Abstract: This paper examines how Education of Sustainable Development has assisted the Climate Action Awareness of the world and whether or not a more comprehensive inclusion of Education of Sustainable Development in the national education system will bring an improvement in climate literacy, responsibility, and climate action, taking into consideration socioeconomic, institutional, and digital aspects. Utilizing a mixed-methods approach, the research combines quantitative panel econometric analysis with qualitative policy insights. The formation of a balanced cross-national dataset was based on UNESCO Education for Sustainable Development indicators, socioeconomic data from the World Bank, and the global surveys of climate awareness. It utilizes the use of fixed-effects panel regression models and uses GDP per capita, educational expenditures, the level of governance, the availability of the internet, and climate vulnerability as some of the variables. Results indicate that there is a great difference in Climate Action Awareness (mean = 0.56; SD = 0.18) and ESDI (mean = 0.52; SD = 0.20) among countries. The regression analysis demonstrates that ESD positively and significantly influences CAA, with a one-unit rise in ESDI correlating to a 0.284 increase in CAA ($p < 0.001$). Other significant predictors include GDP per capita ($\beta = 0.092$, $p = 0.001$), education expenditure ($\beta = 0.037$, $p = 0.009$), governance quality ($\beta = 0.065$, $p = 0.002$), and internet penetration ($\beta = 0.004$, $p < 0.001$). Conversely, CAA is adversely affected by climate vulnerability ($\beta = -0.118$, $p = 0.003$). The model accounts for 41% of the variation in climate awareness, with robustness checks affirming these results. The research gives solid empirical evidence of the necessity of ESD as a key driver in increasing climate action awareness in the world, with the importance of strengthening ESD, governance, educational investment, and digital access to support informed climate action across the globe.

Keywords: Climate Action Awareness; Education for Sustainable Development; Governance Quality; Internet Penetration; Sustainability Education; Sustainable Development Goals.

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I. Introduction

The growing rate of climate change has made more urgent the necessity of informed and joint global action that not only demands technological solutions but also social, behavioral, and institutional change (Filonchyk et al., 2024). Education Sustainable Development (ESD), which is advocated by UNESCO as an essential generator of the 2030 Sustainable Development Agenda, is increasingly becoming a significant tool for developing climate literacy, pro-environmental attitudes, and responsible citizenship (Ferguson et al., 2021; Nousheen et al., 2020). Through the incorporation of environmental, social, and economic aspects of sustainability into both formal and informal learning frameworks, ESD aims to train individuals to possess the knowledge, skills, and ethical orientations that they need to solve intricate global issues like climate change (Priatna & Khan, 2024).

The climate action awareness in terms of knowledge of climate science, perceived urgency, individual responsibility, and readiness to participate in mitigation and adaptation initiatives is a decisive factor in determining how people respond to climate risks (Demaidi & Al-Sahili, 2021), Nevertheless, disparities in climate awareness across the world continue to exist, and they depend on disparities in educational access, quality, institutional capacity, and socio-economic contexts (Pérez-Sánchez et al., 2020). In this setting, ESD has become a strategic action that can help close the gap between the scientific understanding and the population, developing not only awareness but also critical thinking, systems thinking, and behavioral sustainability orientation (Okada & Gray, 2023).

The main aim of the research is to investigate how Education for Sustainable Development affects awareness of global climate action. Specifically, the research will be utilized to assess how ESD impacts how individuals perceive climate change, their perceptions of environmental responsibility, and their readiness to participate in climate mitigation and adaptation initiatives. A global perspective of comparative analysis is one of the purposes of the research that aims to recognize patterns and changes in the efficacy of ESD in various socio-economic and educational conditions (Olsson et al., 2022).

Although increasing attention is paid to climate education by scholars, the literature is largely confined to local case studies, curriculum assessments, or immediate behavioral changes (Al Husban, 2025). There is still limited empirical evidence about ESD and its relationship with wider, cross-national climate action awareness. In addition, numerous studies put a strong focus on knowledge acquisition without giving significant attention to the integrative role of ESD in the development of values, agency perception, and readiness to engage in collective action at a global level (Kalaycı Alas & Korutürk, 2024). The systematic analyses are also missing in significant numbers, and instead, ESD is treated as a transformative approach and is not seen as a support element in teaching, especially when it comes to quantifiable climate awareness levels.

This hypothesis leads this study with the assumption that H0: Increased levels of Education and Sustainability Development are positively linked with increased climate action awareness at a global level. It is also postulated that ESD will lead to better climate knowledge as well as increased perceptions of responsibility and a positive tendency to take up climate-related activities.

