



Addressing Geographical Disparities in Education: An Integrated E-Learning Approach for Empowering Students in Diverse Regions of India

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Abstract. A comprehensive e-learning application aims to transform the educational landscape by seamlessly integrating study materials, job opportunities, research and development initiatives, communication tools, mentor access, and information about grants and loans. In response to the growing importance of education in the 21st century, particularly in the wake of the global pandemic, this e-learning application aims to provide a holistic and inclusive learning environment. The platform offers a user-friendly interface accessible from anywhere, with resources available in multiple languages to help all kinds of learners. The application provides a Learning Management System (LMS) to deliver a structured and interactive learning experience. As technology continues to reshape the educational landscape, this application stands out as a pioneering initiative, embracing innovation to create a platform that not only meets the current demands of education but also anticipates and adapts to future challenges. This research paper explores the innovative features of this application, examines its potential impact on education, and highlights its role in promoting holistic learning and career development in the evolving landscape of online education.

Keywords: E-learning · Learning Management System (LMS) · Career development · Online education · Interactive learning · Mentorship · Holistic education

1 Introduction

India, a developing country with a vast population exceeding 1.31 billion, boasts extensive diversity [1]. A significant majority, around 60% or more, resides in rural areas. Since ancient times, India has been known as the ‘Home of Rural Life’, where the people in the villages embody the true essence of ‘Real India’. Though there has been a slight increase in education among the populace, there remains a drastic difference between rural and urban education. Urban areas showcase a higher literacy rate of 87.7%, while rural areas lag at 73.5% [2].

The notable disparity in educational attainment between urban and rural areas can be attributed to a lack of resources. The scarcity of well-equipped schools, libraries, modern teaching methods, and other educational facilities, coupled with socioeconomic factors, makes it challenging for individuals in rural regions to access quality education. The existing education system in India is notably inadequate, particularly in rural areas, where educational needs often go unaddressed.

This disparity in education further widens the gap between urban and rural populations, hindering social progress. To address this issue, education should serve as a catalyst for social change, raising awareness among rural communities about their rights and responsibilities, elevating living standards, and creating employment opportunities [3]. Effectively addressing these challenges is crucial for the growth of the economy, as education remains a key tool in mitigating various issues affecting rural life, including poverty, unemployment, and illiteracy. In rural areas, the issue of uneducated individuals can be addressed by the implementation of E-learning portals. These platforms offer a plethora of learning opportunities for students, enabling them to enhance their skills in a more efficient and convenient manner. Additionally, E-learning portals facilitate connections between individuals, thereby improving their ability to communicate with a diverse range of people [4].

2 Geographical Barriers

According to the 2023 survey, there is a 5% increase in the literacy rate. However, several states such as Andhra Pradesh (66.4%), Arunachal Pradesh (66.95%), Rajasthan (69.7%), Bihar (70.9%), Telangana (72.8%), Uttar Pradesh (73.0%), Madhya Pradesh (73.1%), and Jharkhand (74.3%) have a literacy rate of less than 75.0% [5]. These states are lagging behind in education due to a lack of awareness among the people about the educational schemes and scholarship opportunities provided by the government, poverty, poor implementation of government policies and programs aimed at improving literacy, and various geographical barriers leading to gender disparities, prevalent child labor, and a lack of schools and qualified teachers. Additionally, there is a significant number of dropouts in the age group of 6–16. The dropout rate was 47.4% in 2013 [6].

The main causes include school infrastructure and management issues, malnutrition, gender disparities, health issues, delays in scholarship disbursement, domestic work responsibilities, child labor, lack of interest, regional disparities, and unequal distribution of resources between rural and urban areas (refer to Fig. 1).

