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THE CHALLENGES OF CLASSROOM

TEMPERATURE ON STUDENTS LEARNING.

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ABSTRACT

A good study environment is key to students' academic achievement. Much insight has been gained through scientific studies about the thermal environment of a classroom and its relationship with learning and the students' ability to grasp instruction. An ideal classroom environment has an effect on the mental efficiency of students, especially in situations where students are performing tasks calling for quick recognicion and response. The challenges of the effect of classroom temperature on students' learning was therefore discussed by looking at the concept of temperature and the human body temperature. The growing concern for classroom temperature and the effect of classroom temperature on students' learning were analysed. The physiological implications of deviate classroom temperature on students was viewed before concluding with an advocacy for the need of nechanical units (air condtioning) or proper ventilation in school buildings to improve the thermal environnent of the classroom, and consequently, promote higher students' performance.

INTRODUCTION

Researchers (Wargocki and Wyon, 2007; Moran and Shampiro, 2006) agree that an optimum learning environment requires comfortable temperatures. Physical discomfort sends distress messages to the brain, causing the central processor of the brain (cerebellum) to limit the brains normal operations. According to Hannaford (1995), the electrolytic balance for proper brain funcioning comes from water, but as a result of excessive sweating, students achievement is affected. Dehydration has been identified as a common classroom problem that leads to lethargy and impaired learning, consequently, reduced achievement (Wargocki and Wyon, 2007). The challenges of the efect of temperature on students' learning in the classroom is therefore discussed.

TEMPERATURE

Temperature can be defined as a physical property of matter that quantitatively expresses the common notions of warmth or coldness. Temperature, as distinct from a quantity of heat, may be viewed as a measure of a body, or of heat. Recently, temperature has been defined by Nave (2012) as "the measure of the average translational kinetic energy associated with the disordered microscopic motions of atoms and molecules." He further stated that the flow of heat is from a "high temperature region towards a lower temperature region." This means that temperature is not directly proportional to internal energy since temperature measures only the kinetic energy part of the internal energy. Two objects with the same temperature, according to Nave (2012), do not in general have the same internal energy. The transfer of heat between two objects, or regions, results in mutual thermal equilibrium. This heat transfer can be achieved through conduction or thermal radiation.

In human body system, temperature plays important role in determining thhe rate and extent to which chemical reactions occur This is one reason why the human body has several elaborate mechanisms for maintaining the body temperature at 37- 05"C since temperature Only a few degrees higher can result in harmful reactions with serious Consequences.

FACTORS AFFECTING TEMPERATURE

Hutchinson (2008) presented the following as lactorsS allecting temperature in a environment:

Latitude (Distance from the equator)

This is the major factor affecting global climate - the further you go from the equator the Cooler it gets. This is because the earth is curved, meaning that the sun's energy is more concentrated at the equator. This, and thinner atmosphere at the equator, means that the earth gets hotter here. It implies that schools in the tropics are at risk of having higher temperature since temperature is usually high at lower latitudes.

Altitude (Height)

Temperature decreases by 1'C for every 100 metres increase in altitude. Mountainous areas are therefore cooler. This shows that schools around mountainous areas tend to be cooler because air pressure gets lower as the altitude increases.

Continentality (Distance from the sea)

The sea is cooler than the land in the dry season, but warmer during the cold season. This is because it takes the sea a long time to heat up, but it is slower to cool down than land.

Therefore, schools around water bodies are likely to be cooler in the dry season, but warmer during the cold seasons.

Prevailing Winds and Ocean Currents

The prevailing wind is the direction that the wind blows most often. Winds take on the characteristics of the source region. Ocean currents can be warm or cold and they affect the temperature of coastal areas. Schools around this region are not left out as they experience temperature changes.

THE NORMAL HUMAN BODY TEMPERATURE

The human body temperature 1S a measure of the body's ability to generate and get rid of heat. The body is very good at keeping its temperature within a narrow, safe range in spite of large variations in temperatures outside the body. Normal body temperature (Neormothermia) depends on the part of the body at which the measurement is made, time of the day and level of acivity of the individual. Despite what students are taught, there is no single number that represent a normal temperature for all people under all circumstances. The commonly accepted average core body temperaure is 37C. Variations in body temperature are part of the circadian rhythm. In healthy adults, body temperature fluctuates about 0.5 C (Harrison, 2011) throughout the day Witlh lower temperatures in the morning and evening. This shows that no Person has exactly the same temperature at every moment of the day.

