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Sustainable school infrastructure for learning continuity: Health, hygiene, and safety conditions of public secondary school buildings in Kenya

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Abstract

Safe and healthy school infrastructure is a key enabler of sustainable education, influencing attendance, wellbeing, discipline, and continuous participation in learning. This study examined the status of school building health-safety conditions—cleanliness, ventilation, safety provisions, and lighting—and their perceived effects on teaching and learning in public secondary schools in Nairobi and Kajiado Counties, Kenya. A convergent parallel mixed-methods design was used, combining questionnaires from principals, teachers, and students with interviews involving key informants (including county quality assurance officers). Quantitative data were analysed descriptively, and qualitative data were analysed using content analysis. Findings suggest that classrooms and laboratories were reported as largely clean, well ventilated, and sufficiently lit, supporting learner engagement and participation in practical lessons. However, persistent challenges were identified in sanitation and shared spaces: student responses indicated concerns about toilet adequacy and cleanliness, and dining areas were less consistently maintained and more frequently reported as congested. Safety governance showed uneven readiness—many schools lacked emergency kits, and quality assurance officers highlighted limited health-and-safety training for principals and teachers, even where schools implemented local mitigation practices (cleaning routines, competitions, drills, signage, and laboratory safety rules). Participants associated healthier and safer premises with improved attendance, better discipline, stronger reading culture, fuller participation in learning activities, and reduced illness-related absenteeism. The study underscores that strengthening compliance, training, and preparedness in school facilities management is a sustainability strategy for protecting learning continuity and improving educational outcomes.

Keywords: Attendance and learning continuity; Health and hygiene; Learning environment; School infrastructure; School safety preparedness; Sustainable education

1. Introduction

Education for the children is part of their everyday life and this can take place through home learning or in schools. Schools play the bigger role in providing learning areas for the students and since they accommodate the largest part of the population, the need for adequate and appropriate infrastructure is crucial. Although learning can take place anywhere as long as the learner is eager and willing to learn, school infrastructure plays an important role in enhancing teaching and learning. In sustainable education systems, infrastructure quality is also linked to learning continuity and equity, because health-related absenteeism and unsafe conditions can reduce instructional time and participation (Haverinen-Shaughnessy et al., 2011; Mendell & Heath, 2005). The location of a school in a quiet serene environment can enable learners to concentrate better. The learning areas should be spacious, well-lit and the compound clean and welcoming. Empirical research suggests that classroom design and indoor environmental quality (e.g., lighting, air quality, and layout) are associated with learners' engagement and academic progress, supporting the need to treat facilities as part of education quality and sustainability (Barrett et al., 2015). Nalanda International School (2024) in an article giving reasons why school buildings are important, state that the surroundings in which students learn can either inspire them or hamper their education progress such that run-down buildings can bring out a negative mentality that does not motivate learners. These practitioner-oriented observations align with evidence indicating that facility quality is related to school climate and student outcomes (Uline & Tschannen-Moran, 2008). On the other hand, well looked after buildings inspire students to learn better and this also leads to improved discipline and positive attitudes. The article continues to state that the aesthetics and acoustics of school buildings help students' emotional perspective, inventiveness, learning

process and cooperation with the school staff (Did Teach, 2024).

School buildings consist of classrooms, laboratories, libraries, dining areas, dormitories and toilets. School buildings are among the most important aspects of a school as it is in these premises that learning takes place and students spend about 7590 hours out of 8784 hours (86%) per year in the classrooms (OECD, 2019). The World Health Organization [WHO] (2007) has laid down expectations on the attainment of good health by all. The purpose of health and safety is to create a harmless working atmosphere by decreasing accidents, injuries and mortalities in the given institution. School health and safety entails a situation where learners and the whole school community are safe from accidents and injuries while in school. From a sustainability perspective, health and safety in schools also protects learning time and supports uninterrupted participation in teaching and learning activities. As such schools should ensure that learning takes place in a conducive environment. According to UNICEF (2018) children spend most of their time in school hence the need to ensure their surroundings are safe and clean. Schools should be able to provide safe drinking water, toilets, kitchens, classrooms, laboratories and other premises being used by the learners. Indeed the sustainable development goal number 4 calls for provision of quality education by providing free and compulsory education and by improving the school infrastructure (UNICEF, 2023).

Construction of public schools in Kenya is funded partly by the government and partly by the parents. The government allocation to schools is, however, inadequate to meet all the needs. According to a report in the daily nation of 8/11/2023, money allocated to schools was inadequate and did not reach the schools on time. Due to the scarcity of funding, challenges in school infrastructure are bound to be experienced. Such constraints can also affect compliance, maintenance cycles, and emergency preparedness, which are critical for sustainable and safe learning environments. This study therefore sought to establish the status of school buildings and how the health and safety of the buildings affect teaching and learning in Nairobi and Kajiado counties, Kenya. The purpose of the study was to establish how school buildings affect teaching and learning outcomes of attendance, completion and maintenance of school discipline. In line with sustainable education and systems resilience, the study further positions these outcomes as indicators of learning continuity and sustained student participation.

