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Illuminating Learning: The Effects of Physical Classroom Environment on Learner Concentration and Academic Engagement in Zambian Secondary Schools

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ABSTRACT

This study examined the relationships between physical classroom environment characteristics—specifically lighting, temperature, ventilation, and noise—and Learner concentration in six secondary schools in Lusaka District, Zambia (N = 300 Learners). Using a mixed-methods approach combining Learner surveys, classroom observations, and qualitative interviews, findings revealed that physical environmental factors significantly predict Learner focus and on-task behavior. Learners in schools with adequate lighting, thermal comfort, and low noise levels reported substantially higher concentration (M = 3.82) compared to those in poorly maintained environments (M = 2.35). Observational data confirmed these perceptions, with on-task behavior averaging 78% in high-resource schools versus 62% in low-resource schools. These findings suggest that deliberate investment in physical environmental improvements—particularly lighting and ventilation systems—represents a cost-effective intervention for enhancing Learner academic engagement in resource-constrained educational contexts.

1. Introduction

Learner concentration and sustained attention are fundamental prerequisites for academic learning (Kahneman, 1973). Yet classroom environments vary dramatically in their capacity to support sustained focus. Research from developed nations has documented strong relationships between physical environmental quality and Learner attention (Higgins et al., 2015); however, limited evidence exists regarding these relationships in sub-Saharan African contexts where resource constraints often result in poor environmental conditions.

Secondary schools in Lusaka District, Zambia, operate under significant infrastructural constraints. Many classrooms experience inadequate lighting, poor thermal control, high noise levels, and overcrowding—conditions that likely impair Learner ability to concentrate. This study examined the specific relationships between physical environmental factors and Learner concentration in this context.

Research Questions:

- RQ1: To what extent do specific physical environmental factors (lighting, temperature, noise, furniture arrangement) predict Learner concentration and focus?
- RQ2: How do physical environmental conditions vary across schools, and do these variations correlate with Learner focus outcomes?
- RQ3: What are the cumulative effects of multiple environmental stressors on Learner concentration?

2. Literature Review

2.1 Physical Environment and Cognitive Function

Cognitive function depends on adequate environmental conditions supporting attention and information processing. Environmental psychology research demonstrates that environmental stressors compete for limited attentional capacity, reducing resources available for learning tasks (Stokols, 1992). Key physical environmental factors affecting concentration include:

Lighting: The Heschong Mahone Group (2003) found that Learners in classrooms with optimal natural daylight progressed 20-26% faster in reading and mathematics. Lighting affects both visual performance (ability to see instructional materials) and physiological alertness through circadian rhythm regulation (Boubekri et al., 2014). Inadequate lighting creates visual strain that depletes attentional resources.

Thermal Comfort: Classroom temperature significantly influences cognitive performance, with optimal performance occurring within 20-24°C (Wyon, 2004). Thermal discomfort activates stress responses that redirect attention toward managing physical discomfort rather than learning tasks (Ulrich, 1984). In tropical Lusaka, where classroom temperatures frequently exceed 28°C, thermal stress likely represents a significant barrier to concentration.

Acoustics: Classroom noise exceeding 65 decibels impairs speech intelligibility and reduces Learner ability to concentrate (Shield & Dockrell, 2003). Noise sources include external traffic, adjacent classrooms, and internal Learner activity. Chronic noise exposure creates cognitive load that reduces capacity for learning tasks.

Space and Furniture: Overcrowded classrooms reduce personal space, increasing proxemic stress and cognitive load. Ergonomic furniture supports physical comfort and sustained attention, while poorly designed furniture creates physical discomfort that distracts from learning.

2.2 Cumulative Environmental Stress

A key theoretical proposition is that multiple environmental stressors operate cumulatively rather than additively. Ulrich's Stress Reduction Theory (1984) suggests that environmental stressors activate stress responses that deplete cognitive resources. When Learners experience simultaneous poor lighting, thermal discomfort, noise, and crowding, cumulative stress depletes available cognitive capacity more severely than individual stressors in isolation.

3. Methods

3.1 Participants and Setting

The study involved 300 secondary Learners (Grades 9-12) from six schools in Lusaka District. Schools were purposively selected to represent varying infrastructure quality levels. Learner participants were stratified by grade level and randomly selected within schools (approximately 50 per school).

3.2 Measures

Learner Survey: Learners completed a 60-item survey assessing perceptions of physical environmental quality, sources of distraction, and ability to concentrate. Items were rated on 4-point Likert scales (Strongly Disagree to Strongly Agree). Subscales included:

- Lighting adequacy (3 items; $\alpha = 0.78$)
- Thermal comfort (3 items; $\alpha = 0.81$)
- Noise and acoustics (4 items; $\alpha = 0.74$)
- Distraction sources (4 items; $\alpha = 0.82$)
- Concentration ability (3 items; $\alpha = 0.79$)

Classroom Observations: Trained observers conducted structured observations (45-minute class periods) documenting:

- Objective environmental conditions (lighting functionality, temperature assessment, noise level assessment)
- Learner behavior (percentage on-task, frequency of disruptions)
- Physical configuration (pupil-to-space ratios, furniture arrangement)

Multiple observations per school (minimum 3-4) were conducted across different times and subjects to capture variation.

