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Strengthening Participatory Pedagogy to Improve STEM Learning in Pakistan: Evidence from a Nationwide Mixed-Methods Study

Evidence from the DARE Research Consortium

Policy Brief







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ABOUT
This policy brief was produced by the DARE Research Consortium. It summarises the findings from a full report (forthcoming) detailing research conducted as part of the DARE-RC portfolio, and was authored by the researchers of that report. This brief forms a part of a series to provide actionable evidence to policymakers in Pakistan to improve education.

DISCLAIMER
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DARE Research Consortium

DARE-RC is Pakistan's largest education research programme, generating rigorous, actionable evidence to improve education policy and practice.
DARE's 44 research studies and scoping papers offer critical insights on inclusion, teaching and learning, governance, data, accountability, and system resilience.

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Key Messages

Studentlearningoutcomes in mathematicsand scienceare weak, particularly inpublicschools. While teaching quality isknownto drive student achievement, Pakistani classrooms are still teacher- centred, with limited use of the participatory practices that support conceptual understanding in STEM subjects.

Small class sizes (fewer than 40 students) and effective use of instructional time help establish student- centred participatory approaches. Where reducing class size is not feasible, co-teaching or redeployment can ease overcrowding.

Private-school students significantly outperform public-school students, and this gap is partly explained by different pedagogical practices within the classroom.

Teachersare aware of participatory pedagogyand intend to practise it, but theirpractice is inconsistent and constrained by structural barriers like minimal guidance from school leadership, overcrowded classrooms, and limited resources.

Teachers' professional development and school leadership must prioritise helping teachers actually practise participatory approaches, rather than focusing on awareness alone.

STEM learning can also be reinforced through parental engagement strategies such as parental literacy and numeracy programmes, since parental education has a strong influence on student achievement.





AT A GLANCE DARE RESEARCH CONSORTIUM · POLICY BRIEF SUMMARY

Strengthening Participatory Pedagogy to Improve STEM Learning in Pakistan: Evidence from a Nationwide Mixed-Methods Study

Dr Sadia Muzaffar Bhutta, Dr Sajid Ali, Sohail Ahmad, Aisha Naz Ansari

Methodology

- **Strand 1:** 436 maths and science teachers from 96 schools across six regions, observed using COS-R and surveyed on professional agency.
- **Strands 2–3:** 162 teachers and 3,836 students from 36 schools (path analysis); qualitative interviews with 21 teachers on enactment of participatory pedagogy.

Key Figures

26.2M childrenoutof school in Pakistan

43M enrolledlearners struggling withfoundational skills

47% averagenational science sc ore

38% averagenational mathematics score

10–15% oflearning variance explained byteaching q u a lity

40 students – class size threshold for participatory practice

Findings

1
Participatory pedagogy is limited and uneven
Classroomsshowlow-to-moderateparticipatory practice;discipline and interaction score higher than engagement or higher-order thinking.

2
Classroom conditions matter more than school type
Classsize (under40) and effectiveuse ofinstructional time arethe strongest predictors of participatory practice – more than school system or credentials.

3
Large public-private learning gaps persist
Nationalscores average 47% in scienceand 38%inmaths; school system explains 20% and 16% of the variance respectively.

4
Pedagogy mediates the public-private gap
Differencesinachievementbetweenpublicand private schools are partly explained by variation in classroom-level teaching practice.

5
Parental engagement is an overlooked driver
Parentaluniversityeducation is thestrongestdirectpredictor of achievement, yet mechanisms to engage parents remain limited.

6
Teachers understand participatory pedagogy but struggle to enact it
Intentionsare student-centred,butenactmentisinconsistent and constrained by overcrowding, resources, and language barriers.

Policy Implications

- **Policy intent alone cannot shift classroom practice without addressing classroom conditions and teacher support structures.**
- **Structural conditions shape pedagogical quality: large classes and limited instructional time directly suppress participatory teaching.**
- **Teacher professional development must prioritise enactment, not awareness – teachers already understand the concepts.**
- **Equity gaps require targeted interventions, given the strong influence of parental education on learning outcomes.**

Re comme n d a ti on s

TEACHER DEVELOPMENT
Strengthen Teacher PD
- Shift PD from awareness to subject-specific, classroom-embedded coaching.
- Introduce semi-scripted lesson plans that allow contextual adaptation.

