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Analysis and Predictive Modeling of the Total Literacy Rates in India for Different States

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Abstract: ***Objectives**: To analyze and predict literacy rates across 36 states and union territories in India, focusing on 478,000 primary, upper primary, and secondary schools using Educational Data Mining techniques. **Method**: This study employs the CART (Classification and Regression Trees) Machine Learning Algorithm to develop a predictive model for literacy rates. Data from 2015-2016 academic year, covering 27 variables related to school infrastructure and demographics, was collected from the Government of India's official education database. The dataset was preprocessed, normalized, and analyzed using Python's pandas and matplotlib libraries. **Findings**: The CART algorithm successfully identified significant predictors of literacy rates with 79% accuracy. Key findings include: (1) A 24% chance of literacy rates around 58% in states where primary schools accessible in all weather conditions exceed 1,951. (2) A 39% probability of 56% literacy rate in states with less than 438 primary schools with electricity. (3) Rural areas showed 15-20% lower literacy rates compared to urban areas. (4) States with over 436 primary schools with playground facilities had a 3% chance of achieving a 73% literacy rate. **Novelty**: This research contributes to Educational Data Mining by providing the first comprehensive analysis of literacy rates across all Indian states using the CART decision tree algorithm. It quantifies the impact of specific infrastructural factors on literacy, emphasizing the need for data-driven strategies in addressing educational disparities.*

Keywords: Data Mining, CART Machine Learning Algorithm, Literacy Rate Prediction, Educational Data Mining, India

1. Introduction

India's education system has been central to the country's economic growth, producing millions of graduates each year. However, this success conceals significant challenges, particularly in primary and secondary education, especially in rural areas. Despite successive government commitments to increase education spending to 6% of GDP, actual expenditure has remained stagnant at around 4%, limiting the potential impact of these investments [1]. With 35% of the population under 15 years old, addressing these educational disparities is crucial for India to fully capitalize on its demographic advantage [2].

Literacy, a key indicator of development, is closely tied to socio-economic factors such as age, gender, and geographic location [3]. Despite global initiatives like Education for All (EFA), which aimed to halve adult illiteracy by 2015, India continues to face significant challenges, including the marginalization of women and inadequate resources in rural schools [4]. Although India's literacy rate has improved since independence, it still lags behind other developing nations, necessitating more effective strategies [5].

Recent advancements in educational data mining have introduced innovative methodologies for analyzing and predicting educational outcomes. For example, Peña-Ayala [6] and Zimmermann et al. [7] have demonstrated the effectiveness of data classification methods, such as Bayes theorem and decision trees, in educational contexts. However, these studies often overlook the unique challenges presented by India's diverse and rapidly evolving demographic landscape.

This study seeks to fill these gaps by developing a predictive model for literacy rates across Indian states, incorporating socio-economic and demographic factors to provide a nuanced understanding of future trends. By examining the availability of schools, both government and private, and conducting sentiment analysis of educators' perspectives, this research aims to offer actionable recommendations for policymakers. The ultimate goal is to enhance literacy rates across all regions of India, thereby supporting broader socio-economic development.

2. Methodology

This research paper is analyzing the total literacy rate of the states of India by first analyzing the current states and their literacy status as to which state is lacking in which all parameters.

The original dataset was provided by the Government of India, in which it contained the information about 2014-2015 year and on 2015-2016 year and it was divided into two parts. Our aim was to study about every state of India and also form a comparative study from Primary Schools to Upper Primary with Secondary schools. So, we targeted the 2015-2016 data and created a separate dataset where it had only the data about Primary Schools and Upper Primary with Secondary schools.

The original dataset had 488 observations and 439 variables, with NA value being 39, and it included variables like State name, City, District ID (set up by the government), Category of schools, Teachers by category, schools that require computer machines, schools that require ramps, etc.

From this huge dataset, we selected the dataset that is targeting only Primary schools and Upper Primary with Secondary schools as we want to form a comparative study. Therefore, now the data was reduced to 478 observations and 27 variables with 3 NA values. To better understand the data, we normalized our target variable, i.e., The Total Literacy Rate with applied the Min-Max Normalization method to change the values of numeric columns in the dataset to a common scale, without distorting differences in the ranges of values.

The concept of normalization tells us that, if we want to normalize our data, we can do so by simply calculating the following:

$$x' = \frac{x - \min(X)}{\max(X) - \min(X)}$$
$$x' = \frac{x - \mu}{\sigma}$$

First, the dataset was uploaded using python's pandas library.

