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THE MEDIATING EFFECT OF SCIENTIFIC EPISTEMOLOGICAL BELIEFS ON THE RELATIONSHIP BETWEEN CLASSROOM SOCIAL ENVIRONMENT AND ADAPTIVE LEARNING ENGAGEMENT OF SCIENCE STUDENTS

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Abstract:
This study explored the potential mediating impact of scientific epistemological beliefs on the correlation between the classroom social environment and adaptive learning in the field of science. The researcher used a quantitative, non-experimental approach using a correlational technique. The study was conducted in seven selected public schools in Davao City where senior high school students are present. There were two hundred ninety (290) grade 12 student participants in total. The researcher applied the five Likert Scaling Method wherein the respondents will choose between 1 - 5, 4.20 - 5.00 is very high and 1.00 - 1.79 is very low. Also, ethical procedures were observed. The data that were gathered from the Level of Adaptive Learning Engagement of Science Students showed high levels. In addition, The Correlations between Classroom Social Environment and Scientific Epistemological Beliefs of Science Students, The Correlations between Adaptive Learning Engagement and Classroom Social Environment, and The Correlations between Scientific Epistemological Beliefs of Science Students and Adaptive Learning Engagement also showed positive correlations. Meanwhile, the Level of Classroom Social Environment and Level of Epistemological Beliefs were found to be moderate in level. Therefore, there is a significant effect of the Mediating Effect of Scientific Epistemological Beliefs, but student adaptive learning engagement emerges as a concern to address challenges like low achievement, disinterest, alienation, and high dropout rates.

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1. Introduction

The concept of adaptation has garnered significant attention in recent years concerning learning systems. Studies have consistently demonstrated that incorporating adaptive mechanisms can lead to enhanced learning environments [1]. This is attributed to the fact that learners exhibit diverse perceptions and information processing methods, and adaptation caters to these individual differences, ultimately fostering a more effective and personalized learning experience [2] As referenced by [3], the Global Competitiveness Report of the World Economic Forum revealed that the Philippines ranked seventh out of the nine Southeast Asian nations surveyed in science, technology, and innovation, indicating a comparatively low standing in these areas. Low engagement as one of the key factors contributing to challenges in science education within the Philippines [4].

Recognizing and tackling this issue is essential in enhancing the overall efficacy of science education and encouraging greater student engagement and interest in the subject [5]. In line with this, the study of [6] emphasizes that taking action to address low engagement empowers educators and policymakers to elevate the quality of science instruction, leading to positive learning outcomes and academic growth for senior high school students. Likewise, [7] highlighted in his literature review that the lack of student interest in learning science can be largely attributed to the inadequacy of science curricula and classroom methods to spark students' curiosity and engagement in the subject.

Adaptive learning shows great educational potential by providing personalized and individualized learning opportunities for students. Tailoring the learning experience to each student's specific needs can increase satisfaction, improve learning effectiveness, and foster more engaged and successful learners, leading to enhanced educational outcomes [8]. The implementation of adaptation in education has the potential to create a more conducive and effective learning environment, as learners have distinct ways of perceiving and processing information [9]. Emphasizing student adaptive learning engagement has become increasingly recognized as a crucial approach to tackling prevalent challenges like low academic achievement, disinterest, feelings of alienation, and high dropout rates among secondary students [10]. This implies that by catering to individual learning needs, adaptive learning in science can help revitalize students' interests, enhance academic performance, and foster a more inclusive and engaging educational experience.

The available information strongly supports the positive relationship between student engagement and crucial factors, including academic achievement, emotional and social well-being, higher retention rates, and successful high school graduation. This underscores the significance of fostering student engagement as it directly influences students' overall well-rounded development and educational outcomes.

The study of [11] emphasizes the crucial role of classroom environments in shaping students' motivation and engagement. The results show that classrooms characterized by teacher support, positive interactions, and mutual respect fostered positive changes in students' motivation and engagement. In contrast, classrooms emphasizing performance goals and competition were associated with negative changes in student motivation and engagement [12]. Thus, emphasizes the importance of caring and engaging teachers who establish genuine and trusting relationships with each student, as they play a vital role in supporting students' learning and overall academic success.

The role of teachers in fostering a classroom environment is vital because it promotes mutual respect and emotional well-being by modelling healthy behaviors and encouraging students to adapt positively [13]. Furthermore, emphasizing task-related interactions among students cultivates a cohesive classroom atmosphere, facilitating motivation and self-regulation in science learning. However, the pursuit of performance goals, driven by a desire for positive judgments of competence and fear of negative evaluations, may influence students' focus on intelligence rather than on intrinsic learning [14]. Thus, creating a supportive and engaging learning environment is vital in shaping students' attitudes and approaches towards their educational journey.

