

Learning Environments as Predictors of Learner Engagement and Academic Achievement in Mathematics. A Case Study of Private Secondary School Students in South Africa

Themba. Saziwa ^{1*}

¹ Department of Adult Literacy and Educational Foundations, Faculty of Education, Walter Sisulu University, South Africa, Email: tsaziwa@wsu.ac.za, Orcid Number: <https://orcid.org/0009-0009-4425-3986>

*Corresponding Author: tsaziwa@wsu.ac.za

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ABSTRACT

This study examines learning environments as key predictors of learner engagement and academic achievement among Private secondary school students in South Africa. The study is grounded in the understanding that the physical and psychosocial qualities of learning spaces play a crucial role in shaping learners' motivation, engagement, and cognitive development, ultimately influencing educational outcomes. Despite ongoing efforts to improve access to education, many Private secondary schools in South Africa continue to experience infrastructural challenges such as overcrowded classrooms, inadequate ventilation, poor lighting, and poorly organised learning spaces, particularly within the Private secondary school phase. A quasi-experimental research design was employed, involving two purposively selected schools with contrasting levels of classroom resources and facilities. Data were collected using an academic achievement test and structured questionnaires designed to measure learners' academic performance and levels of engagement. Quantitative data were analysed using both descriptive and inferential statistical techniques to compare outcomes between learners taught in well-facilitated classrooms and those in poorly facilitated learning environments. The findings revealed statistically significant differences in both academic achievement and learner engagement between the two groups. Learners in well-resourced learning environments demonstrated higher academic performance and greater levels of behavioural, emotional, and cognitive engagement than their counterparts in under-resourced classrooms. The results further indicated that classroom factors such as ventilation, lighting, furniture quality, and spatial organisation emerged as significant predictors of learner engagement and academic achievement. Based on these findings, the study highlights the importance of prioritising the quality of learning environments in educational planning and policy development within South Africa's Private secondary school education system. It recommends implementing cost-effective, contextually appropriate design strategies, such as improved lighting, ergonomic furniture, and flexible classroom layouts, to create inclusive and engaging learning spaces. The study concludes that enhancing the physical learning environment is essential for promoting learner engagement, improving academic performance, and advancing educational equity in South African Private secondary schools.

Keywords: Learning Space, Engagement, Academic Achievement

INTRODUCTION

Effective learning space design has become a central theme in contemporary educational discourse, particularly in private secondary schools. Rindenow and Dorot (2025) note that learning environments play a critical role not only in meeting learners' physical needs but also in promoting engagement, stimulating creativity,

and enhancing academic achievement. In the South African Private secondary school context, where many Private secondary schools continue to face infrastructural constraints, the quality of learning environments is especially significant. Over time, educational theorists have increasingly emphasised the close relationship between learning environments and learner outcomes, recognising that where learning takes place is as important as how it is taught.

The quality of the learning environment can either support or hinder learners' academic performance. Factors such as school climate, availability of instructional materials, discipline, physical facilities, teacher quality, school location, class size, and learner–teacher ratios all interact to shape learning outcomes. School infrastructure, therefore, remains a fundamental component of quality education. Lee and Huh (2025) argue that learning occurs through interaction with the environment, and in this context, the learning environment refers to the physical and material resources that support academic development. A supportive and well-organised learning space enhances learners' comfort, concentration, and motivation, enabling them to engage more effectively with academic tasks and achieve better outcomes.

Learner engagement is widely recognised as a key determinant of academic achievement and encompasses behavioural, emotional, and cognitive dimensions. It refers to the time, effort, and resources that learners invest in their learning, as well as the extent to which schools create conditions that support meaningful participation. According to Rindenow and Dorot (2025), learner engagement is influenced by factors such as institutional organisation, teaching approaches, learning spaces, and classroom design. Research consistently shows that the design and quality of learning environments significantly influence learners' levels of engagement, which in turn affects academic achievement.

Studies have demonstrated that well-designed learning environments characterised by flexible seating, natural lighting, and visually stimulating features create welcoming spaces that encourage active participation and collaboration (Abdullah & Sudo, 2025). In contrast, poorly organised classrooms with inadequate furniture and low-quality facilities are associated with learner disengagement and poor academic outcomes (Lee & Huh, 2025). In many South African Private secondary schools, overcrowded classrooms, insufficient furniture, and inadequate ventilation remain common challenges. These conditions not only reduce learner engagement but also contribute to health issues such as fatigue and respiratory problems, further limiting learners' academic performance (Quevedo et al., 2025). Addressing these challenges requires a holistic approach to learning space design that balances functionality, comfort, and aesthetics.

Classroom layout directly influences how learners interact, participate, and learn. Active learning classrooms with movable desks and chairs arranged to promote face-to-face interaction encourage collaboration, discussion, and experiential learning (Abdullah & Sudo, 2025). Learners' perceptions of a classroom are shaped by its physical layout; traditional lecture-style arrangements often signal passivity, whereas circular or group seating arrangements promote dialogue and active engagement (Velmurugan et al., 2026). Reducing physical barriers between teachers and learners also enhances interaction and supports a more dynamic learning environment (Rands & Gansemer-Topf, 2017). Grouped seating arrangements further allow teachers to move freely around the classroom, provide individual support, and create a sense of ownership and belonging among learners.

Active learning classroom designs enable teachers to implement a range of learner-centred strategies, including group work, peer instruction, and collaborative problem-solving, thereby enhancing engagement and deepening understanding. Research indicates that learners taught in active learning spaces consistently outperform those in traditional classroom settings, even when the duplicate curriculum content is delivered (Hodges, 2018). Importantly, creating active learning environments does not necessarily require expensive technology or extensive renovations. Simple interventions such as movable furniture, whiteboards, and flexible seating arrangements are effective in supporting active learning approaches (Velmurugan et al., 2026).

Academic achievement, as a key indicator of educational success, is closely linked to the quality of the learning environment. Research shows that learners perform better in well-designed classrooms that support diverse teaching and learning methods (Asikhia, 2021). Environmental factors such as temperature control, acoustics, and ergonomic furniture have been found to influence concentration, memory, and overall cognitive performance (Olaseni & Saziwa, 2024). The integration of appropriate educational technologies also enhances academic achievement by facilitating interactive and personalised learning experiences (Astuti et al., 2026). However, many Private secondary schools in South Africa continue to experience infrastructural limitations, including insufficient classroom space and poor facility maintenance, which negatively affect learner–teacher interaction and academic performance.

