Artificial Intelligence and Digital Technologies in Rural School Education: Opportunities, Challenges and Emerging Research Directions

Jagatap, P.V.[a,*]

[a]Zilla Parishad Primary Marathi School, Khojanwadi, Jath, District Sangli, Maharashtra, India

A B S T R A C T

Indian policy increasingly presents digital technologies and artificial intelligence (AI) as tools for improving access, equity and quality in school education, but evidence from rural government classrooms is uneven. This narrative review examines how policy, infrastructure and teacher readiness shape the use of such technologies in rural Indian schools and identifies gaps for future research. A purposive search of official documents, peer-reviewed studies and credible grey literature was carried out in October 2026. Policy is traced from the National Education Policy 2020 and the National Curriculum Framework for School Education 2023 to the computational thinking and AI curriculum planned for Classes III–VIII from 2026–27, and evidence on general digital learning is separated from evidence on AI-enabled interventions.

Technology-aided instruction has produced measurable learning gains in large Indian field experiments, whereas AI-specific evidence is narrower, concentrated on English literacy and adaptive learning, and partly linked to technology providers. School-level availability of computers and internet overstates functional access. Within the literature reviewed, no study was identified that jointly examines AI adoption, infrastructure, teacher readiness and learning outcomes in Marathi-medium Zilla Parishad schools in Maharashtra. The review offers a conceptual framework of testable propositions and identifies a potential direction for empirical research, with relevance for teachers, administrators and policymakers in rural government school systems. It does not itself measure learning gains or teacher readiness.

Keywords:
rural education; artificial intelligence; digital divide; teacher readiness; Zilla Parishad schools

Corresponding author: Jagatap, P.V., pjagatap68@gmail.com

1. Introduction

India's school system serves one of the world's largest and most geographically diverse learner populations, and a large share of children attend government schools in rural areas. Over the past decade, national policy has treated digital technology and, more recently, artificial intelligence (AI) as instruments for widening access, equity and quality. The National Education Policy (NEP) 2020 calls for investment in digital infrastructure, online platforms, virtual laboratories and multilingual technology-supported learning, and the National Curriculum Framework for School Education (NCF-SE) 2023 and later curriculum decisions bring computational thinking and AI literacy into the school curriculum (Government of India, 2020; National Council of Educational Research and Training, 2023).

Policy ambition and classroom reality do not necessarily coincide. Many rural classrooms still contend with unreliable connectivity, a shortage of working devices and limited opportunities for teacher professional development. This review therefore asks how digital technologies and AI can support teaching and learning in rural Indian schools, and where the available evidence is thin. It addresses four questions:

- RQ1: How do national policies position digital technology and AI in school education, and how do policy objectives, planned initiatives and demonstrated implementation differ?
- RQ2: What does the evidence show for general digital learning compared with AI-enabled interventions in Indian government schools?
- RQ3: How do infrastructure, functional access and teacher readiness shape implementation in rural schools?
- RQ4: What gaps remain, particularly for Marathi-medium Zilla Parishad (ZP) schools in Maharashtra?

The paper is a narrative literature review. Its contribution is threefold: it clarifies the distinction between policy intention and school-level implementation; it separates evidence on general educational technology from evidence on AI; and it identifies, within the literature reviewed, an under-examined context for future doctoral research.

1.1 Key terms

Four terms are used consistently. *Digital learning* (or educational technology) refers to any technology-supported teaching or learning, including broadcast content, computer-assisted learning and online platforms. *AI-enabled education* refers to tools that use machine-learning or other computational-intelligence methods, for example adaptive learning software, AI-based reading platforms, AI-based teacher-support tools and language technologies. *AI literacy* is the knowledge, skills and ethical understanding needed to use, evaluate and teach about AI. *Teacher readiness* is a multi-dimensional construct covering technical skills, pedagogical competence, AI literacy, ethical awareness, self-efficacy and institutional support (see Section 5.2).

