



Implementation of Smart Classroom Teaching in Secondary Schools: Status, Infrastructure and Challenges

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Abstract

Smart Classroom teaching has emerged as an important component of technology-supported education at the secondary school level. The integration of computers, digital learning resources, internet connectivity and other technological devices can make classroom teaching more interactive and learner-centred. At the same time, effective implementation depends on physical infrastructure, electricity, connectivity, maintenance, administrative support and trained manpower. The present article is based on the findings of a study conducted in secondary schools of Nayagarh and Kandhamal districts of Odisha. Implementation status was examined from 40 schools, while implementation-related problems were analyzed using 200 teachers, comprising 100 from each district. The findings show a sharp increase in implementation up to 2022, when 90% of the surveyed schools reported implementation, followed by a much lower figure in 2023. All surveyed schools had three-dimensional concrete roofs and digital library facilities; 97.5% had computer laboratories apart from Smart Classrooms and 92.5% reported uninterrupted electricity. However, only 17.5% had atmosphere-controlled classrooms and 12.5% had a separate room for an ICT Coordinator. Regular internet facilities were reported by 95% of schools in Nayagarh and 55% in Kandhamal. In the problem analysis, 69% of respondents identified inadequate infrastructure as an impediment, while only 55.5% reported Smart Class equipment in every classroom. The findings indicate that sustainable Smart Classroom teaching requires continuous infrastructural development, dependable internet, maintenance, financial support, technical assistance and systematic teacher training.

Keywords: Smart Classroom, Secondary Schools, ICT, Infrastructure, Digital Learning, Teacher Training

1. Introduction

Information and communication technology is increasingly influencing school education. The traditional classroom, based mainly on textbooks, blackboards and verbal explanation, is being complemented by digital and technology-supported teaching. A Smart Classroom integrates resources such as computers, projectors, digital learning materials, internet connectivity and other ICT facilities into classroom practice. At the secondary level, such resources can support conceptual understanding, digital literacy, problem-solving and independent learning.

The presence of devices alone, however, does not guarantee meaningful technology integration. Teachers require reliable electricity, connectivity, technical support, maintenance facilities and opportunities for pedagogical training. The present study therefore examines implementation as a broader process involving availability, functioning, infrastructure and human support. The study covered Nayagarh and Kandhamal districts and provides the data used in this article.

2. Rationale and Objectives

The introduction of Smart Classrooms is intended to strengthen teaching and learning through effective use of technology. The study shows that implementation developed considerably in both the districts, but the pattern was not



uniform. There was also a clear difference between basic facilities and specialized support facilities. All surveyed schools had concrete roofs and digital library facilities, whereas only a small proportion had atmosphere-controlled classrooms or a separate room for an ICT Coordinator. These differences make it necessary to study actual implementation rather than merely the installation of equipment.

The article focuses on three connected dimensions—status of implementation, infrastructure and challenges. The objectives were to examine the status of Smart Classroom implementation, assess essential infrastructure, identify infrastructural challenges, examine manpower-related challenges and identify areas requiring attention for effective and sustainable implementation.

3. Methodology

The article is based on the data collected and follows a descriptive cum survey approach. The study covered secondary schools in Nayagarh and Kandhamal districts of Odisha. For examining implementation status and infrastructure, information was obtained from 40 schools, with 20 schools from each district. For analyzing problems associated with implementation, the thesis used 200 teachers, comprising 100 respondents from Nayagarh and 100 from Kandhamal. The data were primarily analyzed through percentages and comparative interpretation.

4. Status of Smart Classroom Implementation

Year	Nayagarh (%)	Kandhamal (%)	Overall (%)
2020	0	0	0
2021	5	5	5
2022	85	95	90
2023	10	0	5

(Table no -01, Year-wise status of Smart Classroom implementation)

The study (Table no -01) shows the implementation a marked rise between 2020 and 2022. In 2020, none of the surveyed schools reported implementation. In 2021, implementation was reported by 5% of schools in each district. By 2022, the proportion had increased to 85% in Nayagarh and 95% in Kandhamal, giving an overall figure of 90%. In 2023, the figures represented in the study were 10% for Nayagarh, 0% for Kandhamal and 5% overall. The pattern highlights the importance of examining continuity and functioning in addition to initial installation.