The learning environment also shapes learners' behaviour and responses to their immediate surroundings. Astuti et al. (2026) argue that environmental influences are embedded within cultural contexts and play a significant role in shaping learners' attitudes, behaviour, and academic engagement. A supportive learning environment fosters positive behaviour and motivation, while an unfavourable one may reinforce disengagement and underachievement. As enrolments in Private secondary schools continue to grow, the demand for both

quantitative expansion and qualitative improvement of learning spaces has increased. Research by Freiberg, Driscoll, and Astuti, et al. (2026) highlights that factors such as school climate, instructional resources, discipline, physical facilities, teacher quality, and class size collectively influence academic achievement. Schools that provide high-quality facilities and resources are more likely to experience improved learner engagement, reduced dropout rates, and stronger academic outcomes.

Innovative methods for learning space design are being used by educational institutions worldwide. To create a dynamic learning environment, Finland, well-known for its modern educational system, emphasises open-plan classrooms, flexible furniture, and technological integration (OECD, 2015). Similarly, schools in the US and Australia have implemented adaptable classroom layouts to accommodate different teaching philosophies and student preferences (Astuti et al., 2026). By highlighting the value of flexibility, these strategies ensure that learning spaces can adapt to evolving educational needs. Although these examples offer insightful information, their relevance to the South African context requires careful evaluation of regional factors such as financial constraints, cultural norms, and weather patterns. Polokwane. can achieve sustainable and contextually appropriate solutions by combining indigenous knowledge and resources with international best practices. For example, using locally produced building materials and involving community members in the design process can ensure that solutions are both economical and culturally appropriate (Adeyemi, 2019).

Statement of the Problem

The quality of the physical learning environment is increasingly recognised as a key determinant of learners' academic achievement and levels of engagement. Despite this recognition, many private secondary schools in South Africa continue to operate in classrooms that are poorly designed to support effective teaching and learning. These classrooms frequently exhibit challenges such as overcrowding, inadequate ventilation, insufficient lighting, non-ergonomic or worn-out furniture, and inefficient spatial arrangements. Such conditions can negatively affect learners' comfort, concentration, and sustained attention, particularly in cognitively demanding subjects that require high levels of focus, logical reasoning, and problem-solving.

While educational improvement initiatives in South Africa have focused mainly on curriculum reform, teaching methodologies, and teacher professional development, less attention has been paid to the physical learning environment. Consequently, learners are often expected to perform at high academic standards within spaces that limit motivation, reduce opportunities for collaboration, hinder meaningful engagement, and constrain active participation. Poorly facilitated classrooms may also perpetuate disparities in academic outcomes, particularly in resource-constrained schools, thereby undermining educational equity.

Although research indicates that well-designed learning environments can enhance learners' engagement and academic performance, there is a lack of empirical evidence specific to the South African Private secondary school context. In particular, few studies have systematically investigated how classroom design elements—such as lighting, ventilation, furniture quality, and spatial organisation—affect learners' engagement and achievement in critical subjects. This gap limits evidence-based decision-making for school administrators, educational planners, and policymakers regarding the prioritisation of infrastructure development and resource allocation.

Therefore, the continued neglect of the physical learning environment may undermine efforts to improve learner engagement, academic performance, and equitable educational outcomes. Addressing this problem is essential to establish clear links between learning space quality, learner engagement, and academic achievement, and to provide actionable insights for the design and maintenance of effective, learner-centred classrooms in South African private secondary schools.

Research Objectives

The objectives of this study are to

1. Examine differences in academic achievement between Private secondary school learners in well-facilitated classrooms and those in poorly facilitated classrooms.
2. Assess variations in learner engagement during lessons between students in well-resourced and under-resourced learning environments.
3. Investigate the relationship between the quality of the learning environment and learners' overall academic performance.
4. Explore the relationship between the quality of the learning environment and learners' levels of engagement in the classroom.

Significance of the Study

This study is significant as it provides empirical evidence on how the quality of classroom learning environments influences students' academic achievement and engagement in Mathematics. By establishing clear links between well-facilitated classrooms and improved learning outcomes, the findings contribute to the existing literature on educational environment design and its role in enhancing cognitive engagement and performance in Mathematics, a subject foundational to scientific and technological development.

The study is also valuable to educational stakeholders, including policymakers, school administrators, and planners, as it highlights the importance of prioritising physical learning infrastructure alongside curriculum and instructional reforms. Evidence generated by this research can inform policy decisions on classroom design, resource allocation, and school renovation initiatives, particularly in Private secondary schools where infrastructural challenges may hinder effective Mathematics instruction.

Furthermore, the findings of this study provide a practical guide for teachers and school managers by emphasising how improved classroom conditions can foster active student participation, sustained attention, and positive learning experiences. By promoting learner-centred and supportive learning spaces, the study contributes to efforts to improve equity, academic excellence, and the overall quality of Mathematics education.

LITERATURE REVIEW

The learning space comprises components that influence the student's learning curve. These components, according to Balog (2020), include: people, teaching materials, technical tools, and learning resources; curriculum, training, and instruction; and physical environment/learning space. People are individuals who affect students directly or indirectly through connections or relationships, which can contribute to students' growth and success in their careers. The teaching materials, technical tools, and learning resources are highly advanced tools or other instructional resources that are aligned with the curriculum as part of student learning support. The curriculum, training, and instruction are the core foundations of the learning process; they influence one another and play vital roles in facilitating the flow of knowledge and the delivery of instructional content/curriculum. The physical environment/learning space refers to the physical setting in which learners learn, which should evoke positive responses and hold the interest of those who inhabit it (Balog, 2020). Mondal (2021) identified several important factors that may affect the learning process, including the intellectual factor, which refers to an individual's cognitive level. Learning factors are factors arising from faulty methods of work or study and the narrowness of the experimental background, which may affect the learning process. Physical factors include health, physical development, nutrition, visual and physical defects, and glandular abnormalities. Mental factors are attitudes such as interest, cheerfulness, and openness that are important in personality development. Personal factors, such as instincts and emotions, and social factors, such as cooperation and rivalry, are directly related to a complex psychology of motivation.