2.1 Box Plot Representation for Literacy Rates

According to Fig. 2, the box plot visually represents the distribution of literacy rates across different states in India, offering insights into the central tendency and variability of the data. The key components of the box plot for literacy rates include Box, Median and Whiskers. As per our survey dataset, we have estimated the three components as follows:

Our dataset X , the box plot components can be expressed as:

$$Q_0 = \text{MinimumValue}(x)$$

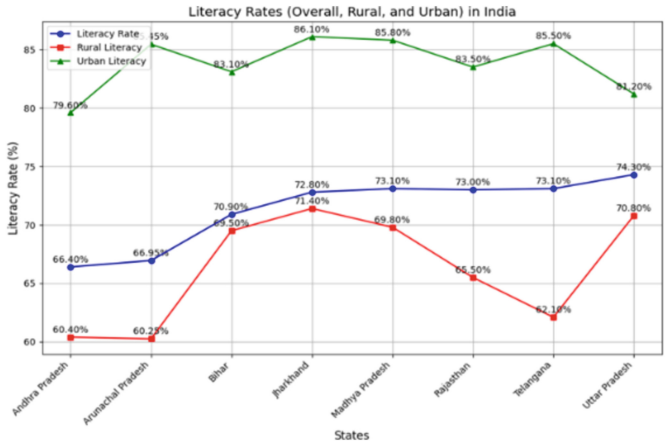


Fig. 1. Regional disparities and unequal distribution of resources between rural and urban areas

$$Q_1 = \text{FirstQuartile}(x)$$

$$Q_2 = \text{Median}(x)$$

$$Q_3 = \text{ThirdQuartile}(x)$$

$$Q_4 = \text{MaximumValue}(x)$$

Additionally, the interquartile range (IQR) is calculated as:

$$IQR = Q_3 - Q_1$$

And the whiskers typically extend to:

$$Q_1 - 1.5 \times IQR \text{ (Lower whisker)}$$

Box (Quartiles). The height of the box illustrates the interquartile range (IQR) for each state. The bottom and top edges of the box correspond to the first (Q1) and third (Q3) quartiles, respectively. The larger the box, the greater the spread of literacy rates within the state.

Median (Line Inside the Box). The line inside the box represents the median literacy rate for each state. It signifies the middle point when arranging literacy rates in ascending order. The position of the median within the box provides insights into the central tendency of literacy rates.

Whiskers. The whiskers extend from the box to the minimum and maximum literacy rates within a certain range, usually 1.5 times the IQR. Points beyond the whiskers are considered outliers and are plotted individually. Longer whiskers indicate higher variability in literacy rates.

2.2 Interpreting the Box Plot for Literacy Rates

States with taller boxes indeed have a larger interquartile range, indicating greater variability in literacy rates among the population. The position of the median within the

box provides a quick comparison of the central tendency of literacy rates across states. Longer whiskers suggest higher variability, with some states exhibiting literacy rates that deviate from the central tendency. The overall, rural and urban literacy rates is designated in the below scatter plots as shown in the Fig. 3 for ease of understanding.