2. Literature Review

2.1. Importance of School Buildings

School buildings are a fundamental enabler of sustainable education systems because they influence not only where learning happens, but also whether teaching and learning can occur safely, equitably, and continuously. When classrooms are overcrowded or lack adequate lighting and ventilation, the learning environment may become less conducive, reducing learners' engagement and concentration (Walden University, 2024). Research on indoor environmental quality similarly shows that ventilation, air quality, and thermal conditions are associated with student performance and attention, highlighting infrastructure as a determinant of learning continuity (Haverinen-Shaughnessy et al., 2011; Mendell & Heath, 2005). Likewise, classroom design features—including space, lighting, and layout—have been linked to learners' academic progress (Barrett et al., 2015), reinforcing the importance of designing and maintaining school facilities as part of education quality.

Different school spaces support different learning processes. Laboratories are central for science learning and practical competence; where laboratories are absent or substandard, practical lessons may be constrained and the learning process becomes incomplete (Ali et al., 2020). Libraries support independent learning, reading culture, and research-oriented habits; thus, missing or inadequate library facilities may limit learners' opportunities to develop self-directed learning skills. Beyond instructional spaces, the condition of kitchens and dining halls is important for learner wellbeing: poor hygiene increases risks of food contamination and illness, which can lead to absenteeism and reduced concentration, ultimately affecting teaching and learning.

From a sustainability lens, school infrastructure also contributes to institutional capacity and

school climate. Facility quality has been associated with school climate and student achievement, and may affect teacher recruitment, retention, and commitment (Uline & Tschannen-Moran, 2008). Andrews (2019) similarly argues that, across contexts, improved school facilities are linked to student success and teacher effectiveness, while budget constraints often push facilities down the priority list. Governance frameworks increasingly position safe, inclusive, and supportive learning environments as a core responsibility of education systems, requiring school-level leadership and governing bodies to establish and monitor policies that protect students' physical and psychosocial wellbeing and safeguard learning continuity (UNESCO, 2026).

International evidence further suggests that safe and healthy school infrastructure is associated with improved attendance, wellbeing, and academic performance, including features such as adequate lighting, air quality, acoustics, and climate-appropriate design (Teixeira et al., 2017). Studies in African contexts also report that inadequate infrastructure is linked to lower academic outcomes and reduced participation (Assoumpta & Andala, 2020; Yangambi, 2023). In Kenya specifically, findings indicate that academic performance is associated with the adequacy of classrooms, libraries, laboratories, water supply, and sanitation facilities (Mwikali, 2024), and that inadequate toilets can create time losses during breaks and reduce timely return to class—thereby diminishing effective learning time (Mokaya, 2013). The literature positions school buildings as more than physical assets: they are sustainability levers that protect learning time, support equitable participation, strengthen school climate, and enhance the system's ability to deliver quality education reliably.

2.2. Status of School Buildings

School buildings are the primary settings in which formal teaching and learning occur; therefore, school structures should provide safe, adequate, and health-supportive environments that enable sustained participation in learning. Fisher (2016) emphasizes that school buildings should be designed and constructed appropriately to support the learning process. Consistent with this view, evidence suggests that the physical condition of school facilities is closely linked to learners' health, comfort, and performance, particularly through indoor environmental quality factors such as ventilation, lighting, and exposure to pollutants (Baker & Bernstein, 2012; Mendell & Heath, 2005; Haverinen-Shaughnessy et al., 2011). In this respect, the "status" of school buildings is not only a facilities issue but also a sustainability concern, because inadequate infrastructure can reduce learning time through illness, absenteeism, and diminished concentration, thereby weakening learning continuity.

International evidence illustrates that many education systems face substantial facility deficits. For example, surveys in the United States have reported large numbers of learners attending schools with deteriorating conditions such as peeling paint, inadequate lighting, broken toilets, poor ventilation, and ineffective heating/cooling systems (McIntyre, 2016). Such conditions matter because indoor air quality and pollutants in older buildings have been associated with reduced attention and poorer learning-related outcomes (McIntyre, 2016; Mendell & Heath, 2005). Related assessments have also highlighted safety and health concerns in public school infrastructure, reinforcing the need for systematic investment in maintenance and compliance (Hunt Institute, 2021).