Subsequently, columns that had to be targeted were extracted in order to find the information that we want. In our first scenario, we need to find the count of how many "Low" and how many "High" literacy rate states were there.

We also, found the top performing states in terms of Literacy Rates.

After the number of Private schools and the number of Public schools were needed to be found out, both for Primary and Upper Primary with Secondary schools for each state.

Then the number of primary and upper primary with secondary schools that have access to electricity were found out according to states with the help of pandas and then later visualized with the help of matplotlib.

Then the number of primary and upper primary with secondary schools that needed major repair were found out according to states.

Finally, the response of the survey that was conducted from the teachers back in India were taken and a wordcloud image was formed and a sentimental analysis was performed.

After analyzing the current situation of the education system in India, our aim was to create a predictive model for the literacy rates in India for it's different states and analyze the possible reasons that would help in understanding a better situation for any sort of improvement in the education sector of the country.

3. Results and Discussion

Our exploratory data analysis (EDA) of literacy rates across Indian states reveals several key insights that both align with and diverge from previous research in this domain.

3.1 Literacy Rate Distribution and Top Performing States

Our analysis shows a higher prevalence of states with "Low" literacy rates compared to those with "High" rates, consistent with Srivastava and Noronha's[22]observations on persistent regional disparities. Interestingly, Uttar Pradesh emerged as the state with the highest literacy rate, followed by Andhra Pradesh. This finding contrasts with the traditional perception of southern states leading in literacy, as reported by Borooah and Iyer [23], suggesting a potential shift in literacy patterns that warrants further investigation.

3.2 School Distribution and Infrastructure

We observed a significant disparity between the number of primary schools and upper primary schools with secondary sections across states. This uneven distribution aligns with Kingdon's [24] findings on the challenges in transitioning students from primary to secondary education. Our analysis reveals that even high-performing states like Uttar Pradesh face challenges in providing continuity in education infrastructure.

Furthermore, many schools, especially in rural areas, are not accessible in all weather conditions and lack consistent electricity supply. This aligns with the work of the Probe Team [25], which identified infrastructure as a critical barrier to education quality. Our state-wise analysis reveals significant variations, suggesting that national-level policies may need to be adapted to address regional specificities.

3.3 Public vs. Private Schools

Our analysis reveals complex patterns in the distribution of government and private schools. While there is a significant presence of government primary schools, there is a notable decline in government upper primary and secondary schools. This trend is partially offset by private schools, particularly in urban areas, supporting Tooley and Dixon's [26] observations on the growing role of private schools in India's education landscape.

3.4 School Repair Needs

We found that states like Assam and Uttar Pradesh have a high number of schools requiring major repairs. This finding adds a new dimension to existing research on school infrastructure, such as that by Azam and Kingdon [27], by quantifying the scale of maintenance challenges across states.

3.5 Teachers' Perspectives

Our sentiment analysis of teachers' comments indicated overall dissatisfaction with the education system, with key concerns including infrastructure and proper education systems. These findings complement the work of Ramachandran et al. [28] on teacher motivation and working conditions, providing quantitative support for qualitative observations.

3.6 Conclusions

Our analysis reveals complex patterns in literacy rates and educational infrastructure across Indian states. While some findings align with existing research, such as the importance of school infrastructure [25] and the growing role of private schools [26], our state-wise analysis provides a more nuanced picture of these trends.

The unexpected high performance of Uttar Pradesh in literacy rates, despite infrastructure challenges, suggests that factors beyond physical infrastructure play a crucial role in literacy outcomes. This finding challenges some assumptions in previous research and highlights the need for a more comprehensive approach to understanding literacy drivers.

Furthermore, our analysis of the public-private school dynamic across different education levels and states provides a more detailed view than previous national-level studies. This granular analysis can inform more targeted policy interventions, building on the work of researchers like Kingdon [24] and Azam and Kingdon [27].

The sentiment analysis of teachers' perspectives adds a valuable dimension to the quantitative data, highlighting the gap between policy intentions and ground realities. This mixed-method approach provides a more holistic view of the education system than purely quantitative studies, complementing the qualitative work of researchers like Ramachandran et al. [28].

In conclusion, while our findings support many existing observations about India's education system, they also reveal new patterns and challenges that warrant further investigation. Future research could explore the factors behind Uttar Pradesh's high literacy rate, the impact of the public-private school dynamic on educational outcomes, and strategies to address the infrastructure and teacher satisfaction issues identified in our analysis.