This study contributes to the current literature in a number of ways. To start with, it offers an empirical study on the world correlation between Education and Sustainable Development and climate action awareness, filling a fissure in cross-national research on sustainability education. Second, the study conceptualizes the idea of climate awareness as a multidimensional construct that goes beyond knowledge to include attitudes and action-based preparedness. Third, the results can be utilized in formulating policies that help to bring ESD into the national education agenda and global climate governance systems more efficiently. The study strengthens ESD as a pillar upon which long-term transitions of sustainability can be achieved by showing how Education is a strategic tool that can be used in promoting global climate action.

The paper is designed such that it systematically reviews the contribution of Education Sustainable Development (ESD) towards improving Climate Action Awareness (CAA) in the world. It starts with an introduction that describes the climate challenge, research objectives, gaps, hypotheses, and contributions. The literature review represents a synthesis of the theoretical and empirical evidence of the connection between ESD and climate awareness and action. The section of materials and methods gives the research design, conceptual framework, data sources, variable construction, and econometric models. Findings are presented in results with simple trends, regression, and non-weakness checks using figures and tables. The analysis puts major findings into the perspective of theory and policy. The paper ends with implications, limitations, and future research directions.

II. Literature Survey

Education Sustainable Development (ESD) has become an important tool towards becoming better climate action aware and pro-environmental attitudes oriented in line with the United Nations Sustainable Development Goals (SDGs), especially SDG 13 on Climate Action. Previous studies all focus on the idea that Education is capable of not only influencing environmental knowledge but also forming values, competencies, and behavioral intentions required to cope with global climate issues (Priatna & Khan, 2024; Mehmood, 2021). With the growing strength of climate change because of escalating greenhouse gas emissions (Filonchyk et al., 2024; Wang et al., 2024), Education as a productive way of preparing a responsible citizen has gained more relevance.

Empirical research indicates that the inclusion of sustainability principles in formal Education positively influences the awareness and interest of learners in the problems of climate change (Tunji-Olayeni et al.,

2021). The awareness of SDGs and the aspects of being climate-action-oriented among the university students can play a major role in the project-based learning procedures since the theoretical and real-life issue-solving is intertwined, as note. Similarly, as (Al Husban, 2025) points out, the inclusion of SDGs in the academic curricula positively affects the environmental awareness and pro-environmental behavior of students, which promotes the transformative quality of ESD. Longitudinal data also confirms such findings, as Olsson et al., 2022 have proven that action competence to sustainability grows considerably in students over time.

Climate education also has conceptual frameworks that support pedagogical principles. (Alam, 2022) pays attention to transformative learning, critical Reflection, and responsible citizenship as the major aspects of ESD, and Okada & Gray, 2023 propose the CARE-KNOW-DO model, including the aspects of awareness, knowledge acquisition, and actionable engagement. Based on these strategies, it is likely that climate education can be most effective when it is not only information delivery, but also incorporates the promotion of behavior change.

The applicability of climate awareness education to the whole world is supported by discipline studies. The article by Álvarez-Nieto et al., 2022 shows that the attitude toward climate change among nursing students is strongly influenced by sustainability education, which is why ESD is cross-sectoral. In addition to the education focus, research on green finance, climate risk disclosure, and low-carbon transitions (Lee et al., 2024; Wang et al., 2024; Tan et al., 2024) also indicates that informed individual awareness, which is often based on Education, promotes a more comprehensive institutional and policy-based climate response (Tian et al., 2022). Macroeconomic and environmental assessments also indicate that climate can be influenced by quality governance, intensity of the energy, and consumption patterns, and educational interventions that help to contextualise climate knowledge in socio-economic systems are needed (Li et al., 2024; Chau et al., 2022).

Regardless of increasing evidence, there are still gaps in the knowledge of how ESD can be turned into sustained climate action awareness at the regional and educational levels. The literature on learning interventions is also biased in the majority of cases, as most of it occurs in localized or department-specific settings, and there is a necessity for interdisciplinary, comparative research connecting educational interventions with larger, climate action outcomes. This paper fills this gap by analyzing how ESD can be used to enhance the global awareness of climate action within a global sustainability agenda.

III. Materials and Methods

Research Design

This research paper applies the mixed-method explanatory research design to identify how Education for Sustainable Development (ESD) is affecting global climate action awareness. The design combines quantitative analysis on a large scale with qualitative contextual interpretation to reflect both the quantifiable outcomes of awareness and the mechanisms by which the educational process operates that form the basis of the knowledge, attitude, and behavioral intentions of climate effects as influenced by ESD. A cross-national panel design is used to externalize the time change and structural heterogeneity across the countries, which accelerates the external validity and explains the difference in educational systems and climate governance situations. Qualitative policy analysis supports quantitative econometric modeling, facilitating triangulation and more profound results interpretation.

Conceptual Framework

The theoretical basis of the analytical framework is the transformative learning theory and the theory of planned behavior, which states that ESD leads to awareness of climate action along three interconnected pathways: cognitive (climate knowledge and systems thinking), affective (environmental values, responsibility, and risk perception), and behavioral (pro-climate intentions and civic engagement). The concept of climate action awareness is developed into a multidimensional scale that includes climate

literacy, perceived urgency of climate change, support of mitigation policies, and self-reported engagement in climate action.