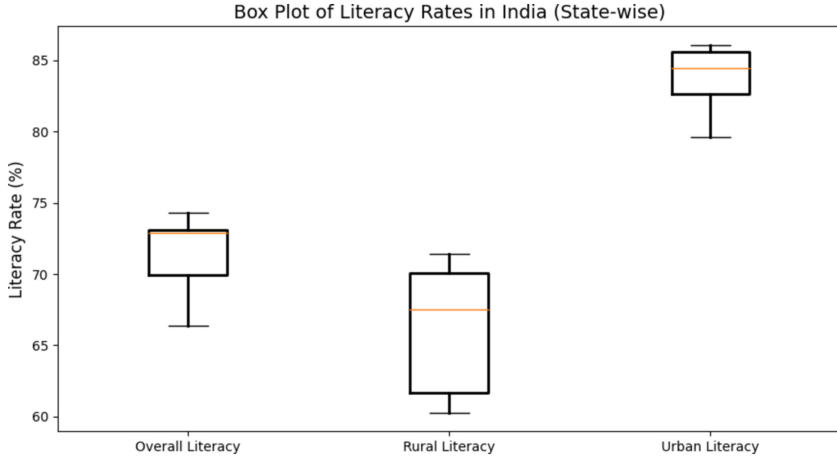


Fig. 2. Distribution of literacy rates across different states in India

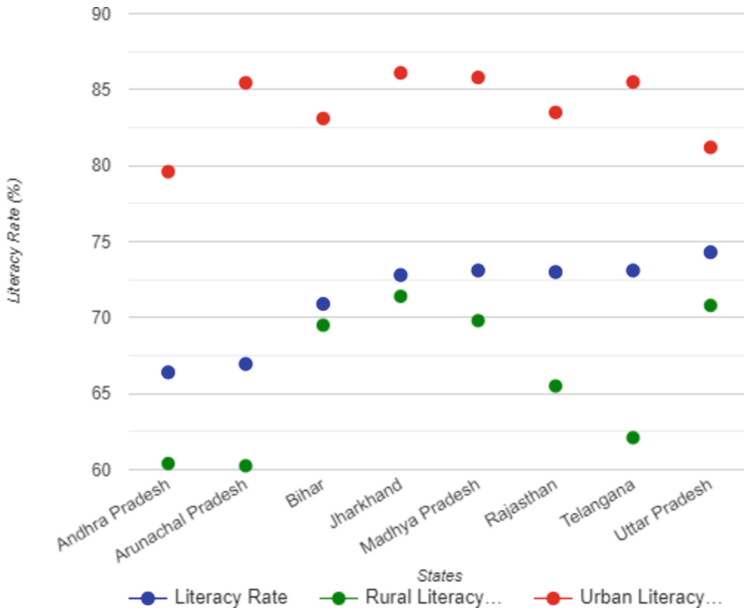


Fig. 3. Rural and urban literacy rates

3 Analysis of Existing E-Learning Platforms

While the Indian government is making efforts to increase the nation's literacy rate through various initiatives, the ultimate responsibility lies with each individual [7]. However, despite these efforts, many applications designed to assist students lack certain essential components as in Fig. 4.

Content Quality. Numerous applications fail to provide all the necessary information about grants and loans, which are crucial for those unable to afford excessive fees [8].

Linguistic Diversity. Most applications are available only in one language, potentially leaving out those who do not understand that language [9].

Lack of Personalized Attention. Many applications show minimal concern for individual students, leading to an increased risk of plagiarism in exams [10].

Limited Parental Involvement. A significant number of parents do not actively participate in their child's development, leading to the possibility that the child may feign reading [11]. Many notable works have been developed in transforming the education towards the better India and ease of the students learning [12–15].



Fig. 4. Challenges with existing models

4 Methodology

Users can access the application with different roles: teacher, parent, or student. Each role offers specific access to features designed to meet the unique needs of educators, parents, and students, providing a personalized experience within the platform. Teachers have the capability to conduct live classes and quizzes. Parents can monitor their child's progress and communicate with mentors regarding academic performance. Students can actively participate and access the materials provided. Some of the applications is lack some functionalities, those we overcome in our proposed model (Fig. 5).

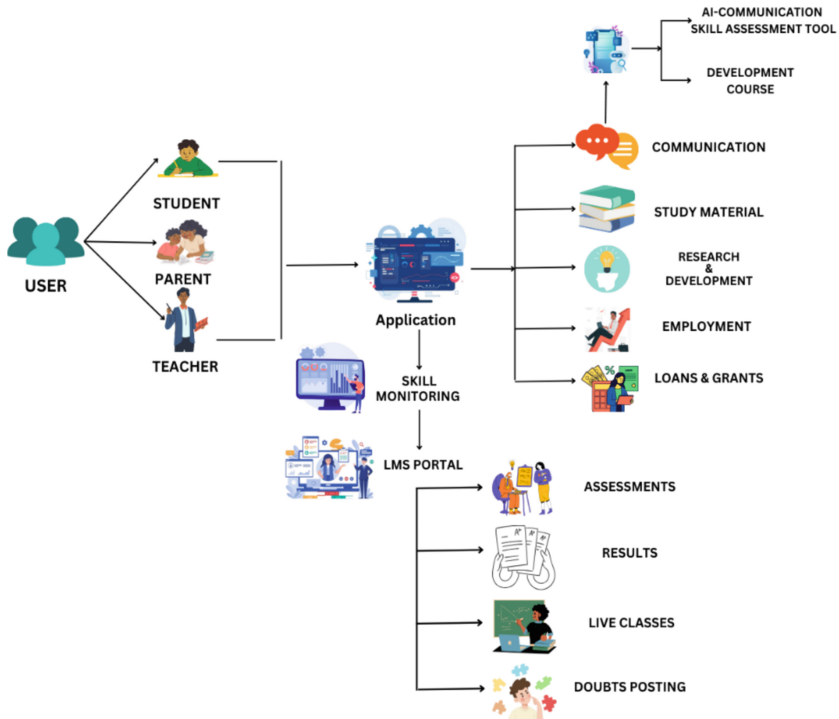


Fig. 5. Features of the proposed model

All age groups will have access to necessary study materials directly on this platform through downloads. Every board textbook can be accessed on this platform. Students only need to attend class to access these materials.