There is a significant association between students' epistemological beliefs and their motivational strategies and study engagement [15]. The findings reinforce this notion by emphasizing that epistemological beliefs play a crucial role in shaping students' approaches to studying, problem-solving, and their overall motivation and persistence in seeking information and learning. Understanding and addressing these beliefs can have a profound impact on students' learning outcomes and academic success [15]. Thus, educators should be mindful of the role epistemological beliefs play in students' learning experiences and tailor instructional approaches to foster positive and effective learning attitudes.

Various studies reveal the relevance of previous research on adaptive learning engagement and its impact on students' successful learning experiences. This implies that by building upon existing knowledge, the study aims to contribute to the ongoing efforts to promote effective learning environments and enhance student engagement in the educational setting. The researcher's analysis in this study highlights a gap in the existing literature concerning the three variables: classroom social environment, scientific epistemological beliefs, and adaptive learning engagement in science. The scarcity of studies investigating the relationship between these variables and the potential mediating effect of scientific epistemological beliefs underscores the significance of conducting this research. By exploring these aspects together, the study aims to offer valuable insights and make a meaningful contribution to new knowledge in the field of education and science learning. The findings have the potential to advance our understanding of how these variables interconnect and influence students' engagement and learning experiences, thus filling an important void in the current body of research.

2. Research Objectives

The primary objective of this research is to explore the potential mediating impact of scientific epistemological beliefs on the correlation between the classroom social environment and adaptive learning in the field of science.

The study specifically aimed to address the following inquiries:

1) To describe the level of classroom social environment in terms of:
   1.1 teacher support;
   1.2 mutual respect;
   1.3 student task-related interaction; and
   1.4 performance goal.
2) To ascertain the adaptive learning engagement of science students in terms of:
   2.1 learning goal orientation;
   2.2 task value;
   2.3 self-efficacy; and
   2.4 self-regulation.
3) To describe the level of scientific epistemological beliefs of the students in terms of a four-dimension epistemological belief model.
   3.1 resource;
   3.2 certainty;
   3.3 improvement; and
   3.4 verification.
4) To determine the significant relationship between:
   4.1 classroom social environment and adaptive learning engagement in science;
   4.2 classroom social environment and scientific epistemological beliefs; and
   4.3 scientific epistemological beliefs and adaptive learning engagement in science.
5) To determine if scientific epistemological beliefs have a significant mediating effect on the relationship between classroom social environment and adaptive learning engagement in science.

2.1 Hypothesis

The following were the hypotheses of the study.

1) There is no significant relationship between:
   1.1 classroom social environment and adaptive learning engagement in science;
   1.2 classroom social environment and scientific epistemological
   1.3 scientific epistemological beliefs and adaptive learning engagement in science
2) Scientific epistemological beliefs have no significant mediating effect on the relationship between classroom social environment and adaptive learning engagement in science.

3. Methodology

This section emphasizes the methodology employed in the study, encompassing the research design, geographical area, population and sample, the research instrument utilized, the process of data collection, and the statistical tools applied for analysis.

3.1 Research Design

This research employed a quantitative non-experimental approach utilizing correlational technique. It falls under the category of quantitative non-experimental research as it aims to describe existing characteristics related to scientific epistemological beliefs, classroom social engagement, and adaptive learning engagement. Non-experimental research is suitable when the independent variable is not manipulated, and there is no random assignment to groups [16].

In this study, correlational techniques were utilized to explore the connections between the variables under investigation, namely classroom social environment, adaptive learning engagement, and scientific epistemological beliefs. This approach was beneficial in determining whether there is an association between two or more variables, both independent and dependent, by explaining their relationship without implying causation [17]. Additionally, the technique leverages existing mutual relationships within the data to establish statistically significant correlations [9].

A mediating variable serves to elucidate the relationship between the independent and dependent variables by explaining how or why this connection exists [12]. It acts as a potential mechanism through which the independent variable can bring about changes in the dependent variable [18]. When the effect of the mediator was fully considered, the direct relationship between the independent and dependent variables might diminish. In this model, the independent variable does not directly influence the dependent variable; instead, it does so indirectly through a third variable, acting as an intermediary. In essence, a specific variable may be considered a mediator to the extent that it accounts for the relationship between the predictor and the criterion.

3.2 Geographical Area

The research was carried out in cluster two (2) divisions within Davao City, specifically focusing on selected public senior high schools. Davao City is located in the Davao region, which was previously known as Southern Mindanao and is classified as Region X1 in the Philippines. This can be observed in Figure 2, which shows Davao City's location at Davao Del Sur. Davao City holds a prominent status as a premier and central hub in Mindanao, and it is known for its significant economic activities. It was often referred to as the "Crown Jewel" of Mindanao due to its economic importance. As one of the most influential economies in the region, Davao City stands as the third most crucial urban center in the country. Positioned approximately 588 statute miles southeast of Manila, it holds strategic significance in the Philippine landscape.