Within Kenya, the literature similarly documents infrastructure challenges that can constrain learning opportunities and threaten safe schooling. Parnwell (2015) reported limited library availability and overcrowded, poorly maintained classrooms in Ruiri location, Meru County. In early childhood settings, Chepkonga (2017) found that many ECDE centres lacked basic learning facilities (e.g., classrooms, desks, water, kitchen stores), which negatively influenced the provision of quality education. Studies in Kajiado and other counties further indicate that construction practices and adequacy of key facilities—particularly classrooms, laboratories, dormitories, and sanitation—do not always align with established guidelines, with toilet ratios and adequacy repeatedly identified as a persistent issue (Mokaya, 2013; Wanderi, 2018). Concerns about the safety implications of poor design and maintenance are also evident in Turkana County, where

building conditions and architectural layouts were reported as insufficient to enhance school safety (Kipngeno, 2018). Importantly, infrastructure and sanitation constraints have been linked to educational progression outcomes, including primary school dropout in Kajiado North (Kang'aru et al., 2022), suggesting that facility conditions can influence completion and retention, not only day-to-day learning.

Evidence from Nairobi highlights how infrastructure inequities may be concentrated in disadvantaged areas. Atemi (2018) reported sanitation deficits in schools located in informal settlements, including toilet-to-student ratios below recommended standards. Wakapisi (2017) similarly documented poor drainage and inadequate facilities in Kasarani Sub-county, with infrastructure-related hazards associated with accidents and injuries among learners. High-profile incidents have also drawn attention to structural safety risks in a minority of schools, underscoring the consequences of non-compliance and insufficient oversight (Oyugi, 2019). This body of work suggests that strengthening school building standards, maintenance systems, and safety governance is integral to sustainable schooling, because safe and healthy facilities protect learner wellbeing, safeguard learning time, and support equitable access to quality education.

2.3. Policies on School Buildings

Policies provide the governance framework through which education systems plan, regulate, finance, and monitor school facilities to ensure that learning environments are safe, inclusive, and fit for purpose. In education, facility policies are particularly important because children spend a substantial proportion of their day in school settings; therefore, infrastructure standards are directly linked to learner wellbeing, learning continuity, and the sustainability of schooling. From a sustainable education perspective, school-building policies operationalize minimum conditions for health protection, risk prevention, equity (including disability access), and resilient service delivery, thereby safeguarding instructional time and participation.

In Kenya, policies and regulations for the management and safety of learners are anchored in the Constitution and supported by sectoral legislation and technical standards, including the Education Act (Cap 211), the Public Health Act (Cap 242), Ministry of Public Works building regulations, the Safety Standards Manual, and the National School Health Policy. These frameworks require that school facilities—such as classrooms, dormitories, offices, kitchens, toilets, and other physical spaces—are kept clean, well maintained, safe, and appropriately used (Ministry of Education [MOE], 2008). In addition, infrastructure governance increasingly emphasizes inclusive access, requiring accessibility features so that all students, including learners with disabilities, can participate fully in school life. Accordingly, infrastructural and environmental safety measures should adhere to the relevant regulations and standards set by the Ministry of Public Works, the Ministry of Health (MoH), and the Ministry of Education (Ministry of Education, 2018). When implemented consistently, such policies support sustainable schooling by reducing preventable injuries and illness, minimizing disruption to teaching and learning, and enabling equitable participation across learner groups.

Operationally, such policies typically specify minimum requirements for school sanitation and hygiene (e.g., safe water, adequate toilets, and cleanliness routines), basic indoor environmental standards (ventilation, lighting, and space/occupancy norms), and safety risk controls (e.g., fire safety measures, safe laboratories, hazard prevention in compounds, and emergency preparedness such as first-aid provisions). They also commonly outline compliance mechanisms, including routine inspection, documentation, corrective actions, and accountability structures at school and county/national levels to ensure that standards are maintained over time. When implemented consistently, these policy instruments support sustainable schooling by reducing preventable injuries and illness, minimizing disruption to teaching and learning, and enabling equitable participation across learner groups. These expectations are consistent with international guidance that links safe, inclusive learning environments to education quality and sustainability (UNESCO, 2016; WHO & UNICEF, 2009).

3. Method

3.1. Research Design

This study used a Mixed Method approach whereby the Convergent Parallel Design was applied. This design (which entails collecting both the quantitative and qualitative data simultaneously) was suitable for the study in that it enabled the researcher to reach out to a wide range of the respondents at the same time and hence saved time. The design was also chosen as it would enable the researcher to cover any weaknesses of the qualitative information from the few respondents. The design would also allow the researcher to deliberate on areas of convergence and that of deviation between the qualitative and quantitative results (Harvard Catalyst, 2023). The assumption as stated by Creswell and Creswell (2018) was that both quantitative and qualitative data would provide different types of information and to determine whether there is convergence, difference or there is some combination of the information.

3.2. Participants

A total of 9860 respondents were targeted comprising of 197 secondary school principals, 884 class teachers, 8580 students and the two county quality Assurance officers. The study targeted 197 secondary schools in the two counties under study distributed as 104, and 93 in Nairobi and Kajiado respectively. The schools were categorized as Boys boarding, girls boarding and mixed day. The study targeted a total of 113,516 students distributed as 79,390 and 34,126 in Nairobi and Kajiado Counties respectively. Stratified sampling was used to sample the 19 schools, purposeful sampling was used to sample the 19 school principals and the 76 teachers. 152 Students were sampled using random purposive sampling and Convenience sampling technique was used for the two County Quality Assurance Officers.