The range for nomal human body temperature is 37-'0.5"C, according to Mackowiak, et al1902), Temperature outside this range may force people to expend energy regulating their internal temperature. Research has been conducted by several scientists on what the normal body temperature should be for optimal activities. Some of the views as shared by Mackowiak, Et al(1992) and Dewdney (1993) are as follows:

"Our findings conflicted with Wunderlich's in that 36,8'C rather than 37C was the mean oral temperature ol our subjects,... 37'C should be abandoned as a concept relevant to clinical thermometry" (Mackowiak, et al 1992).

Dewdney (1993) made bold to say that "for decades it was thought that the normal temperature was 98.6^{O}E.This number was calculated from a study in Germany, which reported normal at 98^{O}E what was not known was that this number was an average rounded to the next degree." In other words, he continued, "it was only accurate to tWo significant digits, not the three we have with 98.6. Scientists today know that normal temperature is actually 98.2- 0.6. That is to say any temperature measurement around 97.6^{O}F should be considered normal." Finally, Shoemaker (1996) commented thus on the issue of body temperature that we all know. In his words, "One popular mean that students all know is the mean normal body temperature of 98.6^{O}F What is surprising is that recent research has posited that the mean normal temperature is really 98.2^{O}E"

Conditions Influencing Body Temperature

Kelly (2006) stated the following as several conditions that are capable of influencing body temperature:

- Temperature varies with the change of seasons during each year;
- Increased physical acivities increases the amount of daily variations in temperature;
- With increased age, both average body temperature and the amount of daily variability in the body temperature tends to increase;
- Temperature increases after eating or drinking anything with calories. Caloric restrictions as for a weight loss diet, reduces overall body temperature;
- Drinking alcohol reduces the amount of daily change, slightly lowering daytime temperatures;
- Exercise raises body temperature, In adults, a noticeable increase usually requires strenuous exercise, or exercise sustained over a significant time. Children develop higher temperatures with milder activities like playing:
- Psychological factors also influence body temperatures: a very excited person often has an elevated temperature,
- Wearing more clothes slows daily temperature changes and raises body temperature;
- Sleep disturbances also affect body temperatures. Normal body temperature drop significantly at a person's normal bedtime. Short-term sleep deprivation appears to reduce temperature;
- The temperature of an environment has, to a great extent, an cffect on people,

THE GROWING CONCERN EOR CLASSROOM TEMPERATURE

Controlling the thermal environment of a school building has been rather a recent development, however, concern over the thermal environment of a classroom is not. As early as 1832, William A. Alcott (in Bryan 1907) wrote an essay on the need for proper ventilation: Holes or windows should be made in the roof of every school house, that the impure air sometimes be suffered to escape in that direction..."

In the essay Alcott expressed the feeling that it is inexcusable to make a child live in poor thermal environment. He puts it this way:

How preposterous and inexcusable would everyone regard it to give them (school children) their food constantly mingled with poison, or their drink with perrnicious and loathsome insects. Yet it

is not less inexcusable to furnish them with halfcorrupted ai.. The food is given but three times a day, while the air is administered every moment. The child is at liberty to receive or reject food, but he is forced to breathe the air in which we place him."

Years later, a great deal of attention was given to providing the proper ventilation in the classroom. In the surge of school buildings that followed World War 1 in the United States of America, much progress was made in improving thermal conditions in the classroom. By 1929. the unit ventilator was the accepted standard. However, unit ventilators were considered too costly to install in school houses. Unit ventilators began to reappear in school houses constructed following World War Il.