3.3 Population and Sample

The participants of this research are Grade 12 GAS and STEM students from specific schools within cluster two divisions in Davao City. The distribution of respondents was detailed in the subsequent chart, indicating a total of 461 senior high students from cluster two for the 2019-2020 school year as the study's participants. The researcher utilized a maximum of 461 samples at a significance level of 0.05 in Slovin's formula to determine the sample size. Stratified sampling will be employed for this study, limiting the respondents to senior high GAS, And STEM students from the chosen public schools within Cluster 2 division in Davao City.

3.4 Distribution of Respondents

Table 1: Distribution of Respondents

Cluster	Number of Students	Sample	Percentage (%)
A	63	44	10%
B	580	148	32%
C	120	93	20%
D	153	116	25%
E	50	21	4.5%
F	62	39	8.5%
Total	**1028**	**461**	**100**

3.5 Research Instrument

The researcher used an adapted questionnaire, which was derived from three distinct sources and divided into three parts. Prior to its administration to the respondents, the questionnaires underwent validation by a panel of experts to ensure their credibility and accuracy.

The initial segment of the questionnaire centers on the classroom social environment of the respondents, adapted from Patrick & Ryan (2003), consisting of 17 items of questions, encompassing indicators such as teacher support, mutual respect, student task-related interaction, and performance goals [19]. The study employed a scoring guide with a scale ranging from 1 to 5, utilizing the five-Likert scaling method to provide descriptive ratings for the following aspects:

Range of Means	Descriptive Level	Interpretation
4.20 – 5.00	Very High	This means that the classroom environment for students' learning is always observed.
3.40 – 4.19	High	This means the classroom environment for students' learning is oftentimes observed.
2.60 – 3.39	Medium	This means that the classroom environment is neither observed or not observed
1.80 – 2.59	Low	This means that the classroom environment for students' learning is rarely observed.
1.00 – 1.79	Very Low	This means that the classroom environment is student learning that is never observed.

The second section of the questionnaire focuses on adaptive learning engagement and consists of 32 questions encompassing four indicators: learning goal orientation, self-regulation, self-efficacy, and task value. The research utilized a scoring guide with a range from 1 to 5, employing the five-Likert scaling method to offer descriptive ratings for the following elements:

Range of Means	Descriptive Level	Interpretation
4.20 – 5.00	Very High	This means that the students' adaptive learning engagement is always observed.
3.40 – 4.19	High	This means that the students' adaptive learning engagement is oftentimes observed.
2.60 – 3.39	Medium	This means that the students' adaptive learning engagement is neither observed nor not observed.
1.80 – 2.59	Low	This means that the students' adaptive learning engagement is rarely observed.
1.00 – 1.79	Very Low	This means that the students' adaptive learning engagement is never observed

The third section of the study focuses on scientific epistemological beliefs, adapted from Özbay and Köksal (2021), which encompasses four indicators: resource dimension, improvement dimension, verification dimension, and certainty, that consists of 25 questions [20]. The study utilized numeric equivalents and descriptive interpretations to assess and understand the scientific epistemological beliefs of the respondents.

Range of Means	Descriptive Level	Interpretation
4.20 – 5.00	Very High	This means that scientific epistemological beliefs are always observed.
3.40 – 4.19	High	This means that scientific epistemological beliefs are oftentimes observed.
2.60 – 3.39	Medium	This means that the scientific epistemological beliefs are neither observed or not observed
1.80 – 2.59	Low	This means that scientific epistemological beliefs are rarely observed.
1.00 – 1.79	Very Low	This means that the scientific epistemological beliefs are never observed.

3.6 Data Collection

The data-gathering process for this study followed a series of steps. First, the researcher sought permission from the Graduate School Dean of the University of Mindanao through an endorsement letter signed by the advisor. Once the Dean's approval was obtained, the initial data-gathering process began. The researcher then requested permission from the Office of the School's Division Superintendent of the Division of Davao City Division to conduct the study. Additionally, letters of permission were sent to the principals of the six schools in Davao cluster two.

After obtaining approval from the division superintendent and school principals, the researcher sought an endorsement from the six school principals in the cluster 2 division to allow the administration of the questionnaire to the study's respondents. The researcher gave the questionnaire to the respondents through Google platform. Guidance and explanations on the data-gathering process and the study's purpose were provided. Subsequently, the researcher retrieved the questionnaires and reviewed each filled-in instrument to ensure all items had corresponding responses. The collected questionnaires were forwarded to a statistician for statistical computation and analysis.

3.7 Statistical Tool

The data analysis and interpretation in this study relied on the following statistical methods and tools:

- **Mean.** This statistical technique was employed to assess the extent of the classroom social environment, adaptive learning engagement, and the scientific epistemological beliefs of the student-respondents in relation to research objectives 1, 2, and 3.
- **Pearson Product-Moment Correlation Coefficient (Pearson-r).** This statistical tool was employed to determine the significant relationship between the variables under study in answer to objectives 4 and 5.
- **Med graph using Sobel z-test.** This approach was utilized to establish the mediation effect and reinforce the findings obtained.