3.3. Instrument

Data were collected using questionnaires for principals, teachers and students and interview schedules for the County Quality Assurance Officers. The convergent parallel research design was applied in data collection where both the quantitative and qualitative data were collected simultaneously. Ethical considerations were considered before and during the data collection with the researcher getting authorization from the National Commission for Science, Technology and Innovation.

3.4. Data Analysis

This study adopted a mixed-methods approach, generating both quantitative and qualitative data. Quantitative data collected from principals, teachers, and students were analyzed using descriptive statistics, specifically frequencies and percentages. Responses were organized according to the five-point Likert scale (Not at All, Little Extent, Moderate Extent, High Extent, and Very High Extent) and presented in tables to allow comparison across groups and key variables such as cleanliness, ventilation, safety, lighting, and the effects of school buildings on teaching and learning.

For clearer interpretation, the categories “High Extent” and “Very High Extent” were combined to indicate overall positive perceptions. This helped identify general trends regarding the condition of school infrastructure and its influence on teaching and learning.

Qualitative data from interviews with principals, teachers, and County Quality Assurance and Standards Officers (CQASOs) were analyzed using content analysis. The data were transcribed, coded, and grouped into themes related to cleanliness, health and hygiene, safety, ventilation, lighting, and their impact on participation, attendance, discipline, and academic performance. The qualitative findings were presented narratively to support and explain the quantitative results.

Combining both data types strengthened the study by enabling triangulation and providing a more comprehensive understanding of how school building conditions affect teaching and learning.

4. Findings

4.1. Status of Cleanliness of School Premises

The researcher looked at the status of cleanliness of the school premises in the following areas: toilets, classrooms, dining areas and laboratories as illustrated in Table 1.

The quantitative results as illustrated by Table 4.4 show that a majority (78.9%) of the principals and 77.7% of the teachers indicated to a High and Very High Extent respectively that they had clean toilets. The response of the students at 55.9% indicated a High and Very High Extent to having clean toilets. A majority (94.8%) of the principals and most of the teachers (86.9%) indicated to a High and Very High Extent that classrooms were cleaned on a regular basis. Similarly, most of the students, 79.6 % indicated a High and Very High Extent of classrooms that were cleaned regularly. The least proportion (26.3%) of the principals, and an average number of both teachers and students at 52.8% and 55.3% respectively indicated having dining areas that are cleaned and well maintained. A majority (79%) of the principals, teachers and students at 68.1% and 78.3% respectively indicated to a High and Very High Extent to having laboratories that are always clean and well maintained. Thus, from this study, most of the schools in Nairobi and Kajiado Counties had clean classrooms, dining areas and laboratories. The findings also indicated a challenge in the toilets where a fair number (55.3%) of the students indicated that toilets were inadequate and not clean Teachers also reported that they held discussions with the learners on ensuring cleanliness in the school premises. Gullani (2021) agreed with this study by stating that 1 out of 3 schools in Pakistan lack toilets.

4.2. The Effects of Cleanliness of School Premises on Teaching and Learning

Table 2 shows that all the principals, teachers (93.1%) and students (89.5%) indicated to a High and Very High Extent that clean environment leads to improved learning outcomes. A majority (94.7%) of the principals, teachers (90.3%) and students (77.0%) indicated to a High and Very High Extent that adequate sanitation facilities enable students to fully participate in learning activities. A majority (94.7%) of principals, teachers (84.7%) and students (72.3%) indicated to a High and Very High Extent that safe, clean and well-maintained libraries encourage learners to read more. A majority (94.7%) of the principals, 75.0% of teachers and 71.1% of students indicated to a High and Very High Extent that a clean school environment enhances students' discipline.

The County quality assurance officers [CQASOs] reported that the principals and teachers were inadequately trained on health and safety matters. The COVID-19 protocols had contributed to the provision of wash points, soap and water and schools had introduced cleaning competitions amongst the learners to improve on cleanliness. The CQASOS emphasized that clean environments would improve attendance, completion rates and discipline. Therefore, clean environments led to improved learning outcomes by students fully participating in learning activities, improved the reading culture and discipline. The study identified a gap in the training of teachers on health and safety and the ministry of education was not in charge. A study carried out in KwaZulu-Natal Province, South Africa, just like this study concluded that cleanliness enhanced learning and boosted teaching and learning activities as well as increasing academic performance of the learners (Uleanya, 2020).

4.3. Status of School Safety and Physical Environment

4.3.1. School safety

On the issue of the status of school safety Table 3 highlights the findings on ventilation, safety and lighting in relation to teaching and learning.