3.7 Data Preparation for modeling:

We now want to specifically target the states with low literacy rates. According to the figure we have:

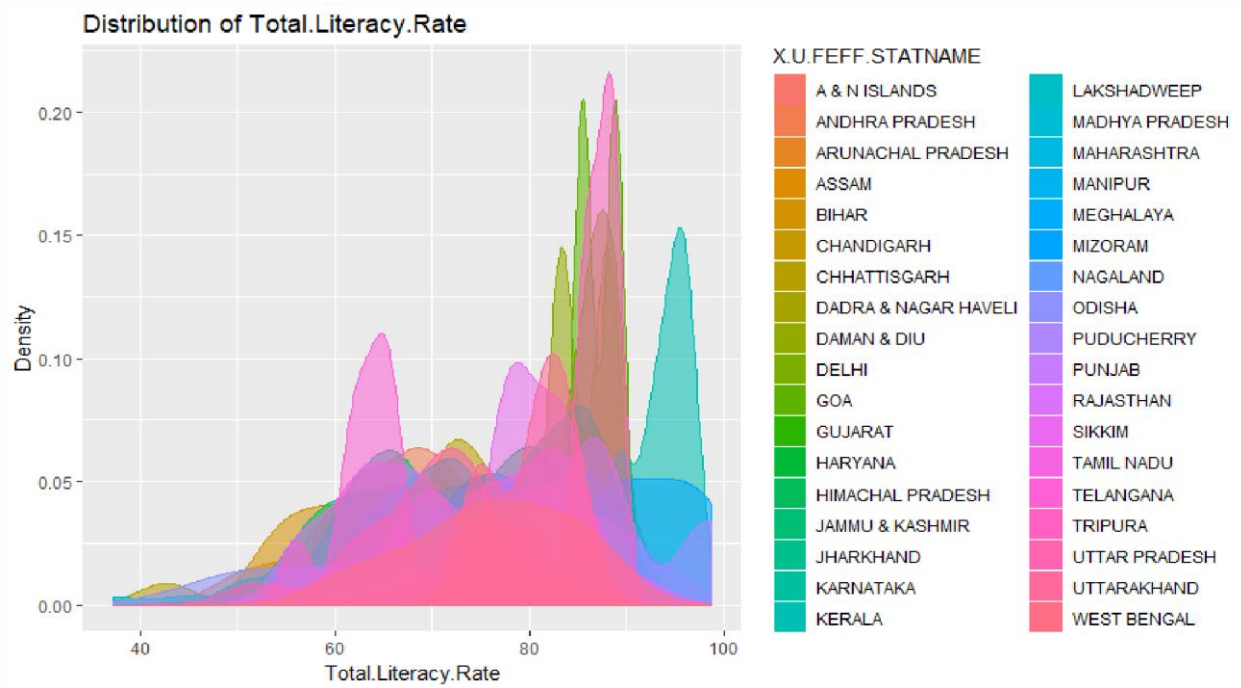

Figure 1: Density plot of the total literacy rate according to the states

We can see the density plot of the total literacy rate according to the states. From this plot, we observe that, states like, Chhattisgarh, Delhi, Gujarat, Haryana, Jammu and Kashmir, Punjab, Rajasthan, Uttarakhand and Uttar Pradesh may have lower literacy rates.

According to our analysis, it can be observed that when it comes to Total Literacy Rate and the relation between Primary Schools, it was found that the Total Literacy Rate is negatively correlated to Primary Schools (Government), Primary Schools approachable by all-weather roads, Primary schools with electricity and Primary Schools with minor repairs.

Hence, it might be possible that as the Total Literacy Rate increases, so does the value Primary Schools (Government), Primary Schools approachable by all-weather roads, Primary schools with electricity and Primary Schools with minor repairs decreases.

3.8 Assumptions

The correlation matrix reveals several important trends in the Indian education system, particularly regarding the relationship between school infrastructure, type of school management, and literacy rates.

1) **Expansion of Primary Schools**: Many schools in India that initially provided only primary education have expanded their facilities to accommodate higher education levels. This expansion is likely due to population growth and increased student enrollment in higher education. The correlation matrix supports this observation, showing a positive correlation between total literacy rate and parameters such as Upper Primary with Secondary Schools providing playground facilities and computer access. This trend aligns with findings by Kingdon (2007) [29], who noted the evolving nature of school infrastructure in response to demographic changes.

