

Evolution and Structural Transformation of Education in Puducherry: A Longitudinal Analysis of Growth and Emerging Trends

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ABSTRACT

Education is a very important tool for human development, social progress and economic development. In the last few decades the Union Territory of Puducherry has experienced very high levels of educational progress with an improvement in literacy, an expansion of educational infrastructure and an increase in educational participation. Based on the above background, in this study the pattern of educational development and structural transformation in Puducherry has been studied in the period 1961-2021. The study is based entirely on secondary data collected from the Census of India, Directorate of Economics and Statistics, Government of Puducherry, Abstracts of Statistics, Statistical Handbooks and other public educational information. Percentage method, descriptive statistics, Compound Annual Growth Rate (CAGR), trend analysis, correlation analysis for selected educational resources is employed to study the long-term variation in literacy, education institutions, student representation and teacher strength. The significant increased in the literacy rate along with educational institutions, student enrolment and teacher strength during the study period demonstrates impressive educational progress. The correlation between educational indicators (education, student enrolment and teacher strength) with literacy is very strong. Based on the above findings policy suggestions are provided for further educational development in Puducherry along with employment opportunities, encouraging entrepreneurial activities, innovation, and development of startups.

Keywords: Educational Development, Literacy Growth, Educational Infrastructure, Educational Participation, Structural Transformation, Puducherry, Human Capital Formation.

1. INTRODUCTION

Education is crucial for human capital development and economic development, as it increases knowledge, skills, productivity and employability. It also improves social mobility, living standards, democratic participation and has the potential to promote inclusive development. Education development is widely considered to be an indicator of society and well-being. The human development and socio-economic progress are based on education. Since Independence, the Indian education system has been developed through policy initiatives and institutional reforms. The National Policy on Education, Sarva Shiksha Abhiyan, Right to Education Act, Samagra Shiksha and National Education Policy (NEP) 2020 have all contributed to the development of literacy, enrolment and educational access in India. These initiatives have enabled the development of educational infrastructure and increased participation at different education levels. Yet the pace and pattern of educational development differ from region to region on the basis of demographic, economic and institutional factors.

Union Territory of Puducherry is a very significant case study to analyse this Education development and structural transformation. In the last six decades, literacy levels, educational institutions, students enrolled and teacher strength have increased significantly in Puducherry. The education system has made significant structural changes in the form of higher secondary, collegiate, professional and technical institutions. Educational institutions, student enrolment and teacher strength are the most important measures of educational accessibility. Analyzing all these indicators together helps to understand how educational progress has advanced and the structure of education has changed throughout time. Based on the above background, the

Evolution and Structural Transformation of Education in Puducherry: A Longitudinal Analysis of Growth and Emerging Trends

current study attempts to explore the growth, trend and structure of education in Puducherry for the period of 1961-2021. Hence the following objectives has been framed

1. To examine the trend and pattern of literacy in Puducherry during the period 1961–2021.
2. To analyze the expansion and structural transformation of educational institutions in Puducherry.
3. To assess changes in student enrollment and teacher strength and to examine the relationship between literacy and selected educational indicators such as educational institutions, student enrollment, and teacher strength.

To analyse the above objectives, secondary (time Series-Decadal) data was collected from various official sources, including the Census of India, Directorate of Economics and Statistics, Government of Puducherry, Statistical Handbooks, Abstracts of Statistics, AISHE Reports, and other government publications from 1961 to 2021. Various statistical tools such as percentage analysis, decadal growth rate, Compound Annual Growth Rate (CAGR), trend analysis, and Pearson's Correlation Coefficient have been employed to examine the above objective. Trend analysis has been used to examine the pattern of literacy growth, while correlation analysis has been applied to assess the relationship between literacy and selected educational indicators. Based on the objectives of the study, the following hypotheses has been formulated:

H₀: There is no significant relationship between educational indicators (educational institutions, student enrollment and teacher strength) with literacy levels in Puducherry.

