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THE EFFECT OF INCREASED THERMAL ENVIRONMENT ON SENIOR SECONDARY ONE MALE AND FEMALE STUDENTS' PERFORMANCE TEST IN BIOLOGY

UDEOZO, F. C.
AND
ALFRED, EUNICE
Biology Department
Federal College of Education, Pankshin.

Abstract

A comparative study of the effect of increased thermal environment on male and female students academic performance test in Biology was carried out on thirty randomly selected male (15) and female (15) senior secondary one (SS1) students in Pankshin metropolis. Three research questions and one null hypothesis were raised to guide the investigation. Ten sets of lesson plan were drawn from five Biology sub-topics and used as guide to teach the students biology lessons in the morning (at ideal classroom temperature range of 24 – 25.5°C) and afternoon (at a raised classroom temperature range of 27 – 30°C) for five days. Ten sets of standardized achievement multiple choice objective questions were administered at the end of each lesson period, marked, graded and mean calculated each day for the male and female students, respectively. The hypothesis was tested at 0.05 levels of significance using the Pearson Product Moment Correlation Coefficient (PPMCC) statistical tool. Higher scores were achieved in the morning periods (mean temperature 24.6°C) by both the male and female students, with the females having the better mean score (3.43 > 3.13), indicating that a significant relationship exist between classroom thermal conditions and students' performance. The mean temperature was established as the ideal and most conducive for optimum learning and achievement. Gender analyses of the results however, showed the male students performing better in the afternoon mean test scores than the females at raised classroom temperatures (mean temperature 29.2°C). It was concluded that thermal environments as high as the range of 27 – 30°C is capable of producing physiological effects that decrease work efficiency and output in students, with the male students having higher ability to withstand the effect, leading to better academic performance than the female students.

Key words: Effects of increased thermal environment on students' performance test in

Biology.

INTRODUCTION

Congestion and unsuitably high temperatures are common classroom features in most of our public secondary schools in the localities. The ideal classroom should, otherwise, be as welcoming as a home. Temperature is very important when providing a comfortable environment for learning. Conducive thermal environment will improve students' performance.

The thermal environment of a school is one of the environmental factors which affect, to a certain extent, the teaching – learning process. Educators have known for several decades that there is a close correlation between thermal comfort and students' achievement. Anderson, (2007) had opined that "thermal comfort is not a luxury. It is a physical and mental requirement for effective use of a classroom. Schoolroom discomfort means inattention, restlessness, poor behaviour habits and a minimum of ability to maintain attention to any mental task". He concluded that as temperature increased, achievement and task performance deteriorated, attention span decreased, and students reported greater discomfort, while cooler classrooms created feelings of comfort, activity and productivity.

Researchers (Hattie, 2009 and Anderson, 2007) agreed that an optimal learning environment requires comfortable temperatures. Physical discomfort sends distress messages to the brain, causing the cerebellum (central processor of the brain) to limit the brains normal operations. The electrolytic balance for proper brain functioning comes from water, but as a result of excessive sweating an imbalance is often created which affects the normal brain functions. Alternatively, as the body temperature rises the brain sends out instructions to decrease the muscle tone. Consequently, the students may feel tired and listless, and not able to work as they would have done when the temperature is at optimum level. Not only does performance suffer as a result, but also, the students' feel more of the burden of work. Hajat (2010) identifies dehydration as a common classroom problem that leads to lethargy and impaired learning.

The human body functions optimally at a core body temperature of about 37^{o}C (Hattie, 2009). For the body to maintain this temperature and sustain heat balance, it uses thermoregulatory system processing signals from the hypothalamus in the central nervous system. This regulates the cardiovascular system, kidneys and water content in the intravascular system, interstitial places and the cells by hormones and behavioural response actions, such as removing of clothes and use of fan. Meanwhile, the most important physiological regulatory mechanism for thermoregulation is sweating. With massive sweating, there is dehydration and loss of fluids and salt. Dehydration affects physical and mental performance at losses of as little as 1% (Parson, 2003)

Lower classroom temperatures and improved ventilation have been found to improve learning ability in students. They help students better their performance as much as 10 – 20% (Wargocki and Wyon, 2007). On the other hand, students are easily distracted by the discomfort they experience and, hence not able to fully concentrate on their lessons in high classroom temperatures. Higher temperatures tend to make students feel tired and lethargic as compared to cooler temperatures, which help them stay alert.