4. Results

This section presents the data and analysis that have led to the conclusions drawn from the study's acquired data. The subsequent sections are organized as follows for discussions: the level of classroom social environment; the level of adaptive learning engagement of science students; the level of scientific epistemological beliefs; the correlations between classroom social environment and adaptive learning engagement; the correlations between classroom social environment and scientific epistemological beliefs of science students; the correlations between epistemological beliefs of science students and adaptive learning engagement; and on the mediating effect of scientific epistemological beliefs.

4.1 Level of Classroom Social Environment

The data presented in Table 1 outlines the evaluation of the Classroom Social Environment, with a focus on the level of responses across different indicators. The relatively low overall standard deviation, measuring less than 1.00, indicates a notable consistency in respondents' perceptions. This implies that the responses for each indicator were closely aligned, reflecting a shared perspective among participants. The calculated overall mean score of 3.32 falls within the moderate range, indicating that the respondents occasionally observed the classroom social environment. This suggests that while elements of a positive social environment were recognized, there may also have been instances where such dynamics were less prevalent or noticeable to the students.

Table 1: Level of Classroom Social Environment

Indicators	SD	Mean	Descriptive Level
Teacher Support	1.06	3.19	Moderate
Mutual Respect	1.21	3.67	High
Student Task-related Interaction	1.16	3.45	High
Performance Goal	0.98	2.96	Moderate
Overall	**0.92**	**3.32**	**Moderate**

The assessment of the classroom social environment yielded varying levels across distinct indicators. Mutual respect and student task-related interaction emerged as high, indicating that these aspects were frequently observed within the classroom. On the other hand, teacher support and performance goals received a moderate ranking, implying that these elements were perceived as being present on an occasional basis by the respondents. This suggests that students perceived a consistent presence of mutual respect and task-related interaction, while teacher support and performance goals were acknowledged to a somewhat lesser extent.

4.2 Level of Adaptive Learning Engagement of Science Students

The outcomes depicted in Table 2 unveil the extent of adaptive learning engagement observed among science students. With an overall standard deviation of less than 1.00, the analysis signifies a convergence of mean scores across each indicator, suggesting a uniformity of participant responses. The collective mean score registered at 3.41, characterizing it as high. This indicates that adaptive learning engagement was frequently observed based on the respondents' perceptions. In essence, the findings reveal that students perceived a consistent presence of adaptive learning engagement within the context of science education.

Table 2: Level of Adaptive Learning Engagement of Science Students

Indicators	SD	Mean	Descriptive Level
Learning Goal Orientation	1.16	3.57	High
Task Value	1.11	3.54	High
Self-efficacy	0.94	3.24	Moderate
Self-regulation	1.00	3.29	Moderate
Overall	**0.96**	**3.41**	**High**

Evident in the presented data, the analysis showcases the levels of adaptive learning engagement across distinct indicators as outlined. Notably, learning goal orientation and task value emerged as high indicators, reflecting their frequent observation among science students. This implies that students commonly demonstrated a proactive approach to learning goals and displayed a notable appreciation for the significance of tasks. Conversely, self-efficacy and self-regulation exhibited a moderate level, indicating that these dimensions were intermittently observed by students. This suggests that while students occasionally exhibited a sense of confidence in their abilities and demonstrated elements of self-regulation, these aspects were not as consistently prevalent as learning goal orientation and task value. In essence, the analysis underscores the variability in the levels of adaptive learning engagement across these specific dimensions among science students.

4.3 Level of Scientific Epistemological Beliefs

Illustrated in Table 3 is a comprehensive depiction of the scientific epistemological beliefs held by science students. The calculated overall mean score of 3.15, classified as moderate, is indicative of the frequency with which these beliefs were observed among the students. This mean score provides insights into the extent to which students' scientific epistemological beliefs were demonstrated in their perspectives and actions. The associated standard deviation of 0.95 is noteworthy, as its value of less than 1.00 denotes a sense of homogeneity or consistency in the responses offered by the surveyed students. This uniformity underscores the convergence of opinions among respondents regarding their scientific epistemological beliefs, contributing to a coherent understanding of the student's attitudes towards the nature of scientific knowledge and its acquisition.

A distinctive pattern emerges after scrutinizing the specific items pertaining to scientific epistemological beliefs among science students. Notably, "Experimenting and scientific studies are an important part of learning how things happen" garnered the highest mean of 3.46, indicating its substantial presence within the students' perspectives and actions. This high mean score conveys that science students frequently endorsed this particular belief. It is noteworthy that the standard deviation for this item, at 1.25, surpasses 1.00, implying that responses to this item were heterogeneous or inconsistent, suggesting varying degrees of agreement or endorsement.

