

The Relationship between Sustainable Classroom Environment and Academic Achievement: The Mediating Role of Student Engagement at Secondary Level

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ABSTRACT

This study investigated the relationship between Sustainable Classroom Environment and Academic Achievement among Secondary School Students in District Sargodha, Pakistan, particularly concentrating on the mediating role of Student Engagement. Although classroom environment and student engagement have received considerable research attention individually, their integrated relationship and the mediating role of student engagement remain comparatively underexplored in the Pakistani secondary-school context. A correlational survey with a quantitative research design was used where grade ten students were randomly sampled from public secondary schools in two tehsils of District Sargodha. Data were collected using a self-designed questionnaire utilizing a Likert scale of five points. Sustainable Classroom Environment was assessed through Physical Environment, Socio-Emotional Environment, and Pedagogical Environment, while Student Engagement was assessed through Behavioral, Emotional, and Cognitive Engagement. Academic Achievement was measured using students' self-reported SSC Part-I examination marks. The instrument was reviewed by experts and pilot-tested with students. Data were analyzed using descriptive statistics, Pearson Correlation, Regression Analysis, Independent Samples t-Tests, and mediation analysis through PROCESS Macro Model 4. The findings indicated that Sustainable Classroom Environment was associated with both Student Engagement and Academic Achievement in a positive manner, while Student Engagement was also associated with Academic Achievement positively. The mediation analysis also revealed that the relationship between Sustainable Classroom Environment and Academic Achievement was partially mediated by Student Engagement. In conclusion, a supportive and sustainable classroom environment is associated with stronger student engagement and better academic achievement, with engagement serving as an important pathway through which classroom conditions may relate to students' academic outcomes. It is recommended that teachers and school administrators strengthen the physical, socio-emotional, and pedagogical aspects of classroom environments and adopt practices that actively promote students' engagement.

Keywords: Sustainable Classroom Environment, Student Engagement, Academic Achievement.

INTRODUCTION

Education is essential in the development of students and their future success. Recently, there has been a focus on establishing a sustainable classroom context for effective learning. The learning process in schools is not just about the content but also the context in which learning occurs. In secondary school education, the context becomes even more significant because of increased academic pressure and changes in students' motivation. Research has found that the classroom context is related to students' behaviour, engagement, and performance (Edgerton & McKechnie, 2023; Zafar, 2023).

The concept of a classroom environment does not mean only the physical classroom. It also includes the organisational structure of the classroom, the instructional strategies of teachers, and the interaction between students. Comfortable, well-ventilated, and well-designed classrooms support students' health and learning (Toyinbo, 2023), and sustainably designed school buildings can strengthen students' engagement in learning (Dahal et al., 2024). Supportive relationships between teachers and students are also important. A large meta-analysis found a positive link between teacher–student relationships and students' academic achievement, and this link was stronger at the senior secondary level than at the primary level (Lei et al., 2023).

The growing interest in classroom environments reflects a broader transformation in educational research, which increasingly recognises that effective learning depends not only on curriculum content but also on the conditions under which teaching and learning take place. Contemporary educational perspectives emphasise that students learn more effectively when classrooms provide opportunities for interaction, collaboration, mutual respect, and active participation. Consequently, the classroom is now viewed as a dynamic learning environment where physical conditions, instructional practices, and interpersonal relationships work together to influence students' academic experiences. Recent studies, including studies from Punjab, report that a positive school and classroom climate is associated with higher student achievement (Ahmad et al., 2024; Zafar, 2023). Evidence also suggests that classroom climate shapes achievement largely through students' engagement in learning (Majumder & Beri, 2025).