(Insert Table 1 & 2)

Table 3 shows that a majority (94.7%) of the principals, 70.9% of teachers and 69.8% of students indicated to a High Extent and Very High Extent that they had adequate classroom ventilation as shown by Figure 4.6. A majority (79.0%) of the principals, 75.0% of the teachers and 81.6% of students indicated to a High Extent and Very High Extent to having laboratories that are well ventilated. The least proportion of principals (26.3%), 48.6% of teachers and 40.1% of students indicated to a High Extent and Very High Extent to having dining areas that are not congested.
On the qualitative results the principals, teachers and CQASOs concurred that they ensured there was adequate spacing and ventilation and that the doors to the learning areas were always left open. In agreement with this study, a study in England showed that low ventilation has a huge impact on learners' attention, observance and also affects learners' memories and concentration (Bako- Biro et al., 2018). A study on association between classroom ventilation and learning outcome in Danish schools concluded that inadequate ventilation affects teaching and learning negatively (Toftum et al., 2015).

4.3.2. Status of School Safety

The quantitative results as shown by Table 3 show that the least proportion (21.1%) of principals and teachers (37.5%) respectively indicated to a High Extent and Very High Extent to having emergency kits in the staffroom. An average number of students (53.3%) also indicated having emergency kits in the staffroom. This shows that most schools in Nairobi and Kajiado did not have emergency kits in the staffroom. The least proportion (36.8%) of principals, 36.1% of teachers indicated to a High Extent and Very High Extent to having a proper perimeter wall. An overwhelming number (71.7%) of students indicated to a High Extent and Very High Extent to having a proper perimeter wall. A majority (68.4%) of principals and 70.9% of teachers indicated to a Very High Extent to grass being kept short and stagnant water avoided in the school to eliminate harmful insects and animals.

A majority (84.3%) of principals, 76.4% of teachers and 61.8% of students indicated to a High Extent and Very High Extent to there being no abandoned buildings in the school compound that can be used for illicit activities like smoking and drug peddling. A majority (68.4%) of the principals and 66.6% of teachers indicated to a Very High Extent to having rules and regulations on laboratory safety. Similarly, a majority (77.7%) of the students indicated to a Very High Extent to having rules and regulations on laboratory safety.

On the qualitative results on compliance with Health and Hygiene Safety of School Buildings, the CQASOs indicated that while most schools complied with the regulations others did not. This could endanger the learners with buildings collapsing resulting to injury and death of learners which in turn hinders teaching and learning. The CQASOs had been trained in health and safety whereas the school principals and teachers had not been trained. The principals, however, had put up competitions and rewards to ensure cleanliness in the schools. Teachers also reported of creating awareness among the learners on the importance of health and safety through posters, carrying out regular fire safety drills, having proper signage, fire extinguishers, fire assembly points and first aid kits and by training on proper handling of laboratory apparatus, appliances and inspecting tools around the school.

The qualitative and quantitative data indicated that most schools complied with health and hygiene safety of school buildings despite most of them not having emergency kits. For safety within the school compounds however, most schools had proper perimeter walls, short and well-kept grass and lacked stagnant water.

4.3.3. Status of Lighting

Quantitative results as indicated in table 3 illustrate the quality of lighting in the laboratories. Table 3 illustrates that a majority (89.5%) of the principals and 73.6% of teachers indicated to a High Extent and Very High Extent to having enough lighting in their laboratories. Similarly, a majority (78.2%) of the students indicated to a High Extent and Very High Extent to having enough lighting in their laboratories.

From the qualitative results, most of the principals, teachers and CQASOs indicated that Schools had enough lighting in their laboratories and classes which enabled learners to take part in learning activities as they could see better and observe activities easily. In agreement with this study, Dahlan and Eissa (2015) examining the effect of day lighting in classrooms on students' performance concluded that daylight in classrooms assist in energy saving, increase student' attendance makes learners to be environmentally responsible as well as ensuring a conducive environment enabling students to learn.

4.4. Effects of School Buildings on Teaching and Learning

On seeking to establish the effects of school buildings on teaching and learning, the quantitative results as illustrated by Table 4 show that an overwhelming majority (84.2%), of the principals, teachers (80.5%) and students (71.7%) indicated to a High Extent and Very High Extent that a clean school environment contributes to improved learning outcomes. Similarly, all the principals (100%), teachers (91.7%) and students (79.6%) indicated to a High Extent and Very High Extent that well-maintained school buildings enable students to attend school. Clean premises attracted students to remain in school and attend classes. A majority (42.1%) of the principals, teachers (63.9%) and students (54.6%) indicated to a Very High Extent that safety in the laboratories enable learners to fully participate in practical classes.

5. Discussion

This study examined how the health and safety conditions of school buildings relate to teaching and learning in public secondary schools in Nairobi and Kajiado Counties, Kenya. Given that learners spend substantial time within school facilities, the quality of the physical environment is not merely a background condition but a key factor shaping learning continuity, learner wellbeing, and opportunities to participate meaningfully in classroom and practical activities. While motivation and learner agency matter, the findings reinforce that school buildings can either enable or constrain learning by influencing comfort, safety, and the efficient use of instructional time.

