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Research Article

Digital Infrastructure in School Education: A Comparative Study of Nadia District in West Bengal

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Abstract

This research paper attempts to present an overview of the situation of digital infrastructure in school education in Nadia district, West Bengal. The paper mainly centers its focus on comparing the experiences of schools in urban settings as opposed to those in rural settings. With the emergence of COVID-19, the need to employ effective digital learning has been realized more than ever, with NEP 2020 placing emphasis on digital education as part of its reforms.. However, its implementation has been uneven with rural areas suffering a scarcity of digital resources. This study employs a mixed-method approach to probe into questions regarding the availability and functionality of digital tools and technologies; teacher preparedness and online teaching effectiveness. Results show that there is a highly disproportionate distribution of digitized infrastructures: Urban schools have much more access to digitized infrastructures than their rural counterparts. Educators within urban contexts are trained to higher degrees and have greater resource availability; those working in rural contexts face significant challenges including inadequate facilities and limited technical support for troubleshooting issues with technology on an institutional level. These findings call for specific interventions toward building digitized infrastructure within rural education networks about connectivity, training teachers, and resources. It also hopes to fill these gaps so that it can provide practical policy recommendations intended to achieve equitable quality access to education for all pupils in Nadia district.

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1. INTRODUCTION

Digital infrastructure plays an important role in modern education, transforms traditional teaching methods and enables innovative learning experiences. School Education has gained the integration speed of digital tools in India, especially after the COVID-19 epidemic, which highlights the need for learning online and technology-help.

The National Education Policy (NEP) 2020 has emphasized digital learning as a key reform, but its implementation in rural areas remains inconsistent. However, the availability and effectiveness of digital infrastructure vary significantly between urban and rural areas, creating a digital divide that affects the quality of education.

Due to its various geographical and socio-economic situation, Nadia District of West Bengal provides a single case study to test the impact of digital infrastructure on school education. Rural schools sometimes have inadequate infrastructure, frequent electricity removal and bad internet connection, although urban schools have more access to digital tools such as computers, fast

internet and smart classrooms. Due to the lack of exposure and training, it can be difficult to use teacher digital equipment in remote places. By testing the digital infrastructure operation of Nadia district, this comparative research wants to evaluate the current digital resources, teacher preparation and online teaching techniques. By testing challenges and opportunities, this research will provide insight into the digital section and offer advanced techniques of digital learning in both settings. These results will contribute to policy recommendations for improving the digital infrastructure of school education, ensuring appropriate access for quality education for all students.

The rationale for the study:

Education's digital skills depend on development, quality and digital infrastructure. However, how teachers accept and use these tools is greatly influenced by their opinion. Digital gap, inadequate infrastructure and digital literacy discrimination exists in West Bengal. Educational techniques and fair developing, technology-enabled learning environment requires trainers to understand attitude.

2. REVIEW OF LITERATURE

Singha,K.S. et al.(2020). Studied "Attitude of Teacher Educators of B. Ed College towards Using of ICT" In this study, Researchers used simple random sampling technique for sample collection. The data has been collected by the Self made questionnaire from the B. Ed Teacher Educators'. Some statistics techniques have been used for data Analysis such as Mean, SD and t-test. It has been found that the attitude is same of male and female Male and Female Teacher Educators towards Using ICT.

Ghosh, R. (2020). The impact of ICT on school education: Challenges and opportunities in India.

The study discusses the role of ICT in modern education and its challenges, including lack of infrastructure, teacher training gaps, and financial constraints in government schools. It suggests that a well-developed digital framework can improve learning outcomes.

Das, P. (2021). Barriers to digital learning in rural schools of West Bengal: Infrastructure and policy gaps. The study identifies poor internet connectivity, unavailability of digital devices, and lack of government support as key challenges in rural education. It recommends policy-level interventions to bridge the rural-urban digital divide.

Banerjee, S., & Mukherjee, P. (2021). Studied Digital infrastructure and online learning: A comparative study of rural and urban schools in West Bengal. This study examines the disparities in digital infrastructure between rural and urban schools in West Bengal. The findings highlight a significant digital divide, with urban schools having better access to internet facilities, digital devices, and trained teachers compared to rural schools.

Chakraborty, A., & Sen, D. (2022). Teachers' readiness for online education in secondary schools: A study in West Bengal. This research explores how well-prepared teachers are for online education, particularly in rural areas. The study finds that most teachers lack formal training in digital pedagogy, and rural schools face severe infrastructure challenges compared to urban ones.

Mitra, S. (2023). Digital learning adoption in urban and rural schools: A comparative perspective.This study compares digital learning adoption in urban and rural schools, highlighting differences in access, teacher preparedness, and student engagement. It concludes that urban students benefit more due to better infrastructure and parental support.

