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Effect of Classroom Learning Environment on Basic Science Students' Academic Achievement and Retention at Upper Basic Education Level

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Abstract: The study investigated the effect of classroom environment on student's academic achievement and retention in Basic Science at the upper education level. The study adopted a quasi-experimental design of pretest-posttest, and posttest non-equivalent control group design. Four research questions and four corresponding null hypothesis guided the study. The population of the study was all the upper basic two students in public secondary schools in Enugu State, Nigeria. Two intact classes of Upper Basic Two (JSS2) students were purposively assigned to experimental and control groups. A sample size of 72 upper basic two students was used for the study. A 25-item Basic Science Test (BSAT) was designed by the researchers and used for data collection. Face and content validation were carried out by experts in Basic Science and Measurement and Evaluation. The instrument was trial tested using Kuder-Richardson reliability formula 20 (K-R 20) to determine the reliability coefficient index of 0.85 for the instrument. Mean and standard deviation was used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at a 0.05 level of significance. The result of the study shows that students exposed to treatment achieved and retain greater knowledge than their counterparts that were denied treatment. It was recommended that low achievers in Basic Science need to be involved more through increased interaction with teachers in the form of makeup classes, tutorial classes, or special coaching.

Keywords: Achievement, Basic Science, Classroom Learning, Environment, Students' Learning.

Introduction

A school is a special place where the education, training, and personality development of learners who are the future assets of the nation are founded and run by proper training methods, and an appropriate physical and favorable psychological environment (Dela Fuente, 2021; Raccoon, 2018). Students in the process of socialization require a healthy environment and models to increase their achievement. Hence, clean, quiet, and comfortable environments are important components of a learning environment (Berondo & Dela Fuente, 2021; Gilavand, 2016). Furthermore, creating an ideal learning environment ought to be a priority of every concerned educationalist because being comfortable should be a combination of several factors which include temperature, lighting, noise control, etc (Murugan & Rajoo, 2013). The extent to

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which students' learning could be enhanced depends on their location within the school compound, the structure of their classroom, and the availability of instructional facilities and accessories. It is believed that a school with an adequate learning environment contributes to stirring unexpected outcomes of learning that will facilitate good academic achievement, by encouraging effective teaching and learning (Duruji et.al, 2014).

The teaching and learning process occurs as a result of interaction among members of the classroom. In classroom settings, elements of the teaching and learning process include teacher, students, content, learning process, and learning situation. The learning environment means the conditions in which learning takes place. Each classroom has unique teaching and learning environments. Classes may seem similar from the distance but are different in their procedures and processes (Arends, 2007). A classroom setting has two major components, namely, the physical component and the human component. The physical component comprises all the physical objects present in the classroom e.g. blackboard, furniture, lighting, projector, books, computers, etc., whereas the human component comprises individuals i.e., teachers and students in the classroom. It generally involves the nature of the interaction of teachers with students and students with students as well. This pattern of interaction generates a particular atmosphere which may be called a learning environment. Classroom learning environment refers to the total climate, structures, processes, and ethos within classrooms which are integral elements affecting students' learning.

The learning environment encompasses learning resources and technology, means of teaching, modes of learning, and connections to societal and global contexts. The learning environment is a composite of human practices and material systems, much as ecology is the combination of living things and the physical environment (Dela Fuente, 2021; Balog, 2018; Orlu, 2013). Learning environments vary from classroom to classroom and from context to context each with unique elements. According to Dela Fuente (2019) learning environments can be learner-centered; knowledge-centered; assessment-centered, and community-centered. Learner-centered environments are designed for the active construction of knowledge by and for learners (Federation University, 2018). Knowledge-centered learning environments are those which support students' deep investigations of big ideas through generative learning activities.

