A SPATIAL-CLUSTERING ANALYSIS ON EDUCATION, HUMAN DEVELOPMENT, AND LITERACY AMONG COUNTRIES WORLDWIDE

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ABSTRACT; *This study used the spatial-clustering analysis to identify distinct clusters of 186 countries based on their educational indicators, and Human Development Index (HDI). Additionally, it explores the causal relationship between the selected educational indicators of the identified clusters. Findings revealed that the countries with the highest mean Education Index belong mostly to America, Europe, Asia, and Australia regions. On the other hand, clusters with the lowest education index seemed to be situated in African and some Asian regions. The result also obtained the best fit causal model on the education index among countries.*

Keywords: Education index, cluster analysis, human development index, path analysis, and spatial analysis

INTRODUCTION

Education is an essential component of human development and has the potential to break the cycle of poverty across generations [8]. By providing children with the necessary life skills and knowledge, education equips them to tackle the challenges of today's world. Thus, education is vital in shaping human life and promoting overall development. It is evident that developed countries are generally more successful than developing countries in providing quality education and are better equipped to address the challenges that impact education. However, it is essential to recognize that ensuring quality education is a complex and challenging task. Several factors, such as the socio-political environment, physical surroundings, pedagogy, and technological advancements, significantly influence the quality of education. Unfortunately, many government efforts to address these factors and ensure quality education are unsatisfactory. This results in obstacles that hinder quality education, preventing individuals from realizing their full potential. Therefore, governments need to prioritize and invest in the factors that influence quality education to ensure that every individual has access to a high-quality education that equips them with the skills necessary to thrive in today's world.

There have been many studies that link education to the human development index. The study of [7] aimed to find out how much the influence of education toward Human Development Index (HDI) in Indonesia. The results showed that indicator of education has the significant effect toward Human Development Index in Indonesia. The author emphasized that increasing of quality in education sector is also able to encourage the increasing of Human Development Index. The researchers [9] employed structural equation modeling to measure the effect of higher education on human development of the 128 countries. Based on the results, Higher education directly has a positive impact on the country's human development index through the education index. They concluded that increasing economic growth and per capita income, regardless of education and health, will not have much impact on human development in the countries.

While there are many studies on education achievement and progress across countries, there is a need for more research that examines the education index and its factors. This includes an analysis of factors contributing to disparities in education access and quality and the complex relationship between education, the human development index, and other underlying factors. This study will use a spatial clustering analysis on the education index, human development index, and other factors among countries worldwide. This would provide valuable insights into the spatial patterns and complex relationships among factors. Moreover, this study will employ path analysis to explore the complex relationships of the factors by estimating direct and indirect relationships on one variable to another variable.

The result of this study would reveal regional disparities in education and human development outcomes, which can help countries target interventions to specific regions and communities that are lagging. This would also provide insights into identifying the most effective strategies and highlight areas of focus. It can provide policymakers and stakeholders with evidence-based data to inform decision-making and improve accountability in education and human development policies.

Objectives of the Study

This study sought to answer the following objectives:

1. to identify distinct clusters or groups of countries based on their educational indicators, including HDI, literacy rates, education expenditure, mean years of schooling, and education index; and

2. to explore the relationship between the selected educational indicators (HDI, literacy rates, education expenditure, mean years of schooling, and education index) and identify patterns or trends within the clusters.

THEORETICAL FRAMEWORK

This paper is anchored on the following theories:

Human Capital Theory

According to [1], education is an investment in human capital that can boost output and spur economic progress. This idea contends that increasing HDI results from higher individual earnings as education levels rise. Also predicted are higher levels of human capital and economic development in nations with higher education spending and longer school years.

Education Production Function Theory

This theory indicates that education outcomes are the results of the inputs and processes involved in the educational system. These inputs include resources such as education expenses, teacher excellence, and infrastructure, while the processes include teaching strategies, curriculum design, and assessment. Based this theory, the cost on higher education and spending longer years of schooling can enhance the quality of education and lead to improved education

outcomes, such as higher levels of literacy and human development [3][5].

Cultural Capital Theory

According to French sociologist Pierre Bourdieu's cultural capital theory from the 1970s, education is not only about obtaining information and skills but also about acquiring cultural capital, which refers to the social and cultural resources that people may use to go around in the world of others [4]. This idea contends that children from wealthy family are more likely to have access to cultural capital, including top educational institutions, extracurricular activities, and social networks, which may provide them an edge in the educational system and later in life. This theory emphasizes how vital it is for the educational system to eradicate cultural prejudices and grant equal access to cultural resources.