2. Review Methodology

2.1 Sources and search strategy

The review is a purposive narrative review, not a systematic review. Searches were carried out in October 2026 using general web search engines, journal and repository pages (including the American Economic Association, the National Bureau of Economic Research, publisher DOI pages and the EdTech Hub library), and official portals (the Press Information Bureau, the Ministry of Education and its Department of School Education and Literacy, the Unified District Information System for Education Plus (UDISE+) dashboard, the National Council of Educational Research and Training (NCERT), the Central Board of Secondary Education (CBSE) and parliamentary records). Search terms combined *artificial intelligence*, *educational technology* and *computer-assisted learning* with *rural*, *government schools* and *India*; *teacher readiness*, *AI literacy* and *AI readiness* with *teachers* and *India*; and *Zilla Parishad*, *Marathi medium*, *Maharashtra* and *digital school* with *technology*. Official data were located using *UDISE+ 2025-26*, *UDISE+ 2024-25* and the names of individual programmes. Foundational experimental studies were not restricted by date; policy documents and infrastructure data were limited to 2020–2026.

2.2 Inclusion and exclusion criteria

Sources were retained if they were (a) official policy documents or administrative data, (b) peer-reviewed articles or working papers reporting empirical evidence on technology or AI in Indian school education, (c) systematic reviews relevant to teacher AI literacy, or (d) clearly identified grey literature, such as survey reports, which is flagged as such. Opinion pieces, commercial or vendor marketing material, studies confined to higher education, and sources whose authors, titles and publication details could not be traced to a stable DOI or URL were excluded.

2.3 Credibility and traceability

Sources were ranked by type: official administrative data and policy statements; peer-reviewed publications; and working papers and grey literature, which are flagged in the text. For every empirical claim, the cited source was checked for author, title, publication details and consistency with the claim made. Where an original report could not be opened (the 2026 survey of government-school teachers and the October 2025 Press Information Bureau release), its findings are attributed as described in news coverage or secondary summaries and are flagged as such. Where study authors are connected with the technology provider being evaluated, this is noted. Findings are reported at the level of detail the source supports.

2.4 Limitations of the search

The search was conducted by a single reviewer, restricted to English-language sources, did not use formal quality-scoring tools and did not cover Marathi-language literature or unpublished state-level reports systematically. Statements about gaps in the literature are therefore indicative and should be confirmed by a systematic search before being treated as definitive.

3. Policy framework: from vision to school-level implementation

India's approach to digital and AI-enabled school education can be read as four layers: policy vision, curriculum and delivery platforms, infrastructure funding, and classroom implementation (Fig. 1). The analysis below separates stated objectives, planned initiatives and what is documented at school level (Table 1).

3.1 Policy vision and the AI curriculum

NEP 2020 set the broad direction for blending digital learning with school education, including online platforms, virtual laboratories, digital repositories and multilingual technology-enabled learning (Government of India, 2020). The NCF-SE 2023 translated this vision into curriculum guidance (National Council of Educational Research and Training, 2023). In October 2025 the Ministry of Education announced that AI and computational thinking (CT) would be introduced from Class 3 from the 2026–27 session, with teacher training through the National Initiative for School Heads' and Teachers' Holistic Advancement (NISHTHA) and other programmes, and said it was supporting CBSE, NCERT and the States and Union Territories in designing the curriculum (Press Information Bureau, 2025a). The CBSE curriculum for Classes III–VIII was launched on 1 April 2026 for the 2026–27 session: CT is introduced first as a basis for learning AI in higher classes, supported by teacher handbooks and competency-based assessment (Press Information Bureau, 2026). In May 2026 the Secretary of the Department of School Education and Literacy said that NCERT and CBSE had jointly introduced the curriculum, that teachers would be trained during the summer break and that NCERT was developing AI textbooks for Classes 9–12 (News on AIR, 2026).

These are policy objectives and planned initiatives. The sources reviewed describe a CBSE curriculum; they do not state how state-board schools such as Zilla Parishad (ZP) schools will adopt it, in which languages materials will be provided, or how training will reach rural teachers. These questions are central to implementation in Maharashtra and could not be answered from the sources reviewed.