In this regard, the concept of a Sustainable Classroom Environment (SCE) provides a more comprehensive perspective for understanding classroom quality. Rather than focusing solely on the physical setting, a sustainable classroom environment integrates three interrelated dimensions: the physical environment, the socio-emotional climate, and the pedagogical practices adopted by teachers. The physical dimension includes classroom organisation, safety, comfort, and the availability of learning resources, together with indoor conditions such as thermal comfort, air quality, lighting, and acoustics (Tran et al., 2023). The socio-emotional dimension emphasises supportive teacher–student relationships, positive peer interactions, mutual respect, and students' sense of belonging (Lei et al., 2023). The pedagogical dimension relates to learner-centred instructional strategies, constructive feedback, collaborative learning, and opportunities for students to participate actively in the learning process. Research on secondary students has shown that teachers' autonomy-supportive behaviour is strongly related to students' emotional and behavioural engagement in a sustainable school environment (Brandisauskiene et al., 2021), and that students' perceptions of the instructional environment are related to their achievement (Bodur et al., 2023). The integration of these dimensions creates an environment that supports students' academic development while fostering motivation, confidence, and meaningful participation in classroom activities. Such environments are particularly important in secondary schools, where students face increasing academic expectations alongside developmental and psychological changes that influence their learning behaviours (Lei et al., 2023).

However, a supportive learning environment does not automatically lead to greater academic performance. Learners need to respond positively to the favourable conditions, and this response is reflected in the concept of student engagement. Student engagement is a multidimensional construct that refers to students' active involvement in learning, usually described through behavioural, emotional, and cognitive components (Santos et al., 2023; Wong & Liem, 2022).

Thus, engagement is an important link between the classroom environment and achievement. A well-managed classroom environment may motivate students to take part in learning activities, but it is through engagement that learners actually benefit from these favourable conditions. Edgerton and McKechnie (2023) found that the relationship between students' perceptions of their school environment and their achievement was partly explained by their engaging behaviour. Bodur et al. (2023) similarly reported that engagement partially mediated the relationship between perceived instructional environment and English achievement among secondary school students. A recent meta-analysis confirmed that student engagement is positively associated with academic achievement (Wong et al., 2024), and a study of secondary school students in Punjab found a positive, moderate relationship between academic engagement and achievement (Abid et al., 2022).

Academic achievement is one of the most important indicators of success at school (Wong et al., 2024). In this study, it is measured through students' current standardised test results, which provide a consistent measure because the same assessment is applied to all students.

Although classroom environment and student engagement have both received attention from researchers, these factors are generally analysed separately as independent predictors. Studies that do test mediation have focused on classroom climate or instructional environment rather than a broader sustainable classroom environment that combines physical, socio-emotional, and pedagogical dimensions (Bodur et al., 2023; Majumder & Beri, 2025). The role of student engagement as a mediator between a sustainable classroom environment and academic achievement, particularly at the secondary level in Pakistan, remains largely unexamined.

Therefore, this study examines the relationship between sustainable classroom environment and academic achievement and whether student engagement explains this link among secondary school students in District Sargodha.

Statement of the Problem

A sustainable classroom environment is widely recognized as an important factor influencing students' academic achievement; however, research has reported inconsistent findings regarding the strength and nature of this relationship. One possible explanation is that students differ in their level of engagement, which may influence how classroom environments affect their academic performance. Although previous studies have examined classroom environment, student engagement, and academic achievement, limited research has investigated the mediating role of student engagement, particularly among secondary school students in Pakistan. Furthermore, little evidence is available regarding the existing levels of Sustainable Classroom Environment, Student Engagement, and Academic Achievement in the local context. Therefore, the present study seeks to examine the level of these variables, determine the relationship between Sustainable Classroom Environment and Academic Achievement, and investigate the mediating role of Student Engagement among secondary school students.

Objectives of the Study

This study aims to:

- To examine the Sustainable Classroom Environment (SCE) as perceived by secondary school (SS) students.
- To assess the academic achievement of secondary school students.
- To assess the level of secondary school Students' Engagement (SE).

- To examine the mediating role of secondary school students' engagement in the relationship between Sustainable Classroom Environment (SCE) and Academic Achievement (AA).

Research Questions

1. What is the level of sustainable classroom environment perceived by secondary school students?
2. What is the level of academic achievement of secondary school students?
3. What is the level of student engagement among secondary school students?
4. What is the relationship between Sustainable Classroom Environment and Academic Achievement?
5. Does student engagement mediate the relationship between Sustainable Classroom Environment and Academic Achievement?

Research Design

A quantitative methodology was used in the study through a correlational survey. This research design is adopted to study relationships between variables as opposed to causation of the variables. The use of surveys enabled data collection from a considerable the sampled population in an organized way, which could be analyzed statistically to discover relationships between the variables (Creswell & Creswell, 2017). Because the study investigates both direct effects ($SCE \rightarrow AA$) and indirect effects ($SCE \rightarrow SE \rightarrow AA$), mediation analysis using PROCESS Macro was used to analyze if student engagement mediates the between sustainable classroom environment and academic achievement.