METHODOLOGY

This study utilized a descriptive-causal research design to investigate the factors contributing to the education index of 186 countries. The study employed a cluster analysis to group the countries based on their education index, human development index, literacy rate, education expenditure, and mean years of schooling. These variables were obtained from the UNESCO Institute for Statistics and United Nations Development Programme (UNDP)-Human Development Reports through an online portal. The Geographic Information System (GIS) was used to understand the spatial patterns of the countries better, enabling the researcher to analyze the data and visualize the relationships among the variables. Lastly, the path analysis was conducted to identify the causal relationships between the variables and to develop a framework that could explain the education index of the countries worldwide.

RESULTS AND DISCUSSION

Based on the results, three (3) clusters were formed. Thirty-eight (38) countries belong to Cluster 1, 108 are from Cluster 3, and 40 are from Cluster 3. It can be noticed that cluster 1 has the largest average distance from the centroid, while cluster 2 has the smallest. This means that among the clusters, countries from cluster 1 are the most variable with respect to the five variables, while cluster 2 is the least.

Table 1: Cluster of countries based on the five variables involved in the study

Cluster	No. of countries	Within cluster sum of squares	Average distance from centroid	Maximum distance from centroid
1	38	8084.66	12.33	37.11
2	108	1217.89	3.11	8.47
3	40	1227.48	5.18	8.68

Cluster 1	*Afghanistan; Angola; Bangladesh; Benin; Bhutan; Burkina Faso; Cameroon; Central African Rep; Chad; Djibouti; Eritrea; Ethiopia; Gambia; Guinea; Guinea-Bissau; Haiti; India; Liberia; Madagascar; Malawi; Mali; Mauritania; Morocco; Mozambique; Nepal; Niger; Nigeria; Pakistan; Papua New Guinea; Rwanda; Senegal; Sierra Leone; South Sudan; Sudan; Timor-Leste; Togo; Uganda; Yemen*
Cluster 2	*Albania; Andorra; Antigua and Barbuda; Argentina; Armenia; Australia; Austria; Azerbaijan; Bahamas; Bahrain; Barbados; Belarus; Belgium; Bolivia; Brunei; Bulgaria; Canada; Chile; China; Colombia; Costa Rica; Croatia; Cuba; Cyprus; Czechia; Denmark; Dominica; Ecuador;*

Equatorial Guinea; Estonia; Fiji; Finland; France; Georgia; Germany; Greece; Grenada; Hong Kong; Hungary; Iceland; Indonesia; Ireland; Israel; Italy; Japan; Jordan; Kazakhstan; Rep of Korea; Kuwait; Kyrgyzstan; Latvia; Lebanon; Liechtenstein; Lithuania; Luxembourg; Malaysia; Maldives; Malta; Marshall Islands; Mexico; Moldova; Mongolia; Myanmar; Netherlands; New Zealand; North Macedonia; Norway; Man; Palau; Palestine; Panama; Paraguay; Peru; Philippines; Poland; Portugal Qatar; Romania; Russian Fed., Saint Kitts and Nevis; Saint Vincent and the Grenada; Samoa; Saudi Arabia; Serbia; Seychelles; Singapore; Slovakia; Slovenia; South Africa; Spain; Sri Lanka; Suriname; Sweden; Switzerland; Tajikistan; Thailand; Tonga; Trinidad and Tobago; Turkey; Turkmenistan; Ukraine; United Arab Emirates; United Kingdom; United States of America; Uruguay; Uzbekistan; Venezuela; and Vietnam

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Cluster 3	*Algeria; Belize; Botswana; Brazil; Burundi; Cabo Verde; Cambodia; Comoros; Congo; Democratic Rep of Congo; Dote d'Ivoire; Dominican Republic; Egypt; El Salvador; Eswatini; Gabon; Ghana; Guatemala; Guyana; Honduras; Iran; Iraq; Jamaica; Kenya; Lao People's Dem Rep; Lesotho; Libya; Mauritius; Micronesia; Namibia; Nicaragua; Saint Lucia; Sao Tome and Principe; Solomon Islands; Syrian Arab Rep; Tanzania; Tunisia; Vanuatu; Zambia; Zimbabwe*

Legend:
- Cluster 1
- Cluster 2
- Cluster 3
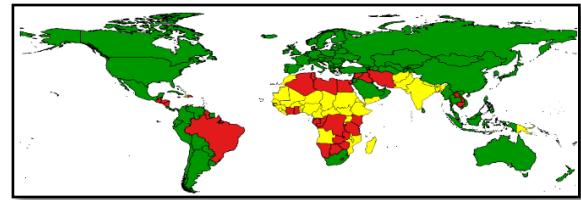
Figure 1: Spatial patterns of the clusters based on the variables in the study