Beginning with sixties, a few school buildings were air conditioned; most school buildings being built without complete thermal environment control in America had provisions for adapting the building to air conditioning should the need arise. Parson (2003) said "there appear to be definite trend in educational building towards providing more desirable air condition whenever possible." This trend, he concluded, "'is growing out of a conviction on the part of educators that an atmospheric environment attuned to the students needs pays indirect dividends in the form of better student - teacher relations, greater student satisfaction and comfort and increased student efficiency in learning"

EFFECT OF CLASSROOM TEMPERATURE ON STUDENTS

Mincy (1961), in his dissertation stated as one of his assumptions that the "thermal environment of a school is one e of the environmental factors which affects, 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' academic performance. Parson (2003) after advising the maintenance of a proper classroom thermal condition for comfort, health and efficiency quoted Charles D. Gibson of California: "Thermal comfort is not a luxury. It is a physical and mental requirenment 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"

In spite of research findings, unsuitably high temperatures are still common in classrooms, whereas a classroom should be as welcoming and comfortable as a home. Temperature is very important when providing a comfortable environment for learning. The human organism is highly adaptive, but a student cannot attend, perceive or process information easily when his thermal environment is uncomfortable. Parson (2003) again, quoted John Lyon's statement: "we know that young people learn better when environmental conditions are right for them."

Many writings in educational publications implied that an ideal thermal environment would improve students' achievement. One of such is Hurst (2005), which reviews the adaptive thermal comfort model, then applied and compared it with the performance of conventional thermal comfort or a school. Measurement data, combined with building thermal response numerical

model were used to define the comfort performance under ambient natural ventilation and passive conditions for various classrooms. Hurst (2005) discovered that students in an ideal thermal environment made significantly few errors on tasks, and required less time to complete tasks than students in regularly controlled thermal environment. Greater gains in academic achievement of students in climate controlled schools as opposed to non-climate controlled schools was reported by Kjellstrom (2009). He later 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.

PHYSIOLOGICAL IMPLICATIONS OF CLASSROOM TEMPERATURE ON STUDENTS

Temperature directly infl uences the rate of all physiological reactions in humans; cooler temperatures then translate to improved learning and increased achievement as a result of physiological arousal in the students (Wargocki and Wyon, 2007).Health impacts related to temperature change have been given increasing attention in recent years. Negative impacts of heat exposure on human health and performance have been known for several decades. Heat exposure can affect physical and mental capacity and can lead to heat exhaustion in extreme case (Hajat, 2010). The main factor underlying these effects is an increase in core body temperature (hypothermia), according to Hajat (2010). When body temperature exceeds 39'C, acute heat disorders may occur. Above 40 C, life threatening severe hyperpyrexia starts to occur, and can lead to death (WH0, 2010). The human body functions and performs optimally at a core body temperature of about 37C. For the body to maintain this temperature and sustain heat balance. Kjellsrom (2009) rightly observed that it uses thermoregulatory system processing signals from the hypothalamus in the central nervous system annd then regulates the cardiovascular system, kidneys and water content in the intravascular system, intersitial spaces, and cells by hormones and behavioural response actions, such as removing clothes. Six factors affect the need for thermoregulation, as pointed out by Hajat (2010). These are ambient air temperature, radiant temperature, air humidity air movement (wind speed), clothing and metabolic heat generated by physical activity. The most important physiological regulatory mechanism or thermoregulation is sweating. With massive sweating there is dehydration and loss of fluids and salts. Dehydration affects physical and mental l performance at losses ofas little as 1% (VWargocki, et cal 2007).

Studies carried out in climate chambers and actual classroons found achievement in school children to be poorer with temperature of 27 -30'C (Fisk and Seppanen, 2005) Negative effect of increase in temperature on health and achievement was observed by Wargocki and Wyon (2007). Fisk and Seppanen (2005) added that increased temperatures and low Outdoor air supply rates can also cause "'sick building syndrome" symptoms such as headaches, difficulty in concentrating, fatigue and lethargy. As climate changes bring increase in temperature, these problems decrease mental performance, and attendance to school may also be affected by high temperatures in schools. Higher temperatures can cause malfunction of body systems (Hajat,

2010) and vulnerability to heat is linked to intrinsic changes in the regulatory system (WHO,2010).

THE NEED FOR MECHANICAL UNIT (AIR CONDITIONING) IN SCHOOL BUILDINGS

The 2008 edition of the American National Council on Schoolhouse Construction contained information that spelt out an ideal schoolhouse thermal environment and the necessity for such an environment. This was informed by the sudden realisation that an optimum thermal condition at which most students are at their greatest efficiency is the object of a good thermal environment.