3.2 Delivery platforms and infrastructure support

PM eVidya, launched on 17 May 2020, unifies digital, online and on-air education: DIKSHA (Digital Infrastructure for Knowledge Sharing) provides e-content for school education, one Swayam Prabha television channel is earmarked for each class from 1 to 12, and radio, community radio and a CBSE podcast reach learners without devices (Press Information Bureau, 2023). Official replies to Parliament describe radio and television lessons, including DD Sahyadri, as the means used to reach rural schools in Maharashtra (Lok Sabha, 2021). On infrastructure, the UDISE+ report records that the Government provides financial assistance to States and Union Territories for school infrastructure, including computing devices and internet, under Samagra Shiksha, and it tracks information and communication technology (ICT) laboratories and smart classrooms (Department of School Education and Literacy, 2026). At state level, Maharashtra's Digital School movement converted a large number of government schools into digital classrooms from 2015. In Dhule district, the National Commission for Protection of Child Rights (NCPCR) studied 1,103 digitalised Zilla Parishad schools and reported widespread use of computers and projectors, Marathi-medium instruction based on the State Board curriculum, and persistent constraints relating to electricity, internet access, content and teacher training (National Commission for Protection of Child Rights, 2018). That study is descriptive, perception-based and district-specific, and the sources reviewed do not independently evaluate how the term "digital school" was defined or how consistently equipment is used.

Table 1 Policy initiatives: purpose, direct AI link and limits for rural Zilla Parishad (ZP) schools

Initiative	Main purpose	Direct AI link?	Relevance and limits for rural ZP schools
NEP 2020	Strategic vision for technology integration, digital repositories and multilingual learning	Indirect	Sets direction; has no school-level delivery mechanism by itself.
NCF-SE 2023 and computational thinking (CT) and AI curriculum (Classes III–VIII, from 2026–27)	Curriculum framework; CT first, then AI in higher classes	Yes	CBSE curriculum; adoption in state-board schools, language versions and rural teacher training are not described in the sources reviewed.
PM eVidya and DIKSHA	Multi-mode access to digital content (online, television, radio)	No	Designed for low-connectivity settings; use depends on teachers' digital exposure and devices.
Samagra Shiksha (infrastructure assistance)	Financial assistance to States for school infrastructure, including computing devices and internet	No	Funding does not guarantee working equipment; UDISE+ reports functional computers separately.
Maharashtra Digital School movement / Dhule digitalisation initiative	Community-supported conversion of ZP schools into digital classrooms	No	The NCPCR Dhule study reports digital classrooms in ZP schools and implementation barriers; it is district-specific and does not evaluate AI or establish causal learning effects.



Fig. 1 Layered policy architecture connecting national vision to rural classroom implementation. NEP: National Education Policy; NCF-SE: National Curriculum Framework for School Education; CT: computational thinking; AI: artificial intelligence; PM eVidya: Prime Minister's e-Vidya programme; DIKSHA: Digital Infrastructure for Knowledge Sharing; ICT: information and communication technology.

3.3 Availability is not functional access

National administrative data show progress but persistent gaps. According to UDISE+ 2025–26 (data as of 31 March 2026), 69.9 % of schools reported a computer facility (64.7 % in 2024–25 and 57.2 % in 2023–24) and 67.4 % reported internet connectivity (63.5 % and 53.9 %); 63.1 % of schools had computers reported as functional for pedagogical purposes, up from 57.9 % in 2024–25, and 95.0 % reported electricity (Department of School Education and Literacy, 2025, 2026; Press Information Bureau, 2025b). The functional-computer shares were calculated by the author from the numbers of schools in Table 2.5 of each report. For Maharashtra, all management types combined, the 2025–26 figures were 83.6 %, 78.2 % and 77.9 % for computer facility, functional computers and internet, above the national averages (Fig. 2); these state aggregates do not separate ZP schools. By management type, analyses of the 2024–25 tables report internet connectivity in 58.6 % of government schools and 77.1 % of private unaided schools, and functional computers for pedagogical use in 52.7 % and 72.5 % respectively (Education for All in India, 2025). Because rural schools are concentrated in the government category, these gaps bear directly on the feasibility of AI-enabled instruction in rural settings.