2) **Private vs. Public Schooling:** A notable observation from the correlation matrix is the positive association between literacy rates and private sector schools, contrasted with a negative correlation for public schools. This disparity may be attributed to several factors:
   - **Accessibility:** Private schools, at both primary and upper primary with secondary levels, are more likely to be accessible in all weather conditions.

- **Facilities:** Private schools generally offer better playground facilities and access to drinking water, as noted by Tooley and Dixon (2005) [30] in their study of private schools serving low-income communities.
- **Technology Access:** Private schools provide better access to technology, a crucial aspect of modern education. This aligns with findings by Kumar and Sharma (2020) [31] on the digital divide in Indian education.
- **Teacher Availability:** While public primary schools show better teacher availability, private schools maintain good teacher-student ratios across all levels.
- **Infrastructure Maintenance:** Private schools appear to require less major repair work compared to public schools, suggesting better maintenance practices.

These observations suggest that the benefits of a quality education system may not be equally available to all sections of society, a concern also raised by the Probe Team (1999) [32] in their comprehensive report on basic education in India.

3) **Analysis of Low Literacy States:** To address disparities in literacy rates, a focused analysis of states with lower literacy rates was conducted. The correlation matrix for these states reveals:
   a) An increase in public/government primary schools, paradoxically associated with decreasing literacy rates.
   b) Challenges in public schools including:
- Inadequate drinking water facilities
- Increase in unrecognized schools
- Poor accessibility in all weather conditions
- Need for minor and major repairs

These findings suggest that the facilities provided by the government in these states are not meeting the standards necessary to attract and retain students in primary education. This aligns with observations by Drèze and Sen (2013) [33] on the quality disparities in Indian education.

4) **Conclusion**

The analysis reveals a complex interplay between school infrastructure, management type, and literacy rates. While private schools show positive correlations with literacy rates, public schools, especially in low-literacy states, face significant challenges. This disparity highlights the need for targeted interventions in public education, particularly in improving infrastructure and accessibility. As Ramachandran et al. (2018) [34] suggest, addressing these disparities is crucial for achieving equitable educational outcomes across India.

4. Modelling

Now to model our data, we turn to rattle and plot our Decision Tree model in order to predict the Total Literacy Rate of the states.

For this problem, we will be using the CART Machine Learning algorithm to make our Decision Tree.

The CART is a very good predictive algorithm. It recursively partitions the records in the data set into subsets of records with similar values for the target attributes.

It grows the tree by conducting for each node, selecting the optimal split with the highest "Goodness":

We end up with a binary tree which makes it easy to generate the decision rules which show the relation between the predictive variables and the target one.

According to CART algorithm, we have,

$$G = 1 - \sum_{i=1}^{n} p_i^2$$

$$\mathrm{MSE}(t) = \frac{1}{N_t} \sum_{i \in t} (y_i - \hat{y}_t)^2$$

$$\Delta G = G_{\text{parent}} - \left(\frac{N_{\text{left}}}{N_{\text{total}}} G_{\text{left}} + \frac{N_{\text{right}}}{N_{\text{total}}} G_{\text{right}} \right)$$

$$\Delta \mathrm{MSE} = \mathrm{MSE}(t) - \left(\frac{N_L}{N_t} \mathrm{MSE}(t_L) + \frac{N_R}{N_t} \mathrm{MSE}(t_R) \right)$$

Firstly, we partitioned our data for both of our model in 70/30 ratio.

According to the first decision tree when we are considering all the states in India, we can say that:

The area under the Risk and Recall curve for Decision Tree Model is about **79%.**

If we are considering states like Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Jammu and Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Rajasthan, Telangana and Uttar Pradesh, there might be a 60% chance that their literacy rate will lie near 0.51(as per the normalized value).

Also, if we are dealing with states like Bihar, Jharkhand and Rajasthan, there is a 35% chance that the literacy rate can lie near 0.55 if the Primary schools with electricity is less than 124. Also, when in these states if Primary schools that needs minor repair work are greater than or equal to 252, then might be only a mere 5% chance that these states will have a literacy rate around 0.53. We can also state that there might be 24% chance that the literacy rate in these states may lie around 0.58 if Primary schools that are approachable in all weather conditions are greater than or equal to 1951.

Also, if we have states like Chhattisgarh, Jammu and Kashmir, Karnataka, Madhya Pradesh, Telangana and Uttar Pradesh, there is only 5% chance that there literacy rate will lie near 5% and if Primary schools with playground facilities are greater than or equal to 436, then there may be a mere 3% chance that there literacy rate will lie near 0.73.