Conversely, the item "In science, all questions have only one correct answer" garnered a mean of 2.92, classified as moderate. This signifies that science students occasionally embraced this belief. A corresponding standard deviation of 1.19, surpassing 1.00, signifies heterogeneous or inconsistent responses regarding this item. This variability underscores the differing viewpoints among respondents in relation to the extent to which they agree with the notion that there is a singular correct answer for all scientific questions. Such observations offer valuable insights into the diverse range of epistemological beliefs science students hold, providing a nuanced understanding of their perspectives on the nature of scientific knowledge and inquiry.

Table 3: Level of Scientific Epistemological Beliefs

Items	**SD**	**Mean**	**Descriptive Level**
All people have to believe in what scientists say.	1.13	2.96	Moderate
İn science, all questions have only one correct answer.	1.19	2.92	Moderate
In scientific experiments, ideas and events are thought of and come forth from curiosity.	1.23	3.21	Moderate
Today, some scientific thoughts are different from what scientists thought of in the past.	1.11	3.07	Moderate
Before starting an experiment, there is a benefit in having an idea about it first.	1.28	3.36	Moderate
You have to believe what is written in scientific books.	1.10	3.02	Moderate
The most important part of a scientific study is to reach a correct answer.	1.30	3.38	Moderate
Information in scientific books can change sometimes.	1.21	3.10	Moderate
In scientific studies, there can be different ways to test thought	1.24	3.27	Moderate
In science class, everything the teacher says is correct.	1.12	2.99	Moderate
Thoughts in science come forth from your own experiments and questions you ask yourself.	1.17	3.20	Moderate
Scientists know practically everything there is to know about science. There is nothing left to learn.	1.14	2.94	Moderate
There are some questions that even scientists cannot answer.	1.33	3.25	Moderate
Experimenting and scientific studies are an important part of learning how things happen.	1.25	3.46	High
You can be sure that everything you read in a science book is correct.	1.14	3.00	Moderate
Scientific information is always correct.	1.10	2.96	Moderate
Scientific thoughts may sometimes change.	1.19	3.20	Moderate
To be sure about the results, it is good to redo experiments.	1.22	3.21	Moderate
Only scientists know for sure what is correct in science.	1.23	3.00	Moderate
The result a scientist receives from an experiment is the only answer.	1.16	3.07	Moderate
New discoveries may change what scientists thought to be true.	1.25	3.26	Moderate
Good ideas in science are not only from scientists but may also be from normal people.	1.25	3.36	Moderate
Scientists always agree on what is correct and what is not.	1.18	3.12	Moderate
The best conclusions are based on evidence obtained from the results of different experiments.	1.23	3.31	Moderate
Scientists may change what they accept as correct in science.	1.22	3.22	Moderate
Overall	**0.95**	**3.15**	**Moderate**

Furthermore, a comprehensive examination of the remaining items reveals consistent trends. The levels of the other items aligned with the "moderate" category, characterized by mean scores spanning from 2.60 to 3.39. This substantiates the notion that the various aspects encompassing scientific epistemological beliefs among science students, which serve as the intermediary variable in the study, were consistently endorsed to varying degrees. This consistency highlights the students' infrequent adoption of these beliefs and provides an overview of their viewpoints on the complex aspects of scientific knowledge and investigation.

4.3.1 Correlations Between Classroom Social Environment and Adaptive Learning Engagement

Evident from the findings presented in Table 4.1 is the outcome of the analysis concerning the correlation between the classroom social environment and adaptive learning engagement. The table exhibits the favorable association that exists between the indicators of the social environment in the classroom and those regarding adaptive learning engagement.

Table 4.1: Significance of the Relationship between Classroom Social Environment and Adaptive Learning Engagement of Science Students

Classroom Social Environment	Adaptive Learning Engagement				
	Learning Goal Orientation	Task Value	Self-Efficacy	Self-regulation	Overall
Teacher Support	.702** .000	.676** .000	.650** .000	.692** .000	**.744** .000**
Mutual Respect	.782** .000	.764** .000	.650** .000	.712** .000	**.798** .000**
Student Task-Related Interaction	.753** .000	.734** .000	.614** .000	.705** .000	**.771** .000**
Performance Goal	.466** .000	.465** .000	.532** .000	.474** .000	**.527** .000**
Overall	**.822** .000**	**.803** .000**	**.737** .000**	**.783** .000**	**.861** .000**

** $p < 0.01$

The outcome of the analysis unveiled an overall r-value of .861, accompanied by a p-value of 0.01, which is indeed less than the critical threshold of 0.05. The r-value indicates a positive correlation between the classroom social environment and adaptive learning engagement. This pivotal finding indicates the presence of a statistically significant relationship between classroom social environment and adaptive learning engagement. Consequently, the null hypothesis, positing the absence of a relationship, can be confidently rejected.

Furthermore, when examining the interrelationships among indicators, it becomes evident that the calculated r-values range from .465 to .782. Notably, the corresponding p-values are consistently below the predetermined significance level of 0.05, all registering at .000. These compelling outcomes underscore the presence of noteworthy and statistically significant connections between the various indicators of classroom social environment and adaptive learning engagement.