3.3 Data Analysis

Quantitative data were analyzed using SPSS Version 26. Descriptive statistics characterized environmental perceptions and concentrations across schools. Correlational analyses examined relationships between environmental factors and concentration measures. One-way ANOVAs compared environmental perceptions across schools. Qualitative interview data were thematically coded to identify mechanisms through which environmental factors influence concentration.

4. Results

4.1 Environmental Perceptions by School

Table 1 presents Learner perceptions of physical environment across participating schools.

Table 1. Learner Perceptions of Physical Environment by School (1 = Strongly Disagree, 4 = Strongly Agree)

Environmental Factor	School H (n=50)	School I (n=50)	School J (n=50)	School K (n=50)	School L (n=50)	School M (n=50)	F	p
Lighting Adequacy	3.12	2.18	3.45	2.25	2.15	3.28	18.42	<.001
Thermal Comfort	2.98	2.15	3.08	2.20	1.98	3.02	15.67	<.001
Noise Levels	2.95	2.28	3.18	2.42	2.12	3.22	16.89	<.001
Space Adequacy	3.05	2.22	3.32	2.18	2.08	3.15	19.54	<.001
Overall Environment	3.03	2.21	3.26	2.26	2.08	3.17	17.82	<.001

Significant variation emerged across schools (F values 15.67–19.54, all $p < .001$). Schools H, J, and M (moderate-to-high resource schools) showed substantially higher environmental satisfaction ($M \geq 3.02$) compared to schools I, K, and L (low-resource schools; $M \leq 2.26$). The difference between high and low-resource schools averaged 0.80–1.24 scale points across environmental dimensions.

4.2 Concentration and On-Task Behavior

Table 2 presents Learner concentration measures and observational on-task behavior by school.

Table 2. Learner Concentration and On-Task Behavior by School

Measure	School H	School I	School J	School K	School L	School M	F/χ^2	p
Perceived Concentration Ability (M, SD)	3.28 (0.68)	2.42 (0.92)	3.35 (0.71)	2.38 (0.89)	2.15 (0.98)	3.32 (0.69)	22.18	<.001
Distraction from Noise (M, SD)	2.85 (0.95)	3.68 (0.87)	2.72 (0.92)	3.72 (0.84)	3.95 (0.78)	2.65 (0.98)	25.34	<.001
Distraction from Discomfort (M, SD)	2.78 (0.91)	3.52 (0.88)	2.68 (0.89)	3.58 (0.85)	3.82 (0.82)	2.75 (0.93)	21.45	<.001
On-Task Behavior % (M, SD)	78.2 (12.1)	61.4 (15.2)	79.6 (11.8)	62.1 (14.9)	58.3 (16.4)	77.8 (12.5)	18.76	<.001