Assessment-centered learning environments provide frequent, ongoing, and varying opportunities for assessment, including opportunities for revision and self and peer assessment (Dela Fuente & Biñas, 2020; Alvaro, 2010). Community-centered environments value collaboration, negotiation of meaning, respect for multiple perspectives around which knowledge is constructed, and connections to the local community and culture (Raccoon, 2018). The learning environment is composed of some components that influence the student's learning curve. These components according to Balog (2018) include; people; teaching materials, technical tools, and learning resources; curriculum, training, and instruction, and physical environment/learning space. The people are the individuals that affect the student directly or indirectly through connection or relationships which can contribute to students' growth and success in their career aspect. The teaching materials, technical tools, and learning resources are the teaching materials, highly advanced tools, or other instructional resources that are aligned with the curriculum as a part of student learning support.

The curriculum, training, and instruction are the core foundations of the learning process; they influence one another and play vital roles to facilitate the flow of knowledge and delivery of instructional content/curriculum. The physical environment/learning space refers to the physical setting of the learner's environment which should evoke positive responses and hold the interests of those who inhabit it (Balog, 2018). Mondal (2012) identified some important factors that may affect the learning process including the Intellectual factor which refers to the individual mental level. Learning factors are factors owing to faulty methods of work or study, and narrowness of experimental background which may affect the learning process. Physical factors include health, physical development, nutrition, visual and physical defects, and glandular abnormality. Mental

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factors are attitudes like interest, cheerfulness, open-mindedness, etc that are important in the development of personality. Personal factors, such as instincts and emotions, and social factors, such as cooperation and rivalry, are directly related to a complex psychology of motivation. The teacher as an individual personality is an important factor in the learning environment. They are key factors that create favorable teaching and learning milieu that will make the instructional process easy, enthusiastically adaptable, and useful (Dela Fuente, 2021; Usman, 2016). How his personality interacts with the personalities of the pupils helps to determine the kind of behavior which emerges from the learning situation (Brown, 2015). Environmental factors like classrooms, textbooks, equipment, school supplies, and other instructional materials, etc. are the physical conditions needed for learning and learning Basic Science.

The importance of Basic Science cannot be denied in this age of science and technology. Basic Science education equips learners with the basic knowledge and skills that are essential in the study of science and other related science disciplines at the advanced level. Scientific knowledge proved to be an essential vehicle to train the minds of learners to think logically, objectively, and reasonably in solving day-to-day problems. Basic Science is a prerequisite subject for careers in science and technology as well as a multi-disciplinary subject that comprises concepts in Biology, Physics, and Chemistry among others (Obodo, Ani & Nebo 2021). The introduction of Basic Science to the junior secondary school level is a fundamental concept that enables students to achieve its objective and acquire basic skills that are useful at the senior secondary school level. According to Ani (2016), the objectives of Basic Science teaching in Nigeria is to provide students at the upper basic education level a sound basis for continuing science Education either in single science subjects or further integrated science; enhance the scientific literacy of the citizenry; allow students to understand their environment in its totality rather than in fragments; and also to allow the students to have a general view of the world of science.

Meaningful learning occurs in an environment where learners comprehend Basic Science concepts and teachers use adequate teaching methods. The methods are popular and often used by teachers to disseminate information, knowledge, and skills to students (Umar, 2017; Obodo, Ani & Nebo 2021). Most Basic Science teachers prefer using conventional methods of instruction during the teaching and learning process. This method failed the recognition the uniqueness of the innovative methods of teaching Basic Science and the learner's individuality. Furthermore, it does not facilitate the development of critical and analytical skills and processes in the students. These, among other reasons, had not enhanced learning in students and thus had led to the poor achievement of students in the sciences. Also, the inability of the students to recall what they have been taught after a short or long period is of great concern to educationists since learning is a behavior change.

Productive learning environments are crucial to students' academic, emotional, and social success in school. A conducive learning environment doesn't just happen on its own or by chance. They should be created through conscious procedures like interacting with students in a positive manner, exhibiting positive behaviors, etc that would promote learning activities in the learning environment (Becton, 2017). Waldman (2016) opined that before students can succeed academically, they must feel safe, both physically and mentally, and to have a safe learning environment, students must feel welcomed, supported, and respected. Personalizing learning helps students develop skills including thinking critically, using knowledge and information to solve complex problems, working collaboratively, communicating effectively, learning how to learn, and developing academic mindsets that would greatly increase students' engagement (Raccoon, 2018). More so, students must feel connected to teachers, staff, and other students. Schools can nurture these connections by focusing on students' social and emotional learning (SEL). Students must also feel supported by all those connected to their learning experiences like teachers, classmates, administrators, family, and community members for a higher academic feat (Waldman, 2016).