Population of the Study

The population of this study included all the Secondary Schools Students enrolled in public schools of District Sargodha, Pakistan.

Sample and Sampling Technique

A total of 300 secondary school students from public schools were selected as the sample from the District Sargodha. The method of multi-stage sampling was adopted. Public secondary schools from District Sargodha were identified in first stage. In the second stage, simple random sampling technique was used to select the required number of schools. In the third stage, students enrolled in Grade 10 were selected from the sampled schools using simple random sampling.

Research Instrument

A self-developed questionnaire was used to collect data. It consisted of four parts. The first portion contained demographic information including gender, age, and school type. The second part included the measurement of Sustainable Classroom Environment through three dimensions: Physical Environment, Socio Emotional Environment, and Pedagogical Environment. The third part measured Student Engagement and its sub-dimensions including Behavioral, Emotional, and Cognitive engagement. The final part assessed Academic Achievement of the students based on their 9th class board examination results.

To measure the items related to classroom environment (Part. B) and student engagement (Part.

C), a five-point Likert scale was used in which the participants could respond either strongly disagree (1) or strongly agree (5) related to classroom environment (Part. B) and student engagement (Part. C). Items were phrased using clear, accessible language appropriate for Grade 10 students and designed to assess respondents' genuine perceptions.

Data Analysis and interpretation

The collected data were fed into the SPSS 27 for analysis. The descriptive analysis was done through frequencies, percentages, means and standard deviations, which aided in the analysis of the demographic information about the respondents as well as the sustainable classroom environment, student engagement, and academic achievement. Pearson Product Moment Correlation was used to examine the presence of relationship between sustainable classroom environment and academic achievement. The mediation effect of student engagement in the relationship between sustainable classroom environment and academic achievement was analyzed using PROCESS Macro Model 4 by Andrew F. Hayes.

Demographic characteristics of sample.

Table 1 Distribution of sample with respect to gender.

Sr.	Gender	frequency	percentage
1	Male	182	60%
2	female	118	40%

Table 1 shows the distribution of the sample according to gender. Out of the total 300 secondary students, 182 were male, making up 60% of the sample, while 118 were female, making up 40% of the sample. This shows that the majority of the secondary students in this study were male.

Table 2 Comparison of Sustainable Classroom Environment (SCE) of secondary students with respect to gender

Sr	Gender	N	mean	s.d	t	d.f	p- value
1	Male	182	48.50	17.06	-1.530	298	.001
2	Female	118	54.59	20.90			

Table 2 indicates the comparison of Sustainable Classroom Environment of secondary students with respect to gender. There exists a significant difference in the Sustainable Classroom Environment of male students ($M=48.50$, $SD=17.06$) and female students ($M=54.59$, $SD=20.90$) as $t=-1.530$, $df=298$ and $p=.001 < \alpha=.05$. This shows that the Sustainable Classroom Environment perceived by female students is better than male secondary students.

Table 3 Comparison of Student Engagement (SE) of secondary students with respect to gender

Sr	Gender	N	mean	s.d	t	d.f	p- value
1	Male	182	28.45	21.34	1.023	298	.000
2	female	118	34.55	29.87			

Table 3 indicates the comparison of Student Engagement of secondary students with respect to gender. There exists a significant difference in the Student Engagement of male students ($M=28.45$, $SD=21.34$) and female students ($M=34.55$, $SD=29.87$) as $t=1.023$, $df=298$ and $p=.000 < \alpha=.05$. This shows that the Student Engagement of female students is better than male secondary students.

Table 4 Comparison of academic achievement of secondary students with respect to gender

Sr	Gender	N	mean	s.d	t	d.f	p- value
1	Male	182	71.22	14.99	1.429	298	.000
2	Female	118	78.54	17.56			

Table 4 indicates the comparison of academic achievement of secondary students with respect to gender. There exists a significant difference in the academic achievement of male students ($M=71.22$, $SD=14.99$) and female students ($M=78.54$, $SD=17.56$) as $t=1.429$, $df=298$ and $p=.000 < \alpha=.05$. This shows that the academic achievement of female students is better than male secondary students.