4.3.2 Correlations Between Classroom Social Environment and Scientific Epistemological Beliefs of Science Students

The outcomes presented in Table 4.2 unveil the investigation's findings into the correlation between classroom social environment and the scientific epistemological beliefs of science students. The indicators associated with the classroom social environment show a positive correlation with the students' scientific epistemological beliefs, as illustrated in the table.

Table 4.2: Significance of the Relationship between Classroom Social Environment and Scientific Epistemological Beliefs of Science Students

Classroom Social Environment	**Scientific Epistemological Beliefs**
Teacher Support	.674** .000
Mutual Respect	.651** .000
Student Task-Related Interaction	.622** .000
Performance Goal	.473** .000
Overall	**. .731**** **.000**

** $p < 0.01$

The analysis outcome showcased an overarching r-value of .731, accompanied by a p-value of .000, which is below the 0.05 significance threshold. The r-value indicates that there is a positive correlation between the classroom social environment and the scientific epistemological beliefs of science students. This robustly implies a statistically significant relationship between classroom social environment and scientific epistemological beliefs among science students. Consequently, the null hypothesis is convincingly refuted, affirming the meaningful linkage between these key factors.

Furthermore, when examining the interconnections between specific indicators of classroom social environment and scientific epistemological beliefs, it becomes evident that the observed r-values span from .473 to .674, accompanied by a consistent p-value of .000, which falls below the 0.05 significance threshold. These outcomes underscore the existence of substantial and meaningful associations between the distinct indicators of the classroom social environment and the mediating variable of scientific epistemological beliefs.

4.3.3 Correlations between Epistemological Beliefs of Science Students and Adaptive Learning Engagement

Presented within Table 4.3 are the outcomes of the analysis concerning the interrelationship between scientific epistemological beliefs among science students and their adaptive learning engagement. The table illustrates that the mediating variable of scientific epistemological beliefs positively correlates with the diverse indicators of adaptive learning engagement.

Table 4.3: Significance of the Relationship between Scientific Epistemological Beliefs and Adaptive Learning Engagement of Science Students

Scientific Epistemological Beliefs	**Adaptive Learning Engagement**				
	Learning Goal Orientation	**Task Value**	**Self-efficacy**	**Self-regulation**	**Overall**
	.654**	.660**	.594**	.696**	**.712****
	.000	.000	.000	.000	**.000**

** p < 0.01

The outcome presented an encompassing r-value of .712, with a p-value of .000, underscoring its significance as it remains lower than the 0.05 threshold. The r-value shows that there is another positive correlation between the epistemological beliefs of science students and adaptive learning engagement. This statistical representation affirms a substantial and meaningful relationship between scientific epistemological beliefs and adaptive learning engagement, consequently rejecting the null hypothesis.

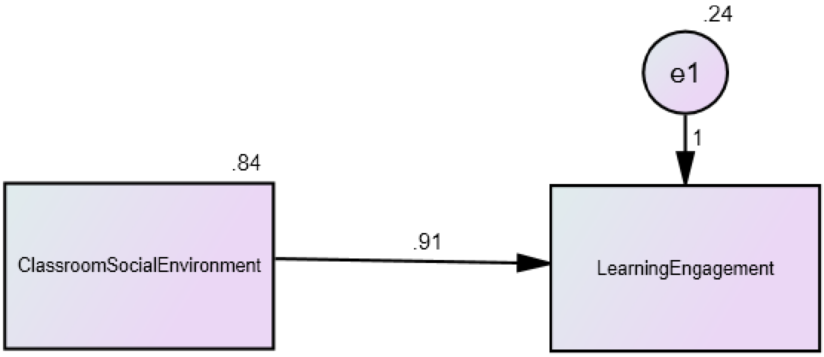
Moreover, examination of the associations between scientific epistemological beliefs, functioning as a mediating variable, and the indicators of adaptive learning engagement reveals notable insights. The observed r-values, spanning from .594 to .696, and the corresponding p-value of .000, significantly below the 0.05 significance level, accentuate the presence of substantial correlations. This strongly suggests meaningful connections between scientific epistemological beliefs as a mediating factor and the diverse indicators of adaptive learning engagement, underlining their interdependence and underscoring the importance of scientific epistemological beliefs in influencing adaptive learning engagement.

4.4 On the Mediating Effect of Scientific Epistemological Beliefs

Table 5 showcases the outcomes of a path analysis, utilizing SPSS Analysis of Moment Structure (AMOS), to explore the mediating impact of scientific epistemological beliefs in the correlation between classroom social environment and learning engagement. This approach offers a comprehensive perspective on the complex relationships between these variables. By employing AMOS, the analysis gains greater statistical accuracy, revealing intricate associations among classroom dynamics, epistemological beliefs, and student engagement.