Figure 1 shows the spatial patterns of the countries in the 3 clusters worldwide. Most of the countries in Cluster 1 are located in Africa. Countries in this region often face challenges related to education infrastructure, including a lack of classrooms, teaching materials, and technology. This can affect the quality of education and access to educational resources. Compared to other countries, this region also has lower levels of socioeconomic development which can impact the availability and quality of educational opportunities; lower levels of funding and resources; have higher educational disparities within African countries, such as rural-urban gaps and gender, which can be more pronounced compared to other countries. Cluster 1 has the lowest education index as compared to the other clusters. One of the reasons for this slump is poverty. Many families struggle to afford the cost of education, resulting in the children being unable to attend school. Limited access to school, poor quality of education, language barriers, gender inequality, and politics are among the reasons African countries have low education indices. Notably, India, Pakistan, Bangladesh, Papua New Guinea, and Timor-Leste belong to Cluster 1. This is due to poverty, limited infrastructure, cultural barriers, limited access to quality teachers and resources, and a large population. Lastly, Haiti is the only country found in the north American continent is this Cluster. A significant portion of Haiti's population contributes to its low education index. Limited economic resources make investing adequately in education infrastructure, teacher training, and learning materials challenging. Also, natural disasters cause damage to property and schools, which leads to disruption of the education system. At the same time, political instability, which results

in a lack of stable governance, has made it difficult to implement long-term strategies and sustain educational progress.

It can be seen in the figure that Cluster 2 has the highest education index. This cluster mostly include countries America, Europe, Asia, Australia, and some in south Africa. Historical factor is one of the reasons of this surge among countries. Many nations in these regions have a lengthy, centuries-long tradition of investing in education. As a result, effective educational systems and institutions have been created. It is worth mentioning that these nations have high levels of economic development, political stability, cultural values, and high access to information and technology. These factors provide an environment that is conducive to learning and academic achievement. These provide resources and funding for education, ensure a safe and secure environment for learning, motivate individuals to pursue education, and give students and educators the resources necessary to learn and stay informed, which can enhance the learning and teaching experience.

Among the clusters, Cluster 3 has an average education index. Several factors influence the average education index in most Central American, South American, and South African nations. It is worth noting that some countries in Central America, like Belize, El Salvador, Guatemala, Honduras, and Nicaragua belong to this Cluster. These countries have free and compulsory education for children between ages 5-15, have literacy rates between 79%-89%, HDI of 0.61 to 0.71, and mean years of schooling of 5-10 years. Compared to other countries in America, these nations have a smaller population which often results in different challenges and resource allocations; have a lower number of schooling; allocate a smaller portion of their budget to education; and have lower levels of socioeconomic development and encountered various economic and social challenges, including poverty, inequality, and limited access to quality education and healthcare. Poverty is one of the key contributing causes. These regions have several nations that suffer from poverty, which prevents them from making large investments in education. Because of this, it may be more challenging for learners to acquire a high-quality education at underfunded schools that lack experienced teachers. Political instability, such as conflicts and civil unrest, disrupts students' attendance, resulting in dropping out and not completing their education. Cultural variables can also influence the results of schooling. Other activities, including physical work or early marriage for girls, maybe prioritized over schooling in some cultures. This may result in fewer educational chances and poorer academic results. This links to the cultural capital theory of P. Bourdieu (1970), which states that individuals from privileged backgrounds are more likely to have access to cultural capital, which can give them an advantage in education and employment. Lastly, historical events like colonization and slavery have had an effect on education in these areas. The effects of these historical occurrences may still impact educational possibilities and access for particular populations within these countries.

Table 2: Statistics on Education Index, HDI, Literacy Rates, Education Expenditure, and Mean Years of Schooling per Cluster

Variable	Cluster 1	Cluster 2	Cluster 3	Grand Centroid
Educ Index	0.419	0.774	0.574	0.659
HDI	0.517	0.822	0.645	0.722
Literacy Rates	56.146	97.571	84.486	86.294
Educ Expenditure	3.414	4.682	4.751	4.438
Mean Years of Schooling	4.259	10.614	7.270	8.596

The table presents data on several variables related to education, human development, and literacy rates for three Clusters. The clusters represent countries with similar values for the variables included in the table.