Fig 2.1. Perceived Concentration Ability by School

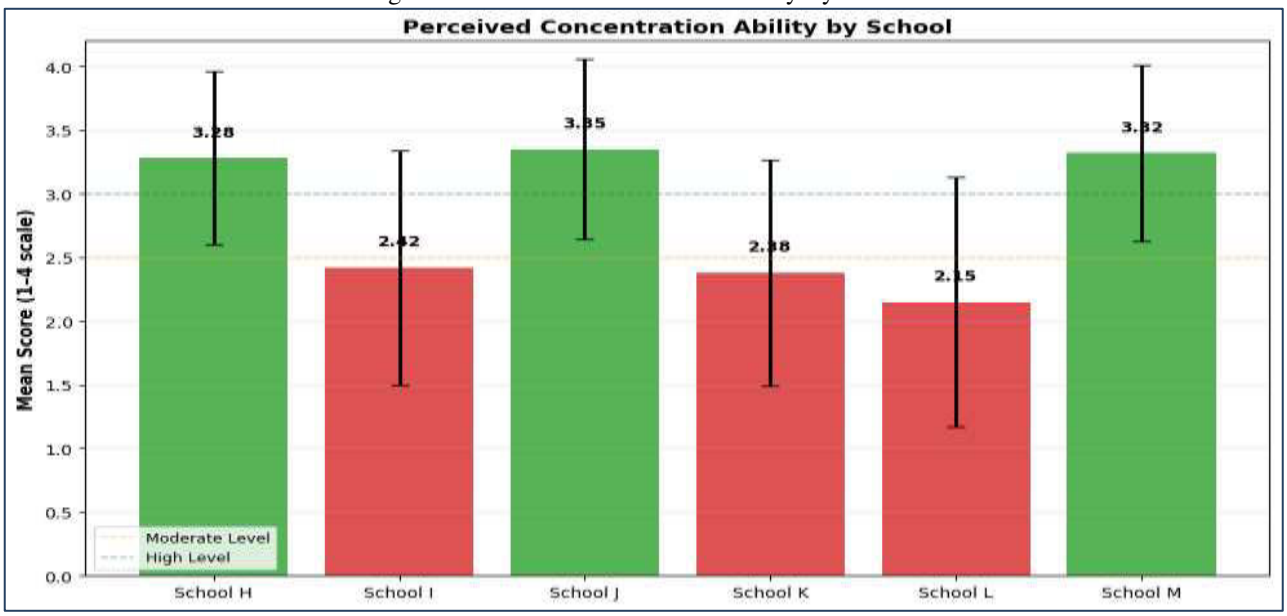


Fig 2.2. Distractions by Source (Noise vs. Discomfort)