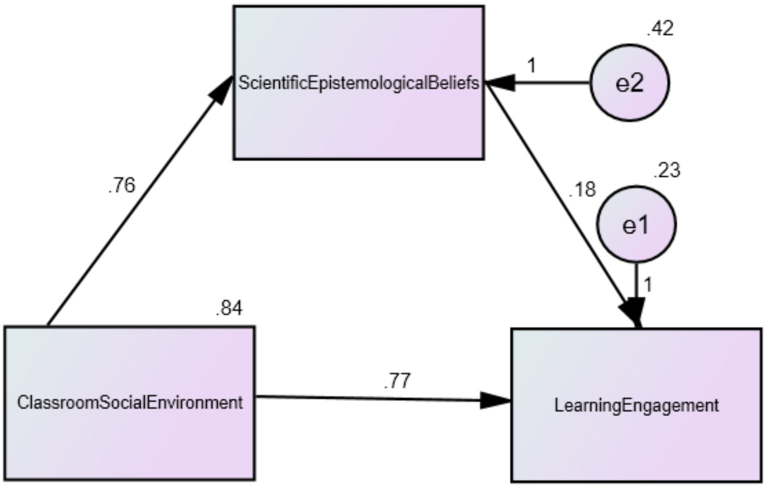
Furthermore, Table 5 highlights the regression weights concerning the direct influence of the classroom social environment on learning engagement. In this analysis, the classroom social environment displays an estimated effect size of .905, a standard error (S.E.) of .025, a critical ratio (C.R.) of 36.383, and a probability value of .000, below the 0.05 significance threshold. This outcome underscores a substantial and statistically significant connection between the two variables. Notably, the low standard error signifies that the estimate is characterized by a higher level of precision compared to a more significant standard error.

Table 5: Mediation Analysis of the Three Variables



Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
Learning Engagement	<---	Classroom Social Environment	.905	.025	36.383	***	



Full Mediation

Regression Weights: (Group number 1 - Default model)

Additionally, as depicted in Figure 3, the graphical representation underscores the mediating impact of scientific epistemological beliefs on the interrelation between classroom social environment and learning engagement. This finding indicates that scientific epistemological beliefs play a substantial role in shaping the correlation between the classroom social environment and Science students' learning engagement. Furthermore, including scientific epistemological beliefs as a mediating variable influences the causal link between classroom social environment and learning engagement, resulting in a noteworthy reduction of the beta coefficient value from .91 to .77 while retaining its statistical significance.

Figure 3: The Mediating Effect of Scientific Epistemological Beliefs on the Relationship between Classroom Social Environment and Learning Engagement

			Estimate	S.E.	C.R.	P	Label
Scientific Epistemological Beliefs	<---	Classroom Social Environment	.757	.033	22.984	***	
Learning Engagement	<---	Classroom Social Environment	.770	.035	21.733	***	
Learning Engagement	<---	Scientific Epistemological Beliefs	.179	.034	5.214	***	

The illustrative diagram presented in Figure 3 visually encapsulates the interconnections among the variables, accompanied by their respective estimates, standard errors, critical ratios, and probability values. Specifically, focusing on the link between classroom social environment and learning engagement (Path C), the introduction of scientific epistemological beliefs as a mediating variable alters the estimate from .905 to .770. This implies that an increment of 1 in the classroom social environment is associated with an increase of .770 in learning engagement. The corresponding regression weights estimate exhibits a standard error (S.E.) of .035 and a critical ratio (C.R.) of 21.733, calculated by dividing .77 by .035. The probability (p) value of .000 indicates that the regression weight for the classroom social environment significantly deviates from zero at the .001 level, reaffirming the sustained significance of the relationship.

Furthermore, delving into the correlation between classroom social environment and scientific epistemological beliefs (Path A), with the latter acting as a mediator, the estimate stands at .757. This indicates that a 1-unit elevation in the classroom social environment is linked with a .757-unit elevation in scientific epistemological beliefs. The associated regression weights estimate is coupled with a standard error (S.E.) of .033 and a critical ratio (C.R.) of 22.984, calculated by dividing .757 by .033. The probability (p) value of .000 underscores that the regression weight for the classroom social environment remains significantly distinct from zero at the .001 level, affirming the continued significance of the relationship.

In addition, exploring the interaction between scientific epistemological beliefs as a mediator and learning engagement (Path C) as the dependent variable, the estimate stands at .179. This implies that a 1-unit elevation in scientific epistemological beliefs is associated with a .179-unit elevation in learning engagement. The corresponding regression weights estimate is accompanied by a standard error (S.E.) of .034 and a critical ratio (C.R.) of 5.214, derived by dividing .179 by .034. The probability (p) value of .000 underlines that the regression weight for learning engagement remains significantly distinct from zero at the .001 level, underscoring the ongoing significance of this relationship.