The teacher as an individual personality is an important factor in the learning environment. They are key factors that create a favorable teaching-learning milieu that will make the instructional process easy, enthusiastically adaptable and useful (Astuti, et al., (2026)). The way in which his personality interacts with the personalities of the pupils helps to determine the kind of behavior which emerges from the learning situation (Brown,2022). Environmental factors like classrooms, textbooks, equipment, school supplies, and other instructional materials etc. are the physical conditions needed for learning (Mondal, 2021). Wandan (2021) observed that before students can succeed academically, they must feel safe, both physically and mentally, and to have a safe learning space, students must feel welcomed, supported, and respected. Personalizing learning helps students develop skills including thinking critically, using knowledge and information to solve complex problems, working collaboratively, communicating effectively, learning how to learn, and developing academic mindsets that would greatly increase students' engagement (Raccoon gang ,2018). Moreso, students must feel connected to teachers, staff, and other students. Schools can nurture these connections by focusing on students' social and emotional learning (SEL). Students must also feel supported by all those connected to their learning experience like teachers, classmates, administrators, family, and community members for a higher academic feat (Waldman, 2020). Productive learning space is crucial to students' academic, emotional and social success in school. A conducive learning environment doesn't just happen on their own or by chance. They should be created through conscious procedures like interacting with students in a positive manner, exhibiting positive behaviors etc that would promote learning activities in the learning environment (Becton, 2021).

Learning spaces can be characterized as social, cultural, and architectural entities, their evaluation goes beyond simply gauging how well they are being used (Olaseni, (2022)). To determine demand and satisfaction, for instance, data-based foot traffic and surveys would not provide a comprehensive picture of how the space is being used since they do not take into account the fact that learning is an activity (Olaseni, (2022)). Evaluations

must be based on learning theories in order to present a stronger case for the existence of a learning space. According to a learner-centered viewpoint, socialization and teamwork can lead to learning at any moment. The field's interest in figuring out how the physical environment impacts instruction and the learning process is modest but expanding. Studies on learning environments can be broadly divided into two categories: psychology and architecture. Many of these studies use an interdisciplinary approach to try to harmonize the two disciplines. While academics from the field of architecture concentrated on how the infrastructure and facilities promote learning, psychologists are more interested in how people view the space and how learning takes place there.

Houtman and Lent (2023) define student achievement as the attainment of a student's short- or long-term educational goals, typically measured through grades, standardized tests, and other assessments. Conversely, Wendler and Koller (2022) characterized achievement as the culmination of a learning journey resulting in the acquisition of knowledge, skills, and competencies within a particular academic field, often evaluated through assessments such as tests and exams. Hattie (2021) defined student achievement refers to a student's understanding and application of school content and skills, often assessed through grades and standardized tests. Hammond (2020) opined that academic achievement refers to the development of students' knowledge, skills, and abilities across various academic domains, indicating their learning and educational success. Boaler (2019) stated that academic achievement involves students' profound comprehension of academic content, the capacity to use knowledge to solve issues, and the development of a passion for learning, beyond just achieving good grades.

Heckman and Murphy (2022) stated that overall, student achievement has increased significantly over time, but there are significant differences by race/ethnicity and socioeconomic status. For example, white students' average reading score increased by 0.16 standard deviations per decade, while black students' average score increased by 0.23 standard deviations per decade. However, the gap between white and black students remains significant, with white students scoring about 0.5 standard deviations higher on average. Students from high-SES families outperformed those from low-SES families by about 1.0 standard deviations on average. Cheng (2022) examined the educational achievement of Grade 5-10 East Asian schoolchildren in Japan, China, South Korea, Taiwan, and Singapore from 1967 to 2020. They identified seven main themes: cultural and educational quantity variables, non-cognitive abilities, cognitive ability levels, curriculum rigor, school factors, socioeconomic factors, and individual factors. The study found that East Asian countries outperformed the OECD average in all three subjects in the 2018 PISA assessment, with Singapore ranking first in all three subjects, Japan second in mathematics and science, and South Korea third in mathematics.

Engagement is a multifaceted construct, referring to "the quality of a student's connection or involvement with the endeavor of schooling and hence with the people, activities, goals, values, and place that compose it" (Skinner, Kindermann, & Furrer, 2021). Multiple types of engagement exist, including behavioral, emotional, and agentic engagement (Reeve et al., 2020). Behavioral engagement has been defined as the enactment of positive classroom behaviors (e.g., adhering to rules), the absence of disruptive classroom behaviors, and the involvement in learning activities, including persistence, concentration, attention, contributing to class discussions and asking questions (Reeve et al., 2020; Skinner et al., 2021). Emotional engagement refers to students' affective states or reactions in the classroom, such as happiness, interest, boredom, and anxiety (Skinner et al., 2021). Agentic engagement is defined as students' proactive and constructive contribution towards the conditions and content of learning activities and instruction (e.g., expressing preferences, communicating needs) (Reeve et al., 2020).

Skinner et al. (2021) developed the Self-System Model of Motivational Development, which frames how personal and contextual factors foster or undermine students' engagement, i.e., the process by which an engaging climate is created and maintained within the classroom. The model proposes that the context (i.e., teachers' construction of the learning spaces and social interactions), contribute to students' self-system processes (i.e., self-perceptions organized around the basic need for autonomy, competence, and relatedness), which influence students' engagement (or disengagement) in activities (Skinner et al., 2021). Previous investigations have shown the significance of engagement for students' outcomes, revealing it to be a positive predictor of academic achievement well-being (Wong et al., 2024), and reducing school dropout (Archambault et al., 2022). Similarly, multiple investigations have examined the contextual factors that foster engagement within traditional classrooms. In addition to task characteristics and classroom structure, prominent factors that are beneficial for enhancing engagement include positive student-teacher relationships, academic and social-emotional support from teachers, as well as autonomy support (Fredricks et al., 2004; Martins et al., 2022; Quin, 2017; Tao et al., 2022). Furthermore, teachers utilize various instructional practices to enhance engagement (Martins et al., 2022), including extrinsic motivators, such as incentives and rewards (Petrasek et al., 2022). Although not often considered, but relevant for the current study, the physical learning space (e.g., classroom equipment, cleanliness, spaciousness) can also have an impact on students' engagement (Kariippanon et al., 2019; Oliveras-Ortiz et al., 2021; Yusof et al., 2018).