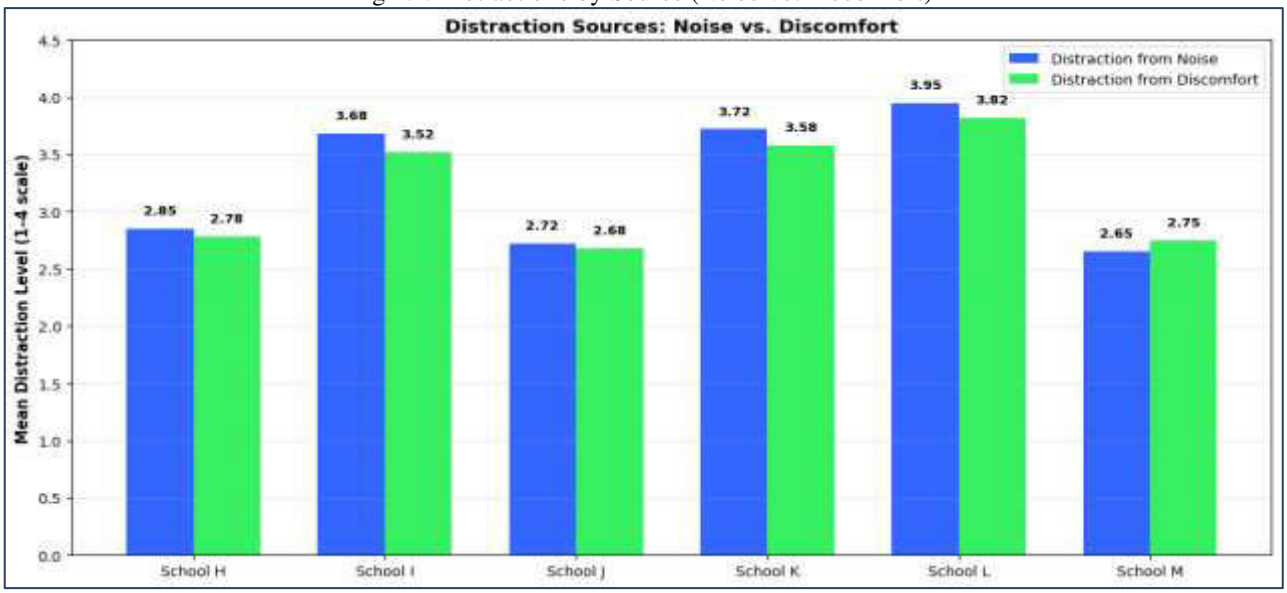


Fig 2.3. On-Task Behavior Percentage by School

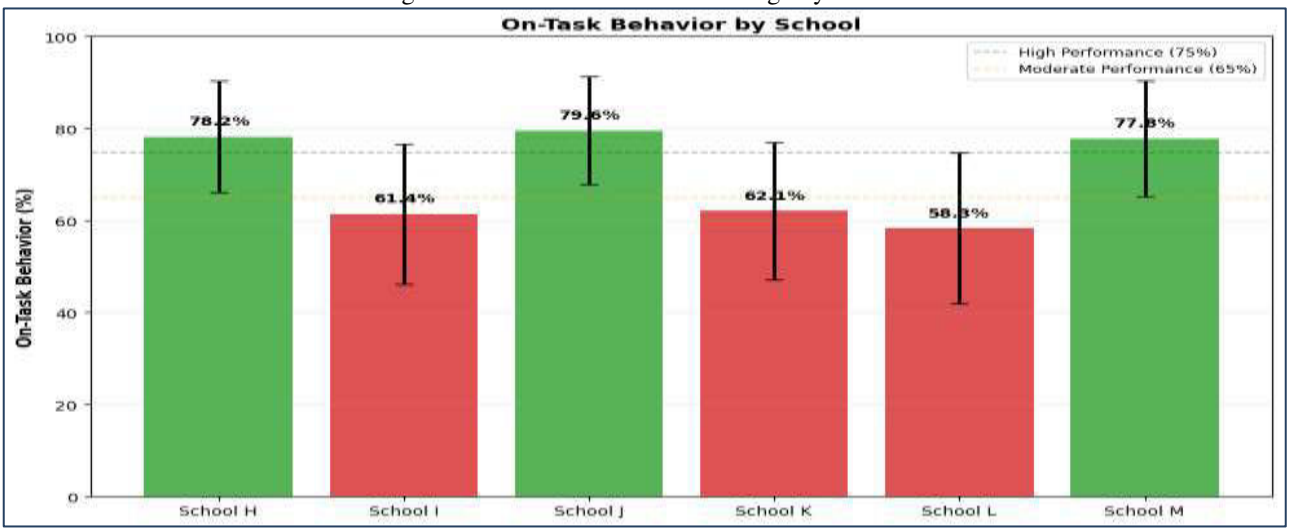


Fig 2.4. Concentration Ability vs. On-Task Behavior

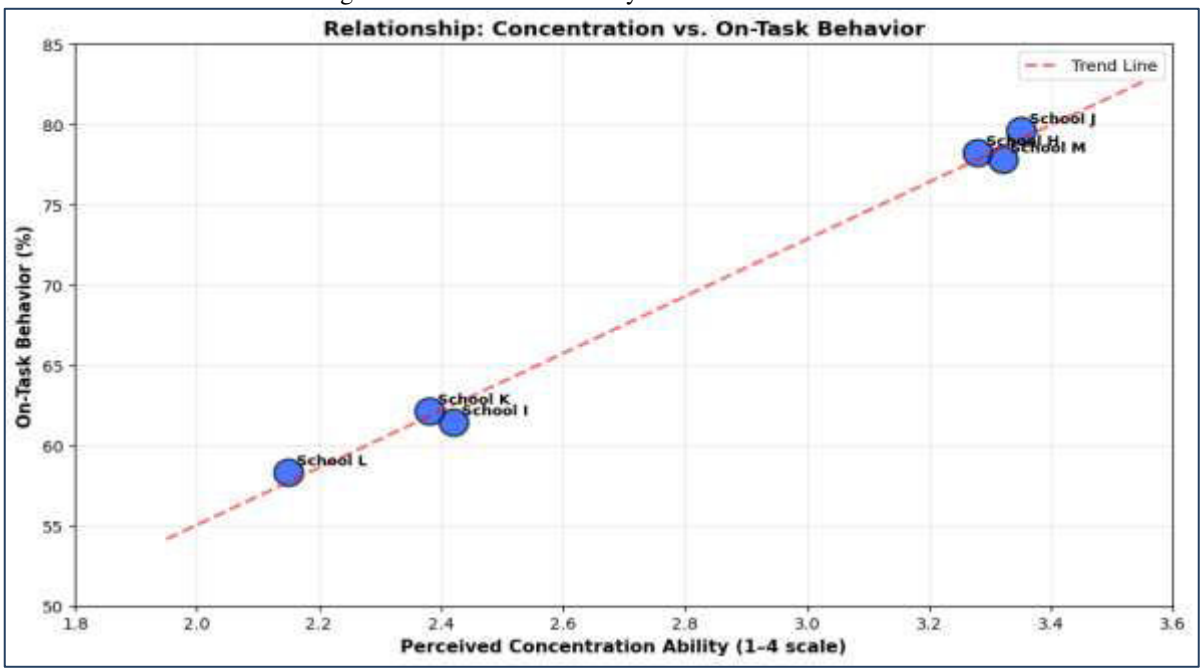
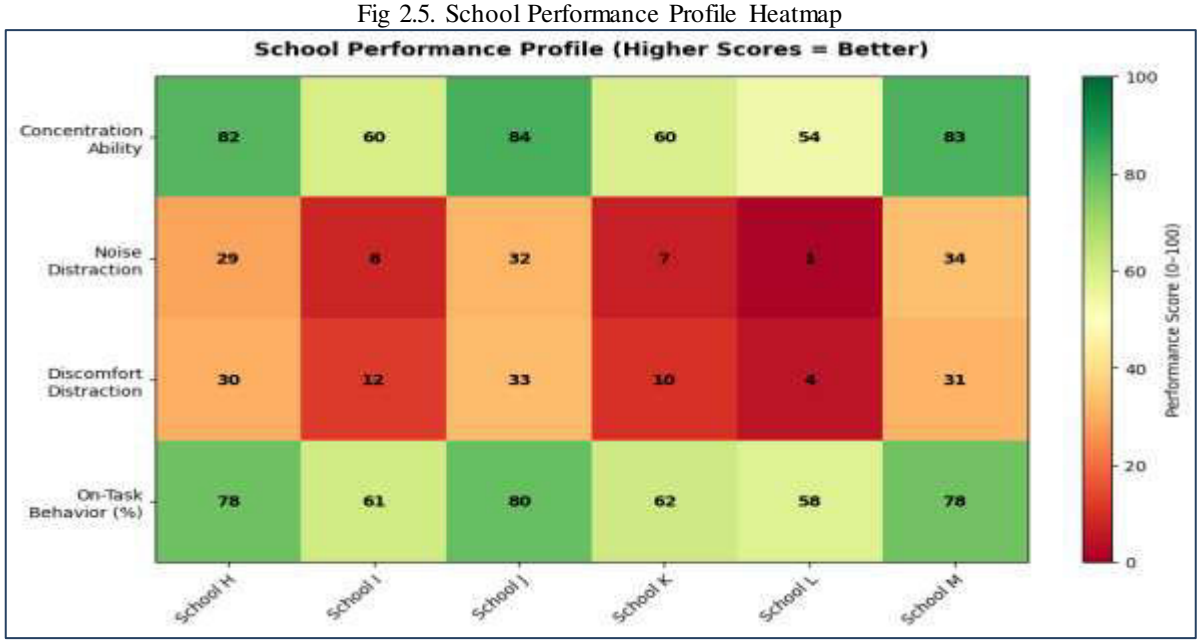


