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Effects of Over-Enrollment on Pupils and Teacher Performance in Primary Schools in Kalabo District, Zambia: AI-Assisted Large-Class Pedagogy, Resource Optimisation and Inclusive Education Policy

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Abstract —Over-enrollment the enrolment of learner numbers that significantly exceed the designed capacity of school facilities, classrooms, and teacher staffing is a pervasive challenge in Zambian primary schools, generating educational quality deficits, infrastructure stress, and teacher performance pressures that compound existing educational disadvantage in rural districts. In Kalabo District, Western Province, rapid population growth combined with insufficient school infrastructure expansion has created severe over-enrollment conditions in selected primary schools, with classrooms designed for 40 learners hosting 80–100 pupils and teacher-learner ratios far exceeding recommended pedagogical standards. This article examines the effects of over-enrollment on pupil academic performance and teacher professional performance in two selected primary schools in Kalabo District, contextualising findings within global scholarship on class size, teacher workload, AI-assisted large-class pedagogy, and educational resource optimisation. Drawing on a mixed-methods survey, findings confirm significant negative impacts on both learner outcomes and teacher well-being, while identifying AI-powered teaching tools, cooperative learning strategies, and school infrastructure policy reforms as evidence-based responses. Policy recommendations are presented.

Keywords *— Over-Enrollment; Large Classes; Kalabo District; Zambia; Teacher Performance; Pupil Outcomes; AI Pedagogy; Educational Resources.*

1. Introduction

The global commitment to universal primary education embodied in SDG 4 and Zambia's national educational policy has achieved remarkable enrolment expansion, with primary school net enrolment ratios rising substantially over the past two decades (Meena et al., 2025; Vettriselvan et al., 2025c). However, enrolment expansion without commensurate investment in school infrastructure, teacher recruitment, and instructional resource provision has generated severe over-enrollment conditions in many Zambian primary schools creating a tension between the quantity of educational access and the quality of educational experience that access delivers (Vettriselvan & Rajan FSA, 2019; Gayathri et al., 2025b).

In Kalabo District, Western Province, over-enrollment is particularly acute in schools serving communities where alternative school options are geographically inaccessible generating conditions of forced learner concentration that place exceptional demands on physical infrastructure, teacher capacity, and institutional resource management (Vettriselvan et al., 2025b; Venice et al., 2025a).

AI-powered large-class pedagogy tools, digital cooperative learning platforms, and policy-driven infrastructure expansion represent complementary short-term and long-term responses to over-enrollment's educational quality consequences (Venice et al., 2025b; Vasantha et al., 2025). This article examines over-enrollment effects in Kalabo District and identifies evidence-based mitigation strategies.

2. Literature Review

2.1 Over-Enrollment and Pupil Academic Outcomes

The negative relationship between learner-to-teacher ratio and academic performance is well-established in educational research, with evidence demonstrating that performance deficits begin to accumulate above a class size threshold of approximately 30–35 pupils per teacher and increase progressively as class size exceeds this threshold (Venice et al., 2025a; Vettriselvan et al., 2025c).

Over-enrollment amplifies these class size effects through additional mechanisms: overcrowded classrooms generate noise levels that impair concentration and auditory discrimination, particularly for learners with hearing difficulties; inadequate seating means learners share furniture or sit on floors in positions that impair writing and visual access to instructional materials; and infrastructure overcrowding toilets, water points, and eating areas generates sanitation and health risks that increase absence

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rates and reduce learning time (Ashifa, 2020a; Gayathri et al., 2025b).

Differential vulnerability to over-enrollment effects is a critical equity dimension: learners with disabilities, those with special learning needs, and those experiencing household economic stress are disproportionately disadvantaged by over-enrolled classroom conditions (Ashifa, 2019; Meena et al., 2025). These learners require the individualised teacher attention that is most severely rationed in overcrowded classrooms generating compounding educational disadvantage for those who are already most vulnerable (Venice et al., 2025b; Vettriselvan et al., 2025a).

2.2 Effects on Teacher Professional Performance

Over-enrollment generates significant negative effects on teacher professional performance through multiple mechanisms (Gayathri et al., 2025b; Zahoor et al., 2025). Lesson preparation quality declines when teachers face the challenge of planning instruction for heterogeneous groups of 80+ learners with diverse learning needs with the result that over-enrolled classroom teachers more frequently deliver standardised whole-class transmission instruction rather than the differentiated, learner-responsive pedagogy that effective instruction requires (Venice et al., 2025c; Vettriselvan & Rajan FSA, 2019). Assessment workload in over-enrolled classes is prohibitive the marking of written work from 80+ learners between lessons generates an unsustainable workload that forces many teachers to reduce assessment frequency or quality, depriving learners of the formative feedback essential for learning improvement (Gayathri et al., 2025b; Venice et al., 2025b).

Over-enrollment-generated occupational stress arising from noise, discipline challenges, infrastructure stress, assessment burden, and the professional frustration of being unable to meet learner needs adequately is a significant driver of teacher burnout, absenteeism, and attrition in Zambian rural primary schools (Zahoor et al., 2025; Gayathri et al., 2025a). Emotional intelligence and professional resilience are significant moderators of over-enrollment stress impact on teacher performance with high emotional intelligence teachers maintaining instructional quality more consistently under over-enrollment pressure than those with lower emotional regulatory capacity (Zahoor et al., 2025; Elkin et al., 2025).

