Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/23000
DOI URL: http://dx.doi.org/10.21474/IJAR01/23000

RESEARCH ARTICLE

QUANTIFYING THE LONG-TERM DEVELOPMENTAL IMPACT OF ACCESS TO EDUCATION

Arush Guha and Arya Maam

Manuscript Info

Manuscript History
Received: 10 January 2026
Final Accepted: 12 February 2026
Published: March 2026

Abstract

Education is widely recognized as a fundamental driver of long-term socioeconomic development, yet empirical evidence linking historical access to education with present-day development outcomes at a localized level remains limited, particularly in rural India. This study examines the long-term developmental impact of access to education by analyzing village level data from Karnataka using the Socioeconomi c High-Resolution Rural–Urban Geographic (SHRUG) dataset. Historical indicators of educational access and infrastructure from the 1991 Census of Indiasuch as the number of schools, school electrificati on, and primary school enrolment are compared with contemporary development outcomes from the 2020 Mission Antyodaya survey, including electricity access and other human development–linked indicators. The analysis employs descriptive statistics, difference-in-means tests, and regression techniques to assess the relationship between early educational access and long-term development outcomes.The findings indicate that while the mere presence of schools and enrollment levels show limited long-term effects, the quality of educational infrastructureparticularly access to electricity in primary school sexhibits a statistically significant association with improved development outcomes decades later. These results highlight the importance of prioritizing educational infrastructure quality in rural development strategies and underscore the role of early educational investments in shaping sustained and inclusive development.

Introduction:-

Education is one of the most powerful forces for human and societal progress, shaping economic growth, health outcomes, and social mobility (Hanushek &Woessmann, 2008; World Bank, 2018; UNESCO, 2020). It not only gives people the knowledge and skills they need for jobs and innovation but also improves health, gender equality, and civic engagement. Over time, countries that have invested in education have seen significant gains in productivity, reduced poverty, and increased social stability. While there is a global agreement that education is essential for development, the specific effects of past access to education on long-term rural development are not well understood, especially in India.This study, titled "Quantifying the Long-Term Developmental Impact of Access to Education," looks at how access to education in the early 1990s still affects development outcomes today. It uses the Socioeconomic High-resolution Rural-Urban Geographic (SHRUG) dataset to measure these effects by linking

Corresponding Author:- Arush Guha

education indicators from 1991 with development metrics from the Mission Antyodaya dataset in 2020. By focusing on villages in Karnataka, this research provides a solid basis for understanding local development. The state has a diverse rural landscape, a history of educational reform, and detailed data available.By exploring how early investments in education lead to real developmental benefits many years later, this research offers evidence of the lasting impact of educational infrastructure. The findings enhance academic knowledge and provide useful insights for policymakers who want to reduce rural inequality and encourage sustainable, inclusive growth.Beyond its direct role in shaping individual outcomes, education also generates broader spillover effects that influence the long-term development trajectory of entire communities. Early access to schooling can shape institutional capacity, encourage public investment in complementary infrastructure, and create conditions that support sustained economic and social progress over time. In rural settings, where initial levels of infrastructure and opportunity are often low, these spillover effects are especially important, as even modest improvements in educational access can have far-reaching consequences. Understanding whether and how such early investments translate into durable development gains is therefore essential for designing effective education and rural development policies.

The study focuses specifically on villages in Karnataka to provide a consistent and reliable regional context for long-term analysis. Karnataka presents a suitable case for examining the developmental impact of education because the state has historically implemented several rural education initiatives, including the Nali Kali program, mid-day meal expansion, and early investments in primary school infrastructure. In addition, Karnataka offers relatively complete village-level data in the SHRUG dataset across multiple time periods, making it possible to link historical educational access with present-day development outcomes. The state also contains significant variation across districts, ranging from highly developed regions to historically underdeveloped rural areas, allowing for meaningful comparison of how early access to education influences long-term development under different baseline conditions.

Literature Review:-

Access to education has long been established as a fundamental driver of human development, particularly in underdeveloped and rural areas. Numerous country-level interventions demonstrate that improving educational access leads to lasting social and economic benefits. A common pattern across these case studies is that early investments in education—whether through infrastructure, incentives, or policy reforms—create ripple effects across generations, positively impacting literacy, income, health, and labor participation.Universal education policies have shown particularly strong results in developing economies. In India, the Sarva Shiksha Abhiyan (SSA) program launched in 2001 aimed to universalize elementary education. A study by Asadullah & Chaudhury (2015) published in the International Journal of Educational Development found that adults exposed to SSA had improved educational attainment, literacy scores, and health outcomes. Similarly, Kenya's post-independence education reforms from 1963 to 1983 significantly expanded enrollment and literacy. According to Bunyi (1999) and data cited in IMF publications (elibraryorganisation), government action to abolish school fees and revise curricula laid the foundation for long-term national development.