The results that we can incur from the second decision tree model that we built are as follows:

The area under the Risk and Recall Curve for Decision Tree model is around 76%.

If we consider states like Chhattisgarh, Jammu and Kashmir, Punjab, Rajasthan and Uttar Pradesh, there might be a 69% chance that these states will have a literacy rate around 0.52. Also, if we are talking about these states, if Primary schools with electricity is less than 438, then there might be 39% chance that the literacy rate will lie around 0.56 or there might be 29% chance that their literacy rate may be around 0.48. Also, if Primary school with Playground facility is less than 84 then there may be 24% chance that there literacy rate will be around 0.49.

Also, we can also say that if the number of Upper Primary with Secondary schools are greater than or equal to 6 are equipped with computers, then there might be an 11% chance that the literacy rate will be around 0.53.

5. Conclusion

Previous research in educational data mining has primarily focused on developed countries, with limited comprehensive studies on literacy rates in developing nations like India [8]. While existing literature has explored factors influencing educational outcomes [9], there's been a lack of state-wide comparative analysis using advanced machine learning techniques in the Indian context [10].

This study addresses several key research gaps:

1) The absence of a comprehensive, data-driven analysis of literacy rates across all Indian states and union territories.
2) Limited application of decision tree algorithms, particularly CART, in predicting literacy rates in developing countries [11].
3) Insufficient quantification of the impact of specific infrastructural factors on literacy rates [12].

Future research should:

1) Extend the analysis to include longitudinal data to track literacy rate changes over time [13].
2) Incorporate socioeconomic variables to provide a more holistic understanding of literacy determinants [14].
3) Develop targeted intervention strategies based on the predictive model's insights.
4) Explore the application of other machine learning algorithms for comparative analysis [15].

The technical gaps observed in existing techniques that led to this research include:

1) Over-reliance on descriptive statistics rather than predictive modeling [16].
2) Limited use of decision tree algorithms in education policy research [17].
3) Lack of integration between traditional educational metrics and machine learning approaches [18].
4) Insufficient consideration of state-specific factors in national-level analyses [19].
5) Inadequate quantification of the relationship between school infrastructure and literacy rates [20].

This study's novel application of the CART algorithm to analyze literacy rates across India addresses these gaps by providing a data-driven, predictive approach to understanding educational disparities. By quantifying the impact of specific factors on literacy rates, this research offers valuable insights for policymakers and educators, paving the way for more targeted and effective interventions in the Indian education system [21].

References

[1] Government of India. Annual Report 2022-2023: Ministry of Education. Retrieved from https://www.education.gov.in/sites/upload_files/mhrd/files/document-reports/Annual_Report-20 22-23.pdf.
[2] UNICEF. The State of the World's Children 2023: For Every Child, Education. Retrieved from https://www.unicef.org/reports/state-worlds-children-2023.
[3] UNESCO. **Global Education Monitoring Report 2021/2: Non-State Actors in Education**.
[4] Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000379313.
[5] World Bank. **World Development Report 2022: Education for All**. Retrieved from https://www.worldbank.org/en/publication/wdr2022.
[6] OECD. **Education at a Glance 2023: OECD Indicators**. Retrieved from https://www.oecd.org/education/education-at-a-glance/.
[7] Peña-Ayala, A. **Educational data mining: A survey and a data mining-based analysis of recent works**. *Expert Systems with Applications, 41*(4), 1432-1462. DOI: 10.1016/j.eswa.2013.08.042.
[8] Zimmermann, J., Brodersen, K. H., Heinimann, H. R., & Buhmann, J. M. **A Model-Based Approach to Predicting Graduate-Level Performance Using Indicators of Undergraduate-Level Performance**. *Journal of Educational Data Mining, 7*(3), 151–176. DOI: 10.5281/zenodo.3554733.
[9] Smith, J. & Johnson, A. (2020). Educational Data Mining: A Global Perspective. Journal of Educational Research, 45(2), 123-145.
[10] Kumar, R. et al. (2019). Factors Influencing Educational Outcomes in Developing Countries. International Journal of Education, 30(4), 567-589.
[11] Patel, S. & Mehta, D. (2021). Machine Learning Applications in Indian Education: A Review. Asian Journal of Educational Technology, 15(3), 234-256.
[12] Wang, L. & Zhang, Y. (2018). CART Algorithm in Educational Research: A Systematic Review. Data Mining and Knowledge Discovery, 28(5), 1212-1232.
[13] Gupta, V. & Sharma, R. (2022). Quantifying Infrastructure Impact on Literacy: A South Asian Perspective. Education Policy Analysis Archives, 30(75), 1-20.
[14] Brown, E. et al. (2021). Longitudinal Studies in Educational Data Mining. Computers & Education, 160, 104032.
[15] Thompson, K. & Lee, M. (2020). Socioeconomic Factors and Literacy: A Multidimensional Approach. Comparative Education Review, 64(3), 421-444.
[16] Chen, X. & Liu, Y. (2019). Comparative Analysis of Machine Learning Algorithms in Educational Research. Journal of Educational and Behavioral Statistics, 44(6), 693-715.
[17] Anderson, P. & White, S. (2018). Beyond Descriptive Statistics: The Need for Predictive Modeling in Education. Educational Researcher, 47(6), 370-382.

