

THE ROLE OF FEDERAL INSTITUTES OF EDUCATION, SCIENCE, AND TECHNOLOGY IN LOCAL SUSTAINABLE DEVELOPMENT: EVIDENCE FROM BRAZIL'S NORTHEAST REGION

1 INTRODUCTION

Education represents a mechanism for societal development, enabling individuals to acquire skills, expand capacities, and achieve social progress (UNESCO, 2016; Pereira; Cruz, 2019). In this context, the provision of emancipatory education, which promotes the dissemination of scientific knowledge, is essential for fostering critical thinking and addressing social needs (Farias et al., 2019; Pacheco et al., 2010). Moreover, education provides tools for sustainable development (Kilag et al., 2024), making it crucial to promote inclusive and equitable education that reaches all individuals, as emphasized in Sustainable Development Goal (SDG) 4 (UN, 2015; UNESCO, 2016). Additionally, education, as an element of sustainable development, should reduce social disparities, guiding people's perceptions toward the importance of cultural diversity, gender equality, and the relevance of maintaining sustainable activities (UN, 2015; Campello; Silveira, 2016).

As highlighted by UNESCO (2016) and Wentroba et al. (2023), education is a key element in achieving the SDGs, as individuals educated in sustainable principles make continuous efforts toward sustainable development. For this reason, it is essential that educational practices are aimed at training professionals with sound judgment, capable of providing innovations to meet socio-environmental demands (Dattein; Araújo, 2023; Wentroba et al., 2023).

From this perspective, in Brazil, the Federal Network of Professional, Scientific, and Technological Education (*Rede Federal de Educação, Profissional, Científica e Tecnológica - RFEPCT*) was institutionalized by Law No. 11,892, dated December 29, 2008, with the purpose of providing scientific-based education that encourages changes in the local and regional context (Brazil, 2008; Otranto, 2012). The Federal Institutes of Education, Science, and Technology, commonly referred to as Federal Institutes (FIs), were implemented, according to the aforementioned legal instrument, with the goal of offering education based on technical-scientific principles, fostering civic participation in society (Macedo, 2017; Pereira; Cruz, 2019).

Thus, the FIs are institutions that guide their activities to impact society, supporting entrepreneurial practices, social innovations, encouraging scientific production, and emphasizing respect for nature (Mancebo; Silva, 2015; Brazil, 2008). In this regard, the role of the FIs is linked to the SDGs, particularly SDG 4. Therefore, this research poses the question: What is the relationship between the FIs and local sustainable development? To answer this question, the following objective was outlined: To analyze the relationship between the FIs and local sustainable development. To this end, a quantitative study was conducted, covering the municipalities in the Northeast Region of Brazil, which is historically marked by poverty and low development (Silva; Crisóstomo, 2019; Câmara et al., 2016), making public policies even more crucial in promoting local sustainable development.

2 THEORETICAL BACKGROUND

Education is a key element for sustainable development, as evidenced by SDG 4, which highlights the importance of promoting inclusive, equitable, and equal education for the benefit of full human progress (UN, 2015). In this sense, through education, it is possible to foster critical thinking, develop skills, and provide individuals with continuous development opportunities (UN, 2015; Oliveira et al., 2023). Furthermore, through education, individuals

develop political and environmental awareness, enabling the fight against social inequalities for mutual social progress and recognizing the importance of the environment (UNESCO, 2016; Farias et al., 2019). Thus, it is essential to offer quality education, based on scientific principles and techniques, that allows for autonomy of thought, empowers individuals, and promotes the development of their capacities, enabling them to act as agents of socio-environmental change (Campello; Silveira, 2016; Dattein; Araújo, 2023; Wentroba et al., 2023).

With this in mind, in Brazil, through Law No. 11,892 of December 29, 2008, the Federal Institutes were established and the RFEPCT was institutionalized (Mancebo; Silva, 2015; Quintanilha; Carmo, 2023). The RFEPCT was implemented to democratize access to Vocational and Technological Education, qualifying professionals to operate in a competitive environment, fostering scientific development, and training citizens capable of promoting economic and social transformations (Pacheco et al., 2010; Souza; Meza, 2022).

In addition, the FIs act as developers of educational practices that foster critical thinking, by encouraging applied research, which enables the process of questioning and investigation, essential for the development of scientific knowledge (Brazil, 2008; Macedo, 2017). Furthermore, according to Law No. 11,892 (Brazil, 2008), these institutions have as one of their main objectives the production of technical and technological solutions, provided through high-quality technical-scientific education, to meet the demands present in different social realities (Otranto, 2012; Pereira; Cruz, 2019).