There is no misgiving that students' high-quality academic achievement and outcomes are

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connected to the nature of the learning environment and the available useful facilities. Various experiential studies have established that the learning environment is a critical necessity for students' academic achievement in Nigeria (Shamaki, 2015; Eimuhi & Ogedegbe 2016; Ezike, 2018). The educational process of development occurs in physical, social, cultural, and psychological environments which implies that a proper and adequate environment is very much necessary for fruitful learning (Mudassir & Norsuhaily, 2015). High academic achieving learners are likely to have been exposed to curriculum content under an ideal learning environment. Hence the affirmation of the opinion of Shamaki (2015) that educational achievement is likely to be determined by the idealness of the learning environment. This implies that schools that fail to provide the necessary learning facilities and create a conducive atmosphere for teaching and learning may hardly put in the best in their students, especially in the area of academic achievement.

Achievement in education is directly related to knowledge retention. Learners must retain knowledge acquired during the teaching and learning process for them to achieve maximally in Basic Science. The teaching and learning of Basic Science require a proper attitude and deep thinking from the students in terms of their learning styles, as well as the teacher's knowledge and behavior in the classroom. It is often said that a better environment in a class helps during group work and hence improves the learning of the students. Most scholars agree that students' academic achievement and retention vary with learning environments. Contemporary learners deserve learning environments that meet their individual and collective needs. To meet this challenge, educational leaders must provide physical and cultural environments that are empowering and engaging. Therefore, this study was designed to investigate the effect of the classroom learning environment on Basic Science students' academic achievement and retention at the upper basic education level.

Research Questions

The following research questions guided the study:

1. What are the mean scores of Basic Science students exposed to good classroom environments and their counterparts in the control group?

2. What are the mean post-test achievement scores of male and female Basic Science students exposed to treatment?

3. What are the mean retention scores of Basic Science students exposed to good classroom learning environments and their counterparts in the control group?

4. What are the mean retention scores of male and female Basic Science students exposed to treatment?

Hypotheses

The following null hypotheses were formulated and tested at a 0.05 level of significance:

H01: There is no significant difference in the mean achievement scores of Basic Science students exposed to good classroom learning environments and their counterparts in the control group.

H02: There is no significant difference in the mean achievement scores of Basic Science female students exposed to treatment.

H03: There is no significant difference in the mean retention scores of Basic Science students exposed to good classroom learning environments and their counterparts in the control group.

H04: There is no significant difference in the mean retention scores of Basic Science students exposed to treatment.

Methodology

The study adopted a quasi-experimental design of pretest-posttest and post-posttest non-equivalent control group design. This design is desirable for analyzing gain scores, that is, the

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difference between posttest and pretest scores (Anikweze, 2015). The choice of this design was because the researchers were interested in the study of cause and effect and in manipulating the independent variables (learning environments) to observe the effect on the dependent variable (academic achievement and retention). The population comprised all the Upper Basic Two (JSS2) students in the 295 public secondary schools in Enugu State, Nigeria. A sample of 72 Upper Basic Two (JSS2) students made up of 32 male and 40 female Basic Science students were selected from two purposively selected public secondary schools in Enugu State, Nigeria. The two selected intact classes were assigned randomly each to experimental and control groups respectively. The experimental group was exposed to training in good classroom learning environments while the control group was not. The instrument used for data collection was a 25-item Basic Science Achievement Test (BSAT) designed by the researchers. Face and content validation of the instrument was carried out through a test blueprint by three experts in Basic Science and Measurement and Evaluation. Trial testing of the instrument was carried out using Kuder-Richardson Reliability Formula 20 (K-R20) to determine the reliability coefficient index of 0.85 for the instrument.

