Relational and Ecological Pathways to Student Engagement: Ghanaian Senior High School Classrooms' Perspective

John Edem Avedzi., Theophilus Nyamekye., Michael Okyere., Benjamin Cudjoe., Asare Enoch Kwadwo

University of Education, Winneba

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ABSTRACT

This study investigated the impact of the classroom environment on learner engagement among Senior High School students in the Central Region of Ghana, focusing on physical, psychological, and social factors. A cross-sectional survey design was employed with a stratified random sample of 504 students. Data were collected using a structured questionnaire and analyzed through descriptive statistics, Pearson correlation, and multiple linear regression. The findings revealed that the physical classroom environment had no significant effect on learner engagement ($R^2 = .002$, $p > .05$). In contrast, psychological factors emerged as the strongest predictor, accounting for 71% of the variance in engagement ($R^2 = .710$, $p < .001$), while social factors contributed moderately ($R^2 = .251$, $p < .001$). The combined regression model explained 96.5% of the variance in learner engagement, with psychological and social factors exerting significant positive influences, while the physical environment remained non-significant. The results highlight the centrality of psychological drivers such as motivation, self-efficacy, and interest, as well as the importance of supportive teacher-student and peer relationships. The study recommends that educators and policymakers prioritize interventions targeting psychological and social dimensions of the learning environment to enhance student engagement, while maintaining adequate physical conditions.

Keywords: Classroom environment, learner engagement, psychological, social, physical

BACKGROUND

Imagine walking into a classroom that feels like a second home, where every element is designed to inspire learning and growth. The classroom environment plays an important role in shaping learner engagement, which is essential for effective teaching and learning. Research has consistently shown that various factors within the classroom environment, such as physical, psychological, and social, significantly influence learner engagement and academic achievement. A well-structured classroom setting promotes motivation, attention, and participation, whereas a poorly designed learning space may lead to disengagement and academic underperformance (Fu & Xie, 2024). The importance of classroom environment extends beyond the mere physical layout to include emotional and social dimensions that shape the learning experiences of learners.

The physical environment, which includes seating arrangements, lighting, ventilation, and classroom aesthetics, has a direct impact on learners' ability to focus and interact with learning materials. Studies have shown that comfortable and well-ventilated classrooms improve learners' cognitive skills and engagement levels (Shaheen & Ibrahim, 2024). In many educational settings, overcrowded classrooms, poor lighting, and inadequate seating arrangements contribute to learner discomfort and disengagement. Classroom design has been identified as a critical element in enhancing learner learning outcomes. For example, flexible seating arrangements and natural lighting have been shown to improve concentration and reduce fatigue among learners. Moreover, the integration of digital tools and modern classroom layouts, such as smart boards and ergonomic furniture, can further boost learner engagement and facilitate interactive learning experiences.

Additionally, factors such as noise levels and classroom decorations also play a role in enhancing or hindering learning. Excessive noise in classrooms negatively affects learners' ability to concentrate, thereby reducing their engagement (Jones et al., 2024). Noise pollution, whether from within the classroom or external sources, has

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been linked to increased stress levels and decreased academic performance. Schools located in high-traffic areas or near industrial zones often struggle with maintaining an optimal learning environment due to persistent noise disturbances. To mitigate these challenges, the adoption of soundproofing techniques and strategic classroom designs can significantly enhance learner focus and engagement.

Beyond the physical aspects, psychological factors such as learners' perceptions of safety, autonomy, and teacher support influence their level of engagement. A study by (Ye, 2024) indicates that classrooms that promote a sense of belonging and psychological safety encourage higher levels of learner participation and motivation. The psychological climate in a classroom is often shaped by teacher-learner relationships, instructional methods, and the extent to which learners feel valued and included in discussions (Kugai et al., 2024). A positive psychological environment fosters confidence, reduces anxiety, and motivates learners to take intellectual risks in their learning processes. Teachers play a pivotal role in establishing such environments by being approachable, supportive, and fostering an inclusive classroom culture.

Furthermore, classroom environments that promote autonomy and self-directed learning encourage greater engagement. Learners who feel empowered to make decisions regarding their learning process are more likely to exhibit intrinsic motivation.

LITERATURE REVIEW

Physical Factors

A growing literature demonstrates that the physical learning environment functions not as a neutral backdrop, but as a measurable lever influencing learner engagement. For example, (Makaremi et al., 2024) found that active learning classroom designs significantly enhanced students' engagement ($p < .001$), confirming the environment's direct and quantifiable impact on learning. Recent empirical and review research indicates that physical classroom conditions such as thermal comfort, air quality, lighting, acoustics, and classroom layout—are closely linked to students' behavioral, emotional, and cognitive engagement (Mercugliano et al., 2025; Miri et al., 2025). For example, a large-scale systematic review found consistently positive associations between improved indoor environmental quality, including lighting, thermal comfort, acoustics, and ventilation, and students' behavioral outcomes such as participation, attention, and persistence, often mediated by enhanced perceived comfort and reduced fatigue (Brink et al., 2023). Similarly, quasi-experimental and survey studies show that ergonomic seating configurations, including mobile or flexible furniture and opportunities for movement (e.g., standing desks, stability-ball seating), are tied to higher on-task behavior and self-reported engagement, particularly in active learning formats. For example, (Odum et al., 2021) found greater student-to-student and student-to-instructor engagement in active learning classrooms using mobile tables versus mobile desks. Likewise, (Peng et al., 2022) demonstrated that flexible spatial attributes in active learning environments enhance instructional interaction and engagement. Moreover, studies using stability-ball seating observed improved alertness and math performance compared to traditional desks (Mead & Scibora, 2016). These patterns align with load and embodiment accounts: physical affordances reduce extraneous cognitive load and support embodied interaction, freeing capacity for deeper engagement.