It is against this background that the researchers decided to find out if an increased classroom thermal environment (27 – 30^{o}C) will have differential effect on the test score

performance of male and female students in Biology, in view of their relatively different body composition and tolerance to temperature changes. Females tend to have higher percentage of body fat than males. Fat layers insulate the body and prevents loss of heat when the weather is cool. The study also aimed at determining if any relationship exists between classroom temperature and students' performance in biology in Pankshin metropolis. Pankshin is a highly populated sub-urban area in Plateau State of Nigeria with social amenities. The findings will be an addition to the wide search for better teaching and learning environment that will enhance good academic outcomes.

The following questions were raised to guide the investigation:

1. Is there any relationship between classroom thermal environment and students' performance in Biology?
2. Does increased classroom thermal environment have differential effect on Biology test score performance of male and female students?
3. What classroom temperature is most ideal for Biology students' optimum learning achievement?

HYPOTHESIS

There is no significant relationship between classroom thermal environment and students' performance in Biology.

METHODOLOGY

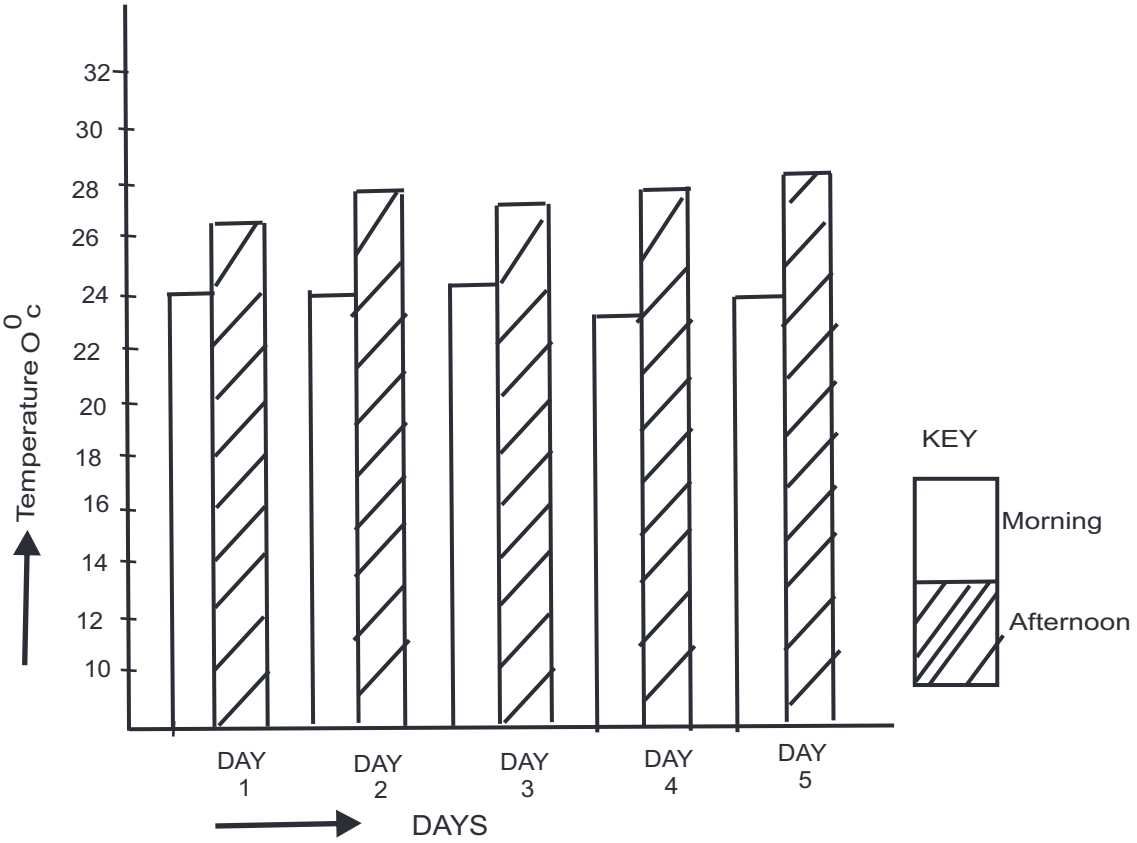
Thirty (30) senior secondary one (SS1) students (15 males and 15 females) were randomly selected and used as the test sample, with a Biology teacher (the researcher). Ten (10) sets of lesson plan were drawn from five sub-topics on "the cell concept" in Biology. Two sets were used each day – one for morning session at the ideal classroom temperature range of 24 – 25.5^{o}C and the other for the afternoon session, under increased classroom temperature range of 27 – 30^{o}C. This procedure was followed for the five days the test lasted.

Ten (10) sets of standardized achievement test questions, which are multiple choice objective questions of equal difficulty on the sub- topics, were drawn from past WAEC questions, 1988 – 2012. Each was used to assess the performance of students at the end of each session on the corresponding topic for the duration of the test.