The study found that school premises were generally reported as clean, with adequate lighting and sufficient ventilation across many learning spaces. These conditions were consistently linked by participants to improved engagement, discipline, and participation in learning activities. In particular, clean and well-maintained classrooms supported regular attendance, while clean, well-lit, and ventilated libraries were perceived to strengthen reading culture and independent study. Similarly, laboratories that were clean, adequately lit, and supported by safety measures were associated with learners' fuller participation in practical lessons. The association between laboratory safety provisions and students' participation in practical lessons is also aligned with evidence that stronger safety behaviours in laboratory settings correlate with higher learning efficiency (Deng-Guang et al., 2023). These results align with earlier evidence that classroom structural and environmental features can facilitate effective teaching and learning (Guardino & Antia, 2012), and they complement findings on the educational value of daylighting and supportive indoor conditions (Dahlan & Eissa, 2015). These findings are consistent with evidence syntheses showing that school infrastructure—particularly safe, healthy, and well-maintained learning environments—can positively influence attendance, engagement, and learning outcomes (Barrett et al., 2019).

Despite these positive patterns, the study identified persistent vulnerabilities in sanitation, especially regarding the adequacy and cleanliness of toilets. Student reports indicated that inadequate or poorly maintained toilets can lead to time loss (e.g., queuing during breaks), which reduces effective learning time and may affect punctual return to lessons—an issue directly addressed in international WASH-in-schools standards that emphasise adequate, accessible sanitation as a condition for safe and functional schooling (Adam et al., 2009). Beyond time loss, sanitation deficits were described as a health risk that may increase illness-related absenteeism,

(Insert Table 3 & 4)

thereby undermining learning continuity; global evidence consistently links inadequate school WASH conditions with risks to children's health, dignity, and learning participation (Adam et al., 2009; UNICEF, 2024), and reviews of school WASH interventions indicate potential impacts on student absence (McMichael, 2019). Participants also suggested that inadequate sanitation could contribute indirectly to school climate challenges, including discomfort, avoidance behaviours, and disruptions to discipline. From a sustainable education perspective, sanitation is therefore not only a facilities issue but a core equity and wellbeing requirement that protects learning time and supports consistent participation, particularly for vulnerable groups (UNESCO, 2016; UNICEF, 2024).

A further system-level concern emerging from the qualitative data was the reported gap in health and safety training for school leaders and teachers, alongside uneven access to guidelines and inconsistent compliance with construction and safety regulations. Although schools reported local mitigation practices—such as cleaning routines, awareness posters, fire drills, signage, fire extinguishers, assembly points, first aid provisions, and laboratory safety rules—the limited availability of emergency kits and the absence of systematic training indicate gaps in preparedness and institutional capacity. International guidance on safer and more resilient schools emphasises that infrastructure safety depends not only on standards, but also on implementation capacity, including staff training, routine monitoring/inspection, preparedness planning, and accountability mechanisms across the school infrastructure cycle (World Bank, 2017, 2024). In sustainable digital transformation and sustainable education frameworks, such capacity gaps represent governance challenges: facilities standards must be matched by ongoing training, routine monitoring, and support structures to ensure that safe environments are maintained over time (UNESCO, 2016; World Bank, 2017).

The findings also highlight the importance of compound-level safety measures. Many schools reported having perimeter walls, well-maintained grounds (e.g., short grass and reduced stagnant water), and the absence of abandoned structures, which participants associated with reduced safety risks and fewer opportunities for harmful behaviour. These patterns are consistent with prior research suggesting that improving safety behaviours and awareness can contribute to learning efficiency and safer learning environments (Deng-Guang et al., 2023). In addition, the association between clean and safe environments and improved teaching and learning reported here aligns with evidence from other contexts where cleanliness and school facility quality are linked to participation and achievement (Uleanya, 2020), and with Kenyan research emphasizing the central role of infrastructure in educational success (Mokaya, 2013).

Taken together, the study suggests that improving school building health and safety is a sustainability strategy: it protects learning time through reduced illness and disruptions, strengthens participation in academic and practical learning, and supports discipline and engagement. The findings suggest policy priorities such as (1) sanitation facility adequacy and maintenance, (2) emergency preparedness (including emergency kits and clear procedures), (3) systematic training for principals, teachers, and student leaders on health and safety, and (4) strengthened compliance mechanisms for construction and maintenance standards. Regular facility audits and school–county collaboration can support continuous improvement and help ensure that policy guidelines are not only available but consistently implemented. In line with SDG 4, ensuring safe and supportive learning environments is integral to sustaining educational quality and equitable participation. Accordingly, school boards and county/national authorities should strengthen routine facilities audits and enforce compliance with construction standards to reduce preventable risks and protect learning continuity.