The general optimum ranges suggested are:

ü Balanced mean radiant temperature;

ü Approximate air temperatures ranging from 69 to 74% temperature gradient;

ü Relative humidity between 40 to 60% RH;

ü Air movement of 20 to 40 cubic feet per minute.

Sharing the view for an ideal schoolhouse thermal environment, one of the nation's largest manufacturers of heating and air conditioning equipment reported in its literature that students will profit greatly from an ideal thermal environment. According to the report titled 'heat stress and heat disorders', students experience roughly a two percent reduction in learning ability tor every degree the room tenmperature rnse above the optimum. Thus, for maximum learning efficiency itis essential that adequate cooling...be provided in the classroom.

A preponderance of writers used the term'air conditioning' to mean the regulation of the thermal environment. The American Association of Heating, Refrigeration and Air Engineers according to Kiellstrom (2009), defined it as "the process of treating air so as to control simultaneously its temperature, humidity, cleanliness and distribution to meet the requirements of the condiioned space. Although it may be true that many people associated the phrase air coditioning with the cooling of air, it is more than the cooling of air.

Many witers (Quinn, 1990; and Wargocki and Wyon, 2006) in the professional educational field agreed that a controlled thermal environment will improve learning. Quinn (1990) contnibuted with the following statement on the need for air conditioning. He said “Teachers have remarked: people laugh and say that the air conditioned school is for the benefit teachers, but we say it is for the benefit of education. Children used to be hot, tired, and soaked inperspiration; now they are alert and attentive all day."

Air conditioning s real value in schoolhouse building is in terms of educational productivity. Two articles implying that a positive relationship exist between the thermal environment of a

classroom and students achievement by Fisk and Sepannen (2005) and Wargocia and Wyon (2006) in their publications wrote about this relationship, respectively. Fisk and Sepannen explained that "the application of air conditioning is an obvious and important aspect of human comfort in school buildings. Air condition is mainly concerned with the correction of abnormal atmosphere and the consequent promotion of comfort, health and efiiciency Wargocka and Wyon, on their part, observed that air condition was being purchased because it provides better learning conditions. They stated that "air conditioning of educational buildings at the elermentary, secondary and college level is proceeding at a pace educators, architects and taxpayers would have thought preposterous five years ago. Basically, air condition is being purchased it provides better teaching- learning conditions."

The provision of mechanical unit /air conditioning in the classroom has its own problems. Two major challenges still seem to stand on the way of the universal provision of school air conditioning First, neither all educators nor all architects have fully accepted the availability and financial practicability of systemns controlling high temperature. Second, board of education, trustees and lay citizens are still fully unaware that air conditioning brings actual Increase in building use and educational effectiveness. This calls for awareness programme that will enlighten all stakeholders and lay citizens on the educational benefits of mechanical units and increasing ciassroosn ventilation to achieve the ideal thermal environment in classrooms for opimum achievement of the poals of teaching and learning.

CONCUSION

Learning takes place in a physical environment which changes with perceptible

quantifiable characteristics, Whether sitting in a large classroom, underneath a tree or in front of a Computer screen, students are still engrossed in environmental factors, And, while we cannot control the whims of weather, we can control the conditions inside our classroom to provide more Confortable earning environment Hajat (2010) concluded it this way: authorities the prie consderations in maintaining an optimal thermal environment" It is therefore recommended that desirable thermal conditions should be maintained in the classroom so that the child i would be less distracted by the conditions surrounding him.

RECOMMENDATION

School administrators and various stakeholders in education can put the following control systems in place to: achieve thermal comfort for students in t the classroom: Administrative Control: This includes planning and rescheduling of lesson periods, practical and break schedules. For example, scheduling brain-tasking lessons for cooler times of the day, or giving students s flexible hours to help avoid the worst effects of studying in high temperatures. Engineering Control: this should be the first choice to reduce or eliminate the hazard of high temperatures. Although the initial cost of engineering control may şeem high, it has been found

that implementation cost is often masked by the resulting improvement in production reduced students' failure and increased achievement.

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