Targeted financial interventions such as scholarships and conditional cash transfers have proven effective for increasing access and promoting intergenerational benefits. A longitudinal study in Ghana by Duflo, Dupas, & Kremer (2017) at the Abdul Latif Jameel Poverty Action Lab (J-PAL) showed that recipients of secondary school scholarships had significantly better educational and employment outcomes, and the children of female recipients exhibited improved cognitive and health outcomes (povertyactionlab organisation). Bangladesh's stipend programs for girls, analyzed by Khandker, Pitt, &Fuwa (2003) and later by Chowdhury et al. (2002) in UNNES Journal, demonstrated rising female literacy and labor force participation, improving family economic stability. In the Philippines, the Pantawid Pamilyang Pilipino Program (4Ps) was evaluated by Acosta & Velarde (2015) through World Bank assessments, showing higher school enrollment and health compliance due to conditional cash transfers (worldbank organisation).

Infrastructure-based interventions further strengthen educational outcomes. In Brazil, the "Light for All in Schools" electrification program was studied by Chagas et al. (2020) and documented by the Inter-American Development Bank (publications.iadb.org), finding dropout reductions of up to 27% in newly electrified rural schools. Indonesia's Early Childhood Education and Development (ECED) program, evaluated by Brinkman et al. (2011) and published by the World Bank, showed that children attending ECED centers performed better in primary school, highlighting the importance of early interventions (worldbank organisation). Similarly, Mexico's compensatory programs for marginalized communities, documented by de Janvry&Sadoulet (2006) and reviewed in World Bank evaluations, improved standardized test scores between 2009–2013, narrowing achievement gaps (worldbank organisation).

In rapidly transforming or post-conflict economies, education has played a critical role in recovery and income mobility. In Vietnam, research by Nguyen & Tran (2021) published in the Journal of Risk and Financial Management found that additional years of schooling significantly increased household income, making education a strong lever for poverty reduction (mdpi). In Rwanda, post-genocide education investments—particularly in universal access and gender equity—were highlighted by Paul Kagame's education policy reviews and analyzed by Zubairi & Rose (2013) through UNESCO and ODI reports. These policies enhanced human capital formation, contributing to sustained economic growth and recovery.

Together, these studies provide a compelling global narrative: education is a long-term investment with measurable benefits across health, employment, and income. These cases—spanning Asia, Africa, and Latin America—demonstrate the versatility of policy instruments and their adaptability to different socio-political contexts. However, there remains a critical gap in village-level, time-series data, especially in the Indian context. By using the SHRUG dataset to study rural villages in Karnataka from 1991 to 2020, this research seeks to provide micro-level empirical evidence that builds upon the global consensus, offering localized insights into the long-term developmental impact of educational access.To address these gaps in the existing literature, four main objectives were formulated for the present study.

Objectives of the Study:-

Based on the overall research design, data, and literature, the primary objectives of this study are:

1. To quantify the long-term relationship between historical access to education (1991) and contemporary development outcomes (2020) at the village level in Karnataka.
2. To assess the influence of educational infrastructure quality—such as school electrification and sanitation—on broader socioeconomic development indicators.
3. To evaluate disparities across regions and districts, identifying where education has had the greatest long-term impact and where gaps persist.
4. To inform policy design by highlighting how educational investments can yield multi-sectoral benefits, including in infrastructure, health, and community development.

Methodology:-

The title "Quantifying the Long-Term Developmental Impact of Access to Education" was chosen to explore how historical access to education influences present-day development outcomes, with a particular focus on rural India. Education has long been recognized as a cornerstone of human capital development, shaping health, employment, income, and social mobility. While global studies affirm these links, there remains a gap in localized, quantifiable research that connects historical educational access to current socioeconomic indicators, especially at the village level. This study addresses that gap by using real-world datasets to empirically measure both the causal and correlational effects of educational access on long-term development.The analysis draws on the SHRUG dataset (Socioeconomic High-resolution Rural-Urban Geographic data) developed by DevDataLab.org, a granular and longitudinal dataset that links administrative and census data across multiple years. SHRUG integrates village-level information from the 1991 Census of India with more recent development indicators, making it particularly suitable for examining long-term outcomes.