CLASSROOM CONDITIONS
Improve Structural Con d it ion s
- Reduce class sizes or introduce co-teaching in overcrowded schools.
- Reduce non-teaching tasks during lesson time to protect instructional time.

LEADERSHIP
Strengthen Instructional Leadership
- Train school heads in observation, feedback, and data-driven decisions.
- Build routines for diagnosing learning needs at the school lev el.

EQUITY
Advance Equity & Parental Engagement
- Pilot contextually relevant parental literacy and numeracy programmes.
- Target remedial support for disadvantaged learners.

Introduction

Pakistan faces a persistent learning crisis that threatens progress towards the constitutional mandate of Article 25-A, which emphasises 'free and quality education for all children aged 5–16'. Despite decades of reform, 26.2 million children remain out of school, while 43 million enrolled learners struggle with foundational skills (PIE, 2024). Learning outcomes in mathematics and science remain particularly weak, with public-school students consistently underperforming relative to their private-school peers (Bhutta & Rizvi, 2022; PIE, 2024; TIMSS, 2020). These disparities reflect deep structural inequities in access, opportunity, and instructional quality.

26.2M
CHILDRENOUTOF SCHOOL

Alongside 43 million enrolled learners struggling with foundational skills

> ***Teaching quality accounts for 10–15% of the variance in learning outcomes.***

Teaching quality is one of the strongest school-based predictors of student achievement, accounting for 10–15% of the variance in learning outcomes (Aaronson et al., 2007; Hanushek et al., 2019; Bhutta & Rizvi, 2022). Yet evidence from Pakistan and other low- and middle-income countries (LMICs) shows that classrooms remain predominantly teacher-centred, with limited use of participatory, inquiry-driven, or formative practices that support conceptual understanding in STEM subjects.

This policy brief draws on a nationwide mixed-methods study conducted under DARE-RC, examining the extent, determinants, and effects of participatory pedagogy in elementary mathematics and science classrooms across Pakistan. The findings offer actionable insights for policymakers seeking to strengthen teaching quality and improve STEM learning outcomes nationwide.

M etho do lo gy

The study employed a concurrent mixed-methods design, integrating quantitative and qualitative data across three strands. Data were collected between November 2024 and May 2025.

Strand 1: A multistage sample of 436 mathematics and science teachers from 96 schools across six regions was observed using the Classroom Observation Scale-Revised (COS-R) and surveyed on professional agency.
Strand 2: A subsample of 162 teachers and 3,836 students from 36 schools participated in classroom observations and STEM learning assessments. Path analysis examined direct and indirect relationships between the school system, participatory pedagogy, and student achievement.

Strand 3: Qualitative interviews with 21 teachers explored their conceptualisations and enactment of participatory pedagogy.

F inding s

1 Participatory pedagogy is limited and uneven across classrooms

Classroom observations show low-to-moderate levels of participatory practice, with limited use of collaboration, high-quality questioning, and formative assessment. Classrooms are predominantly teacher-centred, performing relatively better on discipline and teacher-student interaction than on student engagement or higher-order thinking tasks.

2 Immediate classroom conditions matter more than school system or teacher credentials

Multivariate analyses show that class size (fewer than 40 students) and instructional time (effective use of the allocated 35 minutes per lesson) are the strongest predictors of participatory practices. School system (public/private) and formal teacher qualifications have comparatively weaker effects. Teacher agency plays a more significant role in science teaching quality than in mathematics.

3 Student learning outcomes are low, with large public-private gaps

National assessment data show average scores of 47% in science and 38% in mathematics. Private-school students significantly outperform public-school students, with school system explaining 20% of the variance in science and 16% in mathematics.

4 Participatory pedagogy mediates the relationship between school system and STEM le ar ning

Path analysis indicates that differences in student achievement between public and private schools are partly explained by variation in classroom-level pedagogical practices. School system continues to matter, but its influence operates substantially through the quality of participatory teaching available to students.