A chatbot capable of identifying human speech based on pronunciation and accent can display a paragraph. The score is automatically generated and ranges between 0 and 1. A skill development module offers various resources, including courses, videos, and other materials. Users can find employment through our platform based on their experience and qualifications uploaded to the website. Additionally, the platform facilitates connections between employers and talented individuals. Information from the National Career Services will be available. Research and development form the foundation of our work. Anyone interested can access available research papers on the platform and upload their own papers. The platform also provides details on various loan programs, student-beneficial grants, and scholarship opportunities. The All India Council for Technical Education and the National Scholarship Portal serve as sources of data.

Every student will have access to a mentor through a learning management system. Students can freely share their questions on the platform. Mentors address common questions raised by teachers in a single session. They also monitor student progress using the leaderboard, which is automatically created from quiz results and student participation in assessments. Rewards will be given to mentors and students based on their performance. In-person classes will be led by educators.

5 Results and Discussion

After the quiz, the teacher carefully examines the effects to become aware of which questions posed the maximum problem for the majority of students. By pinpointing these tough subjects, the trainer can recognize them at some point of destiny training to make certain every person grasps the ideas extra very well. Then, they teach those topics again to help everyone understand better.

Also, there's a list of the students who did the best, and they get prizes for doing well. This makes everyone want to try hard in the quizzes. This way, everyone learns better and tries their best because they want to do well and maybe get a prize.

Table 1. Assessment data on sample 10 students for 10 questions

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total
S1	✘	✘	✓	✓	✓	✓	✓	✓	✓	✓	8
S2	✓	✓	✘	✓	✘	✓	✘	✓	✓	✘	6
S3	✓	✓	✓	✓	✘	✘	✓	✓	✓	✓	8
S4	✘	✓	✓	✘	✓	✓	✘	✘	✘	✓	5
S5	✓	✘	✓	✓	✓	✓	✓	✓	✘	✓	8
S6	✓	✓	✘	✘	✘	✓	✓	✘	✓	✘	6
S7	✓	✓	✓	✓	✓	✘	✓	✓	✓	✓	9
S8	✓	✓	✘	✓	✓	✘	✓	✓	✓	✓	8
S9	✘	✘	✓	✘	✓	✓	✘	✓	✘	✘	4
S10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10

The Table 1 displays the results of the assessments conducted, showcasing the scores of students corresponding to the questions, where Q – question number; ✓ – correct answer; ✘ – wrong answer. Additionally, further assessments have been conducted based on these initial assessments, and Table 1 illustrates the results of these subsequent assessments.

The accompanying Fig. 6, depicted as a heat map, represents the performance of students in the assessments, indicating the likelihood of students providing correct answers to each question. The heatmap generated from `plt.imshow(combined_table, cmap = 'viridis', interpolation = 'none')` visually represents the values in the `combined_table`, with color intensity proportional to the value.

The color bar added using `plt.colorbar()` indicates the values associated with different colors. Overall, this heatmap provides an overview of each student's performance across three assessments. It helps in analyzing which students are likely to be at the top and deserve recognition and rewards for their achievements.

The confusion matrix M (Fig. 6) with values m_{ij} where i represents the row index and j represents the column index. Also, assume that the values range from a *minimum* $\min(M)$ to a *maximum* $\max(M)$.

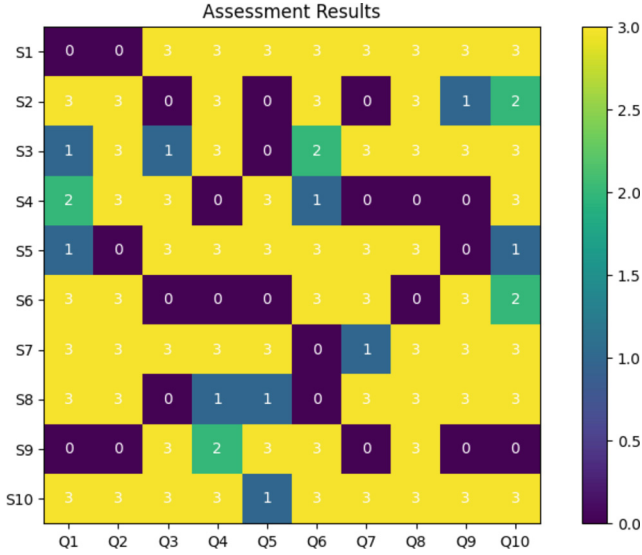


Fig. 6. Performance of students in the assessments.