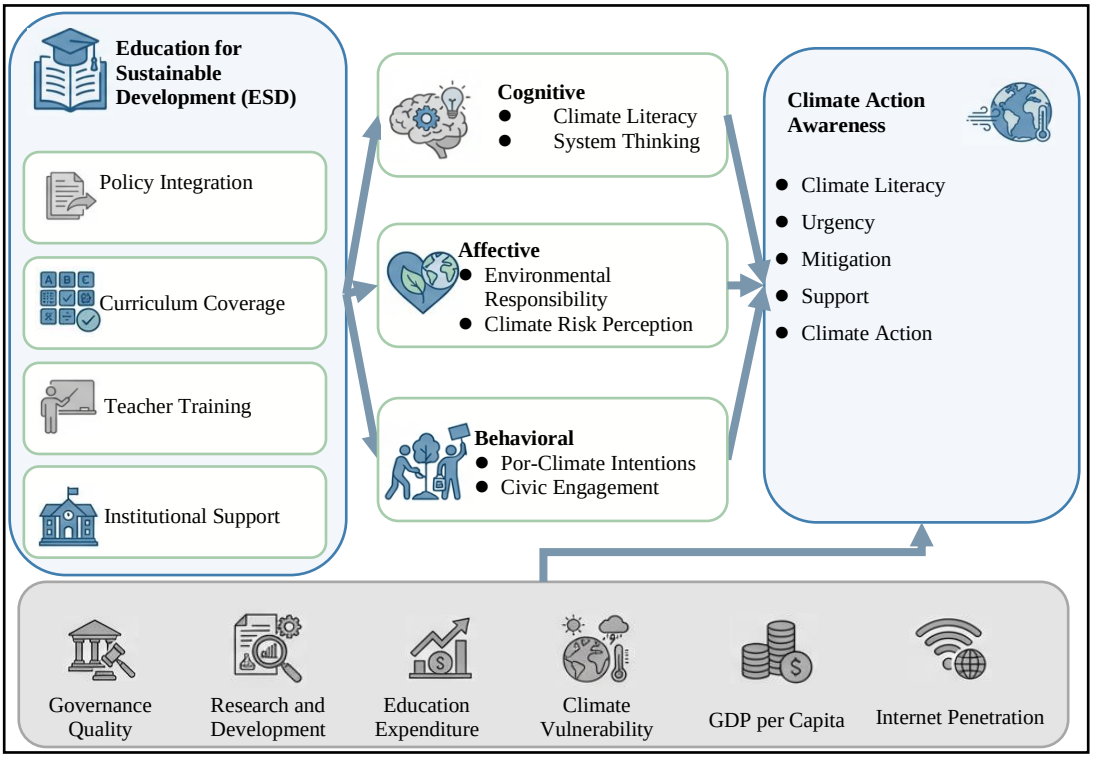

Figure 1: Conceptual Framework Linking Education for Sustainable Development to Climate Action Awareness

Figure 1 illustrates the conceptual framework that Education for Sustainable Development (ESD) can improve Climate Action Awareness in cognitive, affective, and behavioral pathways. It emphasizes the positions of curriculum, policy, institutions, and teacher training and considers socioeconomic, governance, access to digital, and climate vulnerability factors.

Data Sources and Sample Selection

Quantitative data are supplied based on the internationally standardized secondary data, such as UNESCO ESD monitoring indicators, World Bank education and socioeconomic data and statistics, as well as the global climate awareness and perception surveys. The sample of the study includes countries that have indicators of consistent ESD policy implementation and those that have data on climate awareness that are available over a duration of time that is at least five years. The data gaps in the countries are significant and therefore locked out to have a balance in the panel dataset to represent different income groups and geographic locations. The national ESD strategies, curriculum frameworks, and policy documents published by the respective ministries of Education and by international organizations are the source of qualitative data. The sources will add to the context and help explain the quantitative results.

Measurement of Education for Sustainable Development

Sustainable Development: Education for Sustainable Development is operationalized based upon a composite Education for Sustainable Development Index (ESDI), which is formed based on standardized indicators to measure policy integration, curriculum coverage, teacher training, and institutional support:

$$ESDI_{it} = \frac{1}{K}\sum_{k=1}^{K} Z_{kit} \qquad (1)$$

Equation (1) Zkit denotes the standardized value of the kth ESD indicator for country i at time t, and K represents the total number of ESD-related indicators.