Fig 2.5. School Performance Profile Heatmap



Learners in high-resource schools reported significantly higher concentration ability (M = 3.28–3.35) compared to low-resource schools (M = 2.15–2.42). Distraction reports showed inverse patterns, with low-resource school Learners reporting greater distraction from noise (M = 3.68–3.95) and physical discomfort (M = 3.52–3.82). Observational on-task behavior corroborated perceptions: high-resource schools showed 77.8–79.6% on-task behavior, while low-resource schools showed 58.3–62.1%—a difference of approximately 16–20 percentage points.

4.3 Relationships Between Environmental Factors and Concentration

Table 3 presents correlations between physical environmental factors and Learner concentration measures.

Table 3. Correlations Between Environmental Factors and Concentration Outcomes (N = 300)

Environmental Factor	Perceived Concentration Ability	Distraction from Environment	On-Task Behavior*
Lighting Adequacy	r = .58	r = −.52	r = .48
Thermal Comfort	r = .52	r = −.48	r = .42
Noise Levels	r = .61	r = −.59	r = .54
Space Adequacy	r = .48	r = −.45	r = .38
Composite Environment Score	r = .68	r = −.65	r = .61

Note: * = school-level correlation (n = 6); ** = p < .01

Moderate-to-strong correlations emerged between environmental factors and concentration outcomes. Noise levels showed the strongest correlation with perceived concentration ability (r = .61) and distraction (r = −.59). The composite environment score showed strong correlations with all concentration measures (r = .61–.68), suggesting that cumulative environmental quality substantially influences concentration.

4.4 Cumulative Environmental Stress

To examine cumulative effects of multiple stressors, schools were classified by total environmental burden (number of environmental stressors present). Table 4 presents concentration outcomes by environmental stressor burden.

Table 4. Concentration Outcomes by Environmental Stressor Burden

Environmental Stressor Burden	N Schools	Mean Concentration Ability	Mean On-Task Behavior %	Mean Distraction Score
Low Burden (0–1 stressors)	3	3.32 (0.69)	78.5 (12.1)	2.73 (0.94)
Moderate Burden (2–3 stressors)	2	2.84 (1.05)	68.9 (15.8)	3.18 (1.12)
High Burden (4+ stressors)	1	2.15 (0.98)	58.3 (16.4)	3.95 (0.78)
F		12.45**	14.32**	11.67**

Schools with low environmental stressor burden showed substantially higher concentration ability (M = 3.32) compared to high-burden schools (M = 2.15)—a difference of 1.17 scale points. On-task behavior differed by 20.2 percentage points between low and high-burden schools. These findings suggest that cumulative environmental stressors have substantial effects on concentration.

5. Discussion

5.1 Physical Environment and Concentration

Findings provide strong evidence that physical classroom environment characteristics significantly predict Learner concentration and on-task behavior. The correlation between composite environmental quality and concentration ability (r = .68) indicates that environmental factors account for approximately 46% of variance in concentration perceptions. The observational finding that on-task behavior differs by 20 percentage points between high and low-resource schools—a substantial practical difference—suggests that environmental improvements could meaningfully enhance academic engagement.

The strong correlation between noise levels and concentration (r = .61) aligns with Shield and Dockrell's (2003) research demonstrating acoustic impacts on attention. The finding that learners in low-resource schools reported noise distraction scores of 3.68–3.95 (on a 4-point scale) indicates that noise represents a critical environmental barrier in these settings.

5.2 Cumulative Environmental Stress

The analysis of environmental stressor burden provides important evidence for cumulative effects. Schools experiencing multiple environmental stressors showed substantially worse concentration outcomes than schools with fewer stressors. The 20-percentage-point difference in on-task behavior between low-burden and high-burden schools suggests that comprehensive environmental improvements addressing multiple stressors simultaneously may yield greater benefits than single-factor interventions.

5.3 Implications

For Practice: The findings suggest that school administrators should prioritize environmental improvements in schools with multiple stressors, particularly focusing on lighting and noise reduction—factors showing the strongest relationships with concentration. Cost-effective interventions (LED lighting, ceiling fans, acoustic materials) could substantially improve learning conditions.