Importantly, "environment" is not limited to bricks and mortar; students' perceptions of the environment, safety, atmosphere, and academic self-perceptions shaped by the space also matter. A regression study conducted with 441 secondary school students in Scotland demonstrated that students' subjective perceptions of their physical school environment, beyond objective features like temperature or noise, were significantly associated with academic achievement. Engagement and the absence of environmental difficulty mediated this relationship, highlighting the indirect and symbolic role of students' perceived environment (Edgerton & McKechnie, 2023). For instance, a recent path-analytic study in health professions education revealed that students' perceptions of their educational environment significantly predicted emotional engagement, explaining approximately 48% of its variance ($\Delta R^2 \approx .48$) and additionally influenced cognitive and behavioral engagement. Importantly, both cognitive and behavioral engagement subsequently predicted academic achievement, serving as partial mediators in the environment → achievement relationship (Kassab et al., 2024). While the context was health professions education, the mechanisms generalize to secondary settings; spaces that support visibility, audibility,

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and collaborative proximity tend to promote relatedness and competence, two core needs in (Deci & Ryan, 1985) Self Determination Theory (SDT) framework, which underpins several of these models.

Recent evaluations of flexible learning spaces in Europe demonstrate that classroom redesigns featuring movable furniture, designated zones for small-group work, and improved teacher line-of-sight significantly improve students' behavioral engagement. In particular, a large-scale study of secondary schools reported that flexible classrooms were associated with markedly higher collaboration (effect size d = 1.33, p = .001), greater active engagement with lesson content (d = 0.50, p = .001), and reduced off-task behavior (d = –0.44, p = .016) compared to traditional classroom arrangements. These findings highlight that well-designed flexible layouts can boost participation and peer interaction, while simultaneously maintaining or even improving time-on-task, key indicators of sustained behavioral engagement. Collectively, the physical environment exerts both direct effects (comfort, acoustics, layout) and indirect effects via motivational appraisals of the learning climate, with the strongest links typically observed for behavioral (participation/attention) and emotional (interest/enjoyment) engagement.

Psychological Factors

Meta-analytic evidence confirms that psychological drivers, especially need satisfaction (autonomy, competence, and relatedness), intrinsic and identified motivation, and self-efficacy, consistently exhibit moderate to strong positive relationships with student engagement. One meta-analysis spanning over 144 studies (N > 79,000) found that competence was the strongest predictor of self-determined motivation (i.e., intrinsic and identified motivation), followed by autonomy and relatedness. Meanwhile, a focused meta-analysis of 24 correlation studies (68 effect sizes) on self-efficacy reported a moderate average effect (Cohen's d = 0.54) on academic engagement (Bureau et al., 2022; Fatimah et al., 2024). A recent wave of Self-Determination Theory (SDT) syntheses (2024–2025) provides converging evidence that autonomy-supportive teaching practices, such as offering choice, encouraging student voice, and minimizing controlling language, reliably enhance students' intrinsic motivation and satisfaction of basic psychological needs (autonomy, competence, relatedness). In turn, these motivational processes consistently predict higher behavioral, emotional, and cognitive engagement in learning activities. For example, (Fatimah et al., 2024) conducted a meta-analysis showing that academic self-efficacy, closely tied to competence need satisfaction, had a significant positive effect on overall engagement. Complementary review work by (Vansteenkiste et al., 2020) and more recent syntheses by (Howard et al., 2021) confirm that autonomy-supportive instruction fosters deeper persistence, attention, and emotional involvement, with effects generalizing across cultural and educational contexts(Ryan & Deci, 2022). Collectively, this line of evidence underscores that SDT-based drivers are not peripheral but central mechanisms linking instructional climate to student engagement and achievement. Effects are robust across levels (primary to tertiary) and cultures, and remain after adjusting for prior achievement and demographics.

Within Ghanaian secondary schooling, studies echo these global patterns. (Amoadu et al., 2025) demonstrate that academic resilience and motivation are significant predictors of engagement among Ghanaian senior high school students, with motivation partially mediating the resilience → engagement relationship; notably, no significant rural–urban differences were observed, suggesting that motivational resources may buffer against contextual constraints. Complementary Ghana-focused research further underscores this psychological dynamic. In a study of 190 senior high school students, academic resilience was found to positively influence both grit (β = .518, p < .001) and motivation (β = .479, p < .001), each of which significantly predicted well-being; remarkably, grit (β = .321, p < .001) and motivation (β = .356, p < .001) emerged as significant partial mediators of the resilience → well-being pathway, reinforcing the psychological mechanism by which adaptive beliefs foster sustained engagement and flourishing (Amoadu et al., 2025). Together, these findings reinforce SDT's claim that when classrooms support autonomy (voice/choice), competence (optimal challenge/feedback), and relatedness (belonging), engagement rises—even in resource-limited contexts.