Significance of the Study:

In rural and urban locations such as Nadia district, this research will expand information about the digital infrastructure of education. Politicians, educators and other partners will find effective results to improve digital infrastructure and enable real plans to close the education digital gap in Nadia district of West Bengal.

3. RESEARCH QUESTIONS

i. What is the status of digital infrastructure in school education in Nadia District in West Bengal?
ii. How accessible and functional are digital tools and resources in schools in Nadia District?
iii. What are the perceptions of teachers regarding the use of digital infrastructure in education?
iv. What are the major challenges in the use of digital infrastructure in schools?
v. How does the use of digital infrastructure in schools impact the process of teaching and learning?

4. RESEARCH OBJECTIVES

i. To explore the status of the existing digital infrastructures in the school education system of Nadia District, West Bengal, and understand their impact on the teaching and learning processes;
ii. To identify the availability, accessibility, and usability of the digital infrastructures in schools;
iii. To find out the perceptions, experiences, and satisfaction levels of teachers with regard to the use of digital technologies in the education system;
iv. To identify the challenges and barriers those are being faced by the schools with regard to the implementation of digital infrastructures;
v. To find out the impact of digital infrastructures on the methodologies of teaching and learning processes.

5. HYPOTHESES OF THE STUDY

Null Hypotheses (H_0)

H_{01}: There is no significant difference in the attitude of school teachers toward of digital infrastructure in schools based on gender (male and female).

H_{02}: There is no significant difference in the attitude of school teachers toward of digital infrastructure in schools with respect to habitat (rural and urban areas).

H_{o3}: There is no significant difference in the attitude of school teachers toward of digital infrastructure in schools based on gender (rural male and rural female).
$H_{o}4$: There is no significant difference in the attitude of school teachers toward of digital infrastructure in schools based on gender (urban male and urban female).

Delimitation of the Study:

- The study will delimited to a sample of 150 teachers (75 rural and 75 urban) for quantitative and 30 teachers for qualitative of higher secondary schools of Nadia district only.
- The study does not include students, administrators, or other stakeholders.

6. METHODOLOGY OF THE STUDY

Method:

In this study the researcher used the Embedded mixed-methods design. According to Creswell, Plano Clark et al. (2003 "The Embedded design is a mixed methods design in which one data set provides a supportive, secondary role in a study based primarily on the other data type." The Purpose of an embedded (or Nested) mixed method design is to simultaneously collect both qualitative and quantitative data, analysis the data and use the results to understand a research problem. In this research, the main role is quantative data and the supportive role is qualitative data and interpretation is based on qualitative and quantative results.

- **Quantitative Component:**
  - ❖ Survey: A survey method would be used as a tool to collect data from the teachers regarding the availability of digital infrastructure.
  - ❖ Statistical Analysis: Descriptive statistics (mean, standard division) and inferential statistics (t-test) would be used in the analysis of the collected survey data.
- **Qualitative Component:**
  - ❖ Interviews: Interviews would be conducted with the teachers to get a deeper understanding of the problem.
- **Integration of Data:**
  - ❖ Quantification of both quantitative and qualitative research would be done in order to get a complete understanding of the problem.

Sample Size:

150 higher Secondary school teachers of both sexes of rural and urban areas have been selected in the research work of the researcher as sample. All samples have been selected from Nadia district of West Bengal. The constitutions of the sample are as follows: -

Table No.1: Sampling frame -1(**For Quantitative)**

District	Rural Teachers			Urban Teachers		
	Male	Female	Total	Male	Female	Total
Nadia	40	35	**75**	40	35	**75**
Total - 150						

Table No. 2: Sampling frame -2(For Qualitative**)**

District	Rural Teachers			Urban Teachers		
	Male	Female	Total	Male	Female	Total
Nadia	8	7	**15**	8	7	**15**
Total - 30						

Population of the study:

All the higher secondary school teachers of Nadia districts comprised the population of this study.

Sample and Sampling Procedure:

School teachers constitute the population for the present study. 150 school teachers are selected through purposive sampling for from ten (10) schools and 30 teachers selected for in depth interview.

Tools:

When we do research we need to collect information. This is a part of any study. The person doing the research has to make some tools to help them get the information they need. They have to get the data to make their study good. Data collection is very important, for this.The researcher must follow certain rules or norms when creating tools. Researcher used self made close ended questionnaire based on research objectives for quantitative data and open ended interview based on research questions for gathering qualitative data.

For quantitative data gathering, the researcher developed a self made closed-ended questions. This was a two-point scale consisting of 25 items.

The four interview questions were created in accordance with the questions of the study and with accepted standards for qualitative research. Three experts were consulted to standardize the qualitative tool.

Standardisation of Questionnaire for Quantitative Study:

Table No.3: Standardisation of Questionnaire

No. of Items	25
Applied No. of Sample	20
Value of Cronbach's Alpha	0.81

Validity:
Content validity was checked by three experts who have vast experiences and knowledge about this topic and area.