Historical access to education is proxied using village-level variables from the 1991 Census contained in the SHRUG dataset. These include the number of schools in the village (pc91_vd_schools1), the presence of electricity in primary schools (is_primary_school_with_electricity), and the total number of students enrolled in primary schools (total_primary_school_students). These variables capture both the availability of educational institutions and the quality of educational infrastructure during the early period of analysis. These indicators are analyzed against contemporary development outcomes from the Mission Antyodaya 2020 dataset, including electricity deprivation at the village level (no_electricity), continuity of school infrastructure such as electrified primary schools (is_primary_school_with_electricity), and other human-development-related indicators related to sanitation, infrastructure, and basic services. Using these variables allows the study to examine whether differences in early educational access are associated with measurable differences in long-term development outcomes.

The empirical analysis is conducted using multiple statistical techniques to evaluate the relationship between educational access and long-term development. Descriptive statistics are used to summarize differences between villages with varying levels of educational access in 1991. Difference-in-means tests are applied to determine

whether these differences are statistically significant. Regression analysis is then employed to control for other factors that may influence development outcomes, including village population, number of households, and district-level characteristics, allowing for a more reliable estimation of the long-term effects of educational infrastructure. In addition, propensity score matching (PSM) is used to compare villages with similar characteristics, ensuring that the estimated effects of educational access are not driven by pre-existing differences between villages.

The focus on villages in Karnataka strengthens the study because the state provides a consistent regional setting with substantial variation in rural development levels, a strong history of educational reforms such as the Nali Kali program and mid-day meal initiatives, and relatively complete longitudinal data in the SHRUG dataset. A rural focus is particularly important because infrastructure disparities are often wider in villages, making the long-term impact of educational access more visible than in urban areas where baseline conditions are already high. This regional focus also aligns with India's broader development priorities, including those outlined in the National Education Policy 2020, which emphasizes improving educational quality and infrastructure in rural areas.

Analysis:-

Table 1: Descriptive Statistics

Indicator	1991 (Education Access)	2020 (Development Outcomes)
School Availability	Many villages lacked a primary school, especially in rural and underdeveloped districts. Access to education was uneven, with certain talukas having better infrastructure due to early state-led education drives.	Villages that had a school in 1991 report only **12% of households without electricity** in 2020, compared to **18%** in those without schools.
School Electrification	Only a limited proportion of schools had electricity in 1991. This reflected broader gaps in rural infrastructure and administrative capacity.	Villages that had electrified schools in 1991 now show markedly better electrification and infrastructure outcomes.
Sanitation in Schools	Sanitation facilities were scarce or non-existent in most rural schools during 1991.	By 2020, **64% of villages with schools in 1991** had toilets in schools, compared to **47% of villages without schools**.

Source: Compiled by the author using SHRUG (Census of India, 1991) and Mission Antyodaya data (2020).

The descriptive statistics establish a strong foundation for understanding how early access to education correlates with improved long-term outcomes. Villages that had schools and basic educational infrastructure in 1991 experienced higher rates of electrification and sanitation by 2020. This pattern suggests that the benefits of education access extend beyond literacy and enrollment — they trigger a cycle of development. Schools act as nodes of infrastructure investment, attracting other improvements such as roads, electricity, and water. The presence of schools in 1991 likely made villages more visible to government schemes, encouraging subsequent rounds of development assistance.

Table 2: Difference-in-Means Tests

Outcome (2020)	Villages with School in 1991	Villages without School in 1991	Difference	Significance
Electricity Deprivation	12%	18%	-6 pp	$p < 0.01$
School Toilet Availability	64%	47%	+17 pp	$p < 0.01$
Electrified School	72%	58%	+14 pp	$p < 0.01$

Source: Compiled by the author using SHRUG (Census of India, 1991) and Mission Antyodaya data (2020).

The difference-in-means results confirm that these gaps are statistically significant and not random. Villages with schools in 1991 displayed consistently better infrastructure outcomes nearly three decades later. The 6 percentage point drop in electricity deprivation suggests that educational access in the early 1990s had lasting effects on village electrification and economic modernization. Similarly, the 17 percentage point increase in school sanitation facilities demonstrates that educational presence has a cascading influence on social infrastructure and public health priorities. These differences underscore that early investments in education create measurable, long-term development advantages.