Beyond motivation, expectancy–value beliefs and self-efficacy perceptions emerge as robust cognitive drivers of engagement. Students who believe they can succeed (competence beliefs) and who value academic tasks consistently report higher levels of cognitive engagement manifested in strategy use, persistence, and deeper processing (Eccles & Wigfield, 2020; Schunk & DiBenedetto, 2020). Meta-analytic evidence confirms that self-efficacy demonstrates medium-to-large positive associations with persistence and strategy deployment, while

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task value predicts adaptive effort regulation, together reinforcing students' willingness to sustain cognitively demanding engagement (Talsma et al., 2018). Recent structural equation models confirm that interest and perceived relevance are powerful predictors of students' use of deep learning strategies and sustained attention. These factors, often conceptualized within expectancy–value and interest-development frameworks, exert significant indirect effects on achievement through engagement pathways, highlighting how relevance and situational/individual interest not only energize attention but also scaffold long-term persistence and strategic effort (Durik et al., 2015; Harackiewicz & Priniski, 2018). These psychological drivers act as active ingredients that translate instructional climate and environmental affordances into day-to-day effort, enthusiasm, and strategic thinking.

Social Factors

Within the social ecology of classrooms, factors such as teacher–student relationships (TSR), peer climate, and classroom norms of participation show strong and reliable associations with engagement outcomes. Warm, supportive TSRs are consistently linked to higher behavioral, emotional, and cognitive engagement, partly through fostering belonging and perceived teacher care (Quin, 2017; Roorda et al., 2011). Similarly, peer climates characterized by cooperation, respect, and prosocial norms enhance participation, persistence, and willingness to take academic risks, while negative peer dynamics predict disengagement and withdrawal (Wentzel, 2005). Together, these findings underscore that engagement is not solely neuropsychological but is co-constructed within the relational and normative ecology of classrooms. A recent meta-analytic review further substantiates the centrality of teacher–student relationships (TSRs) in shaping engagement outcomes. Specifically, findings from a 2024 synthesis indicate that high-quality TSRs characterized by warmth, support, and low conflict are robustly associated with both behavioral and emotional engagement, as well as academic achievement. Importantly, these associations remain significant even after controlling for students' background and personality characteristics, suggesting that TSRs exert an independent and durable effect on learning processes and outcomes (O'Keefe et al., 2023). These results extend earlier evidence, (Quin, 2017; Roorda et al., 2011) by demonstrating that the relational climate functions as a protective factor that promotes engagement and performance across diverse student populations.

Complementing meta-analytic findings, recent systematic reviews grounded in attachment theory underscore the developmental importance of teacher–student relationships (TSRs). Evidence from (Di Lisio et al., 2025) demonstrates that secure TSRs serve "safe haven" and "secure base" functions: they buffer against disengagement while encouraging students to take intellectual risks in learning. These attachment-informed dynamics have been confirmed across both longitudinal and cross-sectional designs, suggesting that TSRs provide not only immediate emotional support but also long-term motivational resources that sustain engagement trajectories. Taken together, this attachment perspective positions TSRs as a relational foundation upon which students' behavioral, emotional, and cognitive engagement can be built and maintained.

Student engagement is increasingly recognized as a co-constructed phenomenon, shaped not only by instructional design but also by the emotional and relational capacities of teachers. Recent meta-analytic evidence affirms that teachers' socio-emotional competence (SEC) is a critical determinant of engagement outcomes, operating through mechanisms that transcend traditional pedagogical boundaries. (Gebre et al., 2025) synthesized 21 quantitative studies conducted between 2018 and 2023, employing quasi-experimental and longitudinal designs to assess the impact of SEC on student engagement. Their findings revealed a statistically significant positive correlation, with SEC influencing behavioral, emotional, and cognitive engagement through relational pathways. These mechanisms include improved classroom interactions, clearer emotional signalling, and more effective conflict regulation, each contributing to students' perceptions of support, safety, and belonging. Improved classroom interactions, facilitated by emotionally attuned teachers, foster psychological safety and openness, which are foundational to active participation and persistence. Clear emotional signalling helps students interpret teacher intentions, reducing ambiguity and reinforcing relational trust. Moreover, teachers with strong SEC manage classroom tensions constructively, modelling prosocial behavior and minimizing disruptions that hinder learning. These relational dynamics position SEC as a pedagogical resource rather than a peripheral trait. It functions as a catalyst for engagement, enhancing students' emotional connection to learning, their strategic thinking, and their willingness to invest effort. Gebre et al. (2025) argue that SEC

should be embedded into professional development programs, given its direct implications for fostering resilient, motivated learners.