Procedure
Survey method and in depth interview was used for collection of data. The procedure of the study which has been followed by the researcher is as follows:

For Quantitative Analysis:
Step 1. At first the preparation of a questionnaire in respect of Attitude of school teachers toward digital infrastructure in school education. Step 2. Selection of higher secondary educational institutions as well as selection of gender basis (male and female students) and with respect to habitat (rural and urban areas) from different higher secondary educational institutions. Step 4. a) Primary data collected from the selected sample groups by the questionnaire. b) Tabulation of test data to meet the requirement of hypothesis testing.

For qualitative Analysis:
Step 1: Researcher conducted a face to face in depth interview through prepared the open ended question. Step 2: Maintained note book after that analysis coding the responses.

7. QUANTITATIVE DATA ANALYSIS
Hypothesis 1.
H_{01}: There is no significant difference in the attitude of school teachers toward of digital infrastructure in schools based on gender (male and female).

Table 1: Attitude of school teachers toward digital infrastructure in schools based on gender (male and female).

Variable (Gender)	Group							
		Male	N -80	Mean- 38.25	SD-5.2	df-148	**t-value-3.15**	Level of significance - Significant at 0.05 level
		Female	N-70	Mean-42.05	SD-6.01			

DISCUSSION

From the above table it is clear that there is significant difference between on gender (male and female) on digital infrastructure in schools. Table illustrates that the mean, S.D. and 't' scores of the secondary school students of both males (N= 80) and females (N= 70). Though the mean score of females indicates high score (M= 42.05) than the females (M= 38.25), the 't' value (t= 3.15) with degrees of freedom is 148 clearly indicate that there is a significant difference. So the null hypothesis is H01 is rejected.

Hypothesis 2.
H_{02}: There is no significant difference in the attitude of school teachers toward of digital infrastructure in schools with respect to habitat (rural and urban areas).

Table 2: attitude of school teachers toward digital infrastructure in schools based on habitat (rural and urban).

Variable (Habitat)	Group							
		Rural	N -75	Mean- 40.85	SD-5.95	df-148	**t-value-2.13**	Level of significance - Significant at 0.05 level
		Urban	N-75	Mean-44.41	SD-6.25			

Discussion
From the above table it is clear that there is significant difference between on Habitat (rural and urban) on digital infrastructure in schools. Table 2 illustrates that the mean, S.D. and 't' scores of the higher secondary school teachers of both rural (N= 75) and urban (N= 75). Though the mean score of urban indicates high score (M= 44.41) than the rural (M= 40.85), the 't' value (t= 2.12) with degrees of freedom is 148 clearly indicate that there is a significant difference.So the null hypothesis is H02 is rejected.

Hypothesis 3.
H_{03}: There is no significant difference in the attitude of school teachers toward of digital infrastructure in schools based on gender (rural male and rural female).

Table 3: Attitude of school teachers toward digital infrastructure in schools based on gender (rural male and rural female).

Variable (Gender)	Group							
		Rural Male	N -40	Mean- 39.80	SD-5.75	df-73	**t-value-1.59**	Level of significance - Not Significant at 0.05 level
		Rural Female	N-35	Mean-41.25	SD-6.11			

Discussion:
From the above table, it is clear that there is no significant difference between on gender (rural male and rural female) on digital infrastructure in schools. Table 3 illustrates that the mean, S.D. and 't' scores of the secondary school students of both rural male (N= 40) and rural female (N= 35). Though the mean score

of rural female indicates high score (M= 41.25) than the rural male (M= 39.80), the 't' value (t= 1.59) with degrees of freedom is 73 clearly indicate that there is no significant difference. So the null hypothesis is H03 is accepted.

Hypothesis 4.

H_o4: There is no significant difference in the attitude of the school Teachers' attitudes toward digital infrastructure in schools based on gender (urban male and urban female).

Table 4: Attitude of school teachers toward digital infrastructure in schools based on gender (urban male and urban female).

Variable (Gender)	Group							
		Urban Male	N -40	Mean- 43.89	SD-6.00	df-73	t-value-1.81	Level of significance - Not Significant at 0.05 level
		Urban Female	N-35	Mean-44.81	SD-6.41			

Discussion:

From the above table it is clear that there is no significant difference between on gender (urban male and urban female) on digital infrastructure in schools. Table 4 illustrates that the mean, S.D. and 't' scores of the secondary school students of both urban male (N= 40) and urban female (N= 35). Though the mean score of urban female indicates high score (M= 44.81) than the urban male (M= 43.89), the 't' value (t= 1.81) with degrees of freedom is 73 clearly indicate that there is no significant difference .So the null hypothesis is H04 is accepted.