The relationship between learning spaces and student engagement has been the subject of increased investigation by educational scholars in recent years, especially in light of changing pedagogical approaches and technology developments. The research has looked at the effects of physical, virtual, and hybrid learning environments on behavioral, cognitive, and affective aspects of student involvement. This review summarizes current empirical research, emphasizing significant developments and advances in our knowledge of how learning environments affect student engagement. Traditional education still heavily relies on physical learning environments, and researchers have focused a lot of attention on how environmental quality, adaptability, and design can increase student engagement. In order to determine how flexible classroom arrangements, affect student involvement, Park and Choi (2021) carried out a quasi-experimental study in South Korea. According to their findings, classrooms featuring collaborative workstations, writable surfaces, and mobile furniture greatly improved students' behavioral engagement by encouraging peer collaboration and greater participation. The physical arrangement has a direct influence on student behavior and engagement, as evidenced by the higher likelihood of active participation in group projects and conversations among students in these flexible settings.

Particularly in secondary schools, hybrid learning environments which combine virtual and physical elements have also drawn a lot of scholarly interest. A multi-site study on student involvement in hybrid classrooms where some students engaged remotely while others attended in person was carried out by Tang and Lim (2022) at five Asian institutions. Their research showed that whereas distant learners frequently experienced affective engagement issues because of feelings of separation, in-person students typically reported higher behavioral engagement since they were physically closer to peers and teachers. However, by providing equal opportunities for participation, the implementation of synchronized collaboration tools like interactive chat features, real-time polling, and collaborative digital boards improved cognitive engagement for both groups.

Student engagement is further increased when smart technologies are incorporated into hybrid classes. Zhang and Liu (2023) looked into how student involvement in Chinese schools was affected by smart classroom technologies. Their research concentrated on classrooms that included smooth content-sharing tools, real-time collaboration platforms, and AI-powered feedback systems. By developing interactive and responsive learning experiences that catered to both in-person and distant learners, they discovered that these smart settings greatly boosted behavioral, cognitive, and affective engagement.

A major subject in recent empirical study has also been the personalization of learning spaces. A survey-based study by Johnson, Carter, and Lee (2023) among US college students looked at how engagement was affected by the capacity to customize both virtual and physical learning settings. According to their findings, students who had some control over their learning environment whether it was through changing the lighting, moving furniture, or personalizing digital interfaces reported feeling more emotionally engaged. Students' emotional attachment to the learning process was positively impacted by personalization, which promoted a sense of comfort and ownership. Student engagement is also influenced by the sociocultural environment in which learning spaces are located. Adegbite and Mohammed (2022) investigated the effects of classroom settings on student involvement in secondary schools in Nigeria with limited resources. Due to increased cognitive load and physical pain, they discovered that students in overcrowded, poorly ventilated classrooms reported decreased levels of cognitive engagement. Furthermore, environmental stressors like heat and noise reduced affective engagement by making it harder for students to feel an emotional connection to the learning process.

It has also been demonstrated that inclusive classroom design increases student participation, especially among underrepresented groups. An ethnographic study was carried out in urban Brazilian schools by Gonzalez, Pereira, and Silva (2023) to find out how involvement was affected by culturally responsive learning environments. They discovered that, especially for children from historically underrepresented groups, classrooms with collaborative hubs, flexible seating configurations, and culturally identifiable symbols promoted more social interaction. These areas improved affective involvement by fostering a feeling of acceptance and cultural validity. Widespread reassessment of learning environments brought on by the COVID-19 epidemic led to innovations that have had a long-lasting impact on student engagement. In order to investigate the effects of pandemic-induced modifications to learning environments on engagement, Anderson et al. (2022) carried out a global survey in ten nations. Their results demonstrated that health-conscious design features like better ventilation and spatial distancing, along with adaptable learning environments that made it easy to switch between in-person and remote participation, promoted higher levels of affective and cognitive engagement.

This recent empirical research reveals a number of recurring features. First, student engagement is continuously improved by flexibility, whether it is in the physical form or the integration of technology. Second, maintaining sustained attention and minimizing behavioral disturbances are greatly aided by the quality of the surrounding environment, including the lighting and acoustics. Third, by encouraging a sense of belonging and ownership, individualized and culturally sensitive learning environments improve affective involvement. Finally, ensuring that all students, irrespective of socioeconomic background, may participate fully in the learning process depends on providing them with fair access to high-quality learning facilities. There are still several gaps in the

literature despite these developments. Since most research uses cross-sectional data, it is unclear how learning environment design affects engagement over time.

Additionally, little study has been done on how socioeconomic status, gender, and disability interact with learning space design to influence engagement. Additionally, although preliminary research on VR and AI-enhanced environments is encouraging, little is known about how these technologies may affect students' participation over the long run in a variety of educational settings.

THEORETICAL FRAMEWORK

Environmental Psychology Theory (Person–Environment Fit)

Environmental Psychology Theory explains how physical environments influence human behavior, emotions, and cognitive processes. The Person–Environment Fit component of this theory posits that optimal outcomes occur when the characteristics of an environment align with the needs and activities of the individuals within it. In educational settings, this means that classroom features such as lighting, ventilation, seating arrangement, spatial organization, and overall classroom design directly affect students' comfort, concentration, motivation, and engagement.

The linkage of this theory to the present study lies in its focus on how variations in the quality of the learning environment (well-facilitated versus poorly facilitated classrooms) influence students' engagement and academic achievement in Mathematics. Mathematics learning requires sustained attention, logical reasoning, and active participation; therefore, classrooms that provide adequate physical support are more likely to enhance students' cognitive engagement and performance. By examining differences in Mathematics achievement and engagement across classroom conditions, the study empirically tests the core assumption of Environmental Psychology Theory that a well-matched learning environment enhances learners' engagement and academic outcomes.

Appraisal of Reviewed Literature and Identified Research Gaps

A critical review of existing literature reveals that learning spaces constitute a fundamental element of the educational process, with substantial influence on students' academic performance and levels of engagement. Scholars widely acknowledge that learning spaces extend beyond mere physical structures; they function as dynamic environments where physical design, pedagogy, technology, and social interaction intersect to shape holistic learning experiences. Studies consistently emphasize that thoughtfully designed learning environments promote student-centered instruction, collaboration, and diverse teaching approaches, thereby enhancing both engagement and academic outcomes. The literature further underscores that contemporary learning spaces must align with modern educational goals, including active learning, critical thinking, problem-solving, and the development of twenty-first-century competencies.

A recurring focus in the literature is the strong association between the quality of learning spaces and student engagement. Empirical studies conducted across various educational contexts, including those by Brooks, Walker, and Pomerantz (2022) and Holland, Edwards, and Maynard (2021), demonstrate that features such as flexible seating, collaborative work areas, access to instructional technology, and favorable environmental conditions particularly lighting, acoustics, and ventilation significantly enhance students' behavioral, emotional, and cognitive engagement. Learning environments designed with students' needs in mind tend to foster higher motivation, increased participation, and a stronger sense of ownership over learning. Conversely, overcrowded, poorly ventilated, and rigidly structured classrooms are frequently linked to disengagement, reduced motivation, and diminished enthusiasm for learning. This relationship is especially critical at the secondary school level, where learners are developing independent study habits, abstract reasoning skills, and academic self-regulation.