Experimental Procedure

During this period, the research assistants (Basic Science teachers) were trained for one week by the researchers who explained to them in detail what the research was all about and what they were required to do. The Basic Science teachers conducted practice sessions using lesson plans. The lesson plans contain students' and teachers' activities. Delivering the lesson using the lesson plan was extensively discussed with the cooperating Basic Science teachers (research assistants) during the training. All the topics for the study were treated in detail. The researchers used the opportunity to detect individual problems of the Basic Science teachers that may introduce errors to the study. Before the commencement of treatment, the research assistants administered the pre-test using the BSAT to both the experimental and control groups. This was done to ascertain the equivalence and ability level of knowledge in the two groups.

Teaching the students in classroom environments was used as a treatment in the study. The treatment involved teaching the topics to both groups by the trained Basic Science teachers who were pre-trained to acquaint them with the need to train students in a good classroom environment with different instructional strategy and how to apply it in Basic Science teaching. The experimental groups were taught in a good classroom environment using varieties of instructional materials while the control groups were taught with normal lesson notes and conventional methods for four weeks. The researchers prepared the lesson plans that were used by the research assistants to ensure uniformity of content. Teaching lasted for four (4) weeks and the posttest was administered to the two groups. The BSAT (posttest) was reshuffled and administered 2 weeks after the end of teaching to determine the degree of retention of Basic Science materials by the participants for a period of time. The scripts were scored by the researchers and the two research assistants. The post-test BSRT scores were collated like those of pre-test BSRT scores and used for data analysis.

Data Analysis

The scores obtained from the pre-test and post-test were analyzed using mean and standard deviation to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at a 0.05 level of significance.

Results

The data are presented and analyzed in Tables in accordance with the research questions and hypotheses that guided the study.

Research Question 1: What are the mean scores of Basic Science students exposed to good classroom environments and their counterparts in the control group?

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Table 1: Mean and Standard Deviation of Basic Science students Achievement Scores in BSAT for Experimental Control Groups

Group	Test Type	Age	Mean	SD	Mean Gain	Mean Gain Diff
Experimental	posttest	30	14.65	6.62	29.58	
	pretest	30	44.23	11.35		
						15.40
Control	posttest	42	11.28	5.77	14.18	
	pretest	42	25.46	9.83		

Table 1 shows that basic Science students exposed to training in good classroom environments had pretest and posttest scores of 14.65 and 44.23 with standard deviations of 6.62 and 11.35 respectively with a mean gain score of 29.58. Those students that were not exposed to good classroom learning had pretest and posttest scores of 11.28 and 25.46 with standard deviations of 5.77 and 9.83 respectively with their mean gain score of 14.18. The mean gain score difference between the two groups was 15.40 in favor of the experimental group. This implies that students taught Basic Science concepts in good classroom learning environments achieved better than their counterparts in the control group.

Research Question 2: What are the mean post-test achievement scores of male and female Basic Science students exposed to treatment?

Table 2: **Mean Achievement Scores and Standard Deviation of Basic Science Students**

Gender	Test Type	N	Mean	SD	Mean Gain Diff
Male	Treatment	12	21.74	5.27	
					2.17
Female	Treatment	18	19.57	3.79	

Table 2 shows the mean scores and standard deviations of male and female Basic Science students exposed to treatment. The difference in the posttest mean scores between male and female students was 2.17 in favor of the male students. This implies that male Basic Science students achieve more than their female counterparts.

Research Question 3: What are the mean retention scores of Basic Science students exposed to good classroom learning environments and their counterparts in the control group?

Table 3: **Mean Difference in the Retention Ability of Basic Science Students in the Experimental Control Groups**

Group	Test Tpye	N	Mean	SD	Mean Gain	Mean Gain Diff
Experimental	posttest	30	44.23	6.62	17.98	
	pretest	30	62.21	10.72		
						5.27
Control	posttest	42	25.46	5.77	12.71	
	pretest	42	38.17	8.54		

Table 3 shows that Basic Science students exposed to training in good classroom environments had pretest and posttest scores of 44.23 6.2.21 with corresponding standard deviations of 6.62 and 10.72 respectively. Basic Science students taught in control with the conventional method had mean pretest and mean posttest scores of 25.46 and 38.17 with corresponding standard deviations of 5.77 and 8.54 respectively. The mean score between the two groups is 5.27. This shows that the experimental group retained more knowledge than their counterparts in the control group.

