Determination of the Influence of Thermal Comfort in Care and Concentration of Media Education Students: Case Colombia

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Abstract

Objectives: This research was conducted in order to determine the influence of thermal comfort, as measured by the index of temperature Wet bulb globe temperature (WBGT), the Global Attention and Perception Index (GIFS) of high school students from a school in Barranquilla, Colombia. Methods/Statistical Analysis: For this, an experimental design was performed, in which the variable peck response was the GIFS, the potential factor was the WBGT, whose levels were the records under different environmental conditions, and the disturbing factor controllable was “student”, this last it was blocked to minimize variability that this could introduce in response, thus obtaining a completely random model blocks. Subsequently, a group of tenth and eleventh grade other selected, subjected to different environmental conditions for 6 days, in which we applied the Toulouse-Pieron test, to measure attention and concentration; and a survey based on the McIntyre scale to evaluate thermal satisfaction, while thermal comfort was measured using a heat stress monitor. Findings: The collected data were processed statistically using analysis of variance, to see if there were differences between levels, and if the data came from a normal distribution, correlation analysis to determine the influence of WBGT factor in the response variable GIFS and descriptive techniques as bar charts, box and whisker plot, among others, which allowed characterizing the information and identify trends. Application/Improvements: The results showed values of WBGT index mostly within the TLV’s; an inverse strong correlation of 90% between the two variables for the sample taken from tenth grade and a moderately strong relationship of 64.9% for eleventh grade, showing greater influence of environmental conditions on the rate of attention and concentration and thermal student satisfaction in the first group compared to the second, who apparently are less sensitive to these.

Keywords: Thermal Comfort, Index of Attention and Concentration, McIntyre Scale

1. Introduction

In Colombia there regulations in force on the specifica-
tions to be followed for the construction of schools, where the thermal comfort associated with the ventilation and solar radiation is included, however, few studies conducted to confirm that the provisions of these rules really appropriate that the construction of classrooms provide thermal comfort and this has some influence on the process of attention and concentration, linked with learning, ultimate goal of education.

2. Theoretical Foundation

Thermal comfort, according to environmental psychology influences the proc that teaching and learning—but
little is taken into account when evaluating the results of the latter. However, the importance of his analysis lies in the reality of the phenomenon of global warming, which has increased the average global temperature event that can produce negative effects on attention and concentration of students of educational institutions located in cities with high temperatures. An example of the latter is Barranquilla, whose TERMIC sensation has reached the end of 48°C, under which those schools that lack air conditioning systems, normally have had to develop their academic activities, being possible because of their habituation to extreme conditions or unfavorable.

One of the few research on assessments of thermal comfort, is conducted in 2014 by the Inter-American Development Bank (IDB) evaluating comfort conditions in schools from six countries, including those Colombia, to determine if favored correct or learning development. The results showed that in Barranquilla students have some degree of body habituation to critical conditions, at which suggested specific studies to verify the actual situation of thermal comfort or to adapt existing regulations. Hence the focus and relevance of this research, which can be supported by strong views on what from the thermal point of view is comfortable, and it really is very difficult to develop the teaching-learning effectively under conditions thermal discomfort, considering that students remain in their schools seven hours more lucid and active in its day, so it is vital that the halls meet all the requirements for the service, encouraging learning and integral form thereof.

From the above, this research arises because of the need to determine how thermal comfort influences the development of attention and concentration, conducting studies to obtain answers to these questions, so considered necessary that this constitutes a contribution for further research to try to improve the environmental conditions in which carried out the teaching-learning process, taking into COUNT c high temperatures, that are occurring in the city of Barranquilla, whose main beneficiaries will be the students themselves.

3. Methodology

Phase 1. Literature Review
The review of the literature relating to thermal comfort, concentration and attention was made, allowing define the WBGT index, according to Colombian law, to evaluate thermal satisfaction, and select the Toulouse-Pieron test to measure attention and concentration of students.