The mapping function f can be defined as follows:

$$f(m_{ij}) = \frac{m_{ij} - \min(M)}{\max(M) - \min(M)} \quad (1)$$

This function scales each value in the matrix to a range between 0 and 1. You can then use this scaled value to interpolate between two colors (e.g., from blue to red).

For example, if C_{low} and C_{high} are the colors corresponding to the minimum and maximum values, respectively, you could define the color C_{ij} for each element as:

$$C_{ij} = (1 - f(m_{ij})) \times C_{low} + f(m_{ij}) \times C_{high} \quad (2)$$

This equation essentially linearly interpolates between the low and high colors based on the scaled value of m_{ij} . The resulting C_{ij} represents the color intensity for the corresponding matrix element. In this assessment, we consider a total of three tables. Finally, from these three tables students' scores has been calculated and presented in the Fig. 7. The provided code employs the combined_table, which is calculated using the following formula:

$$Combined_Table_{i,j} = T1_{i,j} + T2_{i,j} + T3_{i,j} \quad (3)$$

where, i represents the index of the student, and j represents the index of the question.

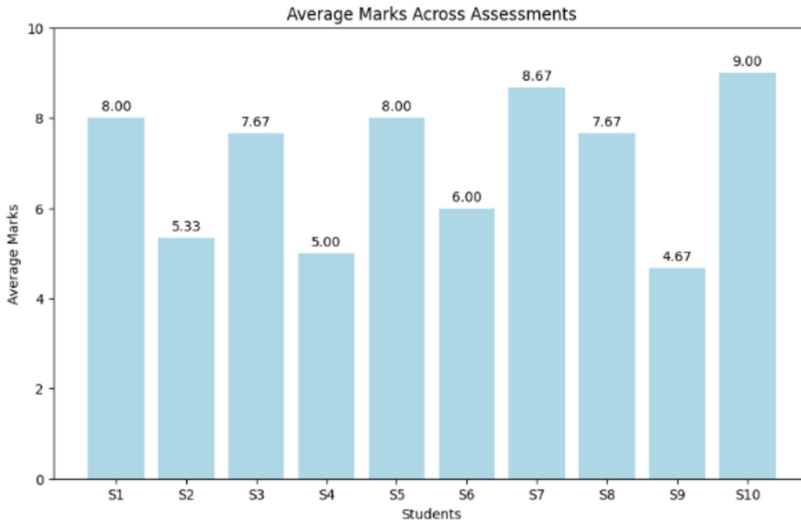


Fig. 7. Student assessments results

6 Conclusion

The proposed e-learning application emerges as a transformative force in addressing key gaps within India's education system. With a dedicated focus on inclusivity and innovation, the platform stands poised to revolutionize the educational landscape by providing essential study materials, fostering parental involvement, and breaking linguistic barriers. Its user-friendly interface and personalized features for teachers, parents, and students signify a commitment to holistic learning. The incorporation of an AI tool, capable of recognizing speech, enhances student engagement and facilitates effective information retrieval. Additionally, the platform serves as a centralized hub for vital resources, such as job information, loans, and grants, streamlining student access and participation in the learning process.

This initiative goes beyond merely rectifying current issues; it sets the stage for a resilient and forward-looking educational ecosystem. The integration of advanced features, including an AI-driven rewards system for active student participation and a research-friendly interface, promotes a culture of lifelong learning and collaboration. As we look ahead, the projected 10% increase in literacy rates by 2026 showcases the potential of technology-driven education to empower students and propel academic excellence. Through this progressive program, the e-learning application aims to leave an indelible mark on India's educational landscape, contributing significantly to the nation's ongoing pursuit of accessible and holistic learning.

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