Table 3: Regression Analysis (with Controls)

Variable (1991)	Dependent Variable: Electricity Deprivation (2020)	Coefficient	Std. Error	Significance
School Electrification (is_primary_school_with_electricity)	no_electricity	-0.061	(0.018)	***
School Availability (pc91_vd_schools1)	no_electricity	-0.013	(0.010)	n.s.
Total Primary Students (total_primary_school_students)	no_electricity	-0.005	(0.007)	n.s.
Controls Included	Population, number of households, district fixed effects	Yes		

Statistical significance levels are denoted as *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Variables marked as n.s. are not statistically significant.
Source: Compiled by the author using SHRUG (Census of India, 1991) and Mission Antyodaya data (2020).

The regression analysis provides stronger evidence by controlling for other influencing factors such as population size, household count, and district-level characteristics. It reveals that school electrification in 1991 remains a powerful predictor of present-day village development. Villages where schools had electricity in 1991 are 6.1 percentage points less likely to experience electricity deprivation in 2020, even after accounting for other variables. This finding highlights a crucial insight: it is not merely the presence of a school that matters, but the quality and infrastructure of that school. Electrified schools symbolize better resource allocation, stronger administrative presence, and local capacity for maintenance all of which compound over time to produce better developmental outcomes. On the other hand, raw school numbers and enrollment alone show weaker effects, implying that physical and infrastructural quality of education access is the key driver of long-term development.The table reports village-level regression estimates linking historical educational access to long-term development outcomes. Coefficients

represent percentage-point changes in the dependent variable. Standard errors are reported in parentheses. All regressions control for village population, number of households, and district fixed effects.

Table 4: Propensity Score Matching (PSM)

2020 Outcome	Villages with School in 1991 (Matched)	Villages without School in 1991 (Matched)	ATT (Average Treatment Effect)
Electricity Deprivation	13%	17%	-4 pp
School Toilet Availability	63%	48%	+15 pp
Electrified School	70%	55%	+15 pp

Source: Compiled by the author using SHRUG (Census of India, 1991) and Mission Antyodaya data (2020).

Propensity Score Matching (PSM) helps ensure that the comparisons between school and non-school villages are fair by matching them on similar characteristics such as population, household size, and regional background. Even after matching, villages with schools in 1991 continue to show superior outcomes in 2020. The 4 percentage point reduction in electricity deprivation and 15 percentage point higher sanitation coverage confirm that these benefits are not due to pre-existing advantages, but rather the result of historical educational access. This reinforces the idea that the presence of schools generates long-term community spillovers — villages become more attractive for further development investment, administrative focus, and citizen participation in government programs.

Table 5: Heterogeneity Across Districts

District Example	1991 Access to School	2020 Development Impact
Belagavi, Tumakuru (less developed)	Lower school availability and minimal electrification in 1991.	School access linked with **8+ percentage points lower electricity deprivation** by 2020.
Bengaluru Rural (more developed)	Higher school availability and stronger baseline infrastructure.	Smaller marginal impact by 2020, with effects under 3 percentage points.

Source: Compiled by the author using SHRUG (Census of India, 1991) and Mission Antyodaya data (2020).

The heterogeneity analysis highlights that the impact of education access is not uniform across Karnataka. In underdeveloped districts like Belagavi and Tumakuru, where infrastructure was weak in 1991, the introduction or improvement of schools led to significant long-term gains in electrification and sanitation. Conversely, in relatively developed districts like Bengaluru Rural, the marginal effect of school presence is smaller because baseline access was already high. This pattern demonstrates that educational investments yield the highest returns in regions starting from a low base, reaffirming the policy importance of prioritizing disadvantaged rural areas.

Conclusion:-

This study set out to quantify the long-term developmental impact of historical access to education, with a specific focus on rural villages in Karnataka. By linking village-level educational indicators from the 1991 Census to development outcomes observed in the 2020 Mission Antyodaya data, the analysis provides robust empirical evidence that early investments in education have persistent and measurable effects on rural development outcomes even three decades later.Consistent with the first objective, the findings demonstrate that villages with access to primary education in 1991 exhibit significantly better development indicators in 2020, including lower electricity deprivation, higher levels of school electrification, and improved sanitation infrastructure. Difference-in-means tests confirm that these gaps are statistically significant, indicating that the observed improvements are unlikely to be driven by random variation.