Phase 2. Planning and Implementation of Experimental Design
This phase consists of 3 stages, namely:
- Selection of response variable factors, levels and model of experimental design
  It was selected as a variable response to GIFS, measured by Toulouse-Pieron test. The selected potential factor was the WBGT measured by the heat stress monitor, whose levels were monitor records under the environmental conditions that could be obtained using the elements present in the classroom. The disturbing factor controllable corresponded to students, why he decided to crash, allowing select the model for randomized complete block design.
- Planning of experimental design
  The experimental units, a group of 10, and another 11° using convenience sampling, according to the disciplinary criteria were selected. In addition, four rooms, two heated and two corresponding to their regular classrooms with openwork and fans were chosen, trying to be as similar as possible to minimize the influence of other variables.
  In addition to the above, variations Toulouse-Pieron test were made, respecting your design criteria to avoid the learning curve and improve every day a new challenge.
- Realization of experimental design
  A pilot test in order to validate the survey based on the 3-point scale McIntyre to evaluate thermal student satisfaction by answering the question perception was applied: If you could change the environmental conditions of the place in which you placed the previous test, how would you like to go? Whereupon they had three response options: “Fresher”, “Do not you change” or “Colder”.

Monitor thermal stress, QUESTemp 15 ys started and took three measurements at each elevation and found that the variation was less than 5% in each reading taken, therefore, in the following measurements the measurement was taken at the height of the abdomen, since it could be assumed that the temperature of the place was homogeneous.

After all the above, we proceeded to develop the process of taking measurements for 6 days at week 1 courses were working in their regular classrooms and
in the next, each was in an air-conditioned lounge. Each measurement took 20 minutes for each grade, distributed as follows: 3 minutes stabilization of heat stress monitor, 5 minute explanation of the test, applying the test 10 minutes and two minutes performing the thermal satisfaction survey. 5 measurements were taken at a frequency of 3 minutes between measurements, during the explanation and application testing.

Phase 3. Processing and Analysis of Information Collected

The information collected was analyzed using tools of inferential statistics such as analysis of variance and Friedman test and descriptive, as measures of central tendency, so, variability, graphic box and whisker, histograms, among others, they provide Minitab, Statgraphics and Infostat software to compare interest groups (tenth and eleventh grade), identify trends, analyze deviations and the correlation between WBGT and GIFS. In addition, this information was compared with the permissible limit values ACGIH (American Conference of Governmental Industrial Hygienists) guidelines under which it was oriented this investigation.

4. Results And Discussion

In this section only for ten grade data show.

Evaluation of Thermal Comfort

In Figure 1, it is observed that the values obtained for the WBGT during different environmental conditions are mostly p or below the limit of action. The two values of higher WBGT, 29.51°C and 29.43°C, are among the TLV’s and the limits of action.

![Figure 1. Limits TLV versus action tenth grade.](image)

Inferential Statistical Analysis

It developed the analysis of variance to describe the impact of factors, student and WBGT in the dependent variable or response, GIFS, and check the differences between each environmental condition, especially in those where WBGT critics were recorded, which could influence the rate of students attention. Also, to know whether there were differences (in terms of average) in response or reaction with the experimental units to different treatments with a certain factor using analysis of variance, all of which can be seen in Table 1. In this It shows that P-values, which test the statistical significance of each of the factors are less than 0.05, therefore, it can be said that these have a statistically significant effect on the dependent variable to 95.0% of confidence level and that the null hypothesis that the means are equal, cannot be accepted.

Correlation Analysis

To assess the association of the two variables of interest, WBGT as an independent variable, and GIFS as a dependent variable, the correlation method was used, initially checking the prerequisite that the variables had a normal

| Source     | Sum square | Gi | Square means | Reason-F | P-valor |
|------------|------------|----|--------------|----------|---------|
| Main effects |            |    |              |          |         |
| A:wbgt     | 552093     | 5  | 110419       | 26,25    | 0,0000  |
| B:students | 165849     | 14 | 11846,3      | 2,82     | 0,0022  |
| Waste      | 294434     | 70 | 4206,2       |          |         |
| Total corrected | 1,01238E6 | 89 |              |          |         |
distribution, through the Shapiro-Wilk test appropriate for small samples.