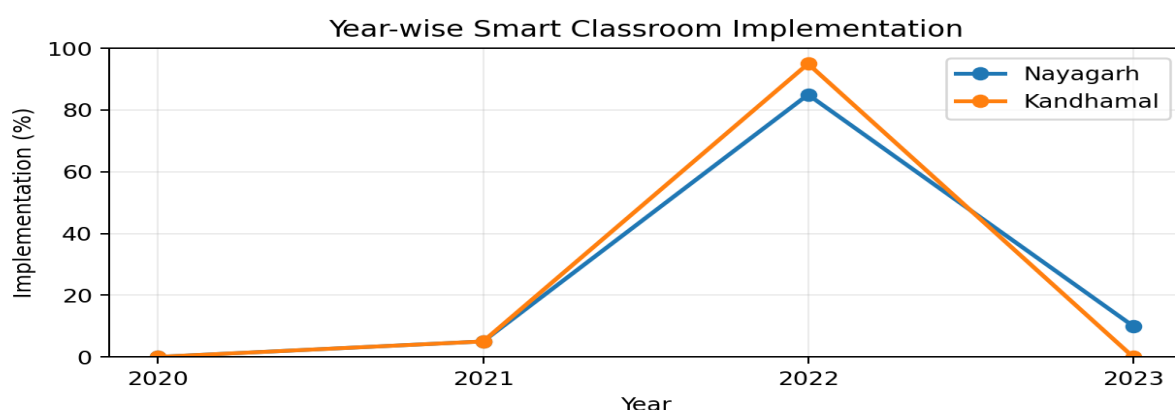


Figure 1. Year-wise Smart Classroom implementation in the selected districts.

5. Physical and Technological Infrastructure

Infrastructure is a foundational requirement for effective Smart Classroom implementation. The thesis presents a mixed picture. Basic facilities were widely available, while specialized facilities and support structures were comparatively limited. All 40 surveyed schools reported three-dimensional concrete roofs and digital library facilities. Computer laboratories apart from Smart Classrooms were available in 97.5% of schools, and 92.5% reported uninterrupted electricity.

Important gaps were also evident. Only 17.5% of schools reported an atmosphere-controlled environment, while 82.5% did not. Similarly, only 12.5% had a separate room for an ICT Coordinator. Internet connectivity showed the clearest

district-level difference: regular internet facilities were reported by 95% of schools in Nayagarh but by only 55% in Kandhamal, producing an overall figure of 75%.

Infrastructure indicator	Nayagarh (%)	Kandhamal (%)	Overall (%)
Three-dimensional concrete roof	100	100	100
Atmosphere-controlled environment/AC	15	20	17.5
Digital library facility	100	100	100
Separate room for ICT Coordinator	10	15	12.5
Uninterrupted electricity	95	90	92.5
Computer laboratory apart from Smart Classroom	100	95	97.5
Regular internet facility	95	55	75

(Table no-02. Infrastructure available for Smart Classroom implementation)

6. Interpretation of Infrastructure Findings

The findings (Table no-02) suggest that infrastructure should be viewed as multidimensional. A school may possess a Smart Classroom room and computer laboratory but still face limitations because of weak internet connectivity, inadequate technical support or insufficient environmental facilities. The difference in internet access between the two districts is particularly relevant because online resources can support digital content, demonstrations and supplementary learning materials. Where connectivity is unreliable, teachers may need to depend more heavily on offline resources. Thus, Smart Classroom provision requires more than hardware installation. Reliable connectivity, electricity, suitable classroom conditions and technical support need to operate together if digital resources are to become a regular part of classroom teaching.

7. Infrastructure-Related Challenges

Selected indicator	Nayagarh (%)	Kandhamal (%)	Overall (%)
Smart Classrooms can operate without sufficient infrastructure	57	68	62.5
Inadequate infrastructure is an impediment	71	67	69
Smart Class equipment available in every classroom	63	48	55.5
Outer infrastructure/campus environment affects implementation	—	—	67
Government provides funds immediately when required	57	58	62.5
Separate maintenance/repair fund	70	61	63.5
Generator/solar panel available	63	51	57
Internet facility for teaching/non-teaching staff	63	67	65
Internet access available to students	66	63	64.5
Alternate power backup available	60	64	62
Monthly maintenance/software upgrading necessary	57	62	59.5

(Table no-03. Selected infrastructure-related problems)

The study reveals (Table no-03) an important tension in respondents' views. While 62.5% believed that Smart Classrooms could operate without sufficient infrastructure, 69% simultaneously identified inadequate infrastructure as an impediment to effective implementation. This can be read descriptively as indicating that respondents recognized teachers' capacity to adapt while also acknowledging the practical limitations created by inadequate infrastructure.

Only 55.5% of respondents reported the availability of Smart Class equipment in every classroom, with 63% in Nayagarh and 48% in Kandhamal. Maintenance and financial support were also relevant. Although 63.5% reported a separate maintenance/repair fund, 36.5% did not. Generator or solar-panel facilities were reported by 57% overall. These findings support a shift from a one-time installation approach toward continuous maintenance and support.