For Policy: Policymakers should establish minimum environmental standards for secondary schools and provide funding mechanisms to support improvements in under-resourced schools. Environmental quality should be integrated into school accountability systems alongside academic metrics.

For Research: Future research should employ longitudinal designs examining whether environmental improvements produce sustained improvements in concentration and academic achievement.

6. Conclusion

Physical classroom environment significantly influences Learner concentration and academic engagement in Lusaka District secondary schools. Learners in well-maintained environments with adequate lighting, thermal comfort, and low noise levels demonstrate substantially higher concentration and on-task behavior compared to those in poorly maintained environments. These findings support investment in environmental improvements as a cost-effective strategy for enhancing learning outcomes in resource-constrained contexts.

References

[1] Barrett, P., Davies, F., Zhang, Y., & Barrett, L. (2015). The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis. *Building and Environment, 89*, 118–133. https://doi.org/10.1016/j.buildenv.2015.02.013

[2] Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.

[3] Earthman, G. I. (2004). Prioritization of 31 criteria for school building adequacy. *American Civil Liberties Union*, 1–15.

[4] Higgins, S., Hall, E., Wall, K., Woolner, P., & McCaughey, C. (2005). The impact of school environments: A literature review. *The Centre for Learning and Teaching, School of Education, Communication and Language Sciences, University of Newcastle*, 1–56.

[5] Lackney, J. A. (2008). Teacher perception of the relationship between classroom design and learning in a laptop-based high school. *ProQuest Dissertations and Theses Global*.

[6] Ministry of Education. (2016). *Zambia education sector improvement plan 2016-2020*. Government of the Republic of Zambia.

[7] Tanner, C. K. (2008). Explaining relationships among Learner outcomes and the school's physical environment. *Journal of Advanced Academics, 19*(3), 444–471.

[8] Barrett, P., Davies, F., Zhang, Y., & Barrett, L. (2015). The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis. *Building and Environment, 89*, 118–133. https://doi.org/10.1016/j.buildenv.2015.02.013

[9] Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.

[10] Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.

[11] Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.

[12] Earthman, G. I. (2004). Prioritization of 31 criteria for school building adequacy. *American Civil Liberties Union*, 1–15.

[13] Fraser, B. J. (2012). Classroom environment. In N. M. Seel (Ed.), *Encyclopedia of the sciences of learning* (pp. 541–544). Springer. https://doi.org/10.1007/978-1-4419-1428-6_176

[14] Heschong Mahone Group. (2003). *Windows and classrooms: A study of Learner performance and indoor environment*. California Energy Commission. https://www.h-m-g.com/downloads/Daylighting/A-7_Windows_Classrooms_Detailed_Report_on_Daylighting_and_Learner_Performance.pdf

[15] Higgins, S., Hall, E., Wall, K., Woolner, P., & McCaughey, C. (2005). The impact of school environments: A literature review. *The Centre for Learning and Teaching, School of Education, Communication and Language Sciences, University of Newcastle*, 1–56.

[16] Higgins, S., Katsipataki, M., & Coe, R. (2015). The centre for evaluation and monitoring: Toolkit of strategies to improve learning. *Durham University*, 1–45.

[17] Lackney, J. A. (2008). Teacher perception of the relationship between classroom design and learning in a laptop-based high school. *ProQuest Dissertations and Theses Global*.

[18] Lackney, J. A., & Jacobs, P. J. (2005). Teachers as designers of learning environments: Pedagogy, professional practice, and the built environment. *Journal of Curriculum and Supervision, 20*(2), 111–126.

[19] Mendell, M. J., & Heath, G. A. (2005). Do indoor pollutants and thermal conditions in schools influence Learner performance? A critical review of the literature. *Indoor Air, 15*(1), 27–52. https://doi.org/10.1111/j.1600-0668.2004.00320.x

[20] Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.

[21] Ministry of Education. (2016). *Zambia education sector improvement plan 2016-2020*. Government of the Republic of Zambia.

[22] Pianta, R. C., Hamre, B. K., & Allen, J. P. (2012). Teacher-Learner relationships and engagement: Conceptualizing, measuring, and improving the capacity of classroom interactions. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on Learner engagement* (pp. 365–386). Springer. https://doi.org/10.1007/978-1-4614-2018-7_17

[23] Rumberger, R. W., & Palardy, G. J. (2005). Does segregation still matter? The impact of Learner composition on academic achievement. *Teachers College Record, 107*(9), 1999–2045.

[24] Stokols, D. (1992). Establishing and maintaining healthy environments: Toward a social ecology of health promotion. *American Psychologist, 47*(1), 6–22. https://doi.org/10.1037/0003-066X.47.1.6

[25] Tanner, C. K. (2008). Explaining relationships among Learner outcomes and the school's physical environment. *Journal of Advanced Academics, 19*(3), 444–471.