The literature also provides substantial evidence linking learning space quality to students' academic performance. Numerous empirical studies, including those by Duruji, Azuh, and Oviasogie (2014) and Mudassir and Norsuhaily (2015), report significant associations between academic achievement and the physical condition of learning environments. Students exposed to classrooms equipped with adequate instructional materials, functional laboratories, libraries, and ICT facilities consistently demonstrate higher academic performance than those learning in resource-deficient settings. Additionally, studies by Shamaki (2015) and Ezike (2018) highlight the influence of factors such as class size, classroom aesthetics, and availability of learning resources on students' learning experiences and achievement. Beyond physical attributes, the literature also recognizes the role of psychological comfort and a sense of belonging within learning spaces as contributors to academic success.

Another prominent theme in the reviewed literature is the role of teachers in shaping effective learning environments. While many studies focus primarily on physical design elements, researchers increasingly emphasize that teachers' ability to create supportive, respectful, and emotionally safe classroom climates enhances

the effectiveness of physical learning spaces. Teachers act as mediators between learners and their environments, ensuring that classroom settings support both intellectual and socio-emotional development. The interaction among classroom design, teacher practices, and student relationships emerges as a critical determinant of positive learning outcomes. In addition, the growing integration of technology into learning environments is well documented. Research indicates that technology-enhanced classrooms—including smart classrooms, virtual learning platforms, and virtual reality applications—can significantly improve student engagement and academic performance by supporting personalized learning, collaboration, and access to diverse instructional resources. However, persistent digital divides in many developing contexts limit equitable access to these benefits and exacerbate educational inequalities.

Despite the breadth of existing research, several critical gaps remain. One major limitation is the scarcity of empirical studies examining the effects of learning environments on student engagement and academic performance at the secondary school level in developing contexts. Much of the available literature is derived from Western educational systems, where infrastructural conditions, policy frameworks, and cultural contexts differ markedly. This limits the applicability of existing findings to Private secondary school education operating under different socioeconomic and infrastructural constraints. Furthermore, most studies adopt cross-sectional designs, offering only short-term insights into learning environment effects. There is limited longitudinal evidence examining how sustained exposure to high-quality or poor-quality learning spaces influences students' long-term engagement, academic achievement, and attitudes toward learning.

Another underexplored area in the literature is the interaction between socioeconomic conditions and learning environments. While it is widely acknowledged that students from more advantaged backgrounds often have access to superior learning spaces, fewer studies have examined how this disparity contributes to differences in engagement and academic outcomes, particularly within Private secondary schools. Additionally, many studies treat physical learning environments and teaching practices as separate variables, overlooking the complex interplay between classroom design, instructional strategies, and teacher–student relationships. A more integrated approach is necessary to fully understand how learning environments function as interconnected systems that influence student outcomes.

The literature also reveals a limited focus on the role of emerging technologies in secondary school learning environments within resource-constrained settings. Although substantial evidence exists from higher education and technologically advanced contexts, little is known about how digital tools and technology-enhanced classrooms affect engagement and academic performance in private secondary schools with limited ICT infrastructure. Moreover, research on inclusive and culturally responsive learning environments remains insufficient. Given the cultural, linguistic, and social diversity present in many educational contexts, there is a need to examine how learning spaces that reflect students' identities and cultural backgrounds influence their engagement, comfort, and academic success.

In summary, while existing literature confirms that learning spaces play a vital role in shaping student engagement and academic achievement, it also highlights significant contextual, methodological, and conceptual gaps. The present study seeks to address these gaps by providing context-specific, comprehensive, and inclusive insights into the relationship between learning environment quality, student engagement, and academic performance at the pre-university level. By integrating physical, pedagogical, technological, and sociocultural dimensions, the study contributes a holistic framework for improving learning environments and enhancing student outcomes in diverse and resource-limited educational settings.

METHODOLOGY

Research Design

A quasi-experimental research design was employed in this study to investigate the impact of learning space design on students' engagement and academic achievement in Mathematics among Private secondary school students in South Africa. The design compared the Mathematics performance and engagement levels of students in two distinct learning environments: well-facilitated classrooms and poorly-facilitated classrooms.

Population of the Study

The target population for this study consisted of Private secondary school students in South Africa. Private schools were selected due to their peculiarity. Private secondary school students were chosen because they represent the stage of education where learners consolidate foundational knowledge and prepare for a tertiary institution.

Sample and Sampling Technique

Two Private secondary schools with differing learning environments were purposively selected for this study. The first school was chosen for its well-equipped classrooms, which include adequate ventilation, lighting, seating arrangements, and spatial organization. The second institution was selected due to its inadequate classroom facilities, including overcrowding, poor ventilation, insufficient seating, and limited educational resources.

From each school, two student groups were selected to ensure participants were of the same academic level and had comparable mathematical skills. This approach ensured that observed differences in academic performance and engagement were attributable to the learning environment rather than other confounding factors.

Over a specified period, the selected students from both institutions participated in identical Mathematics instructional activities. Following the instruction, a Mathematics Achievement Test was administered to assess and compare students' academic performance and levels of engagement across the two classroom settings. This sampling and instructional procedure ensured that the study measured the effect of learning space design on student outcomes in Mathematics directly.

Instrument for Data Collection

Three instruments were employed to collect data in this study: a self-designed Learning Space Questionnaire (LSQ), Student Engagement Questionnaire (SEQ), and a Mathematics Achievement Test (MAT). Section A of the questionnaires captured demographic information, while the remaining sections included:

Learning Space Questionnaire (LSQ)

Section B contained items examining the availability and quality of learning spaces in the institutions. The LSQ consisted of 20 statements measured on a 3-point Likert scale: 1 (Poor), 2 (Fair), 3 (Good).

Student Engagement Questionnaire (SEQ)

Section C focused on students' engagement in Mathematics classes. The SEQ consisted of 20 items measured on a 3-point Likert scale: 1 (Poor), 2 (Fair), 3 (Good).