Three distinctions matter for AI readiness. School-level *availability* of a computer or connection does not show *functional* access (working devices, reliable power and bandwidth), nor *adequate access per student* (a single shared device serves very different numbers of pupils), nor *effective classroom use* by trained teachers. Fig. 2 therefore reports availability and, for computers, reported functional use, but it cannot show devices per student or classroom use.

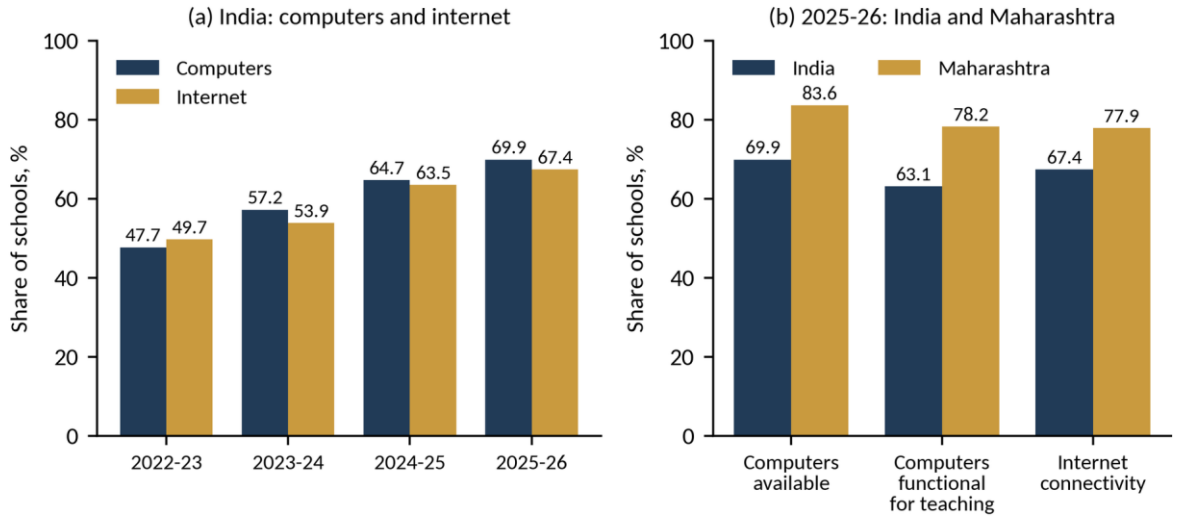


Fig. 2 School digital infrastructure. (a) Share of schools in India reporting computers and internet, 2022–23 to 2025–26. (b) Computer facility, computers functional for pedagogical purposes and internet in India and Maharashtra (all school management types), 2025–26. Data: Unified District Information System for Education Plus (UDISE+); shares in (b) calculated from reported school counts. The figure does not show devices per student or classroom use.

4. Evidence on learning outcomes: general digital learning versus AI-enabled interventions

Evidence on technology and learning is often discussed as a single body, but it covers distinct categories. Table 2 separates them, and the subsections below discuss each. Gains from technology-enhanced instruction should not be read as evidence that AI-based instruction works. UNESCO's 2023 Global Education Monitoring Report cautions that robust evidence on the added value of educational technology is scarce and that much of it comes from those selling the technology (UNESCO, 2023).