6. Conclusion

Based on the study findings, it is concluded that the health and safety conditions of school buildings influence teaching and learning in public secondary schools by supporting regular attendance, sustained participation, and learning continuity. Clean and safe classrooms and school compounds were associated with learners' willingness to attend and remain in school, while clean

and safe libraries were perceived to strengthen reading culture and independent study. In addition, safe and well-maintained laboratories enabled learners to participate more fully in practical lessons, thereby supporting curriculum implementation and active learning.

The findings also highlight the importance of learning-support areas such as kitchens and dining spaces. Clean and hygienic food preparation and dining environments were viewed as essential for preventing contamination and illness, reducing health-related absenteeism, and protecting learners' capacity to concentrate during lessons. The study underscores that strengthening school infrastructure—through consistent maintenance, compliance with safety standards, and attention to sanitation and hygiene—is not only a facilities requirement but also a sustainability strategy that promotes equitable participation, supports learner wellbeing, and enhances the quality of the educational experience. These findings point to the need for sustained compliance with construction and safety standards, routine facility inspections, and ongoing school-based hygiene and safety promotion (e.g., awareness activities and regular drills) to sustain safe and sustainable schooling.

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References

Adams, J., Bartram, J., Chartier, Y., & Sims, J. (2009). *Water, sanitation and hygiene standards for schools in low-cost settings*. World Health Organization.

Ali, N., Khan, A. B., & Ahmed, T. (2020) Effects of school buildings on academic achievement of secondary school students in Southern Pakistan. *Global Educational Studies Review, 5*(2), 28-34. https://doi.org/10.31703/gesr.2020(V-II).04

Andrews, A. (2019, October). *How school facilities improve a child's school experience*. Fresco news. https://fresconews.com/

Assoumpta, U. I., & Andala, D. H. O. (2020). Relationship between school ınfrastructure and students academic performance in twelve years basic education in Rwanda. *Journal of Education*, *3*(1), 60–74.

Atemi, N. (2018, November). *World Toilet Day: The state of school Toilets, Nairobi, Kenya*. Science Africa. https://news.scienceafrica.co.ke

Baker, L., & Bernstein, H. (2012). *The ımpact of school buildings on student health and performance* [Techreport]. McGraw Hill.

Barko-Biro, Z. S., Clements-Croome, D. J., Kochhar, N., Awbi, H. B., Williams M. J. (2011). Ventilation rates in schools and pupils' performance. *Building and Environment, 48,* 1-9. https://doi.org/10.1016/j.buildenv.2011.08.018

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

Barrett, P., Treves, A., Shmis, T., Ambasz, D., & Ustinova, M. (2019). *The impact of school infrastructure on learning: a synthesis of the evidence.* World Bank.

Chepkonga, M. (2017). Influence of learning facilities on provision of quality education in early childhood development centers in Kenya. *International Journal of Education and Research, 5*(6), 15–26.

Creswell, W., & Creswell, J. D., (2018) *Research design qualitative, quantitaive, and mixed methods approaches.* Sage.

Dahlan, A. M., & Eissa, M.A. (2015) The impact of daylighting in classrooms on students' performance. *International Journal of Soft Computing and Engineering, 4*(6), 7-9.

Deng-Guang, Y. U., Du, Y., Chen, J., Song, W., & Zhou, T. (2023). A correlation analysis between undergraduate students' safety behaviours in the laboratory and their learning efficiencies. *Behavioural Sciences*, *13*(2), 127. https://www.mdpi.com/2076-328X/13/2/127

Did Teach. (2024). *Five reasons why school buildings matter.* Author.

Fisher, K. (2016). *The translational design of schools*. Sense Publishers.

Guardino, C. & Antia, S. D. (2012). Modifying the classroom environment to increase engagement and decrease disruption with students who are deaf or hard of hearing. *Journal of Deaf Studies and Deaf Education*, *17,* 518-533. https://doi.org/10.1093/deafed/ens026

Gullani, A. (2021). The association between presence of sanitation facilities and school enrolment in Pakistan. *World Development Perspectives, 21*, 100289. https://doi.org/10.1016/j.wdp.2021.100289

Harvard Catalyst. (2023). *Mixed methods research.* https://catalyst.harvard.edu/

Haverinen-Shaughnessy, U., Moschandreas, D. J., & Shaughnessy, R. J. (2011). Association between substandard classroom ventilation rates and students' academic achievement. *Indoor Air, 21*(2), 121–131. https://doi.org/10.1111/j.1600-0668.2010.00686.x

Hunt Institute. (2021, May). *School infrastructure.* https://hunt-institute.org/

Kang'aru, M. W., Kimosop., M. & Mbugua, Z. (2018). School-related determinants of school completion in public primary schools in Kenya: A case of Kajiado North Sub-County, Kajiado County, Kenya. *African Journal of Education, Science, and Technology*, *4*(4), 282-289.