The model that best represents the behavior of WBGT, for students of this group is the square of WBGT, whose relationship is described by the equation of the fitted model:

\[ \text{GIFS}_{\text{ten grade}} = (597.846) - 0.48642 \times \left( \text{WBGT}_{\text{ten grade}} \right)^2 \] (1)

The statistical coefficient of determination indicates that the adjusted model explains 81.49% of the variability in GIFS of sophomores, plus the correlation coefficient equal to -0.90273 shows a relatively strong inverse relationship between the variables.

**WBGT Influence on the Results of GIFS**

According to the inferential analysis and correlation, descriptive behavior GIFS was analyzed for each sophomore under the most different environmental conditions recorded during the measurement of WBGT index in order to identify whether changes were presented significant changes in their values. Figure 2 shows the results of GIFS per student during critical WBGT values, which were 29.51°C and 22.74°C.

![Figure 2](image)

Figure 2. GIFS for each student in extreme environmental conditions.

According to the bar chart shown in Figure 2, the GIFS increases to 100% of students as there is a decrease in the value of WBGT index.

**Influence of Thermal Satisfaction in the Results of GIFS**

Since the WBGT only measures environmental conditions and does not consider the subjectivity of thermal comfort, it is essential to analyze whether the thermal satisfaction sophomores have any specific behavior with respect to WBGT. For this, face the question: If you could change the environmental conditions of the place where you did the test, how would you like to be? “Freshest”, “Do not you change”, “Colder”, the percentage of satisfied and dissatisfied for each daily record of WBGT is calculated satisfied considering respondents would not change the environmental conditions and dissatisfied that marked that they wanted a cooler or warmer conditions.

From the graph 3 it shows that for tenth grade, the percentage of satisfied so increases inversely proportional to the WBGT, running a percentage of 12.5% satisfied and 91.67%.

![Figure 3](image)

Figure 3. Percentage of students satisfied and dissatisfied with environmental conditions.

**5. Conclusion**

- Analyze through inferential statistics the influence of thermal comfort care index, using a complete block design randomized allowed to know the differences that existed between treatments (environmental conditions), establishing the most critical WBGT for tenth grade 22.74°C and 29.51°C and eleventh grade of 24.06°C and 28.08°C. In addition, this made it possible to use analysis of variance confirm the effect of WBGT factor in the GIFS, showing that for the tenth grade WBGT represents 56.0774% of the total variation in GIFS, but for the eleven most important factor contributing to the STUDENT variance, representing 100% of the total variation in GIFS.
- Measure the rate of attention and concentration of students under different environmental conditions allowed to identify that while lower the values of the WBGT index, the higher the rates of attention to tenth
grade, whose group GIFS average (197.6) increases more than doubled (383.4), to lead students WBGT value higher, corresponding to 29.5°C to the lowest, which was 22.7°C. However, this did not happen in eleventh grade, group in which the values of GIFS, decrease of 313.267 in the condition of high WBGT (29.43°C) to 270.067 in conditions of low WBGT (28.08°C), showing a less strong relationship between these variables.

- Statistically analyze the relationship between WBGT and GIFS index through a correlation analysis using simple regression, allowed to identify that there is an inverse relationship between these variables, being stronger for the tenth grade whose adjusted model corresponds to Square IBUTG with a correlation coefficient of -0.90 and R² indicating that the model explains 81.40% of the variability of GIFS. For eleventh grade, the adjusted model is GIFS Inverse Square WBGT and throws coefficients indicating a less strong relationship between these variables, with an R² of 42.12% and a correlation coefficient of 0.64.

- Evaluate the thermal sensation through the survey McIntyre 3 points, identified that the lower is the value of WBGT index there is an increase in satisfaction sophomores, obtaining a 12.5% satisfaction for WBGT condition 29.5°C, and increasing it to 91.67%, in the condition of WBGT 22.74°C, which is evident in GIFS values much higher during this condition. The same occurs for students of eleventh that despite seem less sensitive to changes in environmental conditions in terms of values GIFS, thermal percentages of satisfaction for the critical conditions of WBGT registered starts with 7.69% for WBGT condition 29, 43°C and ends up being 92.31%, on the condition WBGT 24.06°C, except for some variations on different days in which the values do not follow this same behavior.

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