In the Ghanaian SHS context, empirical evidence underscores the salience of relational and ecological mechanisms in shaping student engagement. Analysis of teacher qualifications and teacher–student interaction quality demonstrate that teacher attributes such as professional preparation and self-efficacy, indirectly influence engagement through their effects on interaction quality, which serves as a proximal determinant of student participation (Ntarmah & Yaro, 2025). A survey-based evidence from Kumasi Metropolis on SHS students reveals that perceptions of the learning environment, particularly teacher-related characteristics and classroom climate, are significantly associated with performance in core subjects such as mathematics (Quainoo et al., 2020). Together, these findings suggest that the social layer of schooling, teacher-student relationships, peer dynamics, and classroom norms not only predict engagement directly but also amplify key psychological drivers such as motivation and self-efficacy, a pattern consistent with self-determination theory (Deci & Ryan, 2000) and social learning perspectives (Bandura, 1997).

METHODS

A cross-sectional survey design was employed to examine the influence of the classroom environment on learner engagement of Senior High School students in the Central Region of Ghana. This design was appropriate because it allowed data collection from a large sample at a single point in time and facilitated statistical analysis of relationships between variables (Creswell & Creswell, 2018). The target population comprised approximately 1,500 students across Forms One to Three. Using (Cochran, 1977) sample size determination formula, a stratified random sample of 504 students was selected to ensure representation across gender and class levels. This sample was considered adequate for regression analysis (Cohen, 1988).

Data were collected through in-person administration of a structured questionnaire. The instrument measured three independent variables, physical classroom environment, psychological factors, and social factors, and the dependent variable, learner engagement. Items were self-developed by the researchers through established frameworks, including (Earthman, 2004) for classroom environment, (Deci & Ryan, 2000) for psychological factors, (Bandura, 1997) for social factors, and (Fredricks et al., 2004) for learner engagement. All items were rated on Likert scales and demonstrated acceptable internal consistency, with Cronbach's alpha values ranging from .960 to .963. Ethical approval was obtained from the Institutional Review Board. Participation was voluntary, with informed consent secured from students and parental consent for minors. Confidentiality and anonymity were assured. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics summarized the data, while Pearson correlation and multiple linear regression analysis tested the relationships and predictive power of the independent variables on learner engagement. Statistical significance was set at $p < .05$, and diagnostic tests confirmed that the data met assumptions for regression analysis (Kutner et al., 2005; Tabachnick & Fidell, 2013).

RESULTS

Demographic data of respondents

Table 1: Sex Distribution of Respondents

Sex	Frequency	Percentage (%)
Male	247	49.0
Female	257	51.0
Total	504	100.0

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

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Table 1 presents the sex distribution of the respondents. Out of the 504 students who participated in the study, 247 (49.0%) were males, while 257 (51.0%) were females. This indicates that the sample was fairly balanced in terms of gender representation, with a slight majority of females. Such a distribution enhances the credibility of the findings as both sexes were almost equally represented, reducing gender bias in the responses.

Table 2: Age Distribution of Respondents

Age	**Frequency**	**Percentage (%)**
13-15	249	49.4
16-20	226	44.8
20+	29	5.8
Total	504	100.0

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

Table 2 shows the age distribution of respondents. The majority, 249 (49.4%), were between 13–15 years, followed by 226 (44.8%) aged 16–20 years, while only 29 (5.8%) were above 20 years. This indicates that most of the learners were in their mid-teens, consistent with the expected age range for senior high school students.

Table 3: Class Distribution of Respondents

Form	**Frequency**	**Percent**
One	165	32.7
Two	161	31.9
Three	178	35.3
Total	504	100.0

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

Table 3 presents the class distribution of respondents. Out of the 504 students, 165 (32.7%) were in Form One, 161 (31.9%) in Form Two, and 178 (35.3%) in Form Three. The distribution is fairly even across the three classes, with Form Three having a slightly higher proportion. This balance ensures that the views captured reflect learners' experiences across all levels of study.

Table 4: Number of Years Distribution of Respondents

Number of Years	**Frequency**	**Percent**
1	137	27.2
2	164	32.5
3	172	34.1
4	31	6.2
Total	504	100.0

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

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Table 4 represents the distribution of respondents by the number of years spent in the school. A total of 137 students (27.2%) had been in the school for one year, 164 (32.5%) for two years, 172 (34.1%) for three years, and 31 (6.2%) for four years. The results indicate that the majority of respondents had between two to three years of experience in the school, suggesting that most students were well-acquainted with the school environment to provide informed responses.

Table 4: Preferred Learning Styles Distribution of Respondents

Preferred Learning Styles	**Frequency**	**Percent**
I learn best when I look at pictures, charts, diagrams, or videos.	98	19.4
I learn best when I listen to the teacher or discussions.	102	20.2
I learn best when I read books or notes and write things down.	93	18.5
I learn best when I do activities, experiments, or practice myself.	114	22.6
I learn best when I work with classmates in groups.	97	19.2
Total	504	100.0

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

Table 5 presents the distribution of respondents based on their preferred learning styles. The highest proportion of students, 114 (22.6%), reported that they learn best through activities, experiments, or practice (kinesthetic learning). This was followed by 102 students (20.2%) who preferred listening to the teacher or discussions, 98 (19.4%) who preferred visual learning through pictures, charts, diagrams, or videos, 97 (19.2%) who preferred group work with classmates, and 93 (18.5%) who preferred reading books or notes and writing. The findings suggest that while all learning styles were represented, a slightly greater number of students favored hands-on, activity-based learning methods.