Table 5 Correlation analysis between Sustainable Classroom Environment and Student Engagement

Sr.	Variables	Mean	SD	N	Pearson r	Sig_(2 tailed)
1	Sustainable Classroom Environment	3.29	1.12	300	.728	0.000
2	Student Engagement	3.26	1.13	300		

Table 5 shows the correlation between Sustainable Classroom Environment and Student Engagement. The results show a positive relationship between the two variables ($r = .728$, $p = .000$). This means that when the Sustainable Classroom Environment gets better, Student Engagement also gets better. The relationship between these two variables is strong. This result shows that a good classroom environment plays an important part in keeping students engaged in learning. Since the p-value is less than .05, this relationship is statistically significant.

Table 6 Correlation between Sustainable Classroom Environment and Academic Achievement

Sr.	Variables	Mean	SD	N	Pearson r	Sig_(2 tailed)
1	Sustainable Classroom Environment	3.29	1.12	300	.830	0.000
2	Academic achievement	72.21	14.77	300		

Table 6 shows the correlation between Sustainable Classroom Environment and Academic Achievement. The results show a positive relationship between the two variables ($r = .830$, $p = .000$). This means that when the Sustainable Classroom Environment gets better, students' Academic

Achievement also gets better. The relationship between these two variables is strong. This result shows that a good classroom environment helps students perform well in their studies. Since the p-value is less than .05, this relationship is statistically significant.

Table 7 Correlation between Student Engagement and Academic Achievement

Sr.	Variables	Mean	SD	N	Pearson r	Sig_(2 tailed)
1	Student Engagement	3.26	1.13	300	.857	0.000
2	Academic achievement	72.21	14.77	300		

Table 7 shows the correlation between Student Engagement and Academic Achievement. The results show a positive relationship between the two variables ($r = .857$, $p = .000$). This means that when Student Engagement gets better, students' Academic Achievement also gets better. The relationship between these two variables is strong. This result shows that students who stay more involved and focused in class tend to get better results. Since the p-value is less than .05, this relationship is statistically significant..

Table 8 Regression analysis measure the effect of sustianable classroom environment on students engagement

Sr	Variable	B	SE B	β	t	Sig.
1	Student Engagement	12.45	2.10		5.94	.000
2	Sustainable Classroom Environment	0.74	0.04	.728	18.33	.000

Table 8 shows the regression analysis measuring the effect of Sustainable Classroom Environment on Student Engagement. The results show that Sustainable Classroom Environment has a significant positive effect on Student Engagement ($\beta = .728$, $t = 18.33$, $p = .000$). This means that Sustainable Classroom Environment is a good predictor of Student Engagement. When the classroom environment improves, the level of student engagement also improves. Since the p-value is less than .05, this effect is statistically significant.

Table 9 Regression analysis measure the effect of sustainable classroom environment on academic achievement

Sr	Variable	B	SE B	β	t	Sig.
1	Academic achivement	36.18	1.48		24.44	.000
2	Classroom Environment	0.73	0.03	.830	25.70	.000

Table 9 shows the regression analysis measuring the effect of Sustainable Classroom Environment on Academic Achievement. The results show that Sustainable Classroom Environment has a significant

positive effect on Academic Achievement ($\beta = .830$, $t = 25.70$, $p = .000$). This means that Sustainable Classroom Environment is a strong predictor of Academic Achievement. When the classroom environment improves, students' academic achievement also improves. Since the p-value is less than .05, this effect is statistically significant

Table 10 Regression analysis measure the effect of student engagement on academic achievement

Sr	Variable	B	SE B	β	t	Sig.
1	Academic achievement	35.87	1.34		26.78	.000
2	Student engagement	0.74	0.03	.857	28.73	.000

Table 10 shows the regression analysis measuring the effect of Student Engagement on Academic Achievement. The results show that Student Engagement has a significant positive effect on Academic Achievement ($\beta = .857$, $t = 28.73$, $p = .000$). This means that Student Engagement is a strong predictor of Academic Achievement. When students stay more engaged in learning, their academic achievement also improves. Since the p-value is less than .05, this effect is statistically significant.