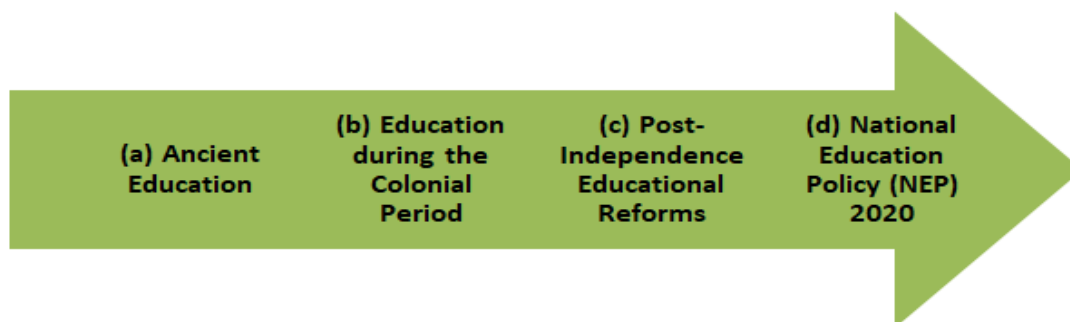
H₁: There is a significant relationship between educational indicators (educational institutions student enrollment and teacher strength) with literacy levels in Puducherry.

Hence, the rest of the paper is organized as follows: section 2 presents the history of educational evolution in India and literature review section 3 presents the methodology, empirical analysis and discussion is presented in section 4 and finally concluding remarks and policy suggestions are presented in section 5.

2. HISTORICAL EVOLUTION OF EDUCATION IN INDIA

The evolution of education in India is primarily explained in four stages: Ancient education, Colonial education, post-Independence education reforms and National Education Policy (NEP) 2020. Each of the stages has played a key role in the development of the current education system.

Figure 1: Evolution of Indian Education



(a) Ancient Education: India's education system is based on old and ancient education (Gurukul system). Students lived with their teachers and learned from them in a way that emphasized intellectual development, moral values, discipline, and character formation. Ancient learning centers like Taxila and Nalanda were known for their contributions to philosophy, mathematics, medicine, astronomy, literature, and religious studies. Education during that time was oriented towards holistic development and the transmission of knowledge from generation to generation. Though education was limited to some sections of society, the ancient educational tradition had a solid philosophical foundation which shaped future educational developments.

(b) Colonial Education: The colonial educational system enabled the diffusion of modern knowledge, administrative skills, and professional education. Nevertheless, education access was still uneven and differences in regional and social levels were still prevalent. The colonial era was an important period with organized educational management and educational opportunities that went beyond the traditional system.

(c) Post-Independence Educational Reforms: In 1947, education was regarded as an important tool of nation-building, social justice, and economic development, and after independence, educational reform was implemented by the Government of India. In 1968, the National Policy on Education focused on equal educational opportunities and national integration through education. The National Policy on Education (1986) also emphasized universal access, education quality, and the reduction of social inequality. A number of big-ticket programs were implemented to strengthen education in India, namely Sarva Shiksha Abhiyan, Mid-Day Meal Scheme, Rashtriya Madhyamik Shiksha Abhiyan, and the Right to Education Act, 2009. These initiatives significantly improved enrolment, literacy, and educational accessibility.

(d) National Education Policy (NEP) 2020 : The National Education Policy (NEP) 2020 is one of the most comprehensive education reforms of the past 20 years. The policy aims to change India's educational system by increasing access, quality, equity, affordability, and accountability. It tackles the problems of a rapidly changing global economy with multidisciplinary learning, skill development, critical thinking, and digital literacy. NEP 2020 places special emphasis on foundational literacy and numeracy, dropout reduction, flexible learning pathways, vocational education, and technology-driven education. It also focuses on educational equity in India, for the poor and marginalized students. NEP 2020 will lead to the development of a more efficient and inclusive education process and will strengthen human capital development through various educational initiatives like NIPUN Bharat, PM eVIDYA, DIKSHA, and the Gender Inclusion Fund. The education system in India has evolved slowly from old-school learning paradigms to modern, inclusive, and development-oriented education. The educational reforms have been able to significantly contribute to literacy, institutional growth, and human resource development, thereby contributing to the overall social progress and national development in different aspects of education.

2.1 MAJOR EDUCATIONAL SEGMENTS

Education is delivered through various institutional and academic structures and they have contributed to literacy improvement, skill development, human capital development, and overall socio-economic development. The educational system is composed of different segments that serve different learning needs and developmental objectives. These segments offer opportunities for foundational learning, advanced knowledge acquisition, professional training, and technical skill development. They can be integrated for educational advancement and workforce preparedness.