4.1 General digital learning and educational technology

The most rigorous Indian evidence concerns conventional educational technology. In a randomised experiment in urban Vadodara, a computer-assisted learning programme of shared computer games raised mathematics scores by about 0.35 standard deviations (SD) in the first year; the same paper's remedial *balsakhi* programme ran in Vadodara and Mumbai but is not a technology intervention (Banerjee *et al.*, 2007). In a large field experiment across 1,823 rural government schools in Karnataka, satellite-delivered technology-aided instruction, replacing roughly one-third of regular classroom teaching, produced positive effects on learning outcomes despite high student-to-computer ratios and minimal teacher training (Naik *et al.*, 2020). The second study is especially relevant to rural settings, but it evaluates a broadcast-style design rather than AI.

4.2 AI-enabled and adaptive learning interventions

Evidence on AI-enabled tools is narrower. Muralidharan *et al.* (2019) evaluated personalised, adaptive instruction software in after-school centres in Delhi and found gains of 0.37 SD in mathematics and 0.23 SD in Hindi over 4.5 months, though in an urban, non-school setting. Srinivasan and Murthy (2021) evaluated an AI-based multisensory reading platform. The programme itself reached about one million

students, 15,000 teachers and 5,000 government schools in 2016–17; the randomised assessment covered over 33,000 students in grades 3–7 in four states, including Maharashtra, and found improvement in the treatment group about 20 % above control overall, ranging from about 8 % to 40 % across grade-state cohorts. Three cautions apply: the outcome is English-language literacy only; gains are reported in percentage terms rather than standardised effect sizes; and the evidence was produced in connection with the platform provider, so independence cannot be assumed (UNESCO, 2023). The sources reviewed do not report results specifically for Marathi-medium ZP schools.

4.3 AI-based teacher-support tools

Digital platforms such as DIKSHA support teachers with content and professional-development resources, but they are content platforms rather than AI tools. The 2026 survey of government-school teachers discussed in Section 5.2 reports teachers using AI tools for explaining concepts and preparing worksheets (JanAI, 2026), which suggests practical use, but it is a survey of self-reported use and not an evaluation of effects. The sources retained for this review did not include a rigorous evaluation of AI-based teacher-support tools in rural Indian government schools.

4.4 Language technologies and AI-assisted translation

Language technologies are plausibly important for Marathi-medium schools, and the sources reviewed do not describe Marathi-language versions of the new AI and CT curriculum materials. However, no outcome-based evaluation of AI-assisted translation or language tools in Marathi-medium rural classrooms was identified in the literature reviewed.

Table 2 Evidence categories, representative Indian studies and limits

Category	Study and context	Reported outcome	Key limits
General digital learning	Banerjee *et al.* (2007): computer-assisted maths games, urban Vadodara	Maths gains of about 0.35 SD in year 1	Urban; not AI.
General digital learning	Naik *et al.* (2020): satellite-delivered teaching, 1,823 rural government schools, Karnataka	Positive effect on learning outcomes	Not AI; one state; effect sizes not reproduced here.
Adaptive / AI-enabled	Muralidharan *et al.* (2019): adaptive software, after-school centres, Delhi	0.37 SD maths and 0.23 SD Hindi over 4.5 months	Urban, after-school setting; adaptive rather than generative AI.
AI-enabled	Srinivasan and Murthy (2021): AI-based reading platform; assessment of over 33,000 students in four states, including Maharashtra	About 20 % higher improvement than control in English reading (about 8–40 % across cohorts)	English only; provider-linked evidence; not ZP or Marathi-specific.
AI teacher-support tools	None rigorous identified	–	Evidence gap.
Language technologies	None outcome-based identified for Marathi-medium schools	–	Evidence gap.

5. Barriers: infrastructure, functional access and teacher readiness

Infrastructure and teacher readiness are discussed together because the literature treats them as interdependent: capable teachers cannot use tools that are absent or unreliable, and well-equipped classrooms do not help if teachers lack the training and support to use them.