A thermometer, hung on the wall of the classroom, was used to determine and verify the room temperature at the beginning and end of each session. Hot plates were used to raise the room temperature during the afternoon sessions. Each of the lesson sessions lasted forty (40) minutes. The assessment test questions followed immediately for the next ten (10) minutes. The test scripts were collected, marked and graded by calculating and comparing the mean test scores of the morning and afternoon sessions respectively, for the male and female students. The hypothesis was tested at 0.05 levels of significance using the Pearson Product Moment Correlation Coefficient (PPMCC) statistical procedure. The result is as presented.

RESULTS

FIGURE 1: Graphical representation of the morning and afternoon temperature ranges for the five days test period



The graph shows that the temperature of the classroom for the morning sessions was 24 – 25.5°C, as compared to the afternoon range of temperatures which were raised (27 – 30°C). The morning sessions mean temperature is 24.6°C, while the afternoon sessions mean temperature was 29.2°C.

TABLE 1: Mean test scores in the morning and afternoon sessions

DAYS	MEAN TEST SCORES	
	Morning session	Afternoon session
1	2.9	2.2
2	3.6	2.3
3	3.4	2.7
4	3.0	2.0
5	3.4	3.0

Higher scores were achieved in the morning sessions when the classroom temperatures were within normal range (24 – 25.5°C) as against the afternoons, with the higher temperature range (27 – 30°C).

TABLE 2: Gender analysis of test scores (morning sessions)

SEX	N	Cumulative score	Mean score	Percentage
MALE	15	47	3.13	47.8
FEMALE	15	51.4	3.43	52.2

The female students scored higher in the morning sessions, with a mean score of 3.43 and a percentage score of 52.2, as compared to the mean score of the male students (3.13) and percentage of 47.8.

TABLE 3: Gender analysis of test scores (afternoon sessions)

SEX	N	Cumulative score	Mean score	Percentage
MALE	15	39.4	2.63	50.4
FEMALE	15	38.8	2.59	49.6

The male students performed better than the female students this time, with a mean score of 2.63 (50.4%), as against the female students' mean score of 2.59 (49.6%).

TABLE 4: PPMCC analysis of the morning and afternoon sessions test scores

Session	N	$\bar{x}$	$\propto$	df	rCal.	rCrit.	Decision
Morning	30	3.28	0.05	29	0.56	0.355	Reject H_o
Afternoon		2.61					

From the analysis, the calculated value of r (0.56) is greater than the critical value of r (0.355) at 0.05 levels of significance. The null hypothesis is therefore rejected. Meaning, there is a significant relationship between classroom temperature and students' performance in Biology.

DISCUSSION

The result shows on tables 1 and 4 that as a class, the morning mean test scores were better than the afternoon mean scores, indicating there is a significant relationship between classroom thermal environment and students' performance in Biology. Comparatively, both the male and female students performed better under the mean morning temperature of 24.6°C {males: 3.13 (47.8%) and females: 3.43 (52.2%)}than in the higher mean

afternoon temperature of 29.2°C {males: 2.63 (50.4%) and females: 2.59 (49.6%)}, thus agreeing with the findings of Udeozo and Alfred (2012), Wargocki and Wyon (2007) that increase in air temperature has negative physiological and psychological disposition of the learner, which ultimately affects his/her work and academic performance.

The gender analyses of the results on tables 2 and 3 indicated that the female students performed better at the mean morning temperature (24.6°C) considered ideal for a classroom environment, while the male students were better than the females at higher classroom temperatures. Parson (2003) explained why the males would do better at higher temperatures. He said it may be due to the fact that males have more ability to withstand higher temperatures than females. They (females) have a different body composition that tends to have a higher percentage of body fat, making them more vulnerable at higher temperatures.

The graph shows varying temperatures for the five consecutive days, implying that temperature changes steadily as each day progressed in the course of the investigation. The mean morning temperature of 24.6°C was established as the ideal temperature and most conducive for optimum learning achievement. This is because performance of the students was consistently better under the morning temperatures. Kelly (2007) noted that an ideal thermal classroom environment had an effect on the mental efficiency of the students, especially in situations where students were performing tasks calling for quick response. He thus supported the maintenance of an ideal temperature range for higher achievement, in contrast to a deviate classroom temperature which is considered uncondusive for maximum learning and achievement. This is evident as there was significant difference when students' test scores performances under the morning and afternoon classroom temperatures are compared.

CONCLUSION

High temperatures affect male and female students differently due to body composition. Female students are more vulnerable at high classroom temperatures than male students. Classroom temperatures above 26.6°C produce harmful physiological effects that decrease work efficiency and output of the students. Male students, however tend to have higher ability to withstand the effect of high temperatures in a classroom setting, leading to a better academic performance than the female students.

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