2.1.1. Educational Institutions: Educational institutions are the core of the educational system as they provide the infrastructure for teaching and learning, and the major educational sectors include educational institutions, school education, higher education, professional education, and technical education.

2.1.2. School Education: They are schools, colleges, universities, and specialized institutions. Educational institutions become more accessible, enhance participation, and contribute to literacy improvement and human capital formation. School education is the most basic stage in learning, and it is important for developing literacy, numeracy, and cognitive skills. It is the basis for higher education, skill development, and socio-economic advancement.

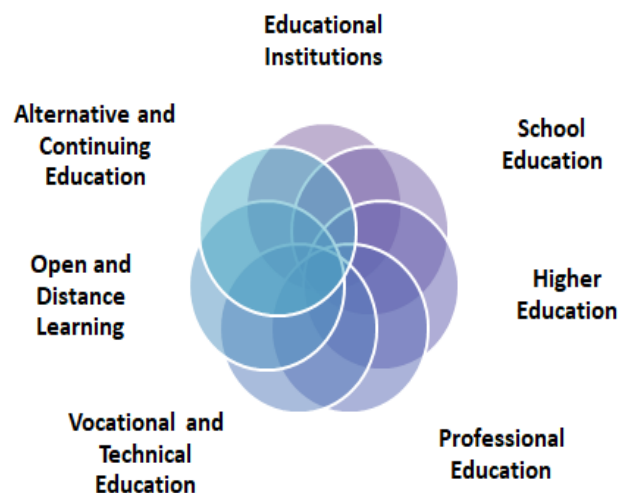
2.1.3. Higher Education: Higher education comprises colleges, universities, and other advanced learning institutions, and is a combination of primary, secondary, and higher secondary education. Higher education not only increases human resource development but also supports economic growth by building a skilled workforce.

2.1.4. Professional Education: Professional education prepares students for specialized careers in fields such as medicine, engineering, management, law, and teacher education. It offers occupation-specific knowledge and skills so that they can become productive, high-skilled, and professional.

2.1.5 Technical Education : Technical education focuses on developing practical skills and technical competencies needed in industry and employment. Through engineering, polytechnic, and vocational programs, it promotes workforce readiness, technological advancement, entrepreneurship, and economic development.

In general, the different parts of education play complementary roles in promoting educational advancement and socio-economic development. Educational institutions provide the necessary infrastructure, school education establishes foundational learning, higher education develops advanced knowledge, professional education prepares specialized human resources, and technical education enhances practical skills and employability. Together, they enrich educational capacity, support human capital formation, and contribute to long-term economic and social progress.

Figure 2 Major Educational Segments



2. REVIEW OF LITERATURE

Various national and international studies are available on education, and few studies pertaining to education and few are available for union territory of Pondicherry.

Schultz (1961) developed a Human Capital Theory and argued education is a valuable investment that increases productivity, prosperity, quality and social well-being of people. **Sen (1995; 1997)** also emphasized that education not only drives the development of the economy but also human development and human freedoms.

Ramadas (1987) investigated educational development in Puducherry and found that educational facilities expanded the educational system along with its efficient and productive. **Rajan (1987)** studied relation between educational expenditure and economic development in Puducherry, the study also revealed a positive link between education expenditure and literacy levels. **Velayutham (1999)**, in his research observed that the expansion of education is important for socio-economic development and lays the groundwork for long-term development. **Viswanathan (2000)** analyzed education progress from a gender perspective and found that female literacy and educational participation in Puducherry has significantly improved (i.e., with supportive government policies and the expansion of educational opportunities). **Dholakia (2003)** noted that education outcomes are closely linked to infrastructure development, economic condition and institutional growth. The study highlighted the importance of educational infrastructure in promoting educational progress and education development. **Kingdon (2007)** highlighted the significant increase in literacy, enrolment and educational participation in India and the need for education infrastructure and policy interventions to increase educational development. **UNESCO (2022)** report highlighted the importance of an inclusive education system with equitable resources, and quality learning opportunities for sustainable education.

Aneesh e.al., (2024) examined educational inequality and development in India and found that while educational indicators have improved significantly over time, huge disparities exist in rural and urban areas and socio-economic groups, especially in access to higher education.

UNESCO (2024) declared that educational development in the twenty-first century is increasingly dependent on educational quality, digital inclusion and equitable access to education resources. **The World Bank (2024)** highlighted that inequalities in educational resources, digital access, and learning opportunities persist to distort educational outcomes. Investing in educational infrastructure, teacher development, and learning support systems is still vital to enhance educational achievement and economic productivity, the report added.