The mediating effect of a third variable follows three essential steps, each of which is demonstrated in Figure 2. In the initial step (Path C), the classroom social environment, serving as the independent variable (IV), has a minimal correlation with individual learning engagement, the dependent variable (DV). Subsequently, the estimate experiences a reduction in step 2 (Path A), wherein the classroom social environment (IV) maintains a significant prediction of scientific epistemological beliefs, the mediator (MV). Transitioning to the final step, step 3 (Path B), scientific epistemological beliefs (MV) significantly forecast individual learning engagement. These initial steps serve to establish the zero-order relationships among the variables. Upon confirming significant relationships in steps 1 to 3, progression to step 4 is warranted. Notably, in step 4, the combined influence of the classroom social environment and scientific epistemological beliefs on learning engagement holds significance. A distinctive pattern emerges - a noteworthy full mediation effect of scientific epistemological beliefs on the link between classroom social environment and learning engagement.

5. Conclusion

The findings indicate that the students' social environment in the classroom has a moderate mean with relatively strong subcategories concerning mutual respect and associated task interactions, and yet the students have lower self-observation of teacher support and performance goals, suggesting the necessity of creating a more supportive educational climate [21]. Overall, the desire to learn, task values and goal commitment among the science students is high; however, self-efficacy and self-regulation are fair, implying that though students are frequently involved and committed to learning and value the science learning tasks, there is a weakness in their perceived ability and skills to manage their learning [22]. Students' scientific epistemological beliefs are moderately consistent with key concepts, but they require intervention to eliminate the belief that all scientific questions must have a single answer, which corresponds to the Student Orientation of Scientific Inquiry [23]. By and large, the current aggregate of research findings supports the need for interventionist approaches concerning classroom organization and management, instructional engagement processes, and epistemological instruction that lead to a better learning climate.

The various correlations established show a positive correlation between the social environment in the classroom and adaptive learning engagement, and thus, a positive social climate in the classroom increases the interaction level of the student with the learning processes [24]. Besides, the finding of a positive relationship between the social environment of the classroom and the students' scientific epistemological beliefs shows that an enriching educational climate helps to develop a sound and sophisticated scientific view of the world [25]. In addition, the strong correlation made by the student with their epistemological beliefs and adaptive learning engagement stresses the importance of epistemological points of view about learning attitudes and methods [26]. Collectively, these results highlight the coexistence of each of the above elements and underscore the importance of a holistic approach in addressing the classroom dynamic, Epistemological beliefs, and learning Engagement to enhance student learning.

The analysis of the mediating role of scientific epistemological beliefs provides evidence of the importance of these beliefs in operating as a mediator between the classroom social environment and adaptive learning engagement. The results highlight that the factor of the supportive classroom environment affects learning engagement and, at the same time, indicates that the effect on learning engagement is significantly higher when epistemological beliefs about science in learning environments are considered as a moderating variable. Further, the mediation analysis provides evidence that students' epistemological beliefs not only mirror but also boost the effects of classroom dynamics on their learning engagement, implying that enhancing the radical scientific beliefs might enhance the benefits of education still further [27]. This has further stressed the role of incorporating epistemological development within educational approaches as a way of enhancing students' motivation and creating a positive classroom environment.

Overall, the study highlights the fact of the high level of supportive classroom environment and adaptive learning engagement, while increasing teacher support and self-regulation for the most effective classroom learning. This means that the epistemological beliefs of the learners are significantly related to the amount of participation in classroom learning activities, learning interest, and general classroom learning atmosphere, thus the importance of incorporating epistemological development when planning for classroom learning environments. Considering the aforementioned research, it can be concluded that by changing these two factors, one can minimize or improve aspects within the classroom environment and the ways that students approach knowledge as a means to promote their learning engagement, providing a larger perspective of education to students [24] [18].

6. Recommendation

Based on the results and conclusion, recommendations are presented. According to Table 1, the Performance Goal had the lowest mean and standard deviation of all the indicators in the Level of Classroom Social Environment, with only a modest descriptive level. To create a better classroom social environment where students may engage constructively in a supportive atmosphere where supportive connections are valued, and performance goals are consistently supported and uplifted, educators must enhance their techniques and competencies, according to a parallel study. In Table 2, it is clear that among the four indicators of the Level of Adaptive Learning Engagement of Science Students, Self-efficacy and Self-regulation have the lowest standard deviation and mean and a descriptive level of moderate only. This implies that science students are less efficient and less regulated with themselves. The elements or motivators influencing self-efficacy and self-regulation must be thoroughly analyzed to guide further research. The least favorable response for the Level of Scientific Epistemological Beliefs questions item, "In science, all questions have only one correct answer," can be found in Table 3.

It has the least mean and has a descriptive level of only moderate. Thus, for future studies, the Scientific Epistemological Belief of this question item must be increased by educating the students on the correct and accurate belief and embracing and accepting this Scientific Epistemological Belief more occasionally.

Lastly, science teachers must inculcate to their learners a robust epistemic foundation where solid scientific theories and beliefs inspire them to achieve success. Additionally, educators must have training and exposure to various learning symposiums to facilitate science classes with a focus on enhancing students' scientific awareness and views regarding their capacity for learning and academic success.

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