Measurement of Climate Action Awareness

The index of climate action awareness is estimated by a composite Climate Action Awareness Index (CAA) of climate literacy, risk perception, policy support, and self-reported climate action:

$$CAA_{it} = \sum_{j=1}^{J} w_j A_{jit} \qquad (2)$$

Equation (2) Ajit represents individual awareness components, and wj denotes equal weights assigned to each component to ensure balanced representation of cognitive and behavioral dimensions.

Control Variables

A vector of control variables is added to capture the heterogeneity in the socioeconomic, institutional, and environmental context:

$$X_{it} = \{GDP_{it}, EDU_{it}, GOV_{it}, ICT_{it}, CVI_{it}\} \qquad (3)$$

GDP is GDP per capita, where EDU is expenditure on Education by the government, GOV is the quality of governance, ICT is the internet penetration, and CVI is the climate vulnerability in equation (3).

Econometric Model Specification

A panel regression model assumes the estimation of the baseline relationship between ESD and climate action awareness:

$$CAA_{it} = \alpha + \beta ESDI_{it} + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4)$$

Equation (4) μi controls for unobserved country-specific effects, λt captures time-specific global shocks, and εit is the error term. Robust standard errors are employed to address heteroskedasticity and serial correlation.

Lagged Effects of ESD

A lagged specification is estimated in equation (5) to estimate the delayed effects of Education on climate awareness:

$$CAA_{it} = \alpha + \beta ESDI_{i,t-1} + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (5)$$

This expression represents the duration of time that intellectual interventions take in order to be converted into consciousness and behavior.

Robustness Analysis

Robustness is assessed by disaggregating ESD components shown in equation (6):

$$CAA_{it} = \alpha + \sum_{k=1}^{K} \beta_k Z_{kit} + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (6)$$

This allows identification of the relative contribution of individual ESD dimensions.

Qualitative Integration

Qualitative policy alignment is quantified using a thematic density score:

$$TDS_i = \frac{n_{ESD}}{N} \quad (7)$$

In equation (7), nESD is the number of ESD-aligned themes identified, and N is the total number of coded policy themes. This metric supports triangulation with quantitative results.

Validity and Reliability

Construct validity is ensured through the use of internationally recognized indicators and cross-dataset triangulation. Reliability is dealt with the help of standardized data normalization processes, alternative model specifications, and sensitivity analysis. The mixed-methods design will improve the internal validity, whereas the cross-national design will facilitate the generalizability.

Ethical Considerations and Limitations

The research uses only secondary and publicly available data, which is why it is not associated with any breach of ethical conduct by researchers, and the use of personally identifiable data is denied. Such limitations as lack of uniformity in the provision of ESD indicators among countries, possible reporting bias in self-reported measures of climate awareness, and restrictions to causal inference in observational designs are limitations. These restrictions are handled by strong tests and responsible analysis of findings.

IV. Results

Descriptive Statistics and Preliminary Trends

The summary statistics of the key variables in the balanced cross-national panel are provided in Table 1. Education for Sustainable Development Index (ESDI) has a great variability over time and countries, as it demonstrates heterogeneous levels of political integration, curriculum coverage, and support by institutions. There is also a significant difference in Climate Action Awareness (CAA), which implies the existence of significant cross-country variability in climate literacy, risk perception, and pro-climate engagement. Correlation analysis shows that ESDI has a positive relation with CAA, which is the first indication of the postulated relationship.

Table 1: Descriptive Statistics of Climate Action Awareness, Education for Sustainable Development, and Control Variables

Variable	Mean	Std. Dev.	Min	Max
Climate Action Awareness Index (CAA)	0.56	0.18	0.21	0.89
ESD Index (ESDI)	0.52	0.20	0.15	0.91
GDP per capita (log)	9.87	1.12	7.45	11.92
Education Expenditure (% GDP)	4.3	1.2	2.1	7.8
Governance Quality Index	0.12	0.89	−1.75	1.92
Internet Penetration (%)	61.4	22.7	14.3	98.1

Figure 2 presents a forest plot that explores the relationship between various Education for Sustainable Development (ESD) and socioeconomic factors and Climate Action Awareness. It incorporates such variables as the ESD Index (ESDI), the measure of ESD program effectiveness, and GDP per capita (log), the measure of economic prosperity of a country. Education Expenditure is evaluated in terms of the percentage of GDP, which indicates the amount of financial dedication to Education compared to climate awareness. The Governance Quality Index shows the level at which governance quality impacts climate action, whereas Internet Penetration shows the implications of digital access in creating awareness of climate. Also, there is the Climate Vulnerability that demonstrates how exposure to climate risks may have an impact on awareness. The estimated values of each variable have been presented as their coefficient with a 95% confidence interval (CI), with the dots depicting the point estimates and the horizontal lines depicting the extent of uncertainty. The dashed vertical line at 0 represents the null hypothesis, and the spread of confidence intervals helps to identify which factors have a statistically significant influence on climate action awareness.