3. METHODOLOGY

Simple charts, percentage analysis, Compound Annual Growth Rate (CAGR), trend analysis and correlation analysis is used to analyse the objective of the study.

3.1. Percentage Analysis

The literacy rate is calculated using the standard demographic formula:

$$\text{Literacy rate (\%)} = \left(\frac{\text{Number of Literates}}{\text{Total Population}} \right) * 100$$

This measure helps to examine changes in literacy levels over time.

3.2. Compound Annual Growth Rate (CAGR)

CAGR is used to measure the average annual growth rate of educational institutions during the study period.

$$CAGR = \left(\frac{\text{Ending value}}{\text{Beginning value}} \right)^{1/n} - 1$$

Where n = Number of years

3.3. Trend and Regression Analysis

A log-linear regression model is used to examine the trend in literacy growth.

$$\text{Ln}(Y_t) = \beta_0 + \beta_1 T + \epsilon_t$$

Where

Y_t = Literacy rate

T = Time trend

β_0 = Intercept

β_1 = Growth coefficient

ϵ_t = Error term

3.4. Correlation Analysis

Correlation analysis is employed to examine the direction and degree of association between literacy and selected educational indicators such as educational institutions, student enrolment, and teacher strength. The analysis is intended to identify broad relational patterns rather than establish statistical causality. The Pearson's Product-Moment Correlation Coefficient is calculated using the following formula:

$$r = \left(\frac{\Sigma \left((X - \bar{X})(Y - \bar{Y}) \right)}{\sqrt{\Sigma \left((X - \bar{X})^2 \right) \Sigma \left((Y - \bar{Y})^2 \right)}} \right) * 100$$

Where:

r = Correlation coefficient

X = Independent variable (Educational Institutions / Students / Teachers)

Y = Dependent variable (Literacy Rate)

$\bar{X}$ = Mean of X

$\bar{Y}$ = Mean of Y

Σ = Summation operator

4. Empirical Analysis and Discussion

In order to examine the objectives, the present section analyzes selected demographic and educational indicators relating to population, literacy, educational institutions, student enrollment, and teacher strength. Table 1 presents the trends in population, number of literates, and literacy rate in Puducherry during 1961–2021.

Table 1 Population and Literacy Rate in Puducherry (1961–2021)

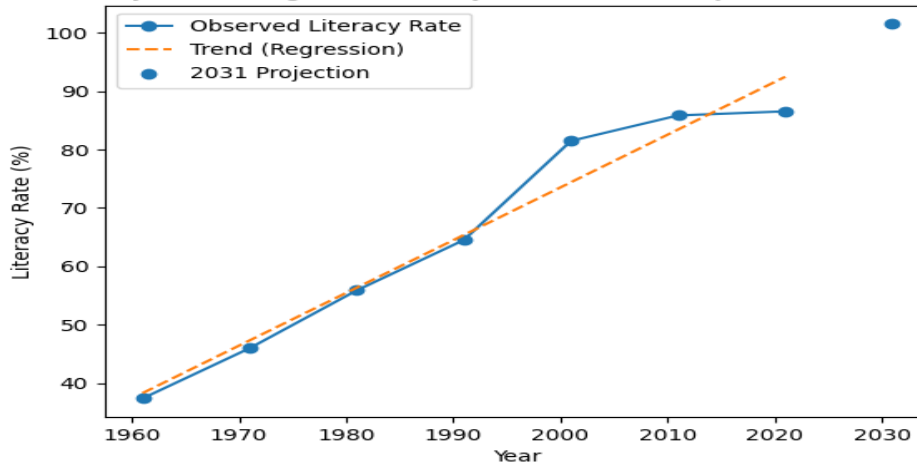
Year	Population	Number of Literates	Literacy (%)
1961	369,079	138,149	37.4
1971	471,707	217,058	46
1981	604,471	337,615	55.9
1991	807,785	521,213	64.52
2001	973,829	793,573	81.49
2011	1,247,953	1,071,000	85.85
2021	1,608,849	1,392,458	86.55

Source: Census of India (1961–2011); Directorate of Economics and Statistics, Government of Puducherry, Statistical Handbook/Abstract of Statistics (Various Years). Note: The 2021 literacy figure is based on administrative estimates and not on Census enumeration.