Research question 1: How does the physical classroom environment influence learner engagement?

Table 6: Descriptives for research question one

	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Physical Classroom Environment	504	20.00	40.00	30.5754	4.16726
Total	504				

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

Table 6 presents the descriptive statistics for Research Question One on the physical classroom environment. The results show that respondents' scores ranged from 20.00 to 40.00, with a mean score of 30.58 and a standard deviation of 4.17. This indicates that, on average, students perceived the physical classroom environment positively, and the relatively low standard deviation suggests that responses were fairly consistent across the sample.

Table 7: Pearson Correlation between Physical Classroom Environment and Learner Engagement

Variables	**Physical Classroom Environment**	**Engagement**
Physical Classroom Environment	1.000	-0.045

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Engagement	-0.045	1.000
Sig. (2-tailed)	-	0.310

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

Table 7 represents the Pearson correlation between the physical classroom environment and learner engagement. The results indicate a weak, negative correlation (r = –.045) which is not statistically significant at the 0.05 level (p = .310). This suggests that there is no meaningful relationship between the physical classroom environment and learner engagement among the respondents. In other words, variations in the physical classroom conditions did not significantly influence students' level of engagement.

Table 8: Model Summary of Regression Analysis (Physical Classroom Environment → Engagement)

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of Estimate**
1	.045	.002	.000	.39232

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

Table 8 shows that the correlation between physical classroom environment and learner engagement was weak (R = .045). The model explained only 0.2% of the variance in learner engagement (R^2 = .002), which is negligible.

Table 9: ANOVA of Regression Model (Physical Classroom Environment → Engagement)

Model	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Regression	0.159	1	0.159	1.031	.310
Residual	77.265	502	0.154		
Total	77.424	503			

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

Table 9 indicates that the regression model was not statistically significant, F(1, 502) = 1.031, p = .310. This indicates that the physical classroom environment does not significantly predict learner engagement.

Table 10: Coefficients of Regression Model (Physical Classroom Environment → Engagement)

Predictor	**Unstandardized B**	**Std. Error**	**Standardized Beta**	**t**	**Sig.**
(Constant)	3.938	0.130	—	30.400	.000
Physical Classroom Environment	-0.004	0.004	-0.045	-1.016	.310

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

Table 10 indicates that the physical classroom environment had a negative but non-significant effect on learner engagement (β = -0.045, t = -1.016, p = .310). This means that variations in the physical classroom environment do not meaningfully predict changes in learner engagement among the respondents.

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Research question 2: What psychological factors contribute to learners' engagement in the classroom?

Table 11: Model Summary of the Effect of Psychological Factors on Learner Engagement

Model	R	R Square	Adjusted R Square	Std. Error of Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.843	.710	.709	.21155	.710	1228.029	1	502	.000

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

In Table 11 above, the regression model examining the influence of psychological factors on engagement was statistically significant, $F(1, 502) = 1228.029$, $p < .001$. The model explained approximately 71.0% of the variance in the dependent variable ($R^2 = .710$, Adjusted $R^2 = .709$), indicating a strong explanatory power. The correlation coefficient ($R = .843$) suggests a very strong positive relationship between psychological factors and the outcome variable. The standard error of estimate (SE = .21155) indicates that the model's predictions closely approximate the observed values. This implies that psychological factors are a strong and significant predictor of [dependent variable], accounting for a substantial portion of the variance.

Table 12: ANOVA Results for the Effect of Psychological Factors on Engagement

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	54.958	1	54.958	1228.029	.000**
Residual	22.466	502	.045		
Total	77.424	503			

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

The ANOVA results in Table 12 showed that the regression model was statistically significant, $F(1, 502) = 1228.029$, $p < .001$. This indicates that psychological factors significantly predict students' engagement, explaining a substantial amount of variance. Specifically, the regression sum of squares (54.958) was far greater than the residual sum of squares (22.466), highlighting that psychological factors account for a large portion of the variability in engagement. In practical terms, this means psychological factors play a critical role in determining students' engagement, and the relationship is unlikely to have occurred by chance.

Table 13: Coefficients of Psychological Factors Predicting Engagement

Model	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	t	Sig.
(Constant)	1.432	.068	–	20.916	.000**
Psychological Factors	.070	.002	.843	35.043	.000**

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

Table 13 presents the regression coefficients, indicating that psychological factors are a strong and significant predictor of engagement. Specifically, the unstandardized coefficient ($B = .070$, $p < .001$) suggests that for every one-unit increase in psychological factors, students' engagement increases by .070 units, holding other factors constant. The standardized coefficient (Beta = .843) shows that psychological factors have a very strong positive influence on engagement compared to other potential predictors. The high t-value (35.043) further confirms the

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robustness of this effect. Taken together, these results imply that enhancing students' psychological factors (e.g., motivation, self-efficacy, interest) substantially improves their engagement levels.

Research question 3: In what ways do social factors affect learner engagement in the classroom?