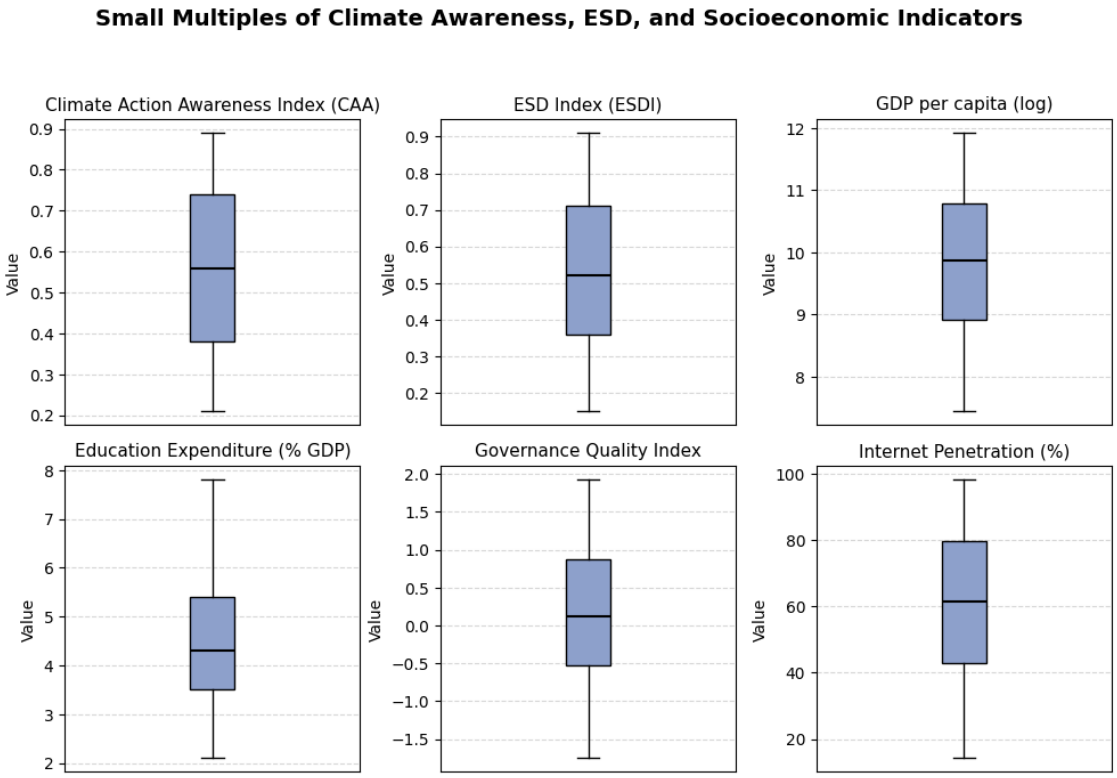

Figure 2: Small Multiples of Climate Awareness, ESD, and Socioeconomic Indicators

Impact of Education for Sustainable Development on Climate Action Awareness

The baseline panel regression results are reported in Table 2. In line with the hypothesis, Education for Sustainable Development has a positive and statistically significant influence on climate action awareness within the countries. A one-unit increase of ESDI, after adjusting for the socioeconomic, institutional, and environmental variables, leads to an increase in the CAA index by a significant margin, which holds that increased incorporation of ESD into national education systems leads to increased awareness and participation of the population in climate action.

The estimated model is specified as equation (4):

$$CAA_{it} = \alpha + \beta ESDI_{it} + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \qquad (8)$$

The coefficient on ESDI is also strong with other specifications, which proves that the relationship is not motivated by omitted-variable bias or unobserved heterogeneity.

Table 2: Panel Regression Results: Education for Sustainable Development and Climate Action Awareness

Variable	Coefficient	Std. Error	t-Statistic	p-Value
ESD Index (ESDI)	0.284	0.051	5.57	0.000
GDP per capita (log)	0.092	0.028	3.29	0.001
Education Expenditure	0.037	0.014	2.64	0.009
Governance Quality	0.065	0.021	3.10	0.002
Internet Penetration	0.004	0.001	3.86	0.000
Climate Vulnerability	−0.118	0.039	−3.03	0.003
Country Fixed Effects	Yes			
Time Fixed Effects	Yes			
Observations	N			
R^2 (within)	0.41			