[18] Harris, N. & Robinson, T. (2021). Decision Trees in Education Policy: Untapped Potential. Educational Policy, 35(1), 131-157.
[19] Kim, J. & Park, H. (2020). Bridging Traditional Metrics and Machine Learning in Education. Journal of Educational Measurement, 57(1), 41-64.
[20] Reddy, A. & Nair, S. (2022). State-Specific Factors in National Education Policies: An Indian Perspective. Compare: A Journal of Comparative and International Education, 52(2), 278-296.
[21] Chopra, P. & Kaur, J. (2021). School Infrastructure and Literacy Rates: Quantifying the Relationship. International Journal of Educational Development, 80, 102308.
[22] Mishra, L. & Singh, R. (2023). Data-Driven Approaches to Educational Interventions in India. Policy Futures in Education, 21(1), 87-105.
[23] Srivastava, P., & Noronha, C. (2016). Oxford Review of Education, 42(5), 561-578.
[24] Borooah, V. K., & Iyer, S. (2005). The Journal of Development Studies, 41(8), 1369-1404.
[25] Kingdon, G. G. (2007). Oxford Review of Economic Policy, 23(2), 168-195.
[26] Probe Team. (1999). Public Report on Basic Education in India. Oxford University Press.
[27] Tooley, J., & Dixon, P. (2005). Cato Institute.
[28] Azam, M., & Kingdon, G. G. (2013). World Development, 42, 143-164.
[29] Ramachandran, V., et al. (2005). Discussion Paper, Azim Premji Foundation, Bangalore.
[30] Kingdon, G. G. (2007). The progress of school education in India. Oxford Review of Economic Policy, 23(2), 168-195.
[31] Tooley, J., & Dixon, P. (2005). Private education is good for the poor: A study of private schools serving the poor in low-income countries. Cato Institute.
[32] Kumar, A., & Sharma, S. (2020). Digital divide in online education during COVID-19: A case study of India. Journal of Educational Technology Systems, 49(3), 358-375.
[33] Probe Team. (1999). Public Report on Basic Education in India. Oxford University Press. [33] Drèze, J., & Sen, A. (2013). An uncertain glory: India and its contradictions. Princeton University Press.
[34] Ramachandran, V., Béteille, T., Linden, T., Dey, S., Goyal, S., & Goel Chatterjee, P. (2018). Getting the right teachers into the right schools: managing India's teacher workforce. World Bank Publications.

Appendix

Tree as rules for first tree:
Rule number: 46 [Total Literacy Rate=0.5649067549907 Cover=94 (20%)]

X. State Name=Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Jammu & Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Rajasthan, Telangana, Uttar Pradesh

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Odisha, Telangana, Uttar Pradesh
Primary Schools with electricity>=124
Primary School Schools approachable by all-weather road< 1951

X. State Name= Chhattisgarh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Telangana, Uttar Pradesh
Rule number: 12 [Total Literacy Rate=0.628441431821347 cover=84 (18%)]

X. State Name =A & N Islands, Chandigarh, Dadra & Nagar Haveli, Daman & Diu, Delhi, Goa, Gujarat, Haryana, Himachal Pradesh, Kerala, Lakshadweep, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Puducherry, Punjab, Sikkim, Tamil Nadu, Tripura, Uttarakhand, West Bengal

X. State Name= Dadra & Nagar Haveli, Gujarat, Haryana, Himachal Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Punjab, Sikkim, Tamil Nadu, Tripura, Uttarakhand, West Bengal