5.1 Infrastructure, affordability and content fit

UNESCO's global review identifies unequal meaningful connectivity, the lack of electricity in many schools worldwide, underestimated costs and weak evidence as recurring barriers, and reports that learning benefits can disappear when technology is used without a qualified teacher (UNESCO, 2023). In India, UDISE+ 2025–26 reports electricity in 95.0 % of schools, so devices, functional use and connectivity are more binding national constraints than power supply (Section 3.3), although reliability of supply in remote schools is not measured in the sources reviewed. The sources retained offer no quantitative evidence on affordability or on the fit of content with learners' language for rural ZP schools; both remain evidence gaps. The Karnataka experiment (Naik *et al.*, 2020) suggests that designs built around constrained infrastructure, using one computer per school and satellite delivery, can still work, which indicates that implementation design matters as much as the technology.

5.2 Teacher readiness

Teacher readiness for AI is best understood as multi-dimensional. This review distinguishes six components:

- *Technical skills*: operating devices, software and connectivity.
- *Pedagogical competence*: integrating tools into lesson design and multi-grade teaching.
- *AI literacy*: understanding what AI tools do, and their limits.
- *Ethical awareness*: data privacy, bias and responsible use.
- *Self-efficacy*: confidence to use and adapt tools.
- *Institutional support*: training, time, technical help and leadership.

Measurement is still developing. A systematic review of AI literacy scales identified 16 scales across 22 validation studies, with various target groups including teachers; most showed good structural validity and internal consistency, but few were tested for other psychometric properties, none was tested for cross-cultural validity, and only three were performance-based rather than self-reported (Lintner, 2024). Using such instruments with rural Marathi-speaking teachers would therefore require adaptation and validation.

Evidence from India is emerging. A study of Indian school teachers' AI literacy describes it as uneven and points to the importance of hands-on exposure, especially in rural and government schools (Kundu *et al.*, 2025). A 2026 survey by JanAI of 797 government-school teachers in Uttar Pradesh, Karnataka, Jharkhand and Maharashtra, as reported in the press, found 72 % positive about AI and 26 % using it regularly; teachers were using AI on personal phones even where schools lacked computer labs; and more than half of the AI-using teachers had entered a student's name, marks or photograph into an AI tool, which the report links to the need for school rules, state policy, training and a named contact for help (JanAI, 2026). This is grey literature, reported here from news coverage rather than the full report, and the coverage reviewed does not break results down for ZP or Marathi-medium schools. Taken together, these sources suggest that among surveyed teachers favourable attitudes may be less of a constraint than institutional support. This inference should be tested, and findings from these samples should not be generalised to all rural teachers in India. Studies that directly compare rural and urban teachers' AI readiness in India were not available among the sources retained for this review.

6. Conceptual framework

Fig. 3 summarises a conceptual pathway from policy and infrastructure through technology adoption and teacher readiness to student learning outcomes, with barriers acting on adoption. It is a synthesis of the literature reviewed and is offered as a set of conceptual propositions, not as relationships established by empirical evidence:

- *P1 (infrastructure as prerequisite):* reliable devices and connectivity are necessary but not sufficient conditions for classroom use of digital or AI tools.
- *P2 (teacher readiness as mediator):* the effect of technology access on learning outcomes operates largely through teachers' readiness and classroom practice.

- *P3 (language and content fit as moderator):* the benefit of tools depends on whether content and interfaces are available in the learners' language of instruction.
- *P4 (institutional support as enabler):* training, technical support and policy follow-through affect teacher readiness and the extent to which classroom practice translates into learning outcomes.

On this view, barriers such as connectivity, device availability and training (shown in Fig. 3) do not act in isolation; interventions that address only one of them are unlikely to change classroom outcomes. These propositions are testable in future empirical work.