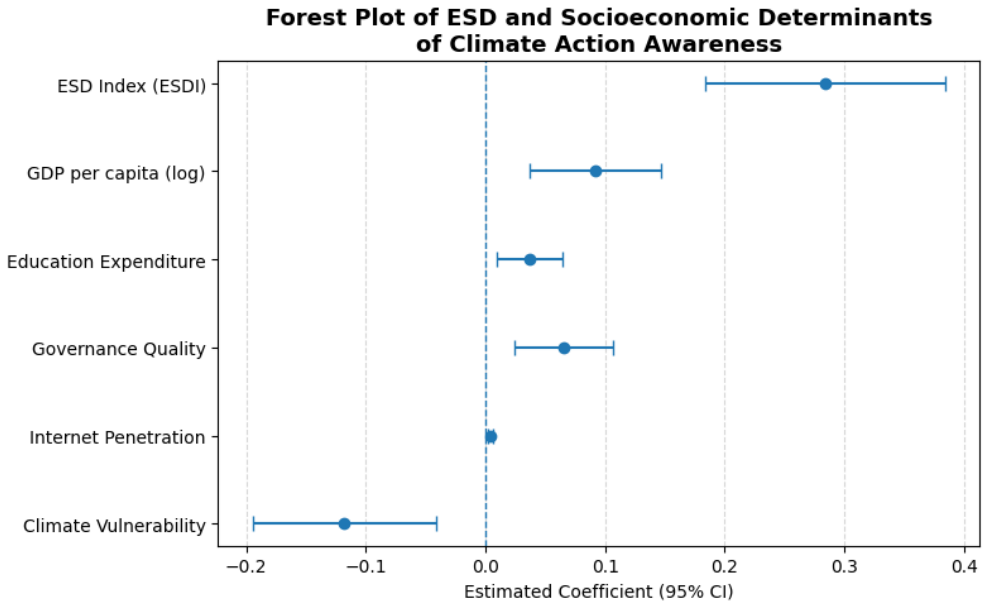

Figure 3: Forest Plot of ESD and Socioeconomic Determinants of Climate Action Awareness

The forest plot exemplified in Figure 3 shows the estimated values of coefficients and 95% confidence intervals (CI) of different Education for Sustainable Development (ESD) and socioeconomic variables that affect Climate Action Awareness. The variables that are discussed are the ESD Index (ESDI), which investigates the correlation between the quality of Education and Sustainable Development programs and climate action awareness. Also, GDP per capita (log) is the effect of economic wealth on climate awareness, and Education Expenditure is a percentage of GDP that examines the effect of national investment in Education on climate action awareness. The Governance Quality Index is provided to demonstrate how the quality of governance has been factored into the development of climate action awareness, and the Internet Penetration emphasizes how digital access has been used to encourage climate awareness. Lastly, the Climate Vulnerability is taken into account to see which connection exists between the climate change vulnerability of a country and climate action awareness. The estimated coefficient is represented by each point of the Plot, and the horizontal lines show the range of the confidence interval. The Plot assists in determining the factors that have a significant influence on climate action awareness, with factors on the right having a more significant positive relationship and factors on the left having a negative relationship or insignificant relationship. The null effect (the dashed vertical line at 0) is where the coefficients on the right and the left side show the direction of the influence.

Interpretation of Control Variables

Climate action awareness is positively and significantly related to economic development and quality of governance, implying that institutional capacity and the existence of resources facilitate the implementation of Education in climate-sensitive attitudes and behaviors. The awareness of the climate is further enhanced due to the Internet penetration, which underscores the supportive functionality of digital access to support the results of Education. Conversely, greater climate susceptibility is linked to a reduced level of awareness, which implies that exposure does not necessarily result in informed action on climate in the absence of enabling educational and institutional supports.

Robustness and Qualitative Triangulation

The positive correlation between ESD and climate action awareness is not changed with alternative weighting schemes and subsample analyses. These findings are strengthened by qualitative policy analysis, where countries that have higher scores in thematic density in ESD-aligned policy documents have always portrayed greater quantitative performances of ESDI on CAA. This convergence of quantitative and

qualitative evidence strengthens the internal validity of the results and supports the proposed cognitive–affective–behavioral transmission pathways.