5 Parental engagement is a critical but overlooked driver of student learning

Parental university education is the strongest direct predictor of student achievement, yet mechanisms for engaging parents in learning support are limited. This gap suggests an opportunity to strengthen home-school partnerships to reinforce STEM learning.

6 Teachers understand participatory pedagogy but struggle to enact it

Teachers conceptualise participatory pedagogy as student-centred, interactive, and contextualised. In science, participation is linked to demonstration and hands-on exploration; in mathematics, to problem-solving and scaffolding. However, enactment is inconsistent and constrained by overcrowded classrooms, limited resources, weak foundational skills among students, and language challenges.

7 Instructional leadership gaps limit teachers' ability to implement participatory pedagogy

Teachers report minimal pedagogical guidance from school heads and middle-tier leadership, including limited support for diagnosing learning needs and responding with appropriate assistance. These leadership gaps reduce teachers' capacity to translate participatory intentions into consistent classroom practice.

8 A persistent gap exists between teachers' intentions and observed practice

Teachers report student-centred intentions, but observations show limited enactment of student-centred practices, particularly around collaboration, peer interaction, and formative assessment. This pattern appears driven more by structural constraints than by a lack of awareness, collectively sustaining the implementation gap.

Policy Implications

Policy intent alone cannot shift classroom practice: curricular emphasis on active learning has not translated into practice due to systemic constraints. Without addressing classroom conditions and teacher support structures, participatory pedagogy will remain aspirational.

Teacher professional development must prioritise enactment, not awareness: teachers understand participatory pedagogy conceptually. What they lack is structured, practice-focused support that helps them implement these strategies in real classrooms.

Structural conditions shape pedagogical quality: large class sizes, limited instructional time, and resource shortages directly suppress participatory teaching. Policy must address these enabling conditions alongside teacher training.

Equity gaps require targeted interventions: the strong influence of parental education on learning underscores the need for home-school engagement strategies and support for disadvantaged learners.

Middle-tier leadership is a missing link: school heads and district officials need tools and routines to support instructional improvement, including observation, feedback, and data-driven decision-making.

> *"What teachers lack is structured, practice-focused support – not more awareness.*

Rec o m m endat io ns

Strengthen Teacher Professional Development

- Shift professional development from awareness to practice and make it subject-specific through coaching, modelling, and classroom-embedded support. This aligns with national and provincial sector plans calling for continuous, school-embedded, outcome-focused CPD, though findings suggest uneven implementation.
- Introduce semi-scripted lesson plans that provide structure for participatory pedagogy while allowing contextual adaptation, helping address resource constraints without compromising teacher autonomy.

Improve Classroom Structural Conditions

- Reduce class sizes in overcrowded schools or introduce co-teaching models. Where reducing class size is not immediately feasible, co-teaching, double-shift schooling, or redeployment can help increase meaningful instructional time.
- Ensure effective use of instructional time for STEM by providing semi-scripted plans, reducing non-teaching tasks during lesson time, and strengthening peer mentoring through structured classroom observation.

Strengthen Instructional Leadership

- Train school heads and middle-tier officials in observation, feedback, mentoring, and data use for instructional decision-making, including building capability to diagnose learning needs and schedule regular classroom observations.

Advance Equity and Parental Engagement

- Implement parental engagement strategies, especially in low-literacy communities. National and provincial governments should consider developing and piloting contextually relevant parental literacy and numeracy programmes, alongside targeted remedial support for disadvantaged learners.

Co nc lus io n

This study provides concise evidence that improving STEM (science and mathematics) learning in Pakistan requires a systemic shift towards participatory pedagogy. The recommendations draw on national and provincial policies, recognising that education is devolved in the country, offering a practical framing to strengthen implementation of agreed priorities at both levels. Although teachers understand the value of participatory approaches, structural constraints and limited instructional support prevent effective enactment. By addressing classroom conditions, strengthening professional development, and empowering school and district leadership, Pakistan can move closer to achieving SDG 4 commitments on equitable, quality education and learning. The findings call for coordinated, multi-level action to ensure that every child has access to meaningful, engaging, and effective STEM learning experiences.

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