Evolution and Structural Transformation of Education in Puducherry: A Longitudinal Analysis of Growth and Emerging Trends

The above table reveals that educational development in Puducherry has progressed at a faster pace than demographic growth during 1961–2021. Although the population increased over the study period, the growth in the number of literates was considerably higher, indicating that educational expansion was not merely a consequence of population increase but the result of sustained improvements in educational access and participation. The sharp rise in literacy, particularly during the period 1991–2001, suggests the significant influence of educational policies, expansion of schooling facilities, literacy programs, and increased public investment in education. This phase may be regarded as a turning point in Puducherry's educational development, reflecting the successful integration of educational infrastructure with growing social demand for education. The relatively slower increase in literacy after 2001 does not necessarily indicate stagnation. Rather, it reflects the phenomenon of educational saturation, where further improvements become progressively difficult once a region has already attained a high literacy level.

Chart 1 Literacy Trend with Regression Forecast
Literacy Trend, Regression Analysis and 2031 Projection – Puducherry



Source: Census of India (1961–2021); Directorate of Economics and Statistics, Government of Puducherry (Various Years); Regression Trend and Projection computed by the researcher using a log-linear trend model.

Chart 1 highlights the steady improvement in literacy levels in Puducherry over the study period and confirms the strong upward trend observed in Table 1. The close correspondence between the observed values and the fitted regression trend suggests that literacy growth has been regular rather than random, reflecting sustained educational development in the state. The projected trend for 2031 indicates that if the education progress is maintained further literacy level is expected to improve.

Table 2 Structural Composition of Educational Institutions in Puducherry (1981–2021)

Type of Institutions	1981	1991	2001	2011	2021
Arts & Science Colleges	6	10	18	28	35
Higher Secondary Schools	20	40	80	120	188
High Schools	45	70	110	140	194
Middle Schools	50	70	85	95	81
Primary Schools	150	200	250	280	275
Pre-Primary Schools	20	30	50	85	110
Total (A) General Education	291	420	593	748	883
Professional & Technical Institutions	2	8	25	60	112
Grand Total (A + B)	293	428	618	808	995

SOURCE: Data of Directorate of Economics & Statistics, Government of Puducherry, Abstracts of statistics (Various Years); AISHE reports (Various Years); Compiled and classified by the researcher.

Table 2 presents the structure of the educational institutions in Puducherry from 1981 to 2021. The level of education infrastructure has grown quite rapidly, with the total number of institutions rising from 293 in 1981 to 995 in 2021. This is because of the continuous investment in education, increasing demand for education and the increasing diversity of the educational opportunities for different levels of learning, especially in higher secondary, colleges, professional and technical institutes. As general education institutions continued to dominate the educational, the rise of professional and technical institutions from 2 to 112 indicates much greater emphasis on skill and employment-related education. The growth of Arts and Science Colleges and Higher Secondary Schools also shows a growing participation in post-secondary and higher education. In the school system, a decline in middle and primary schools after 2011 may be due to the consolidation of the education system, as well as the higher education level. In contrast, the continued growth of pre-primary institutions indicates growing recognition of early childhood education.

Table 3 Compound Annual Growth Rate of Educational Institutions in Puducherry (1981–2021)

Category	Colleges	Higher Secondary	High Schools	Middle Schools	Primary Schools	Pre-Primary	General Education	Technical Education	Grand Total
CAGR (%)	4.5	5.8	3.7	1.2	1.5	4.3	2.8	10.6	3.1

Source: Computed by the researcher from Directorate of Economics and Statistics, Government of Puducherry, Abstracts of Statistics (Various Years) and AISHE Reports (Various Years).

Table 3, presents the Compound Annual Growth Rate (CAGR) of educational institutions in Puducherry over the years 1981-2021. CAGR measures the average annual rate at which different categories of educational institutions expanded during the study period and helps identify the sectors that contributed most to educational growth. In Puducherry, it is clear that education development has not been uniform across all institutions. Technical education recorded the highest growth rate, reflecting the increasing importance of professional, vocational and employment-oriented programmes within the educational system. The overall CAGR of 3.1 per cent reflects the steady expansion of educational infrastructure in Puducherry over four decades and highlights the government's continued emphasis on educational development.