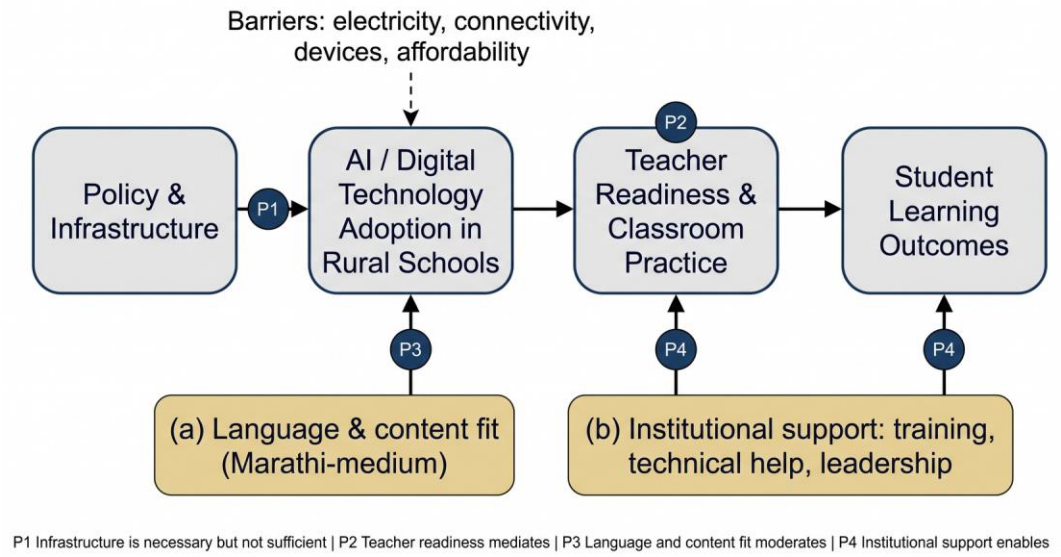


Fig. 3 Conceptual pathway from policy and infrastructure through technology adoption and teacher readiness to student learning outcomes. P1–P4 are conceptual propositions, not empirically established effects. (a) Language and content fit; (b) institutional support (training, technical help and leadership). AI: artificial intelligence.

7. Research gap and future directions

7.1 The gap identified in the literature reviewed

The reviewed literature supports three observations. National policy has shifted from digital access towards AI integration. Experimental evidence shows that technology-aided instruction can improve outcomes in government schools, with narrower AI-specific evidence. And infrastructure and teacher readiness are the principal implementation constraints. Evidence is also concentrated: the large field experiments reviewed were conducted in Karnataka and Delhi or across mixed-state samples.

Maharashtra operates one of India's largest ZP school networks, serving a predominantly rural and Marathi-medium population, and related evidence exists. Maharashtra schools were among those assessed by Srinivasan and Murthy (2021) for English reading; a 2026 multi-state survey included government-school teachers in Maharashtra (JanAI, 2026); UDISE+ reports state-level infrastructure (Section 3.3); and official and practitioner accounts describe radio, television and the Digital School movement (Section 3.2), while an NCPCR field study of digitalised ZP schools in Dhule district provides district-level evidence on implementation constraints (National Commission for Protection of Child Rights, 2018). Within the search described in Section 2, however, no study was identified that jointly examines AI or digital-technology adoption, infrastructure, teacher readiness and learning outcomes in Marathi-medium ZP schools, and the sources above, as reported, do not separate ZP schools. Fig. 4 illustrates the gap as the intersection of four themes that the existing literature addresses separately. This is a gap in the literature reviewed, not a claim that no relevant research exists: Marathi-language, unpublished or state-level sources were not searched systematically (Section 2.4).