8. Manpower-Related Challenges

Technology cannot function independently without teachers and school personnel. The study found that 62% of respondents believed that teachers' intellectual nature and students' mental readiness affect the teaching-learning process in Smart Classrooms. A technical coordination committee for providing assistance was reported by 56.5% of respondents. The study finds also the trained teachers had a higher mean attitude score than untrained teachers, with the trained group having a reported mean score of 105.44.

9. Internet Connectivity, Power and Maintenance
Internet connectivity is a major practical component of technology-supported instruction. Although 75% of the surveyed schools reported regular internet facilities, the district-wise distribution was considerably different: 95% in Nayagarh compared with 55% in Kandhamal. This disparity matters because contemporary Smart Classroom teaching can draw on online educational resources, digital content and supplementary materials. Reliable connectivity therefore needs to be considered part of the instructional infrastructure rather than a separate facility.

Power supply and maintenance are equally important. The infrastructure survey showed 92.5% reporting uninterrupted electricity, but only 57% reported generator or solar-panel facilities and 62% reported alternate power backup. In addition, 59.5% of respondents supported monthly maintenance of teaching equipment and software upgrading. The difference between regular electricity and dedicated backup suggests the value of contingency arrangements for technology-supported teaching.

10. Discussion

The findings show that Smart Classroom implementation as a process involving both expansion and continuing challenges. The sharp rise in implementation by 2022 indicates substantial institutional adoption in the selected districts, while the lower figure represented for 2023 indicates that continuity and sustainability require attention. Consequently, implementation should not be understood only as installation of devices; regular classroom use, functioning, maintenance and teacher preparedness are also relevant.

The infrastructure results show that basic facilities were relatively widespread, whereas specialized facilities were much less common. The district-level difference in internet access further indicates that the availability of physical Smart Classroom infrastructure does not necessarily mean equal digital access. The problem-related responses reinforce this point: 69% identified inadequate infrastructure as an impediment, while only 55.5% reported Smart Class equipment in every classroom.

Manpower is another central component. Technical assistance, teacher preparation and student readiness influence how technology is used in practice. Technology becomes educationally meaningful when teachers can select appropriate digital resources and integrate them with curriculum objectives and classroom pedagogy. The evidence in the study therefore supports a combined focus on infrastructure, maintenance, connectivity and human capacity.

11. Educational Implications

The findings suggest that the Smart Classroom programmes should be supported by a comprehensive infrastructure plan. Installation should be accompanied by dependable electricity, internet connectivity, suitable classroom conditions and maintenance facilities. District disparities in connectivity also indicate the need for equitable provision of digital infrastructure.

Teacher training should be continuous and should address both device operation and pedagogy, including lesson planning, digital-content selection, multimedia presentation, classroom management and technology-supported assessment. Schools also need accessible maintenance funds and technical support. Monitoring should focus on actual classroom use, functioning of equipment, teacher preparedness, student participation and maintenance rather than merely recording installation.

12. Suggestions

1. Strengthen internet infrastructure so that reliable connectivity is available in secondary schools implementing Smart Classrooms.
2. Provide adequate Smart Class equipment across classrooms to reduce unequal access.
3. Establish trained ICT personnel or an effective technical-support mechanism.
4. Ensure periodic inspection, repair and software upgrading of equipment.
5. Create readily accessible maintenance funds for Smart Classroom repair and replacement.
6. Strengthen backup power through solar panels, generators or other suitable systems where required.
7. Organize continuous, practical teacher training linked with classroom pedagogy.
8. Monitor actual use and functioning of Smart Classrooms at school and district levels.
9. Address district-level disparities through targeted infrastructural and technical support.
10. Promote sustainable implementation that moves beyond installation toward long-term academic integration.

13. Conclusion

The study of Smart Classroom implementation in secondary schools of Nayagarh and Kandhamal districts presents a picture of technological expansion accompanied by infrastructural and organizational challenges. Implementation increased sharply by 2022, with 90% of the surveyed schools reporting implementation overall, but the figures represented for 2023 indicate that continuity and sustainability deserve attention.

The infrastructure findings show that an important foundation for technology-supported education exists in many schools. All surveyed schools reported concrete roofs and digital library facilities, while most had computer laboratories and uninterrupted electricity. At the same time, the limited availability of atmosphere-controlled environments, dedicated ICT Coordinator rooms and regular internet access demonstrate that infrastructure remains uneven.

The challenges identified by respondents reinforce the importance of maintenance, technical support, teacher preparation and financial resources. In particular, 69% identified inadequate infrastructure as an impediment, while only 55.5% reported Smart Class equipment in every classroom. Effective implementation should therefore be viewed as a continuous educational process rather than a one-time technological intervention. Hardware needs to be supported by dependable connectivity, power backup, maintenance, technical assistance and trained teachers.

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