Table 4 Distribution of Students by Type of Institution (1981–2021)

Institution	1981	1991	2001	2011	2021
General Education	1,10,100	1,65,000	2,45,000	2,90,000	3,05,000
Professional & Technical Education	3,000	7,500	18,000	28,000	34,000
Total Students	1,13,100	1,72,500	2,63,000	3,18,000	3,39,000

Source: Directorate of Economics and Statistics, Government of Puducherry, Abstracts of Statistics (Various Years); compiled by the researcher.

Table 4 reveals that Student enrolment in General Education and Professional & Technical Education in Puducherry is distributed on the table above. The data reveal a consistent rise in student participation throughout the study period. Enrolment in general education increased from 1,13,100 in 1981 to 3,39,000 in 2021, reflecting improved educational access and growing public demand for education. The students were mainly in General Education but in 2021 Professional & Technical Education grew much faster. Student enrolment in professional institutions increased from 3,000 to 34,000, indicating an increase towards skill-based and career-oriented learning. The findings indicate that educational progress in Puducherry has been accompanied not only by a higher student involvement but also by an increase in enrolment in professional and technical education.

Table 5 Educational Progress Indicators by Census Year in Puducherry (1981–2021)

Indicator	1981	1991	2001	2011	2021
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Evolution and Structural Transformation of Education in Puducherry: A Longitudinal Analysis of Growth and Emerging Trends

Literacy (%)	56	65	81	86	87
Institutions	293	428	618	808	995
Students	1,13,100	1,72,500	2,63,000	3,18,000	3,39,000
Teachers	4,500	6,850	10,950	14,700	17,400

Source: Census of India (Various Years); Directorate of Economics and Statistics, Government of Puducherry, Abstract of Statistics/Statistical Handbook (Various Years); compiled by the researcher.

Table 5 presents the educational progress in Puducherry from 1981-2021 using four key indicators: literacy, educational institutions, student enrolment and teacher strength. The findings demonstrate that educational development in Puducherry has been multidimensional, involving improvements in literacy, institutional capacity, student participation and teacher availability. Hence, these trends highlight the significant educational transformation that Puducherry has undergone in four decades and provide evidence of continued progress in education.

Correlation Analysis

Pearson's correlation coefficient has been used to analyze the relationship between literacy and educational indicators in Puducherry from 1981 to 2021. The analysis examines whether literacy has improved and educational infrastructure, participation and teaching capacity have improved in Puducherry. Table 6 presents the results of correlation coefficients between the variables. Student enrolment is the most correlated with literacy ($r = 0.988$), which is evidence that the literacy level is related to educational participation. The correlation between educational institutions and literacy ($r = 0.974$) is also very strong which suggests that expansion of educational infrastructure has been an important factor in educational advancement. Teacher strength is positively associated with literacy ($r = 0.951$) showing how instructional capacity is a key factor for education development.

Table 6 Correlation Analysis Between Key Educational Indicators

Variable Relationship	Correlation Coefficient (r)
Institutions vs Literacy	0.974
Students vs Literacy	0.988
Teachers vs Literacy	0.951

Source: Computed by the researcher from Census of India

In the table 6, the study has made observations for 1981-2021 and they are trying to point towards the direction and strength of association rather than causality. Therefore, the null hypothesis H_0 that there is no significant correlation between educational indicators and literacy level in Puducherry and accept the alternative hypothesis H_1 . Hence, it is found that educational institutions, student enrolment, and teacher strength are positively related to literacy in Puducherry during the study period.

5. CONCLUSION AND POLICY SUGGESTIONS

The purpose of this paper is to trace the progress of education over time and to know the long-term and structural development in education in Puducherry. Educational development in the Union Territory has shown a continuing growth in literacy, institutional expansion, educational participation and teacher capacity over the last 50 years. The analysis proves a significant progress in all key areas of education development. Educational infrastructure, student numbers, teacher presence and availability of resources are all expanding education capacity and accessibility in education development. The correlation analysis also shows strong positive correlations between literacy and key educational indicators that indicate that educational development has been accompanied by the development of institutional and human resources simultaneously. Overall, the evidence suggests that educational progress has played an important role in strengthening human capital and supporting socio-economic development in Puducherry. Based on the above analysis, the following policy suggestions are given:

Good education should not only provides knowledge and skills but also should create strong connections with (i) employment opportunities, (ii) encouraging entrepreneurial activities, innovation, and (iii) development of startups.

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