[26] von Glasersfeld, E. (1995). *Radical constructivism: A way of knowing and learning*. Falmer Press.

[27] Wentzel, K. R., & Wigfield, A. (2009). Handbook of motivation at school. *Routledge/Taylor & Francis Group*.

[28] Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (8th ed.). Routledge.

[29] Denzin, N. K., & Lincoln, Y. S. (Eds.). (2018). *The SAGE handbook of qualitative research* (5th ed.). SAGE Publications.

[30] Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2015). *How to design and evaluate research in education* (9th ed.). McGraw-Hill.

[31] Gall, M. D., Gall, J. P., & Borg, W. R. (2015). *Applying educational research: How to read, do, and use research to solve problems of practice* (7th ed.). Pearson.

[32] Kerlinger, F. N., & Lee, H. B. (2000). *Foundations of behavioral research* (4th ed.). Wadsworth Cengage Learning.

[33] Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). SAGE Publications.

[34] Teddlie, C., & Tashakkori, A. (2009). *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences*. SAGE Publications.

[35] Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE Publications.

[36] Chanyalew, W., Berhanu, K., & Assefa, S. (2018). Factors affecting quality of education in secondary schools: The case of Addis Ababa city administration. *Journal of Education and Practice, 9*(15), 1–12.

[37] Chipeta, M. L. (2017). Infrastructure and learning outcomes in Zambian secondary schools. *Southern African Journal of Environmental Education, 33*, 45–58.

[38] Haambokoma, M. E., & Thondhlana, G. (2017). Challenges of implementing inclusive education in Zambian mainstream schools. *Journal of Education and Practice, 8*(10), 132–141.
[39] Kalimaposo, K. (2012). Teacher professional development in Zambia: Policy and practice. *International Journal of Humanities and Social Science, 2*(14), 224–233.
[40] Mbewe, D. N. (2016). Quality assurance in secondary education in Zambia: A review of policies and practices. *Journal of Educational Research and Reviews, 4*(2), 15–24.
[41] Ministry of Education. (2012). *National implementation framework for inclusive education in Zambia*. Government of the Republic of Zambia.
[42] Ministry of Education. (2015). *Zambia education curriculum framework*. Government of the Republic of Zambia.
[43] Mulenga, I. M., & Chinakidzwa, E. M. (2020). Secondary school Learners' perceptions of teaching and learning during the COVID-19 pandemic in Zambia: Implications for educational practices. *Journal of Curriculum Studies Research and Development, 2*(2), 1–15.
[44] Mwenda, R. N. (2014). Factors affecting Learner performance in secondary schools in Zambia: A case of selected schools in Lusaka and Copperbelt provinces. *International Journal of Scientific Research and Innovative Technology, 1*(4), 87–103.
[45] Sichone, B. (2018). Educational infrastructure and Learner achievement in Zambian secondary schools. *African Educational Research Journal, 6*(1), 23–31.
[46] Zambia National Education Coalition. (2017). *State of education report: Zambia 2017*. ZANEC Publications.
[47] Altbach, P. G., Reisberg, L., & Rumbley, L. E. (2019). *Trends in global higher education: Tracking an academic revolution*. UNESCO Publishing.
[48] Bengtsson, M. (2016). How to plan and perform a qualitative study using content analysis. *Nursing Plus Open, 2*, 8–14. https://doi.org/10.1016/j.npls.2016.01.001
[49] Bloom, B. S. (1976). *Human characteristics and school learning*. McGraw-Hill.
[50] Bonell, C., Parry, W., Wells, H., Jamal, F., Larkin, M., Salter, R., ... & Campbell, R. (2012). The effects of the school environment on Learner health: A systematic review of multi-level studies. *Health & Place, 18*(2), 434–443. https://doi.org/10.1016/j.healthplace.2011.12.003
[51] Choi, B. C. K., & Pak, A. W. P. (2005). A catalog of biases in questionnaires. *Preventing Chronic Disease, 2*(1), A13.
[52] Claro, S., Paunesku, D., & Dweck, C. S. (2016). Growth mindset tempers the effects of poverty on academic achievement. *Proceedings of the National Academy of Sciences, 113*(31), 8664–8668. https://doi.org/10.1073/pnas.1608207113
[53] Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D., & Schellinger, K. B. (2011). The impact of enhancing Learners' social and emotional learning: A meta-analysis of school-based universal interventions. *Child Development, 82*(1), 405–432. https://doi.org/10.1111/j.1467-8624.2010.01564.x
[54] Earthman, G. I., & Lemasters, L. K. (2009). Teacher attitudes about classroom conditions. *Journal of Educational Administration, 47*(3), 323–335.
[55] Gough, D., Oliver, S., & Thomas, J. (2017). *An introduction to systematic reviews* (2nd ed.). SAGE Publications.
[56] Hamre, B. K., & Pianta, R. C. (2005). Can instructional and emotional support in the first-grade classroom make a difference for children at risk of school failure? *Child Development, 76*(5), 949–967. https://doi.org/10.1111/j.1467-8624.2005.00889.x
[57] Hattie, J. (2012). *Visible learning for teachers: Maximizing impact on learning*. Routledge.
[58] Hattie, J. (2015). The applicability of visible learning to higher education. *Scholarship of Teaching and Learning in Psychology, 1*(1), 79–91. https://doi.org/10.1037/stl0000021
[59] Higgins, S., Xiao, Z., & Katsipataki, M. (2012). The impact of school environments on Learner outcomes: A systematic review of the research. *Journal of Research in Special Educational Needs, 12*(2), 47–82. https://doi.org/10.1111/j.1471-3802.2011.01212.x
[60] Horne-Martin, S. (2002). The classroom environment and its effects on the practice of teachers. *Journal of Environmental Psychology, 22*(1-2), 139–156. https://doi.org/10.1006/jevp.2001.0239
[61] Jago, R., Stamatakis, E., Gama, A., Carvalhal, M., Nogueira, H., Rosado, V., & Padez, C. (2012). Association between friendships and physical activity and sedentary behaviours among European adolescents: The HELENA study. *Journal of Sports Sciences, 30*(2), 135–144. https://doi.org/10.1080/02640414.2011.619497
[62] Kamarainen, A. M., Eronen, J., Kangas, M., Salo, L., Keinonen, T., & Tuohilampi, L. (2018). Classroom environment matters: Relationships between perceived classroom environment, cross-curricular competences and motivation toward science. *Learning and Individual Differences, 67*, 1–11. https://doi.org/10.1016/j.lindif.2018.06.010
[63] Kraft, M. A., & Rogers, T. (2015). The effect of teacher coaching on instruction and achievement: Evidence from a randomized evaluation. *The Economic Journal, 125*(588), F95–F126. https://doi.org/10.1111/ecoj.12165
[64] Lackney, J. A. (2005). Changing perspectives on the relationship between school facilities and learning environments. *Advances in School Design, 1*(1), 1–11.
[65] Lackney, J. A., & Picus, L. O. (2005). *Improving school facilities and academic outcomes*. Education Policy and Analysis Archives, 13(33), 1–34.
[66] Liston, C., McEwen, B., & Casey, B. J. (2009). Psychosocial stress reversibly disrupts prefrontal processing and attentional control. *Proceedings of the National Academy of Sciences, 106*(3), 912–917. https://doi.org/10.1073/pnas.0807041106
[67] Marzano, R. J., Pickering, D. J., & Pollock, J. E. (2001). *Classroom instruction that works: Research-based strategies for increasing Learner achievement*. Association for Supervision and Curriculum Development.
[68] Moos, R. H., & Trickett, E. J. (1987). *Classroom environment scale manual* (2nd ed.). Consulting Psychologists Press.