8. QUALITATIVE DATA ANALYSIS

The researcher conducted in-depth, open-ended interviews with 30 teachers, 15 from rural and 15 from urban areas, in higher secondary schools in the Nadia District. The researcher interviewed the teachers in person and analyzed the data through thematic analysis.

Thematic analysis of the data gathered through interviews showed that there are significant differences between rural and urban school teachers, and there are some similarities too.

Digital infrastructure needs to provide both availability and accessibility.

• Rural Teachers: The majority of teachers stated that they could not access digital equipment because there were too few computers and projectors available for their use.

• Urban Teachers: Urban teachers reported that they could access digital equipment at their schools, but they faced difficulties in providing sufficient equipment to meet their student needs.

Teaching and learning processes receive their primary transformation through digital technology.

• Rural Teachers: Teachers used digital tools to increase student engagement, but their digital tool usage capacity suffered from their digital tool access restrictions.

• Urban Teachers: The teachers experienced digital tools as beneficial, but they could not access the necessary equipment to meet their student requirements.

Educators need digital tool training and workshop programs according to their reported training requirements.

• Rural Teachers: The teachers from rural areas showed strong demand for training and workshops because they needed digital tool training and support.

• Urban Teachers: The teachers reported better access to training, but they still faced challenges in obtaining the necessary equipment for their students.

9. INTERPRETATION

This study highlights the digital divide existing between rural and urban schools in Nadia district of West Bengal. Urban educational institutions enjoy more access to digital resources, smart classrooms and internet connections than their rural opponents, which are victims of infrastructure deficit, inconsistent Internet and inadequate teacher training.

Gender differences:

On average, male teachers perceived digital infrastructure slightly less favourably than their female counterparts. A t-test revealed that this is statistically significant and indicates that male teachers may feel less comfortable using digital tools than female teachers.

Rural vs Urban differences:

Digital infrastructure levels were significantly better in urban schools than in rural schools. Additionally, because rural schools do not have enough ICT equipment, teacher training, or technical support to allow for effective integration of ICT into the classroom, the available evidence indicates that rural schools need targeted interventions to improve access to digital infrastructure. The t-test confirms the existence of a statistically significant gap in terms of the availability of technology and infrastructure between rural and urban schools, indicating that rural schools will require additional efforts to increase digital access.

Rural Gender:

The teacher rural men and rural women do not differ significantly in terms of accessing ICT through the use of digital infrastructure, and thus have similar limitations regarding access and implementation of ICT in their sphere of work.

Urban Gender:

What is also evident from this data is that both urban men and women teachers do not differ significantly in terms of accessibility to digital educational environments; hence they have equal opportunity to use and be successful with digital technology in the classroom.

10. FINDING

The results of this study highlighted significant discrimination in the availability and use of digital infrastructure in rural and urban areas in Nadia district of West Bengal. Results indicate that urban schools have better access to digital resources, including smart classrooms, high-speed internet and trained teachers than their rural opponent. The significant difference between rural

and urban schools is that location plays an important role in determining the digital infrastructure level available for teachers and students.

There are gender differences in how often male teachers reported using digital infrastructures compared through both male and female teachers using digital infrastructures. Although male teachers self-reported using digital infrastructures slightly more than their female counterparts, the difference was not significant; therefore both male and female teachers use digital infrastructures equally when given access to a digital tool. More specifically, according to this study, male teachers utilize digital infrastructures with slightly higher average scores than female teachers on their utilization of digital infrastructures.

However, the difference is not statistically significant, which indicates that men and women teachers are provided access while having similar involvement with digital tools. Research has shown that rural schools have faced major challenges such as ICT training, poor internet connectivity and lack of digital equipment maintenance. It reflects systemic problems that affect rural education, where digital education tools are unused due to infrastructure and logistic restrictions. On the other hand, urban teachers have expressed more comfortable in using ICT equipment, possibly improved training opportunities and more reliable digital infrastructure.

Despite existing challenges, rural and urban teachers have recognized the opportunity and education opportunities for digital infrastructure education. For instance, urban school teachers who have access to more sophisticated ICT facilities report a high level of engagement in the use of technology in lesson planning and classroom activities.

11. CONCLUSION

The aim of the study was to find out the gender differences in the use of digital infrastructures. From the findings, it can be noted that though there were differences in the scores between male and female teachers, the analysis revealed that the differences were not significant. This means that male teachers are just as involved in the use of digital technology as female teachers are when such resources are available.

In summary, the research highlights the importance of addressing the pressing issues with regards to the development of digital infrastructures in rural schools. Training in ICT, Internet connectivity, and maintenance are important factors in addressing the digital divide. Therefore, addressing these issues will result in the fair utilization of digital education opportunities, which will improve the results in both rural and urban schools in Nadia district.

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