Mathematics Achievement Test (MAT)

The Mathematics Achievement Test (MAT) was developed by the researcher to assess Private secondary school students' understanding of key Mathematics concepts. It consisted of forty multiple-choice items, each with four options. The test items were aligned with the Private secondary school Mathematics curriculum and developed using a test blueprint. The initial 80 items were trial-tested to determine their difficulty and discrimination indices, after which 40 items were selected. The final difficulty index ranged between 0.3 and 0.7, and the discrimination index ranged between 0.3 and 0.6. The reliability of the MAT was determined using KR-20, yielding a coefficient of 0.87.

Validity of the Instrument

To ensure validity, the initial draft of each instrument underwent face and content validation by experts, and revisions were made to produce the final versions. The instruments were also reviewed and confirmed by the supervisor.

Reliability of the Instrument

Reliability, which reflects the consistency of an instrument's scores over repeated administrations, was established for the questionnaires using Cronbach's alpha.

Procedure for Data Collection

The instruments were administered to students using a simple random sampling technique. The researcher, assisted by two research assistants, visited the selected institutions, obtained permission from the administrators, and coordinated with instructors. Questionnaires were completed and collected on the same day. The

administration process took fifteen (15) working days. A total of 500 instruments were deemed valid for analysis in the study, "Learning Environments as Predictors of Learner Engagement and Academic Achievement in Mathematics in South Africa: A Case Study of Private Secondary School Students."

Validity of the Instrument

To ensure the validity of the instrument, the initial draft of the instrument was subjected to face and content validation, out of which the final draft was made, and also confirmed by the supervisor.

Reliability of the Instrument

Reliability is the extent to which an instrument yields consistent scores when administered over a number of times. Cronbach's alpha was used to determine the reliability index of the questionnaires.

Procedure for Data Collection

The instruments were given to the students using a simple random sampling technique. The researcher and two research assistants visited each school that had been chosen for the study, obtaining permission from the principal and the cooperation of the teachers. The questionnaire was collected from the students on the same day. It took fifteen (15) working days to complete the administration of the instrument. In all, five hundred (500) instruments were valid for the study.

Method of Data Analysis

The data analysis was both descriptive (percentage and frequency) and inferential statistics (multiple regression and correlation).

1. Examine the difference in students' academic performance in Mathematics between those taught in well-facilitated classrooms and those taught in poorly facilitated classrooms.

Table 1; Independent t-test showing the type (well-facilitated and poorly facilitated classrooms) to students' engagement

Classroom Type	N	Mean	Std. Deviation	Df	T	Sig	Remarks
Well Facilitated	250	122.97	20.879	498	2.014	0.045	Sig
Poorly Facilitated	250	119.44	18.253				

The results of the independent t-test, which are shown in Table 4.7, indicate that there was a statistically significant difference between the two groups. With a t-value of 2.014 and a p-value of 0.045, students in well-facilitated classrooms reported a higher mean engagement score (122.97) than those in poorly facilitated classrooms (119.44). This means that the null hypothesis (H_0) is rejected because the p-value is below the significance level of 0.05. This suggests that the caliber of classroom amenities significantly affects how involved students are, with better-facilitated settings encouraging higher levels of student participation in the educational process.

2. Determine the difference in students' engagement during Mathematics instruction between learners in well-facilitated classrooms and those in poorly facilitated classrooms.
3. Investigate the relationship between the quality of the learning environment and students' academic performance in Mathematics.

The relationship between the quality of the learning environment and students' academic performance.

Table 2: Correlation between Learning Environment and Students' Achievement

VARIABLES	Learning Environment	Student Achievement
Learning Environment	1	0.532**
Student Achievement		1

Correlation is significant at the 0.01 level (2-tailed).

The Pearson correlation coefficient in Table 4.8 demonstrates a reasonably strong positive link ($r = 0.532$) between the quality of the learning environment and students' academic achievement. The double asterisks (**), which normally imply significance at the 0.01 level, show that the result is statistically significant. As a result, the null hypothesis (H_{03}) is rejected, demonstrating that enhanced learning environments are positively correlated with improved academic performance.

Examine the relationship between the quality of the learning environment and students' engagement during Mathematics lessons.

Table 3: Correlation between Learning Environment and Students' Engagement

VARIABLES	Learning Environment	Student Engagement
Learning Environment	1	0.101**
Student Engagement		1

Correlation is significant at the 0.01 level (2-tailed).

The correlation coefficient provided in Table 4.9 is $r = 0.101$, again indicated with double asterisks, signifying statistical significance, albeit at a much lower magnitude. Although the link is modest, it is nonetheless significant enough to reject the null hypothesis (H_{04}). This shows that although student involvement is positively impacted by the learning environment, the effect is not very strong.

The difference in students' academic performance between those taught in well-facilitated classrooms and those in poorly facilitated classrooms.

Table 4

Classroom Type	N	Mean	Std. Deviation	Df	T	Sig	Remarks
Well Facilitated	250	31.94	3.172	498	58.619	0.042	Sig
Poorly Facilitated	250	17.10	2.439				

The academic performance of students taught in well-facilitated classrooms differs statistically significantly from that of students taught in poorly facilitated classrooms, according to the independent t-test result in Table 4.6. With a significance value ($p = 0.042$) below the 0.05 cutoff, students in well-facilitated classrooms scored significantly higher on average (31.94) than those in poorly facilitated ones (17.10). As a result, the null hypothesis (H_{01}) is disproved, suggesting that classroom amenities significantly influence students' academic achievement.

Summary of Findings (South African Private Secondary School Context)

The study revealed that female learners constituted a slightly higher proportion of the participants (55.8%) compared to male learners (44.2%). Most of the respondents were between 15 and 16 years of age, indicating that the sample largely comprised mid-adolescent learners. This age distribution suggests that the findings mainly reflect the experiences of senior secondary learners in the South African Private secondary school phase, particularly within the Further Education and Training (FET) band.

In terms of grade distribution, Grade 11 learners formed the largest group of participants (51.2%), followed by Grade 12 learners (29.6%) and Grade 10 learners (19.2%). Each grade included 250 learners, with an equal number drawn from well-resourced and under-resourced classrooms. This balanced representation enabled a fair and objective comparison of the effects of classroom resources and conditions on learner engagement and academic performance.

The findings showed that academic performance was significantly higher among learners in well-resourced learning environments (Mean = 31.94) than among those in poorly resourced classrooms (Mean = 17.10). The difference between the two groups was statistically significant ($p = 0.042$), underscoring the crucial role that adequate classroom facilities and resources play in enhancing learners' academic achievement in the Private secondary school stage.