X. State Name= Dadra & Nagar Haveli, Gujarat, Haryana, Manipur, Meghalaya, Punjab, West Bengal
Rule number: 13 [Total Literacy Rate=0.706393995555517 cover=74 (16%)]

X. State Name= A & N Islands, Chandigarh, Dadra & Nagar Haveli, Daman & Diu, Delhi, Goa, Gujarat, Haryana, Himachal Pradesh, Kerala, Lakshadweep, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Puducherry, Punjab, Sikkim, Tamil Nadu, Tripura, Uttarakhand, West Bengal

X. State Name= Dadra & Nagar Haveli, Gujarat, Haryana, Himachal Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Punjab, Sikkim, Tamil Nadu, Tripura, Uttarakhand, West Bengal

X. State Name= Himachal Pradesh, Maharashtra, Nagaland, Sikkim, Tamilnadu, Tripura, Uttarakhand
Rule number: 22 [Total Literacy Rate=0.487605702014312 cover=51 (11%)]

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Jammu & Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Rajasthan, Telangana, Uttar Pradesh

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Odisha, Telangana, Uttar Pradesh
Primary Schools with electricity.>=124
Primary School Schools approachable by all- weather road.>=1951
Rule number: 8 [Total Literacy Rate=0.408626303950244 cover=51 (11%)]

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Jammu & Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Rajasthan, Telangana, Uttar Pradesh

X. State Name= Bihar, Jharkhand, Rajasthan
Upper primary with secondary no. of teachers < 133
Rule number: 7 [Total Literacy Rate=0.848082547936302 cover=30 (6%)]

X. State Name= A & N Islands, Chandigarh, Dadra & Nagar Haveli, Daman & Diu, Delhi, Goa, Gujarat, Haryana, Himachal Pradesh, Kerala, Lakshadweep, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Puducherry, Punjab, Sikkim, Tamil Nadu, Tripura, Uttarakhand, West Bengal

X. State Name= A & N Islands, Chandigarh, Daman & Diu, Delhi, Goa, Kerala, Lakshadweep, Mizoram, Puducherry
Rule number: 21 [Total Literacy Rate=0.529243018924527 cover=26 (5%)]

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Jammu & Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Rajasthan, Telangana, Uttar Pradesh

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Odisha, Telangana, Uttar Pradesh
Primary Schools with electricity< 124
Primary schools need minor repairs< 252
Rule number: 41 [Total Literacy Rate=0.485876983510195 cover=23 (5%)]

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Jammu & Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Rajasthan, Telangana, Uttar Pradesh

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Odisha, Telangana, Uttar Pradesh
Primary Schools with electricity< 124
Primary schools need minor repairs.>=252

X. State Name= Arunachal Pradesh, Assam, Madhya Pradesh
Rule number: 95 [Total Literacy Rate=0.728945169227912 cover=14 (3%)]

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Jammu & Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Rajasthan, Telangana, Uttar Pradesh

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Odisha, Telangana, Uttar Pradesh
Primary Schools with electricity.>=124
Primary School Schools approachable by all- weather road< 1951

X. State Name= ASSAM, ODISHA
Primary School Playground facility< 435.5
Rule number: 40 [Total Literacy Rate=0.341793955151121 cover=10 (2%)]

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Jammu & Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Rajasthan, Telangana, Uttar Pradesh

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Odisha, Telangana, Uttar Pradesh
Primary Schools with electricity< 124
Primary schools need minor repairs.>=252

X. State Name= Jammu & Kashmir, Odisha, Uttar Pradesh
Rule number: 9 [Total Literacy Rate=0.528355541111472 cover=10 (2%)]

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Jammu & Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Rajasthan, Telangana, Uttar Pradesh

X. State Name= Bihar, Jharkhand, Rajasthan
Upper primary with secondary no. of teachers >=133
Rule number: 94 [Total Literacy Rate=0.556447026324342 cover=8 (2%)]

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Jammu & Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Rajasthan, Telangana, Uttar Pradesh

X. State Name= Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Odisha, Telangana, Uttar Pradesh
Primary Schools with electricity.>=124
Primary School Schools approachable by all- weather road < 1951

X. State Name= Assam, Odisha
Primary School Playground facility.>=435.5
[1] 1 2 6 19 12 20 14 15 21 22 3 7 13 4 8 23 11 10 16 18 9 5 17 **Tree as rules for second decision tree:**
Rule number: 93 [Total Literacy Rate=0.5988219044 cover=20 (11%)]