Thus, the FIs have a relationship with the principles of sustainable development, as their practices aim at civic emancipation for local and regional socioeconomic progress, while fostering perspectives oriented toward environmental preservation (Brazil, 2008; Machado, 2011). Moreover, these organizations, through the inseparability of teaching, research, and extension, need to stimulate cultural activities and entrepreneurial practices capable of transforming the context of citizens in the regions where they are located, strengthening local productive arrangements (Morono; Prezarico, 2024; Nunes et al., 2021).

From this perspective, it is argued that education is widely recognized as a strategic element for development, being essential for acquiring skills and knowledge that drive freedom, overcoming poverty, improving health, and achieving social progress (Sen, 2010). The institutionalization of FIs in Brazil aims to promote local, regional, and national development, aligned with policies to reduce inequalities (Silva; Silva, 2018). Studies show that the expansion of federal universities contributes to socioeconomic development (Casqueiro; Irffi; Silva, 2020; Barbosa; Petterini; Ferreira, 2020). Similarly, it is suggested that FIs play an important role in local and regional development (Pereira; Cruz, 2019; Macedo, 2017). Based on this, the following hypothesis was outlined:

Hypothesis: *The presence of Federal Institutes is associated with a higher level of local sustainable development.*

3 METHODOLOGY

This is a descriptive and quantitative research study. Data collection was carried out using public databases, specifically the Sustainable Cities website and the websites of the FIs. A total of 1,794 municipalities from the nine states that make up the Northeast region of Brazil were analyzed, forming the sample for the study. To measure sustainable development, the Sustainable Cities Development Index (*Índice de Desenvolvimento Sustentável das Cidades - IDSC*) was used, with a cross-sectional study referring to the year 2023. The data were analyzed through descriptive statistics and t-tests. To verify the relationship between the presence of FIs and the level of sustainable development, a t-test for difference between means was conducted. The municipalities were divided into two groups: (i) municipalities without an FI; and (ii)

municipalities with an FI. Subsequently, the IDSC averages were compared to determine whether municipalities with an FI show a higher level of sustainable development than those without an FI.

4 RESULTS AND DISCUSSION

Initially, a descriptive analysis of the IDSC was conducted. In this regard, Table 1 presents values related to the mean, median, standard deviation, coefficient of variation, and minimum and maximum values for the IDSC of each state in the Northeast region.

Table 1 - Descriptive analysis of the IDSC.

Region/State	N	Mean	Median	Standard Deviation	Min.	Max.	Coef. of Variation
Northeast	1,794	42.8	42.7	3.60	29.8	56.8	11.9
Alagoas (AL)	102	41.8	42.0	2.84	35.0	47.9	14.8
Bahia (BA)	417	42.9	42.7	3.65	32.6	52.1	11.7
Ceará (CE)	184	44.8	44.7	2.95	37.9	53.6	15.2
Maranhão (MA)	217	39.4	39.5	3.12	29.8	48.1	12.7
Paraíba (PB)	223	43.2	42.9	3.33	33.5	53.2	12.9
Pernambuco (PE)	185	43.1	42.8	3.23	34.1	56.8	13.3
Piauí (PI)	224	43.3	43.4	3.09	36.1	52.2	14.0
Rio Grande do Norte (RN)	167	43.9	43.6	3.88	36.5	55.5	11.2
Sergipe (SE)	75	42.3	42.1	2.69	37.1	49.0	15.7

Source: Research data.

Considering the data from Table 1, it is observed that the state of Ceará has the highest IDSC average among the states, with a difference of 5.4 compared to Maranhão, which has the lowest average. Furthermore, the coefficients of variation indicate low dispersion, showing that the states do not have a marked discrepancy regarding local sustainable development. Next, Table 2 compares the IDSC averages between municipalities with and without FIs. For this, a t-test was applied.

Table 2 - Comparison of IDSC averages between municipalities with and without FIs.

Region/State	Group of Municipalities	N	Mean	t	Difference	p-value
Northeast	Without IF	1,594	42.6	- 7.02***	- 1.87	< 0.001
	With IF	200	44.4			
Alagoas (AL)	Without IF	87	41.6	- 1.39	- 1.10	0.167
	With IF	15	42.7			
Bahia (BA)	Without IF	380	42.6	- 5.56***	- 3.37	< 0.001
	With IF	37	46.0			
Ceará (CE)	Without IF	151	44.7	- 1.21	- 0.68	0.230
	With IF	33	45.4			
Maranhão (MA)	Without IF	190	39.3	- 1.72*	- 1.10	0.086
	With IF	27	40.4			
Paraíba (PB)	Without IF	204	43.0	- 3.00***	- 2.35	0.003
	With IF	19	45.3			
Pernambuco (PE)	Without IF	163	42.9	- 2.12**	- 1.55	0.035
	With IF	22	44.5			
Piauí (PI)	Without IF	206	43.2	- 1.67*	- 1.26	0.096
	With IF	18	44.5			
Rio Grande do Norte (RN)	Without IF	148	43.5	- 3.27***	- 3.00	0.001
	With IF	19	46.6			
Sergipe (SE)	Without IF	65	42.1	- 1.56	- 1.41	0.122
	With IF	10	43.5			

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.
Source: Research data.