Addressing the second objective, the study finds that the quality of educational infrastructure—particularly school electrification—plays a more decisive role in shaping long-term development outcomes than the mere presence of schools or student enrollment levels. Regression analysis reveals that villages with electrified schools in 1991 are substantially less likely to experience electricity deprivation in 2020, even after controlling for demographic and regional factors. This underscores the importance of infrastructure quality in amplifying the developmental returns to education.In line with the third objective, the analysis highlights meaningful regional heterogeneity across Karnataka's districts. The developmental impact of early educational access is strongest in historically underdeveloped districts, where baseline infrastructure deficits were more pronounced. This suggests that educational investments have the greatest marginal returns in areas facing structural disadvantages, reinforcing the role of education as an equalizing force in rural development.

Finally, by adopting a village-level, longitudinal approach, this study contributes to the broader development literature by demonstrating that education policy should be understood not merely as a social intervention, but as a foundational component of long-term economic and infrastructural development. The results emphasize the need for integrated policy frameworks that prioritize educational infrastructure quality, target underserved rural regions, and recognize the enduring spillover effects of education on broader development outcomes. These insights are directly relevant to current policy priorities under the National Education Policy 2020 and provide evidence-based guidance for designing interventions aimed at promoting inclusive and sustainable rural development.The findings of this study highlight the importance of viewing education as a foundational component of long-term development rather than as an isolated social intervention. Evidence from village-level analysis indicates that investments in the quality of educational infrastructureparticularly in rural contextsgenerate durable spillover effects on broader development outcomes such as electrification and basic service provision. These results suggest that development strategies should integrate educational planning with complementary infrastructure investments, especially in regions with historically low baseline conditions. Strengthening educational quality in underserved rural areas can play a critical role in reducing regional disparities and promoting inclusive and sustainable development over time.

References:-

1. Angrist, J. D., & Pischke, J.-S. (2009). Mostly harmless econometrics: An empiricist's companion. Princeton University Press.
2. Asadullah, M. N., & Chaudhury, N. (2015). The impact of education policies on school participation and outcomes in developing countries. International Journal of Educational Development.
3. Asher, S., Lunt, T., Matsuura, R., & Novosad, P. (2019). Socioeconomic High-Resolution Rural–Urban Geographic Dataset (SHRUG). Development Data Lab.
4. Asher, S., & Novosad, P. (2020). Rural roads and local economic development. American Economic Review.
5. Adukia, A., Asher, S., & Novosad, P. (2020). Educational investment responses to economic opportunity. American Economic Journal: Applied Economics.
6. DevDataLab. (2024). SHRUG v2.1: Socioeconomic High-Resolution Rural–Urban Geographic Dataset. Development Data Lab.
7. Duflo, E. (2001). Schooling and labor market consequences of school construction in Indonesia. American Economic Review.
8. Duflo, E., Dupas, P., & Kremer, M. (2017). The long-term impacts of secondary school scholarships in Ghana. J-PAL Working Paper.
9. Duflo, E., Dupas, P., & Kremer, M. (2021). The impact of free secondary education: Experimental evidence from Ghana. NBER Working Paper.

10. Hallack, M., Chagas, A., & Carvalho, F. (2018). School infrastructure and educational outcomes in rural areas. Inter-American Development Bank.
11. Hanushek, E. A., &Woessmann, L. (2008). The role of cognitive skills in economic development. Journal of Economic Literature.
12. Khandker, S. R., Pitt, M. M., &Fuwa, N. (2003). Subsidy to promote girls' secondary education: The female stipend program in Bangladesh. World Bank Economic Review.
13. Kingdon, G. G. (2007). The progress of school education in India. Oxford Review of Economic Policy.
14. Muralidharan, K., & Kremer, M. (2007). Public and private schools in rural India. Harvard University Working Paper.
15. Muralidharan, K., Singh, A., &Ganimian, A. J. (2019). Disrupting education? Experimental evidence on technology-aided instruction in India. American Economic Review.
16. Ministry of Education, Government of India. (2001). Sarva Shiksha Abhiyan: Framework for implementation.
17. Ministry of Education, Government of India. (2020). National Education Policy 2020.
18. Mission Antyodaya. (2020). Village-level development survey data. Ministry of Rural Development, Government of India.
19. Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. Biometrika.
20. UNESCO. (2015). Education for All Global Monitoring Report. UNESCO.
21. UNESCO. (2020). Global Education Monitoring Report: Inclusion and Education.UNESCO.
22. World Bank. (2018). World Development Report 2018: Learning to realize education's promise.
23. World Bank. (2020). Human Capital Index. World Bank