Regarding the quality of the learning environment, most learners gave positive ratings to factors such as seating arrangements, ventilation, access to learning materials, and the availability of technological resources. Many learners reported that these elements helped to minimise distractions, encouraged active participation, and improved their ability to concentrate during lessons.

The study further found a positive but weak relationship between the quality of the learning environment and learner engagement ($r = 0.101, p < 0.05$). In contrast, a stronger and moderately positive relationship was observed between the learning environment and academic achievement ($r = 0.532, p < 0.05$). Learner engagement was also positively, though weakly, related to academic achievement ($r = 0.187, p < 0.05$), indicating that while engagement contributes to achievement, the learning environment has a more substantial influence.

Regression analysis confirmed that the quality of the learning environment was a significant predictor of both learner engagement and academic achievement ($F = 3.571, p = 0.00$). The R^2 value indicated that approximately 11.2% of the variation in these outcomes could be explained by the learning environment. Although this effect is meaningful, it also suggests that a larger proportion of learners' academic outcomes (88.8%) is influenced by other factors, highlighting the complex nature of academic success at the Private secondary school level.

Overall, the findings point to the positive impact of a well-organised and adequately resourced learning environment on learners' engagement and academic performance. However, the results also suggest that while the learning environment plays a significant role, it should be complemented by additional academic, social, and emotional support systems to fully support South African Private secondary school learners in achieving their full potential.

Discussion of the Findings (South African Private Secondary School Context)

In relation to research question one, the study found that learners who were taught in well-resourced classrooms achieved higher academic performance than their peers in poorly resourced learning environments. This finding supports Shamaki's (2015) assertion that the quality and suitability of the learning space play a critical role in determining educational outcomes. Similarly, Duruji, Azuh, and Oviasogie (2014) emphasised that school infrastructure, including planning, maintenance, and sanitation, has a significant influence on learners' performance in external examinations. Research further shows that effective learning environments characterised by adequate lighting, proper ventilation, ergonomic furniture, and flexible classroom layouts contribute positively to academic achievement (Barrett et al., 2013; Adeyemi, 2021). In contrast, poorly maintained classrooms with limited facilities have been associated with learner fatigue, health-related challenges, and reduced academic focus (Oluremi, 2013). The significant performance differences observed in this study therefore reinforce earlier findings that a supportive physical learning environment enhances concentration, minimises distractions, and ultimately improves academic outcomes among Private secondary school learners (Ashrad, 2021; Igoro, 2019).

About research question two, the findings indicated that learners in well-facilitated classrooms demonstrated higher levels of engagement than those in poorly facilitated settings. This aligns with Skinner et al.'s (2021) conceptualisation of learner engagement, which highlights the role of environmental factors in shaping learners' motivation, self-perceptions, and participation in learning activities. Previous studies have shown that active learning spaces with flexible seating arrangements, natural lighting, and visually stimulating designs enhance learner motivation and engagement (Hodges, 2018; Harvey & Kenyon, 2013). Conversely, classrooms that are overcrowded, poorly ventilated, and inadequately equipped often contribute to learner disengagement, behavioural challenges, and emotional withdrawal (Uline & Tschannen-Moran, 2008; Adegbite & Mohammed, 2022). Additionally, learning spaces that promote collaboration and learner autonomy through movable furniture and clustered seating arrangements have been linked to increased cognitive engagement and active participation (Rands & Gansemer-Topf, 2017). These findings confirm that the quality of the learning environment plays a significant role in shaping all dimensions of learner engagement in the South African Private secondary school context.

The findings related to research question three revealed a strong positive relationship between learners' academic achievement and the quality of the learning environment. This supports Mudassir and Norsuhaily's (2015) view that the physical, social, and psychological aspects of the school environment significantly influence learning outcomes. Scholars such as Entwisle (2020) and Akintola (2014) have similarly identified classroom conditions, instructional resources, and infrastructural quality as key predictors of academic success. Furthermore, conceptual studies suggest that enriched learning environments that promote emotional well-being, physical comfort, and intellectual stimulation contribute meaningfully to improved academic performance (Balog, 2020; Usman, 2016). Empirical evidence from Odeh, Oguche, and Ivagher (2015) also demonstrates that discipline, physical facilities, and overall school climate have a significant impact on secondary school learners' academic achievement. These findings reinforce the understanding that conducive learning environments extend beyond physical structures and are central to academic success in the Private secondary school phase.

Finally, the results indicated that the quality of the learning environment is a significant predictor of both learner engagement and academic achievement. This finding is consistent with Humanistic Learning Theory, which posits that learners are unlikely to reach their full potential without a supportive, orderly, and nurturing learning environment (Baafi, 2020). Studies have shown that inclusive, learner-centred classroom designs

(Gonzalez, Pereira, & Silva, 2023), flexible and innovative learning spaces (Oblinger, 2006; Hoodless et al., 2021), and active learning environments contribute to higher engagement levels and improved academic outcomes. Further research by Kariippanon et al. (2019) and Martin and Torres (2021) indicates that learning environments influence learners' behavioural, emotional, and psychological responses, which in turn affect academic performance. The findings of this study therefore demonstrate that the quality of learning spaces is not only associated with, but also predictive of, learner engagement and academic success. Well-resourced and thoughtfully designed classrooms that address learners' emotional and cognitive needs are more likely to foster persistence, critical thinking, and academic excellence among South African Private secondary school learners.

Implications of the Study (South African Private Secondary School Context)

The findings of this study have important implications for learners, teachers, school management teams, policymakers, and educational planners within South Africa's Private secondary school education system. Firstly, the study underscores the critical role of the physical learning environment in shaping learners' academic achievement and engagement. It suggests that providing access to schooling alone, without equal attention to the quality of classrooms and learning spaces, is insufficient to achieve optimal learner outcomes. As a result, all stakeholders need to place greater emphasis on both the availability and the quality of educational infrastructure.

Secondly, the study highlights the importance of teachers' effective and creative use of available classroom space to promote active learning, collaboration, and learner engagement. Even in contexts where resources may be limited, teachers can enhance learner participation by arranging classrooms in ways that support interaction and inclusivity. In addition, the findings indicate that school management teams can significantly improve learner engagement and academic performance by prioritising investments in classroom aesthetics, adequate ventilation, appropriate seating arrangements, and regular maintenance of facilities.