V. Discussion

The results given in this research illuminated the connection between Education Sustainable Development (ESD) and Climate Action Awareness (CAA), both through the use of descriptive statistics as well as panel regression analysis. These findings indicate that ESD contributes to the improvement of the level of public awareness and engagement in climate action in a rather important way, yet this aspect is conditioned by a set of socioeconomic, institutional, and digital factors. Table 1 reveals that Climate Action Awareness (CAA) as well as Education for Sustainable Development Index (ESDI) are subjected to a high level of variation across countries as measured by the standard deviations (0.18 in the case of CAA and 0.20 in the case of ESDI). The average scores of 0.56 on CAA and 0.52 on ESDI represent moderate climate action awareness and integration of ESD in the countries represented in the panel. Such differences can be explained by the change in policy frameworks, the extent of ESD integration into the education systems, and national dedication to climate action. This advantageous relationship between ESDI and CAA is also a confirmation of the hypothesis that more holistic ESD programs are related to an increased climate awareness level, which states that the education systems that encompass sustainability principles are likely to produce more knowledgeable and involved citizens in climate-related concerns. Table 2 shows the results of the panel regression, indicating that ESD has a significant impact on CAA, and the coefficient of 0.284 is positive and statistically significant ($p < 0.001$). It means that more effective integration of ESD in national curricula and policies results in increased climate awareness and justifies the theoretical rationale that ESD can help in increasing people's engagement with climate issues. In addition, GDP per capita, Education Expenditure, and Governance Quality are other control variables that have a positive correlation with CAA. In particular, GDP per capita (0.092) and Education Expenditure (0.037) indicate that the improvement in economic development and spending on Education is positive for increasing climate awareness. This means that the more a country is endowed and the better the institutional backing it has, the more it stands to incorporate Education on climate change. Moreover, the complementary effect of the Internet Penetration (0.004) shows that, upon the presence of ESD programs, digital access complements the effect of fostering awareness of climate action, which means that access to digital information promotes the effect of the ESD programs. Conversely, Climate Vulnerability (−0.118) is not significantly related to CAA, which means that the increased vulnerability to climate change does not necessarily lead to increased climate action awareness without the facilitating educational and governance systems. These findings are strong, as shown by other weighting schemes and subsample analyses, which affirm the consistency of the relationships observed. Moreover, the qualitative policy analysis demonstrates that the impact of ESDI on CAA is stronger in the countries with higher scores in the policy document in accordance with ESD, which confirms the validity of the quantitative findings. This quantitative and qualitative overlap makes the internal validity of the study stronger and confirms the suggested paths of cognitive-affective-behavioral transmission, at which ESD increases not only climate knowledge, but also the attitudes and behavioral tendencies towards climate action. To sum up, the paper highlights the fact that although ESD creates a focal point in supporting climate awareness, other factors, including economic development, governance quality, and digital infrastructure, have a great impact on the effect. It demonstrates the necessity of multi-dimensional solutions to Education, as well as policy related to the climate crisis.

VI. Conclusion

The current research offers substantial empirical findings that ESD is an important and positive factor in improving CAA between nations. The analysis undertaken with the help of a mixed-methods explanatory design and a balanced cross-national panel proves that a more integrated ESD in national systems of Education is invariably linked with more climate literacy, perception of risks, and involvement in climate-related behavior. Based on the regression results, the ESDI significantly influences CAA ($\beta = 0.284$, $p < 0.001$), proving that the education-based policies towards sustainability do not yield in terms of outcomes

related to meaningful awareness. Increased CAA is linked to higher GDP per capita ($\beta = 0.092$, $p = 0.001$) and higher spending on Education ($\beta = 0.037$, $p = 0.009$), hence the significance of financial strength and lifelong investment in Education. The quality of governance also has a positive and significant impact ($\beta = 0.065$, $p = 0.002$), which can be viewed as an important aspect of institutional effectiveness that facilitates educational programs to change the minds of the people. The penetration of the internet turns out to be a supplementary factor ($\beta = 0.004$, $p < 0.001$) and indicates that climate-related knowledge distribution and influence are enhanced by the presence of digital access. Conversely, climate vulnerability and awareness are negatively correlated ($\beta = -0.118$, $p = 0.003$), which means that exposure to climate risks does not necessarily increase awareness unless there are favorable educational and governance structures. The results have significant policy and future research implications. They highlight the necessity of combined strategies that would harmonize ESD with the larger socioeconomic growth, governance change, and digital technology expansion. Future research would be able to build on this research by including micro-level data, longitudinal learning outcomes, and experimental or quasi-experimental research to further expand the use of causal inference.

References

[1] Pérez-Sánchez, M., Díaz-Madroñero, M., Mula, J., & Sanchis, R. (2020). The sustainable development goals (SDGs) applied to higher education. a project-based learning proposal integrated with the SDGs in bachelor degrees at the campus Alcoy (UPV). In *EDULEARN20 Proceedings* (pp. 3997-4005). IATED. https://doi.org/10.21125/edulearn.2020.1078

[2] Priatna, D., & Khan, S. M. (2024). The importance of education and role of educational institutions in climate change mitigation and achieving UN SDG 13 "Climate Action". *Indonesian Journal of Applied Environmental Studies*, *5*(1), 1-5. https://doi.org/10.33751/injast.v5i1.10559

[3] Al Husban, W. (2025). The Impact of Integrating Sustainable Development Goals on Students' Awareness and Pro-Environmental Behavior: A Case Study of Jordan. *Sustainability*, *17*(6), 2588. https://doi.org/10.3390/su17062588

[4] Okada, A., & Gray, P. (2023). A climate change and sustainability education movement: Networks, open schooling, and the 'CARE-KNOW-DO' framework. *Sustainability*, *15*(3), 2356. https://doi.org/10.3390/su15032356

[5] Mehmood, U. (2021). Contribution of renewable energy towards environmental quality: The role of education to achieve sustainable development goals in G11 countries. *Renewable Energy*, *178*, 600-607. https://doi.org/10.1016/j.renene.2021.06.118