[69] Mott, M. S., Robinson, D. H., Walden, A., Burnette, J., & Rutherford, A. S. (2012). Illuminating the effects of dynamic lighting on Learner learning, behavior, and physiology. *SAGE Open, 2*(2), 1–9. https://doi.org/10.1177/2158244012445585
[70] Parkinson, A. (2012). *The role of the physical environment in supporting teaching and learning*. University of Plymouth Press.
[71] Peng, W., & Kinsella, G. (2012). Using games and simulations to engage children with learning. *Handbook of Research on Effective Electronic Gaming in Education, 3*, 1–15.
[72] Raver, C. C., & Knitzer, J. (2002). Ready to enter: What research tells policymakers about strategies to promote social and emotional school readiness among three- and four-year-old children. National Center for Children in Poverty.
[73] Reupert, A., & Woodcock, S. (2010). Success and near misses: Pre-service teachers' use, confidence and success in various classroom management strategies. *Teaching and Teacher Education, 26*(6), 1261–1268. https://doi.org/10.1016/j.tate.2010.02.004
[74] Ricciardi, W., Damaske, S., & Hjøllund, N. H. (2015). *Occupational health and safety aspects of work-related stress*. European Agency for Safety and Health at Work.
[75] Schneider, M. (2002). Do school facilities affect academic outcomes? *National Clearinghouse for Educational Facilities*, 1–8.
[76] Shernoff, D. J., Csikszentmihalyi, M., Shernoff, S. B., & Abuhamdeh, S. (2014). Learner engagement in high school classrooms from the perspective of flow theory. *School Psychology Review, 32*(2), 178–190.
[77] Slavin, R. E. (2015). *Cooperative learning: Theory, research, and practice* (2nd ed.). Allyn & Bacon.
[78] Stokols, D., & Altman, I. (Eds.). (1987). *Handbook of environmental psychology* (Vol. 1). John Wiley & Sons.
[79] Tanner, C. K. (2009). Effects of school design on Learner outcomes. *Journal of Educational Administration, 47*(3), 376–392.

Appendices available on request

Author declaration

I declare that this manuscript is my original work and has not been previously submitted for publication elsewhere.

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Conflict of interest

The authors declare no conflict of interest.