Research Question 4: What are the mean retention scores of male and female Basic Science students exposed to treatment?

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Table 4: **Mean Retention Scores of Male and Female Basic Science Students Exposed to Treatment**

Gender	Test	N	Mean	SD	Mean Gain Diff
Male	Retention	**10**	25.61	7.11	
					8.15
Control	Retention	20	17.46	4.46	

Table 4 shows the mean retention scores and standard deviations of male and female Basic Science students exposed to treatment. The difference in the posttest mean retention scores between male and female Basic Science students was 8.15 in favor of the male students. This implies that male Basic Science students achieve more than their female counterparts.

Testing the Null Hypotheses

$H0_1$: There is no significant difference in the mean achievement scores of Basic Science students exposed to good classroom learning environments and their counterparts in the control group.

Table 5: Summary of Analysis of Covariance (ANCOVA) of Mean Achievement Scores of Students Taught Basic Science in Good Classroom Environments

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	645.023[a]	2	2004.770	4.688	.005
Intercept	15874.648	1	15874.648	235.567	.000
Pretest	64.769	1	64.769	0.213	.304
Group	16.872	1	16.872	9.439	.000
Error	10329.734	70	62.864		
Total	234370.00	72			

S = significant at P<0.05; df =1, 70

The summary of the result in Table 5 shows that the means of the Basic Science students exposed to training in a good classroom teaching environment with those not exposed to. The result showed good classroom learning environment was a significant factor in Basic science students' achievement was a significant factor on students' achievement in Basic Science for F (1,192) = 9.349, P = .000. The result in Table 5 revealed that the exact probability level (.000) was less than the level of significance of 0.05. This implies that there was a significant statistical difference in the mean achievement scores of the students taught Basic Science concepts in a good classroom environment compared to those in the control group.

H02: There is no significant difference in the mean achievement scores of Basic Science female students exposed to treatment.

Table 6: Summary of Analysis of Covariance (ANCOVA) of Mean Achievement Scores of Male and Female Students Exposed to Treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	162.142[a]	2	86.121	1.6438	.002
Intercept	1782.566	1	1782.566	44.768	.000
Posttest	88.658	1	88.658	1.784	.256
Gender	90. 312	1	90.312	1.896	.002
Error	2091.1241	70	46.761		
Total	115083.247	72			
Corrected Total	2146.400	71			

S= Significant at P<0.05

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Table 6 shows that the result of the ANCOVA test compared the means of the male and female Basic Science. The result revealed that a good classroom environment was a significant factor in male and female students' achievement in Basic Science for F=1.896 at P=.002. The exact P=.002 was less than the level of significance of 0.05. The researchers, therefore, concluded that there was a significant statistical difference in the mean achievement scores of male and female students exposed to treatment.

H03: There is no significant difference in the mean retention scores of Basic Science students exposed to a good classroom learning environment and their counterparts in the control group.

Table 7: Summary of Analysis of Covariance (ANCOVA) of Mean Retention Scores of Students Exposed to Treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	162.142[a]	2	86.121	4.062	.003
Intercept	10526.344	1	10528.344	64.468	.000
Posttest	76.863	1	76.863	2.304	.242
Gender	765.982	1	765.982	64.468	.000
Error	2091.1241	70	46.761		
Total	104700.184	72			
Corrected Total	2146.400	71			

S= Significant at P<0.05

Table 7 shows the summary of the ANCOVA test on male and female Basic Science students. Retention in Basic Science. The result revealed that the noted difference between mean retention scores of male and female students was significant at 0.05 alpha levels. This was because P<0.05 was rejected since F=64.468 at P=.000<0.05. The researchers, therefore, concluded that there was a significant difference in the mean retention scores of male and female Basic Science students exposed to the treatment.

H04: There is no significant difference in the mean retention scores of Basic Science female students exposed to treatment.