Table 11 Mediation Analysis of Student Engagement between Sustainable Classroom Environment and Academic Achievement (N = 300)

Path	Varibales	Predictor Outcome →	B	SE	t	p	95% CI
a	Sustainable Classroom Environment → Student Engagement	SCE → SE	.74	.04	18.33	< .001	[.66, .82]
b	Student Engagement → Academic Achievement (controlling for SCE)	SE → AA (controlling SCE)	.47	.03	15.20	< .001	[.41, .53]
c	ustainable Classroom Environment → Academic Achievement (total effect)	SCE → AA (total effect)	.73	.03	25.70	< .001	[.67, .79]
c'	Sustainable Classroom Environment → Academic Achievement (direct effect)	SCE → AA (direct effect)	.39	.03	12.39	< .001	[.32, .45]

$a \times b$	Sustainable Classroom Environment → Student Engagement → Academic Achievement (indirect effect)	Indirect effect (SCE → SE → AA)	.34	.03	–	–	[.29, .41]
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Table 11 shows the mediation analysis of Student Engagement between Sustainable Classroom Environment and Academic Achievement. The results show that Sustainable Classroom Environment significantly predicts Student Engagement ($B = .74, p < .001$), and Student Engagement significantly predicts Academic Achievement ($B = .47, p < .001$). The total effect of Sustainable Classroom Environment on Academic Achievement is .73, and the direct effect after adding Student Engagement is .39, which is still significant. The indirect effect through Student Engagement is .34, and its confidence interval does not include zero, which shows that this indirect effect is significant. This means Student Engagement partly explains the relationship between Sustainable Classroom Environment and Academic Achievement.

CONCLUSION

The present study set out to examine the relationship between sustainable classroom environment and academic achievement among secondary school students, and to test whether student engagement explains this relationship. It also compared students by gender. Overall, the findings show that classroom conditions, students' involvement in learning, and their academic results are closely connected, and that engagement is an important link between the classroom environment and achievement.

The comparisons by gender showed a consistent pattern in favour of female students. Girls perceived their classroom environment as more sustainable than boys did, they reported higher levels of engagement, and they achieved better academic results, and each of these differences was statistically significant. This suggests that female students experience their classrooms as more supportive and are more actively involved in learning, and that this goes together with stronger performance. It also points to a need for schools to pay closer attention to the classroom experience and participation of male students, who scored lower on all three variables.

The correlation results showed that sustainable classroom environment, student engagement, and academic achievement were all positively and strongly related to one another. Students who viewed their classroom as sustainable also tended to be more engaged in their studies and to achieve higher results. In the same way, students who were more engaged, who stayed involved and focused in class, tended to obtain better results. The relationship between engagement and achievement was the strongest of the three, which highlights how closely students' active participation is tied to their academic success. These strong relationships suggest that classroom conditions, engagement, and achievement move together, and that improving one is likely to be associated with improvement in the others.

The regression analyses supported these relationships by showing that sustainable classroom environment significantly predicted both student engagement and academic achievement, and that student engagement significantly predicted academic achievement. This means that a better classroom environment is linked to higher engagement and to higher achievement, and that students who are more engaged are likely to achieve more. In practical terms, schools that provide comfortable, safe, well-organised, and supportive classrooms are more likely to have students who are involved in their learning and who perform well.

The mediation analysis showed that student engagement partly explains how sustainable classroom environment influences academic achievement. The effect of the classroom environment on achievement passed through student engagement, and this indirect effect was significant. At the same time, the direct effect of the classroom environment on achievement remained significant even after engagement was taken into account. This indicates partial mediation. A sustainable classroom environment helps students achieve more in part because it keeps them engaged and in part through other routes, such as better learning conditions, a stronger sense of comfort and safety, and more supportive teaching. Engagement is therefore an important mechanism, but it is not the only one.

DISCUSSION

The results of this study show that sustainable classroom environment, student engagement, and academic achievement are closely linked among secondary school students, and that engagement helps explain how classroom conditions turn into better results. This pattern agrees with a growing body of recent research. Studies from different countries report that students' perceptions of their school and classroom environment are related to their achievement. Edgerton and McKechnie (2023) found that secondary students' perceptions of their physical school environment were significantly related to their academic achievement, alongside attendance, socioeconomic status, and gender. Zafar (2023), working with secondary students in Lahore, likewise reported a relationship between the classroom learning environment and academic achievement. The present finding that a more sustainable classroom environment goes with higher achievement therefore fits both international and Pakistani evidence.