At the policy level, the results suggest that infrastructural development should focus not only on expanding the number of schools and classrooms, but also on the design, functionality, and upkeep of learner-centred learning environments. Policymakers are encouraged to review and update education policies to include clear standards for learning space quality, ensuring equity between urban and rural schools and across different socio-economic contexts. Such standards are essential for reducing disparities in learning conditions and outcomes.

Finally, the study implies that future educational reforms should recognise that the physical learning environment is closely linked to teaching quality and learner achievement. The physical context in which learning occurs cannot be separated from effective pedagogy. The study, therefore, calls for further research into the long-term effects of learning space design on learner outcomes and encourages the integration of environmental considerations into curriculum planning and classroom practice within the South African Private secondary school education system.

Conclusion (South African Private Secondary School Context)

The findings of this study support existing literature that emphasises the influence of learning environments, including both physical and psychosocial factors, on educational outcomes. In particular, the results affirm the principles of Humanistic Learning Theory, which highlights the importance of safe, comfortable, and stimulating learning spaces in enabling learners to reach their full potential. The study provides empirical evidence that the design and quality of learning spaces play a significant role in shaping learner engagement and academic achievement within South African private and private secondary schools.

The study further demonstrates that learners who are taught in well-resourced and well-maintained classrooms show higher levels of academic performance and greater engagement compared to those learning in poorly resourced environments. These findings suggest that effective learning environments are not merely supportive additions to the teaching and learning process, but are essential determinants of academic success and meaningful learner participation.

In conclusion, the study underscores the need for learning spaces that actively support learner-centred teaching and learning. Strategic planning, construction, and ongoing maintenance of classrooms should therefore be prioritised as part of South Africa's efforts towards sustainable educational development. Improving educational quality requires deliberate attention to infrastructural challenges and the incorporation of design principles that promote interaction, motivation, and active learning. Private and private secondary schools can only achieve improved learner engagement, reduced educational inequalities, and enhanced academic performance through sustained investment in the creation and maintenance of effective and inclusive learning environments.

Recommendations (South African Private Secondary School Context)

Following a careful analysis and critical appraisal of effective learning space design in private and private secondary schools, and its impact on learner engagement and academic achievement, the following recommendations are proposed:

Firstly, the government and school management teams should prioritise the construction, upgrading, and refurbishment of classrooms to ensure adequate lighting, proper ventilation, ergonomic furniture, and flexible classroom layouts. These features are essential for creating learning environments that support concentration, comfort, and active participation.

Secondly, education funding should be allocated strategically, not only to expand access to schooling but also to improve the quality and design of existing learning environments. Investment in infrastructure should focus on creating learner-centred spaces that enhance both engagement and academic performance.

Thirdly, a comprehensive and sustainable maintenance programme should be implemented in all Private secondary schools to ensure that learning spaces remain safe, functional, and conducive to learning over time. Regular maintenance will help prevent the deterioration of facilities and ensure consistent learning conditions for all learners.

Furthermore, teachers should be provided with ongoing professional development on how to effectively utilise classroom design and environmental features to promote active learning, collaboration, and learners' emotional engagement. Empowering teachers to creatively manage learning spaces can significantly enhance learner participation, even in resource-constrained settings.

School management teams are also encouraged to regularly seek feedback from learners regarding the comfort, accessibility, and usability of their learning environments. Learner input can provide valuable insights to guide improvements and targeted interventions.

Finally, local communities should be encouraged to play an active role in supporting schools through community-based initiatives aimed at maintaining, upgrading, and safeguarding educational facilities. Strong school–community partnerships can contribute meaningfully to the sustainability and effectiveness of learning environments in South African Private secondary school education.

REFERENCES

- Rindenow, E., Davidovitch, N., & Dorot, R. (2025). Teaching and learning in new spaces: the pedagogy-suited learning space approach. *Cogent Education*, 12(1), 2560615.
- Lee, D., Colorado-Resa, J. T., & Huh, Y. (2025). Designing an Active Learning Space. *TechTrends*, 69(2), 310-330.
- Abdullah, M., Maruthaveeran, S., Hasna, M. F., & Sudo, T. (2025). Exploration of Outdoor Learning Space Towards ASD Children: A Systematic Literature Review. *Environment-Behaviour Proceedings Journal*, 10(31), 251-256.
- Quevedo Piratova, D. A., Sánchez Duarte, M. M., Chiappe, A., & Sáez Delgado, F. M. (2025). Intelligent Classrooms: How AI and IoT can reshape learning spaces. *European Journal of Education*, 60(1), e70000.
- Velmurugan, R., Jothi, K., Sudarvel, J., & Thirumalaisamy, R. (2026). Strategies for Fostering Emotional Intelligence in the Classroom. In *Pedagogical Approaches to Bridging Emotional and Cognitive Learning* (pp. 43-70). IGI Global Scientific Publishing.
- Inayah, I., Widayanti, L., Maesaroh, M., Mulyana, A., & Udin, T. (2026). Schools and Classrooms in a Sociological Perspective. *Journal of English Language and Education*, 11(1), 29-39.
- Cleveland, B., & Mahat, M. (2026). Learning spaces in schools: a pedagogic research agenda. *Pedagogies: An International Journal*, 1-13.
- Grannäs, J., Frelin, A., & Östlin, T. (2026). Unpacking flexibility in innovative learning environments: teachers' experiences in practice. *Educational Studies*, 52(1), 76-92.
- Chand, S. P. (2026). Constructivism in theory and practice: implications for classroom pedagogy. *Journal of Advanced Education and Sciences*, 6(1), 23-29.
- Yilmaz, Y., & Açıkgül Fırat, E. (2026). Station-rotation blended learning model in science education: a case study for rural classrooms. *International Journal of Science Education*, 48(1), 45-72.
- Astuti, C. T., Leovanny, S., Aulia, L., Caesaria, N. Z., & Siswanto, D. H. (2026). Learning Approaches, Climate, Motivation, Soft Skills, and Achievement: A Comparative Study of Nature-Based and Conventional Educational Systems. *Jurnal Penelitian Ilmiah Multidisipliner*, 2(04).
- Olaseni, V. M., & Saziwa, T. (2024). Impact of Error Analysis Techniques on Mathematics' Assimilation among a Cohort of Struggling Secondary School Students. *Futurity Education*, 4(4), 227-239.

Saziwa, T., & Olaseni, V. M. (2025). Comparative study of job satisfaction and the role of socio-demographic factors among mathematics teachers in Nigeria and South Africa. *EUREKA: Social and Humanities*, (1), 81-88.