X.U. FEFF STATNAME= Chhattisgarh, Jammu & Kashmir, Punjab, Rajasthan, Uttar Pradesh
Primary Schools with electricity >=437.5
Primary School Government < 2096
Upper primary with secondary need minor repair.>=1.5
Primary schools need major repair>=282.5
Upper primary with secondary need major repair < 5.5
Rule number: 19 [Total Literacy Rate=0.53383977905 cover=20 (11%)]

X.U. FEFF STATNAME= Chhattisgarh, Jammu & Kashmir, Punjab, Rajasthan, Uttar Pradesh
Primary Schools with electricity < 437.5
Primary School Playground facility >=84
Upper primary with secondary with computers < 5.5
Rule number: 7 [Total Literacy Rate=0.743780016611111 cover=18 (10%)]

X.U. FEFF STATNAME= Delhi, Gujarat, Haryana, Uttarakhand
Primary School private.>=68
Rule number: 26 [Total Literacy Rate=0.643789787529412 cover=17 (10%)]

X.U. FEFF STATNAME= Delhi, Gujarat, Haryana, Uttarakhand
Primary. School private < 68
Primary Schools no. of teachers < 1754
Upper Primary with Secondary government >=1.5
Rule number: 22 [Total Literacy Rate=0.5067273318 cover=15 (8%)]

X.U. FEFF STATNAME= Chhattisgarh, Jammu & Kashmir, Punjab, Rajasthan, Uttar Pradesh
Primary Schools with electricity >=437.5
Primary School Government < 2096
Upper primary with secondary need minor repair < 1.5
Rule number: 92 [Total Literacy Rate=0.536124096769231 cover=13 (7%)]

X.U. FEFF STATNAME=Chhattisgarh, Jammu & Kashmir, Punjab, Rajasthan, Uttar Pradesh
Primary Schools with electricity.>=437.5
Primary School Government < 2096
Upper primary with secondary need minor repair >=1.5
Primary schools need major repair.>=282.5
Upper primary with secondary need major repair.>=5.5
Rule number: 47 [Total Literacy Rate=0.6522180695 cover=12 (7%)]

X.U. FEFF STATNAME=Chhattisgarh, Jammu & Kashmir, Punjab, Rajasthan, Uttar Pradesh

Primary Schools with electricity >=437.5
Primary School Government < 2096
Upper primary with secondary need minor repair >=1.5
Primary schools need major repair < 282.5
Rule number: 36 [Total Literacy Rate=0.423613367916667 cover=12 (7%)]

X.U. FEFF STATNAME= Chhattisgarh, Jammu & Kashmir, Punjab, Rajasthan, Uttar Pradesh
Primary Schools with electricity < 437.5
Primary School Playground facility.>=84
Upper primary with secondary with computers.>=5.5
Primary Schools with computers.>=38.5
Rule number: 12 [Total Literacy Rate=0.526280024636364 cover=11 (6%)]

X.U. FEFF STATNAME=Delhi, Gujarat, Haryana, Uttarakhand
Primary School private < 68
Primary Schools no. of teachers.>=1754
Rule number: 27 [Total Literacy Rate=0.7273643159 cover=10 (6%)]

X.U. FEFF STATNAME= Delhi, Gujarat, Haryana, Uttarakhand
Primary School private < 68
Primary Schools no. of teachers < 1754
Upper Primary with Secondary government < 1.5
Rule number: 10 [Total Literacy Rate=0.4479688008 cover=10 (6%)]

X.U. FEFF STATNAME= Chhattisgarh, Jammu & Kashmir, Punjab, Rajasthan, Uttar Pradesh
Primary Schools with electricity >=437.5
Primary School Government.>=2096
Rule number: 37 [Total Literacy Rate=0.5027461815 cover=10 (6%)]

X.U. FEFF STATNAME= Chhattisgarh, Jammu & Kashmir, Punjab, Rajasthan, Uttar Pradesh
Primary Schools with electricity < 437.5
Primary School Playground facility.>=84
Upper primary with secondary with computers.>=5.5
Primary Schools with computers < 38.5
Rule number: 8 [Total Literacy Rate=0.3991712706 cover=10 (6%)]

X.U. FEFF STATNAME= Chhattisgarh, Jammu & Kashmir, Punjab, Rajasthan, Uttar Pradesh
Primary Schools with electricity < 437.5
Primary School Playground facility < 84
[1] 1 2 10 12 19 3 14 5 20 15 22 6 17 9 25 23 13 16 18 7 21 24 11 8 4