Table 14: Model Summary of the Effect of Social Factors on Engagement

Model	R	R Square	Adjusted R Square	Std. Error of Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.501	.251	.250	.33980	.251	168.562	1	502	.000**

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

Table 14 above shows that the regression model examining the influence of social factors on engagement was statistically significant, $F(1, 502) = 168.562$, $p < .001$. The model explained approximately 25.1% of the variance in engagement ($R^2 = .251$, Adjusted $R^2 = .250$), indicating a moderate explanatory power. The correlation coefficient ($R = .501$) suggests a moderate positive relationship between social factors and engagement. The standard error of estimate (SE = .33980) indicates some variability in prediction, though still within acceptable limits. This finding implies that while social factors (e.g., peer relationships, teacher-student interactions, learning environment) significantly contribute to students' engagement, their effect is less substantial compared to psychological factors.

Table 15: ANOVA Results for the Effect of Social Factors on Engagement

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	19.462	1	19.462	168.562	.000**
Residual	57.961	502	.115		
Total	77.424	503			

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

The ANOVA results in Table 15 confirmed that the regression model was statistically significant, $F(1, 502) = 168.562$, $p < .001$. This means that social factors significantly predict students' engagement. However, the regression sum of squares (19.462) was considerably smaller than the residual sum of squares (57.961), indicating that although social factors play an important role, a large proportion of the variance in engagement is explained by other factors not captured in this model. In other words, social factors matter, but they are not the strongest determinant of engagement compared to psychological factors.

Multiple Linear Regression

Multiple linear regression was conducted to examine the combined influence of physical classroom environment, psychological factors, and social factors on learner engagement. This statistical approach was chosen to assess the simultaneous effects of these three independent variables, as outlined in the research questions, and to determine their relative contributions to engagement while controlling for potential interrelationships.

Table 16. Model Summary of Multiple Linear Regression Predicting Student Engagement from Physical Classroom Environment, Social Factors, and Psychological Factors

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate	R^2 Change	F Change	df1	df2	Sig. F Change
1	.982	.965	.965	0.073	.965	4611.503	3	500	.000***

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Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

The findings of the multiple linear regression analysis in Table 16 revealed that the combination of physical classroom environment, social factors, and psychological factors significantly predicted student engagement, $F(3, 500) = 4611.503$, $p < .001$. The model explained 96.5% of the variance in student engagement ($R^2 = .965$, Adjusted $R^2 = .965$), suggesting that these factors play a substantial role in shaping how learners engage in the classroom. The low standard error of estimate (SE = 0.073) further indicates the robustness of the model fit.

Table 17. ANOVA Results for Multiple Linear Regression Predicting Student Engagement

Source	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Regression	74.723	3	24.908	4611.503	.000***
Residual	2.701	500	0.005		
Total	77.424	503			

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

The ANOVA results in Table 17 indicated that the regression model significantly predicted student engagement, $F(3, 500) = 4611.503$, $p < .001$. The predictors, physical classroom environment, social factors, and psychological factors accounted for a substantial proportion of variance in engagement (SSR = 74.723, df = 3), compared to the residual variance (SSE = 2.701, df = 500). This confirms that the model as a whole provides a statistically significant explanation of student engagement levels.

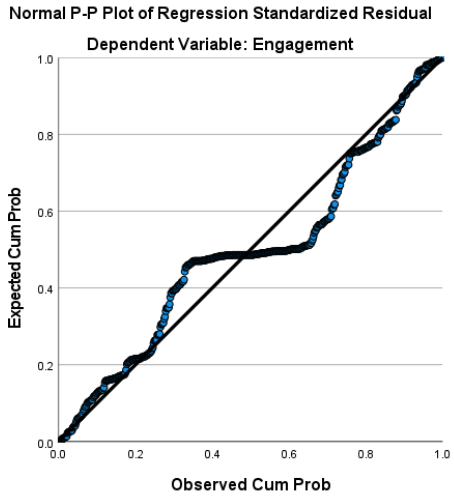
Table 18. Coefficients of Predictors of Student Engagement

Predictor	**B**	**SE**	**Beta**	**t**	**Sig.**
Constant	-0.005	0.042	—	-0.108	.914
Social Factors	0.053	0.001	.505	60.419	.000***
Physical Classroom Environment	0.000	0.001	.003	0.305	.761
Psychological Factors	0.070	0.001	.845	100.824	.000***

Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

Table 18 presents the coefficients analysis and revealed that psychological factors ($\beta = .845$, $p < .001$) and social factors ($\beta = .505$, $p < .001$) were significant positive predictors of student engagement, with psychological factors emerging as the strongest contributor. In contrast, physical classroom environment ($\beta = .003$, $p = .761$) did not significantly predict engagement when the other variables were controlled. This suggests that while social and psychological dimensions of the learning environment substantially influence student engagement, the physical environment alone has little effect. Overall, Engagement is primarily driven by psychological and social factors, not the physical classroom environment.

Figure 1: Normal P-P Plot of Regression



Source: Field Data, 2025, N = 504, sig. = 0.05 (CI = 95%)

Figure 1 presents the Normal P-P Plot of Regression Standardized Residuals for the dependent variable, engagement, based on data collected from 504 SHS students in the Central region of Ghana. The plot compares the observed cumulative probability of the standardized residuals (blue dots) against the expected cumulative probability under a normal distribution (diagonal line). The close alignment of the observed data points with the expected line indicates that the residuals are approximately normally distributed, satisfying a key assumption for the multiple linear regression analysis conducted in the study. This alignment, with a significance level of 0.05 and a 95% confidence interval, supports the validity of the regression model used to assess the impact of physical classroom environment, psychological factors, and social factors on learner engagement.