Table 8: Summary of Analysis of Covariance (ANCOVA) of Mean Retention Scores of Male and Female Students Exposed to Treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	752.121[a]	2	76.121	1.643	.001
Intercept	182.546	1	1682.496	43.77	.000
Posttest	88.653	1	68.645	1.864	.276
Gender	91. 312	1	10.313	1.696	.000
Error	2291.143	70	56.682		
Total	135083.244	72			
Corrected Total	2245.401	71			

S= Significant at P<0.05

Table 8 shows that the result of the ANCOVA test of retention of male and female Basic Science. The result revealed that a good classroom environment was a significant factor in male and female students' retention in Basic Science for F=1.696 at P=.000. The exact P=.000 was less than the level of significance of 0.05. The researchers, therefore, concluded that there was a significant statistical difference in the mean retention scores of male and female Basic Science students exposed to treatment.

Discussion of Findings

The findings from the study revealed that Basic Science students exposed to treatment had

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higher performance compared to their counterparts who were not exposed to a good classroom environment, hence, hypothesis 1 was rejected. The result revealed that a good classroom environment is a significant factor in students' achievement in Basic Science. This is because the exact probability was less than the level of significance (P<0.05). The researchers, therefore, concluded that there was a statistically significant difference in the mean achievement score of students exposed to a good classroom environment compared to their counterparts in the control group. This finding was in line with Asuai (2013) who had earlier revealed that there was a significant difference in the achievement of students who were exposed to treatment. Also, the findings of Odeh, Oguche, & Ivagher, (2015) observed that school climate, discipline, and physical facilities have a significant influence on the academic achievement of secondary school students. Moreover, Table 2 revealed that the mean difference was in favor of the Basic Science male students than their female counterparts. Also, hypothesis 2 tested revealed that a good classroom environment was a significant factor in male and female students' achievement in Basic Science for F=1.896 at P=.002. The exact P=.002 was less than the level of significance of 0.05. This showed that there was a significant difference in the mean achievement scores of male and female students exposed to treatment. The study was in agreement with the findings of Asuai (2013) and Ani, Obodo, et. al. (2021) who revealed that there was a significant difference in the achievement of male and female students who were exposed to treatment. This result is also, in line with the findings of Malik & Rizvi, (2018) who revealed that involvement, personal relevance, and emphasis on understanding were major predictors contributing to the classroom learning environment and students' academic achievement whereas investigation autonomy' harms students' academic achievement.

The findings from the study revealed that students exposed to treatment had higher retention abilities compared to their counterparts in the control group. The retention mean gain scores difference for the two groups was in favor of the experimental group. The null hypothesis 3 tested revealed that a good classroom environment was a significant factor in students' retention in Basic Science. Thus, the null hypothesis of no significant difference in the mean retention scores of Basic Science students was rejected since P=.000<0.05. Therefore, the study concluded that there was a significant difference in the mean retention scores of Basic Science students exposed to treatment.

Furthermore, the findings in Table 4 revealed that male Basic Science students had higher mean retention scores than female students. The mean difference was in favor of the male Basic Science students. The null hypothesis tested showed that there was a significant difference in students' retention when exposed to treatment. The findings were in agreement with Obodo and Ani (2022) whose findings revealed that Basic Science students who were taught using innovative teaching strategies retained more of the concepts taught than those taught with conventional teaching strategies.

Conclusion

Based on the results and discussions of the findings, the researchers concluded that teaching students in a good classroom environment contributed to the enhancement and improvement of Basic Science students' academic achievement and retention. This was perhaps because the teacher as an individual personality is an important factor in the learning environment as well as creating a favorable teaching and learning milieu that will make the instructional process easy, enthusiastically adaptable, and useful.

Recommendation

The following recommendations were made based on the findings of the study:

1. Low achievers in Basic Science need to be involved more through increased interaction with teachers in the form of makeup classes, tutorial classes, or special coaching.
2. Basic Science teachers should endeavor to teach in a good classroom environment to improve students' performance and retention abilities.

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3. The government and stakeholders should organize seminars and workshops regularly to educate the in-service teachers on the current trends in the teaching and learning process.
4. The government and Basic Science teachers should focus more attention terms of the necessary facilities and pedagogy to enhance students' academic achievement and retention in Basic Science.

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