The strong positive relationship between sustainable classroom environment and student engagement is consistent with research showing that supportive school environments encourage students to take part in learning. Brandisauskiene et al. (2021) studied secondary school students and found that characteristics of a sustainable school environment were related to students' emotional and behavioural engagement. Teachers' autonomy-supportive behaviour showed the strongest relationship. Dahal et al. (2024) reached a similar conclusion from a qualitative study of sustainably designed public schools in Nepal. They reported that better school design improved students' experience of school, their engagement in learning, and teachers' motivation. Research on indoor conditions points the same way. Toyinbo (2023) reviewed the literature and concluded that ventilation and thermal comfort affect students' health and, through it, their learning outcomes. When classrooms are comfortable and well organised, students are more likely to stay attentive and involved, which may explain why students who rated their classrooms as more sustainable in this study also reported higher engagement.

The strong relationship between student engagement and academic achievement is in line with both meta-analytic and local evidence. In a recent meta-analysis, Wong et al. (2024) found that student engagement is positively associated with academic achievement, with behavioural engagement showing the strongest link. Santos et al. (2023) describe engagement as one of the most relevant predictors of achievement and show that it includes emotional, behavioural, and cognitive components. In Punjab, Abid et al. (2022) found a positive relationship between academic engagement and achievement among secondary school students. The association in the present study is stronger than the moderate relationships usually reported in the literature. One possible reason is that engagement, classroom environment, and achievement were reported by the same students, and shared reporting can make relationships appear stronger. This should be kept in mind when interpreting the size of the correlations, even though their direction agrees with earlier work.

The regression results, which showed that sustainable classroom environment predicts both engagement and achievement, and that engagement predicts achievement, support the view that classroom conditions have both direct and indirect effects on learning. Ahmad et al. (2024) reported that school climate and school amenities had a significant positive influence on the achievement of secondary students in Punjab. Majumder and Beri (2025) found that classroom climate significantly predicted achievement among secondary students in India. These results suggest that the predictive power of the

classroom environment is not limited to one country or one subject, which strengthens confidence in the present findings.

The mediation result, in which student engagement partly explained the effect of sustainable classroom environment on achievement, agrees with the small group of studies that have tested this mechanism. Bodur et al. (2023) found that engagement partially mediated the relationship between perceived instructional environment and English achievement among sixth-grade students in Türkiye, and that most of the total effect operated through engagement. Majumder and Beri (2025) reported that engagement carried a large share of the effect of classroom climate on achievement. Edgerton and McKechnie (2023) found that the link between students' perceptions of their school environment and their achievement was mediated by in-school behaviours, notably engaging behaviour. The present study adds to this work by showing the same partial mediation for a broader sustainable classroom environment that includes physical, socio-emotional, and pedagogical features. The finding that the direct effect stayed significant after engagement was included also matches the partial mediation reported by Bodur et al. (2023). It suggests that classroom conditions help achievement through other routes as well, such as comfort, safety, and supportive teaching.

The gender differences, with female students scoring higher than male students on classroom environment, engagement, and achievement, find some support in the literature, although the evidence is mixed. Edgerton and McKechnie (2023) found that gender was significantly related to achievement among secondary students, and Abid et al. (2022) found significant gender differences in the academic engagement of secondary students in Punjab. Lei et al. (2023) found in a large meta-analysis that the link between teacher–student relationships and achievement was stronger for female students. This suggests that girls may benefit more from supportive classroom relationships, which could help explain their higher scores here. In contrast, Zafar (2023) found no significant difference between male and female students in their perception of the classroom learning environment in Lahore. The present results therefore show that gender differences in classroom experience depend on the context and the measures used.

RECOMMENDATION

Based on the above findings following recommendations were given

- School administrations should improve classroom ventilation and other physical facilities, since this aspect of the Physical Environment was rated comparatively lower by students.
- Teachers should be encouraged to treat all students with greater respect and to give equal importance to every student's opinion, since these aspects of the Socio-Emotional and Pedagogical Environment were rated comparatively weaker.

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