DISCUSSION

This discussion synthesizes the findings from the study conducted on SHS students in the Central Region of Ghana, which examined the impact of physical, psychological, and social factors on learner engagement. The study utilized a structured questionnaire to collect data from 504 students, with results analyzed through descriptive statistics, correlation, regression, and multiple linear regression analysis. The discussion integrates these findings with theoretical frameworks, compares them to existing literature, and evaluates their implications, limitations, and recommendations for future research.

Demographic Data

The demographic profile of the respondents provides a robust foundation for interpreting the study's results. The gender distribution (Table 1) was nearly balanced, with 49.0% males and 51.0% females, reducing potential gender bias and enhancing the representativeness of the sample. The age distribution (Table 2) showed that 49.4% of respondents were aged 13–15 years, 44.8% were 16–20 years, and 5.8% were over 20 years, aligning with the typical age range for senior high school students in Ghana. The class distribution (Table 3) was relatively even across Forms One (32.7%), Two (31.9%), and Three (35.3%), ensuring that perspectives from different academic levels were captured. The number of years spent in the school (Table 4) indicated that 66.6% of students had two to three years of experience, suggesting sufficient familiarity with the school environment to provide reliable responses.

The distribution of preferred learning styles (Table 5) revealed a slight preference for kinesthetic learning (22.6%), followed by auditory (20.2%), visual (19.4%), collaborative (19.2%), and reading/writing (18.5%) styles. This diversity highlights the need for differentiated instructional strategies, as supported by (Felder & Silverman, 1988), who argue that accommodating varied learning styles enhances student engagement. The balanced demographic profile strengthens the credibility of the findings, as it minimizes biases related to gender, age, or academic level.

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Research Question 1: Influence of the Physical Classroom Environment on Learner Engagement

The findings for Research Question 1 indicate that the physical classroom environment has no significant impact on learner engagement. Descriptive statistics (Table 6) showed a positive perception of the physical environment (mean = 30.58, SD = 4.17), suggesting that students generally viewed classroom conditions favorably. However, the Pearson correlation (Table 7) revealed a weak, non-significant negative correlation ($r = -0.045$, $p = .310$) between the physical classroom environment and engagement. The regression analysis (Tables 8–10) further confirmed this, with the model explaining only 0.2% of the variance in engagement ($R^2 = .002$, $F(1, 502) = 1.031$, $p = .310$) and a non-significant effect ($\beta = -0.045$, $p = .310$).

This result is unexpected given prior research, such as (Higgins et al., 2005), which found that physical factors like lighting, ventilation, and seating arrangements influence student engagement. The lack of significance may be due to contextual factors of SHS students in the Central region, such as uniformly adequate classroom conditions (e.g., functional furniture, consistent lighting), which may reduce variability in perceptions and thus limit the ability to detect an effect. The low standard deviation (4.17) supports this, indicating homogeneity in responses. Alternatively, students may prioritize psychological or social factors over physical conditions, as suggested by the stronger effects observed in Research Questions 2 and 3. This finding contrasts with (Earthman, 2004), who linked well-maintained facilities to improved student outcomes. The multiple linear regression (Table 18, $\beta = .003$, $p = .761$) further confirmed that the physical environment remains non-significant when controlling for psychological and social factors, reinforcing its minimal role in this context.

Research Question 2: Psychological Factors Contributing to Learner Engagement

The analysis of Research Question 2 demonstrated that psychological factors are a robust and significant predictor of learner engagement. The regression model (Table 11) explained 71.0% of the variance in engagement ($R^2 = .710$, Adjusted $R^2 = .709$, $F(1, 502) = 1228.029$, $p < .001$), with a strong positive correlation ($R = .843$). The ANOVA results (Table 12) showed a substantial regression sum of squares (54.958) compared to the residual (22.466), indicating the strong explanatory power of psychological factors. The coefficients (Table 13) indicated that a one-unit increase in psychological factors increases engagement by 0.070 units ($\beta = .843$, $p < .001$), with a high t-value (35.043) confirming the effect's robustness.

These findings align with self-determination theory (Deci & Ryan, 2000), which posits that intrinsic motivation, self-efficacy, and interest drive engagement. The strong effect size suggests that SHS students in the Central region who are motivated, confident, and interested are significantly more engaged. This is consistent with (Fredricks et al., 2004), who emphasize the role of psychological factors in fostering behavioral, emotional, and cognitive engagement. The multiple linear regression (Table 18) reaffirmed psychological factors as the strongest predictor ($\beta = .845$, $p < .001$), highlighting their dominance over social and physical factors. Practically, this suggests that interventions targeting motivation (e.g., goal-setting, positive reinforcement) or self-efficacy (e.g., mastery experiences) could significantly enhance engagement. However, the study's broad measure of psychological factors limits insight into which specific elements (e.g., motivation vs. self-efficacy) are most influential, warranting further investigation.