Cluster 1 has the lowest values for all variables compared to the other two clusters. The Education Index for Cluster 1 is 0.419, which indicates that the level of educational attainment in these countries is relatively low. The HDI for Cluster 1 is also lower than the other two clusters, indicating that these countries have lower levels of human development. The literacy rates in Cluster 1 are also relatively low at 56.146, indicating that a significant portion of the population may have limited reading and writing skills. The expenditure on education in Cluster 1 is the lowest among the three clusters at 3.414, suggesting that these countries have limited resources for investing in education. The mean years of schooling in Cluster 1 are also low at 4.259, indicating that the average level of education among the population is relatively low.

Cluster 2 has the highest values for all variables compared to the other two clusters. The Education Index for Cluster 2 is 0.774, indicating a high level of educational attainment in these countries. The HDI for Cluster 2 is also the highest among the three clusters, indicating that these countries have a high level of human development. The literacy rates in Cluster 2 are the highest at 97.571, indicating that a significant portion of the population is literate. The expenditure on education in Cluster 2 is relatively high at 4.682, suggesting that these countries have more resources for investing in education. The mean years of schooling in Cluster 2 are also the highest at 10.614, indicating that the average level of education among the population is relatively high.

Cluster 3 has intermediate values for all variables compared to the other two clusters. The Education Index for Cluster 3 is 0.574, indicating a moderate level of educational attainment in these countries. The HDI for Cluster 3 is also intermediate, indicating that these countries have a moderate level of human development. The literacy rates in Cluster 3 are relatively high at 84.486, indicating that a significant portion of the population is literate. The expenditure on education in

Cluster 3 is the highest among the three clusters at 4.751, suggesting that these countries have more resources for investing in education than in Cluster 1. The mean years of schooling in Cluster 3 are intermediate at 7.27, indicating that the average level of education among the population is higher than Cluster 1 but lower than Cluster 2.

The grand centroid provides an overall picture of the average values of the variables across all three clusters. The grand centroid for the Education Index is 0.659, higher than Cluster 1 and Cluster 3 but lower than Cluster 2. The grand centroid for HDI is 0.722, the highest among all four groups, indicating that the average level of human development across all three clusters is relatively high. The grand centroid for literacy rates is 86.294, higher than Cluster 1 and Cluster 3 but lower than Cluster 2. The grand centroid for education expenditure is 4.438, higher than Cluster 1 but lower than Cluster 2 and Cluster 3. The grand centroid for mean years of schooling is 8.596, higher than Clusters 1 and 3 but lower than Cluster 2.

Overall, the table suggests a strong relationship exists between education, human development, and literacy rates. Countries with higher levels of investment in education, educational attainment, and literacy rates tend to have higher levels of human development.
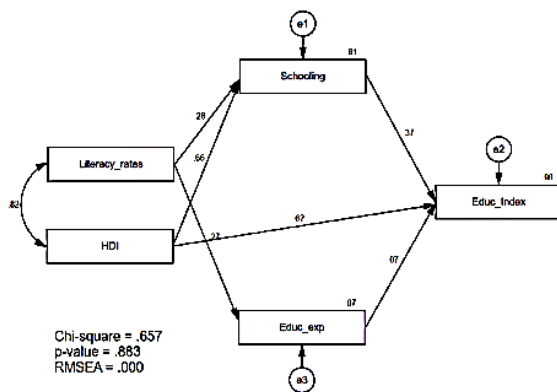

Figure 2: Path Ana: ysis on the Education Index Among Countries Worldwide

Path analysis was used to determine the causal relationships among variables involved in the study. Figure 2 shows the causal model of the education index of the countries worldwide. Based on the results, the obtained model best fits the data $(\chi^2 = .657, p = .883, GFI = .999, TLI = 1.0, CFI = 1.0, RMSEA = .000)$. As shown the country's mean year of schooling $(\beta_S = .37)$, education expenditure $(\beta_E = .07)$, and HDI $(\beta_H = .62)$ have a direct positive effect to its education index. These results indicate that the education index of a country is generally associated with the mean year of schooling. The mean year of schooling reflects the educational quality and effectiveness of the education system. Higher mean years of schooling suggest that individuals have had more opportunities to acquire knowledge, skills, and qualifications through formal education. This can contribute to a higher education index as it indicates a higher overall level of education within the population. The results also show that investing more

resources in education, such as funding for school teacher salaries, educational materials, infrastructure, and overall development and improvements in other areas, such as healthcare, income, and living standards, can lead to improved educational outcomes.