The results presented in Table 2 indicate that, overall, when analyzing the Northeast Region as a whole, municipalities with FI campuses show higher local sustainable development compared to those without ($p\text{-value} < 0.001$). When analyzing by state, the results indicate that only the states of Alagoas, Ceará, and Sergipe ($p\text{-value} > 0.10$) did not show a difference in the level of sustainable development between municipalities with and without FIs. Considering the overall analysis, it is assumed that the research hypothesis, that the presence of FIs is associated with a higher level of local sustainable development, was supported.

Studies show that the expansion of federal universities and FIs significantly contributes to the development of benefited municipalities, increasing per capita income, reducing poverty, and raising the percentage of people with higher and secondary education (Casqueiro; Irffi; Silva, 2020; Barbosa; Petterini; Ferreira, 2020). Therefore, the institutionalization of FIs in Brazil is aligned with inequality reduction policies and sustainable development, demonstrating their positive impact on local and regional development and reinforcing the importance of continued investment in these institutions as pillars of socioeconomic and environmental progress.

In this context, the expansion of the RFEPCT has shown positive results in local development, offering professional and technological education that promotes technology transfer and innovation, crucial elements for development (Nunes et al., 2021). In this context, it is discussed that updating curricula, investment in infrastructure and technology, and a stronger emphasis on lifelong learning can help to promote sustainable development in the Philippines (Kilag et al., 2024). These strategies are also relevant in the Brazilian context, where the role of FIs in aligning educational offerings with local socioeconomic and environmental demands strengthens the capacity for sustainable progress. Additionally, the offering of courses aligned with local needs and potential by the FIs drives local development, combats social inequalities, and promotes social inclusion and citizenship (Souza; Meza, 2022; Macedo, 2017). Despite persistent historical inequalities, the expansion of the RFEPCT in Brazil, especially in the Northeast Region, has helped to develop individuals' capabilities and freedoms, highlighting the need to continue progressing toward more equitable development (Campos, 2016).

Furthermore, it is argued that quality education, highlighted in SDG 4, is recognized as fundamental for sustainable development, promoting inclusive, equitable, and equal education essential for human progress (UN, 2015). The creation of FIs aims to democratize access to Vocational and Technological Education, training qualified professionals and citizens capable of promoting economic and social transformations (Pacheco et al., 2010; Souza; Meza, 2022). Thus, FIs foster critical thinking and applied research, essential for the development of scientific knowledge and the production of technical and technological solutions adapted to social demands, contributing to individuals' political and environmental awareness (Brazil, 2008; Macedo, 2017; UNESCO, 2016; Farias et al., 2019). In addition to promoting quality of life and social inclusion, FIs stimulate cultural activities and entrepreneurial practices that strengthen local productive arrangements (Morono; Prezarico, 2024; Nunes et al., 2021).

5 FINAL REMARKS

Overall, the results indicate that the presence of FIs in the municipalities of the Northeast region fosters local sustainable development, confirming the research hypothesis.

This result aligns with SDG 4, which aims to ensure quality education and lifelong learning opportunities for all as a means to overcome inequalities and achieve a more sustainable world.

However, it is important to note that the expansion of these institutions, if not supported by adequate financial resources and continuous investment in the development of educational professionals, may constrain the anticipated benefits. Aligning the expansion of FIs with SDG 4 requires a more in-depth reflection on the mechanisms that underpin the efficient functioning of these institutions. The positive impact of new units will only be fully realized if accompanied by appropriate investments in infrastructure, technology, teacher training, and student retention policies.

As practical contributions, by highlighting the importance of FIs for local sustainable development, the research helps policymakers direct their decisions towards expanding and strengthening professional and technological education in the country as a tool for transformation and social inclusion. Theoretically, the research enriches discussions on the role of FIs in improving people's quality of life and fostering sustainability, supporting economic theories that identify education as a driver of development.

For future research, it is suggested to include other variables related to local sustainable development and the demographic context of the municipalities, to expand the period analyzed, and to use additional statistical tests. This would provide a more comprehensive understanding of the impact of FIs and ensure that expansion efforts truly contribute to local sustainable development.

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