[6] Alam, A. (2022). Mapping a sustainable future through conceptualization of transformative learning framework, education for sustainable development, critical reflection, and responsible citizenship: an exploration of pedagogies for twenty-first century learning. *ECS Transactions*, *107*(1), 9827. https://doi.org/10.1149/10701.9827ecst

[7] Tian, C., Li, X., Xiao, L., & Zhu, B. (2022). Exploring the impact of green credit policy on green transformation of heavy polluting industries. *Journal of Cleaner Production*, *335*, 130257. https://doi.org/10.1016/j.jclepro.2021.130257

[8] Tan, L., Yang, Z., Irfan, M., Ding, C. J., Hu, M., & Hu, J. (2024). Toward low-carbon sustainable development: Exploring the impact of digital economy development and industrial restructuring. *Business Strategy and the Environment*, *33*(3), 2159-2172. https://doi.org/10.1002/bse.3584

[9] Li, R., Wang, Q., & Guo, J. (2024). Revisiting the environmental Kuznets curve (EKC) hypothesis of carbon emissions: exploring the impact of geopolitical risks, natural resource rents, corrupt governance, and energy intensity. *Journal of Environmental Management*, *351*, 119663. https://doi.org/10.1016/j.jenvman.2023.119663

[10] Álvarez-Nieto, C., Richardson, J., Navarro-Perán, M. Á., Tutticci, N., Huss, N., Elf, M., ... & López-Medina, I. M. (2022). Nursing students' attitudes towards climate change and sustainability: A cross-sectional multisite study. *Nurse education today*, *108*, 105185. https://doi.org/10.1016/j.nedt.2021.105185

[11] Lee, C. C., Song, H., & An, J. (2024). The impact of green finance on energy transition: does climate risk matter? *Energy Economics*, *129*, 107258. https://doi.org/10.1016/j.eneco.2023.107258

[12] Wang, Z., Fu, H., Ren, X., & Gozgor, G. (2024). Exploring the carbon emission reduction effects of corporate climate risk disclosure: Empirical evidence based on Chinese A-share listed enterprises. *International Review of Financial Analysis*, *92*, 103072. https://doi.org/10.1016/j.irfa.2024.103072

[13] Chau, K. Y., Moslehpour, M., Tu, Y. T., Tai, N. T., Tien, N. H., & Huy, P. Q. (2022). Exploring the impact of green energy and consumption on the sustainability of natural resources: Empirical evidence from G7 countries. *Renewable energy*, *196*, 1241-1249. https://doi.org/10.1016/j.renene.2022.07.085

[14] Olsson, D., Gericke, N., & Boeve-de Pauw, J. (2022). The effectiveness of education for sustainable development revisited–a longitudinal study on secondary students' action competence for sustainability. *Environmental Education Research*, *28*(3), 405-429. https://doi.org/10.1080/13504622.2022.2033170

[15] Filonchyk, M., Peterson, M. P., Zhang, L., Hurynovich, V., & He, Y. (2024). Greenhouse gases emissions and global climate change: Examining the influence of CO2, CH4, and N2O. *Science of The Total Environment*, *935*, 173359. https://doi.org/10.1016/j.scitotenv.2024.173359

[16] Tunji-Olayeni, P. F., Adegboye, F., Oluwatobi, A., Adeyemi, G., Olagunju, O., Okoro, A., & Osabuohien, E. S. (2021, March). Accelerating progress on sustainable development goals: Assessing secondary school students' knowledge of climate change actions. In *IOP Conference Series: Earth and Environmental Science* (Vol. 665, No. 1, p. 012041). IOP Publishing. https://doi.org/10.1088/1755-1315/665/1/012041

[17] Kalaycı Alas, D., & Korutürk, K. (2024). Exploring the impact of values education on sustainable environmental awareness and behavior among eighth-grade students. *Sustainability*, *16*(21), 9302. https://doi.org/10.3390/su16219302

[18] Demaidi, M. N., & Al-Sahili, K. (2021). Integrating SDGs in higher education—Case of climate change awareness and gender equality in a developing country according to RMEI-TARGET strategy. *Sustainability*, *13*(6), 3101. https://doi.org/10.3390/su13063101

[19] Ferguson, T., Roofe, C., & Cook, L. D. (2021). Teachers' perspectives on sustainable development: the implications for education for sustainable development. *Environmental Education Research*, *27*(9), 1343-1359. https://doi.org/10.1080/13504622.2021.1921113

[20] Nousheen, A., Zai, S. A. Y., Waseem, M., & Khan, S. A. (2020). Education for sustainable development (ESD): Effects of sustainability education on pre-service teachers' attitude towards sustainable development (SD). *Journal of Cleaner Production*, *250*, 119537. https://doi.org/10.1016/j.jclepro.2019.119537