2.3 AI-Assisted Large-Class Pedagogy Solutions

AI-powered large-class pedagogy tools offer evidence-based technological responses to over-enrollment's instructional quality consequences (Venice et al., 2025b; Akila et al., 2025). Automated formative assessment platforms that generate instant feedback on learner responses enabling whole-class understanding monitoring that manual marking cannot achieve at scale partially compensate for the assessment workload and feedback quality deficits generated by over-enrollment (Venice et al., 2025c; Vasantha et al., 2025). AI-powered cooperative learning group formation systems that create optimal peer learning groups from over-enrolled class populations using data on performance levels, learning styles, and social compatibility enable effective peer-mediated instruction that extends individual teacher attention through structured peer support (Venice et al., 2025a; Swadhi et al., 2025a).

2.4 Policy Responses: Infrastructure and Teacher Supply

Sustainable over-enrollment resolution requires policy-level investment in school infrastructure expansion and teacher recruitment that addresses the structural supply-demand imbalance at the root of over-enrollment (Vettriselvan et al., 2025c; Meena et al., 2025).

Double-shift schooling where two school populations share the same infrastructure in separate morning and afternoon sessions offers a medium-term infrastructure efficiency measure that can halve effective class sizes without requiring new construction, at the cost of reduced instructional time per shift (Gayathri et al., 2025b; Venice et al., 2025a).

AI-powered school infrastructure planning tools that optimise school capacity allocation across geographic areas identifying optimal locations for new classroom construction to maximally reduce over-enrollment across a district's school network can significantly enhance the effectiveness of infrastructure investment decisions (Venice et al., 2025b; Devi et al., 2025).

3. Methodology

A descriptive survey examined the effects of over-enrollment on pupil and teacher performance in two selected primary schools in Kalabo District. Mixed methods combined teacher questionnaires, head teacher interviews, pupil examination performance analysis, classroom observation, and learner focus group discussions (Kombo & Tromp, 2014; Orodho & Kombo, 2012). The sample included 24 teacher respondents, 2 head teacher key informants, and 80 learner participants across Grades 4–7.

Pupil examination results were compared between over-enrolled and appropriately-enrolled class groups where available within study schools. Classroom observations documented class sizes, physical conditions, and instructional approach. Thematic and statistical analysis was applied.

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4. Findings And Analysis

4.1 Over-Enrollment Extent

s

Classroom census revealed mean class sizes of 78 and 84 pupils respectively in the two study schools approximately double the national recommended maximum of 45 pupils per teacher. Physical classroom conditions were severely compromised: 65% of learners in the larger school were observed sharing desks or sitting on the floor; lighting was inadequate in 40% of observed classroom positions; and noise levels during instruction were assessed as significantly above recommended thresholds for effective teaching (Venice et al., 2025a; Gayathri et al., 2025b).

4.2 Effects on Pupil Performance

Examination performance analysis revealed mean scores 15–22 percentage points lower across all subject areas in Grade 7 learners from over-enrolled classes compared to district averages, consistent with the class size-performance relationship documented internationally.

Teacher respondents attributed this differential primarily to reduced individual attention time per learner, more limited assessment feedback, and the distraction effects of overcrowded, noisy learning environments (Venice et al., 2025b; Vettriselvan et al., 2025c).

4.3 Effects on Teacher Performance

Teacher occupational stress scores were significantly elevated (mean 76/100), with 85% of respondents reporting that over-enrollment prevented them from providing the instructional quality they aspired to deliver. Assessment completion rates were 60% lower than in appropriately-sized classes, with teachers reporting having to reduce written assignment frequency to manageable levels. Teacher absenteeism rates in study schools (mean 18%) were significantly above the district average (11%), consistent with research linking over-enrollment to elevated absenteeism (Zahoor et al., 2025; Gayathri et al., 2025a).

4.4 Mitigation Strategies in Use

Current mitigation strategies were limited to cooperative group work (practised by 65% of teachers) and peer tutoring arrangements (45%). No digital pedagogy tools or AI-assisted assessment platforms were in use. Teacher interest in AI-assisted assessment and cooperative learning support platforms was high (88%), with mobile-based solutions identified as most acceptable given infrastructure constraints (Venice et al., 2025b; Vasantha et al., 2025).

5. Discussion

Over-enrollment in Kalabo District primary schools constitutes a systemic educational quality crisis demanding both immediate pedagogical mitigation and sustained structural policy response. AI-powered assessment automation, cooperative learning support, and peer tutoring platforms offer the most practically deployable near-term technological mitigations partially compensating for the instructional quality and assessment feedback deficits generated by overcrowding without requiring infrastructure investment (Venice et al., 2025b; Akila et al., 2025). Long-term resolution requires the school infrastructure investment and teacher recruitment that transforms the structural conditions generating over-enrollment supplemented by AI-powered infrastructure planning tools that optimise the impact of available investment (Vettriselvan et al., 2025c; Meena et al., 2025).

6. Conclusion and Recommendations

Recommendations: (1) deploy AI-powered automated formative assessment enabling whole-class performance monitoring (Venice et al., 2025b; Akila et al., 2025); (2) implement structured cooperative learning and peer tutoring programmes reducing effective learner-teacher ratios (Venice et al., 2025a; Swadhi et al., 2025a); (3) invest in additional classroom construction using AI-optimised infrastructure planning (Venice et al., 2025b; Devi et al., 2025); (4) introduce double-shift schooling as an interim over-enrollment reduction measure (Gayathri et al., 2025b; Meena et al., 2025); and (5) implement teacher well-being programmes reducing burnout risk in over-enrolled school contexts (Zahoor et al., 2025; Elkin et al., 2025).

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