Also, the country's literacy rate has an indirect effect on the educational index through mean year of schooling $(\beta_{L,S} = .10)$ and education expenditure $(\beta_{L,E} = .02)$. This led to a total effect of 0.12 on education index. This result means that the literacy rate is an important factor that led to acquiring the basic skills necessary to engage in educational activities, which can positively impact the education index of a country. This supports the findings of [6] as he examines the economic returns of investment in education worldwide. He emphasizes the importance of literacy rates as a key determinant of education outcomes and highlights their impact on the education index.

Lastly, it can also be observed that the mean year of schooling is a significant mediator of the relationship between the country's HDI and education index. This relationship is positive $(\beta_{H,S} = .24)$ which suggests that the HDI can indirectly influence the education index of a country by positively affecting the mean year of schooling. A higher HDI score implies better development, including increased investment in education, which leads to a higher mean year of schooling. This, in turn, positively impacts the education index. It is worth noting that the relationship between the HDI, mean year of schooling, and the education index is not a direct causal relationship. Many other factors, such as educational policies, socio-economic conditions, cultural norms, and governance, can influence the educational landscape of a country.

Nevertheless, the HDI can be an important indicator of overall development, often aligning with higher educational achievements and a more favorable education index. According to [2] the mediating role of educational variables, including the mean years of schooling, in translating a country's human development (measured by HDI) into educational outcomes (such as the education index). His study highlights that investments in education, particularly in terms of increasing the mean years of schooling, are crucial for bridging the gap between a country's overall human development and educational achievements.

CONCLUSION
Based on the findings, the following conclusions were drawn: The main factors influencing educational outcomes are poverty, infrastructure, cultural hurdles, limited access to qualified teachers and resources, and a large population size. These factors impair access to educational materials, obstruct the creation of conducive learning environments, and reduce chances for academic success.

Some countries have developed efficient educational systems and institutions due to historical reasons including a long tradition of investing in education. Economic development, political stability, cultural values, and high access to information and technology contribute to an environment conducive to learning and academic success. These factors provide resources, funding, and support for education, ensuring a safe and secure environment, motivating individuals to pursue education, and equipping students and

educators with the necessary resources for enhanced learning On the other hand, political instability, conflicts, and civil unrest disrupt schooling, leading to high dropout rates and incomplete education. Cultural variables, including prioritizing other activities over schooling, such as physical work or early marriage, can result in limited educational opportunities and poorer academic outcomes. As described by Bourdieu, the influence of cultural capital suggests that individuals from privileged backgrounds are more likely to have advantages in education and employment. Additionally, historical events like colonization and slavery have had enduring effects on educational possibilities and access for specific populations within these regions.

The findings suggest that a comprehensive approach to education that addresses both the quality and accessibility of education and broader socio-economic development is crucial for improving the education index of a country. This shows the significance of prioritizing education and allocating resources to promote a well-educated population. By improving the mean year of schooling, investing in education, and enhancing overall development indicators, countries can strive to achieve higher education indices and foster a more educated society capable of contributing to social, economic, and individual well-being.

REFERENCES

[1] Becker, G. (1964). Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education. *The University of Chicago Press*

and teaching experiences.

[2] Blomqvist, P. (1996). Economic growth and the quality of education: A review of the empirical literature. *OECD Education Working Papers, No. 4. Paris: OECD Publishing*

[3] Coleman, J. (1966). Equality of Educational Opportunity (COLEMAN) Study (EEOS). *Inter-university Consortium for Political and Social Research [distributor], 2007-04-27.* *https://doi.org/10.3886/ICPSR06389.v3*

[4] Fowler, B. (1997). *Pierre Bourdieu and Cultural Theory*. London: Sage Publications Inc. ISBN 0-8039-7626-7

[5] Hanushek, E. A. (1979). Education and economic growth," *Chicago, IL: University of Chicago Press*

[6] Psacharopoulos, G. (1994). Returns to investment in education: A global update. *World Development*, **22**(9), 1,323-1,341

[7] Rinaldi, M. (2017). Education is as the encouragement of the increasing of human development index in Indonesia. *Conference: Inter national Conference on Global Education V, At: Ekasakti University*

[8] Sivakumar, M., & Sarvalingam, A. (2010). Human deprivation index: A measure of multidimensional poverty

[9] Soviz, Y.E., & Chavooshi, Z. (2019). The impact of higher education on human development. *Proceedings of SOCIOINT 2019- 6th International Conference on Education, Social Sciences and Humanities 24-26 June 2019- Istanbul, Turkey*