Research Question 3: Social Factors Affecting Learner Engagement

The findings showed that social factors significantly influence learner engagement, though their effect is less pronounced than that of psychological factors. The regression model (Table 14) explained 25.1% of the variance in engagement ($R^2 = .251$, Adjusted $R^2 = .250$, $F(1, 502) = 168.562$, $p < .001$), with a moderate positive correlation ($R = .501$). The ANOVA results (Table 15) confirmed significance, but the larger residual sum of squares (57.961) compared to the regression sum of squares (19.462) indicates that other factors contribute to engagement. The multiple linear regression (Table 18) showed that social factors remain significant when controlling for other variables ($\beta = .505$, $p < .001$), though their effect is less than that of psychological factors.

These results align with the Social Learning Theory (SLT) by (Bandura, 1997), which highlights the role of peer and teacher-student interactions in learning outcomes. Positive relationships, as noted by (Roorda et al., 2011), foster a sense of belonging that enhances engagement. The moderate effect size may reflect the cultural context

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of Ghanaian schools, where individual effort and teacher-led instruction (aligned with the 20.2% preference for auditory learning, Table 5) may overshadow collaborative activities (19.2%). The findings suggest that while social factors, such as peer collaboration or supportive teacher interactions, are important, they are secondary to psychological factors in this context.

Multiple Linear Regression: Combined Effects

The multiple linear regression analysis (Tables 16-18) provided a comprehensive view of the combined effects of physical, psychological, and social factors on learner engagement. The model explained 96.5% of the variance in engagement ($R^2 = .965$, Adjusted $R^2 = .965$, $F(3, 500) = 4611.503$, $p < .001$), indicating exceptional explanatory power. The low standard error (SE = 0.073) underscores the model's precision. Psychological factors ($\beta = .845$, $p < .001$) and social factors ($\beta = .505$, $p < .001$) were significant predictors, while the physical classroom environment ($\beta = .003$, $p = .761$) was not. This confirms that engagement is primarily driven by psychological and social factors, with psychological factors having the strongest influence.

The high R^2 value suggests that the combination of these factors captures nearly all variability in engagement, leaving little room for unmeasured variables. This is a notable strength, as it indicates a robust model. However, the non-significant effect of the physical environment in both single and multiple regression analysis reinforces its minimal role in this context, possibly due to adequate baseline conditions or students' prioritization of other factors.

Implications for Practice

The findings have significant implications for educators and policymakers in Ghana:

1. The dominance of psychological factors suggests that interventions should prioritize enhancing motivation, self-efficacy, and interest. Strategies such as goal-setting, providing constructive feedback, and fostering a growth mindset could be integrated into teaching practices (Dweck, 2006).

2. The significant but moderate effect of social factors highlights the importance of fostering positive peer and teacher-student relationships. Professional development programs could train teachers in building supportive classroom climates or incorporating collaborative activities, despite the relatively lower preference for group work.

3. The negligible impact of the physical environment suggests that resources may be better allocated to psychological and social interventions, provided that basic classroom standards (e.g., adequate seating, ventilation) are maintained.

4. The preference for kinesthetic learning (22.6%) indicates that hands-on activities, experiments, or practical exercises could be particularly effective in engaging students. Teachers could incorporate more activity-based methods to align with this preference, potentially amplifying the effects of psychological and social factors.

Limitations and Recommendations for Future Research

The study has several limitations.

1. The non-significant effect of the physical classroom environment may stem from a lack of variability in conditions or the use of a broad measure that did not capture specific aspects (e.g., lighting, noise). Future research should employ detailed instruments to assess specific physical factors.

2. The broad categorization of psychological factors limits insight into which elements (e.g., intrinsic motivation, self-efficacy) are most influential. Subscales or qualitative methods could clarify this.

3. The moderate effect of social factors suggests that unmeasured variables (e.g., teacher quality, curriculum design) may also influence engagement. A more comprehensive model including these factors could provide deeper insights.

The reliance on self-reported questionnaires introduces potential response bias. Mixed-methods approaches, such as classroom observations or student interviews, could validate findings and provide richer data. The study's context-specific nature limits generalizability, so comparative studies across diverse schools or regions in Ghana are recommended.

Finally, the multiple linear regression's high R^2 (.965) suggests a robust model, but it may indicate overfitting or unmeasured collinearity. Future studies should validate the model with different samples or cross-validation techniques.

CONCLUSION

The study at the Central region provides compelling evidence that learner engagement is primarily driven by psychological factors (R^2 = .710), followed by social factors (R^2 = .251), with the physical classroom environment having no significant impact (R^2 = .002). The multiple linear regression model (R^2 = .965) confirms the combined importance of these factors, with psychological factors as the strongest predictor. These findings align with theoretical frameworks, such as self-determination theory and social learning theory, which emphasize the need to foster motivation, self-efficacy, and positive social interactions. Educators should prioritize psychological and social interventions while ensuring basic physical classroom standards. Future research should address the study's limitations by exploring specific subcomponents, employing diverse methodologies, and validating findings in varied contexts.

Ethical Considerations

Ethical approval for this study was obtained from the Institutional Review Board (IRB), ensuring that all research involving human participants was conducted in accordance with ethical standards. Participants provided informed consent, and their privacy and confidentiality were strictly maintained.

Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy and confidentiality considerations.

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