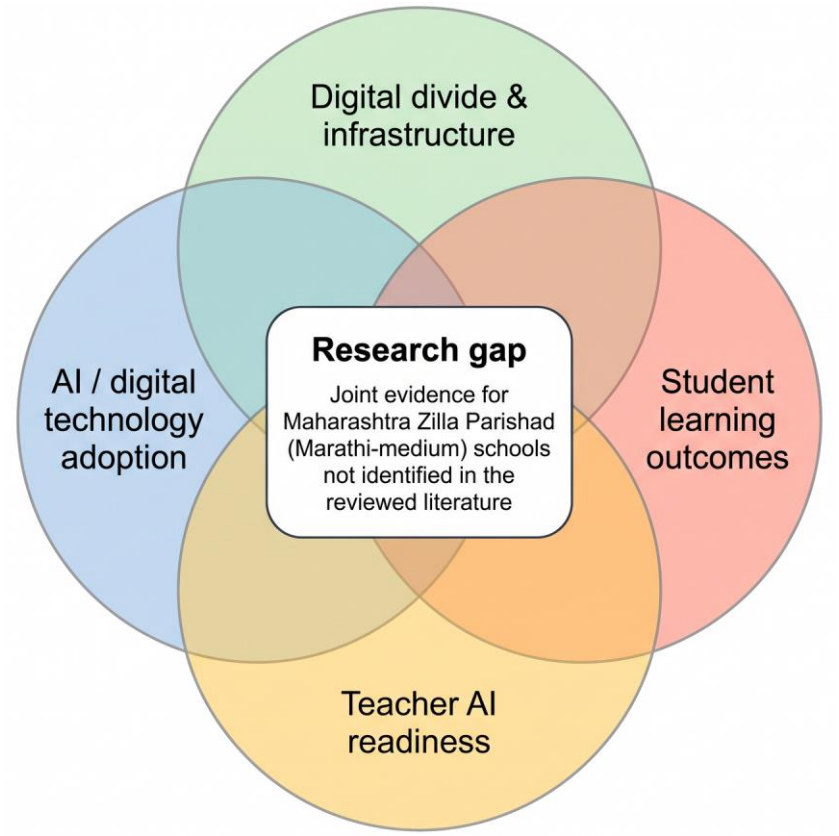


Fig. 4 The research gap at the intersection of four themes addressed separately in the reviewed literature: AI and digital technology adoption, digital divide and infrastructure, teacher AI readiness, and student learning outcomes. Joint evidence for Maharashtra's Zilla Parishad (ZP) Marathi-medium schools was not identified in the literature reviewed. AI: artificial intelligence.

7.2 Why the gap may matter

Marathi-medium instruction, ZP administrative structures and district-level infrastructure in Maharashtra differ in potentially important ways from contexts already studied, so findings from elsewhere cannot safely be assumed to transfer. For a researcher working within the ZP system, the context may also offer access to schools, teachers and administrative data. This feasibility is a potential advantage; it would need to be demonstrated through an approved research design and ethical clearance.

7.3 Possible research questions and methods

Future empirical work could examine: (i) the level of digital and AI-tool competency among ZP teachers in rural Maharashtra, using validated and adapted instruments; (ii) the relationship between infrastructure availability (devices, internet) and actual classroom use; (iii) the extent to which Marathi-language digital content and AI-based language tools reach and are used in ZP classrooms; and (iv) whether learning gains comparable to those in the Indian experiments reviewed can be observed after digital or AI-tool interventions in ZP schools. Suitable approaches include descriptive teacher surveys, quasi-experimental comparisons of schools with and without digital infrastructure, and mixed-methods case studies combining classroom observation with interviews.

8. Conclusion

This review has traced the pathway from national policy on digital and AI-enabled education to rural classrooms, separated evidence on general digital learning from AI-specific evidence, and synthesised infrastructure and teacher-readiness barriers. Its main conclusions are proportionate to the evidence reviewed. Technology-aided instruction has demonstrated benefits in large Indian experiments; AI-specific evidence is still limited in scope and partly provider-linked; and school-level availability of

equipment is an unreliable proxy for functional access. Within the literature reviewed, the combination of AI adoption, infrastructure, teacher readiness and learning outcomes in Maharashtra's Marathi-medium ZP schools appears unexamined, which makes it a potentially valuable direction for empirical research.

The review has clear limitations: a narrative design, a single-reviewer search, reliance on secondary and English-language sources, grey literature that has not been peer reviewed, and no formal quality appraisal. A systematic search, including Marathi-language and state-level sources, is needed before the gap is treated as established, and the feasibility and expected contribution of doctoral research in this area should be regarded as potential rather than assured.

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Declarations

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