Kipngeno, R. (2018). Adequacy of safety procedures and infrastructure for school safety in Kenya. *International Journal of Academic Research in Progressive Education and Development*, *7*(3), 1-10. https://doi.org/10.6007/IJARPED/v7-i3/4407

McIntyre, E. (2016). *Decaying school buildings have physical, psychological consequences*. K-12 Dive.

McMichael, C. (2019). Water, sanitation and hygiene (WASH) in schools in low-income countries: A review of evidence of impact. *International Journal of Environmental Research and Public Health, 16*(3), 359. https://doi.org/10.3390/ijerph16030359

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

Ministry of Education & Ministry of Health. (2018). *Kenya school health policy*. Government Press.

Ministry of Education. (2008). *The Safety Standards Manual for schools in Kenya*. Church World Service.

Mokaya, Z. (2013). *Influence of school infrastructure on students' performance in public secondary schools in Kajiado County, Kenya* [Unpublished master's thesis]. University of Nairobi, Nairobi.

Mwikali, A. (2024). Utilization of school infrastructure and its influence on students' academic performance in public secondary schools in Makueni County, Kenya. *Journal of Education, 4*(6), 53-73. https://doi.org/10.70619/vol4iss6pp53-73

Nalanda International School. (2024). *The importance of having a good school infrastructure.* Author.

OECD. (2019). *Education at a glance OECD indicators.* https://doi.org/10.1787/f8d788od-en

Oyugi, C. (2019). *How safe are Kenyan schools.* Journalism Hub.

Parnwell, R. N. (2015) *Influence of school infrastructure on academic performance in public Primary schools in Ruiri location Meru, Kenya* [Unpublished master's of arts]. University of Nairobi, Nairobi.

Teixeira, J., Amoroso, J., & Gresham, L. (2017). *Why school infrastructure Matters for learning.* World Bank.

Toftum, J., Kjeldsen, B.U., Wargoki, P., Mena, H.R., Hansen, E.M.N., & Clausen, G. (2015). Association between classroom ventilation mode and learning outcome in Danish schools. *Building and Environment*, *92*, 494-503. https://doi.org/10.1016/j.buildenv.2015.05.017

Uleanya, C. (2020). Influence of cleanliness on learners on learners learning capabilities and academic performance: A South African perspective. *Universal Journal of Educational Research*, *8*(2), 5934-5942. https://doi.org/10.13189/ujer.2020.082228

Uline, C. L., & Tschannen-Moran, M. (2008). The walls speak: The interplay of quality facilities, school climate, and student achievement. *Journal of Educational Administration, 46*(1), 55–73. https://doi.org/10.1108/09578230810849817

UNICEF. (2018). *Manual for comprehensive school safety and security programme (CSSSP) 2018-2020*. Author.

UNICEF. (2023). *Partner innovation amplified UNICEF's impact for children in 2023.* Author.

United Nations Children's Fund. (2024, May 27). *WASH in schools*. https://data.unicef.org/topic/water-and-sanitation/wash-in-schools/

United Nations Educational, Scientific and Cultural Organization. (2026). *Safe learning environments*. https://www.unesco.org/en/health-education/safe-learning-environments

United Nations Educational, Scientific and Cultural Organization. (2016). *Education 2030: Incheon declaration and framework for action for the implementation of sustainable development goal 4*. Author.

United Nations Educational, Scientific and Cultural Organization. (2016). *Education 2030: Incheon Declaration and Framework for Action for the implementation of Sustainable Development Goal 4*. Author.

Wakapisi, R. K. (2017). *State of school safety in public urban primary schools: A case of Kasarani sub-County in Nairobi city County, Kenya* [Unpublished master's thesis]. Kenyatta University, Kenya.

Walden University. (2024). *5 ways that overcrowded classrooms affect education.* Author.

Wanderi, A. N. (2018). *School safety and its influence on teaching and learning processes in public secondary schools in Nairobi and Nyeri Counties, Kenya* [Unpublished master's thesis]. Kenyatta University, Kenya.

World Bank. (2017). *Roadmap for safer schools* (GFDRR). https://documents1.worldbank.org/curated/en/473931494931274888/pdf/115068-WP-PUBLIC-gfdrr-roadmap-05.pdf

World Bank. (2024, March 8). *Building safer and more resilient schools in a changing climate*. World Bank. https://www.worldbank.org/en/results/2024/03/08/building-safer-and-more-resilient-schools-in-a-changing-climate

World Health Organization [WHO]. (2007*). Strengthening health systems to improve health outcomes.* Author.

World Health Organization, & United Nations Children's Fund. (2009). *Water, sanitation and hygiene standards for schools in low-cost settings*. Author.

Yangambi, M. (2023) Impact of school infrastructure on students Learning and performance: case of three public schools in a developing country. *Creative Education*, *14*(4), 788-809. https://doi.org/10.4236/ce.2023.144052