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A study on the impact of optimal design of university accommodation environment on the enhancement of college students' psychological health and academic performance

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Abstract Dormitory as an important activity place of campus life, the quality of its indoor thermal environment, and the diversity of its functions are directly related to students' learning efficiency as well as physiological and psychological health. In this paper, starting from the demand for indoor thermal comfort in student dormitories, we studied human thermal comfort, as well as the way and principle of heat exchange between the human body and the outside world, and put forward six parameters affecting the thermal comfort of the human body. A design strategy based on passive retrofit thermal storage roofing, as well as spatial layout co-optimisation is conceived to jointly enhance the indoor thermal comfort of dormitories, and to improve the psychological health and academic performance of university students. A real-life laboratory experiment was conducted to explore the effects of the thermal environment of the dormitory on college students' mental health under the optimal design from the perspective of built environment science. Quantitative and objective evaluations were conducted to assess the effects of indoor thermal environment on students' academic performance and academic performance. It was found that under the optimised accommodation environment, the thermo-neutral temperature of university students was 22.78℃. Both academic performance and academic achievement reached their maximum values at 24℃, which significantly improved the academic performance of college students. The maximum value of the psychological health index of university students was measured to be 3.05, and the minimum value was -1.60, which were within the limit values of the indoor thermal comfort model of the dormitory, indicating that the psychological health level of students was improved in the optimised accommodation environment.

Index Terms thermal environment, student dormitory design, thermal comfort, passive retrofit, thermal storage roofs

I. Introduction

The importance of the university accommodation environment for college students plays a crucial role in the whole college life. The residential environment is not only a place for students to study and rest, but also a platform to promote communication and cooperation among students. Through the residential environment, students can develop management ability and sense of responsibility, and learn to take care of themselves and others [1]-[4]. At the same time, the residential environment is also an important place to influence students' psychological health and academic performance as well as their social interaction ability, so that students can learn to get along and communicate with students from different backgrounds. Since the accommodation environment has an important impact on college students, a reasonable and optimal design of the accommodation environment is crucial to the development of college students [5]-[8].

The design of accommodation environment in colleges and universities needs to do the following in order to achieve optimisation: 1. Upgrading of hardware facilities: update the obsolete facilities, such as replacing the beds, tables, chairs, wardrobes and other furniture, to improve the level of hardware facilities in the dormitory. At the same time, increase the necessary public facilities, such as washing machines, water heaters, etc., to facilitate students' life.2. Space layout optimisation: rational planning of the space layout of the dormitory, giving full consideration to the living habits and needs of students [9]-[12]. For example, study area, rest area, storage area and other functional areas can be set up to make the dormitory space more humane and practical. In addition, environmental hygiene improvement, cultural construction and so on are also used a way to optimise the accommodation environment of colleges and universities [13]-[16]. Only by optimising the accommodation environment and creating a good dormitory environment can we provide healthy, safe and comfortable living conditions, which is conducive to the promotion of students' mental health and academic performance and overall development [17]-[19].

Currently, the design of indoor environments in educational buildings only considers human thermal comfort and does not take other factors into account. The innovation of this paper lies in the introduction of the concept of human thermal comfort, using temperature as a medium to link the mental health, academic performance and thermal comfort of college students. Based on the human thermal comfort model, passive renovation, functional layout space optimisation and structural optimisation are integrated to form an optimal design strategy to improve the indoor thermal environment and functionality of the dormitory. Weighing the temperature requirements of mental health and academic performance, we propose a reasonable range of recommended temperature values for the dormitory environment in colleges and universities. Finally, the effect of the optimised accommodation environment on students' mental health and academic performance is examined through experiments.

II. Thermal comfort of university accommodation

II. A. Human Thermal Comfort

The heat balance equation proposed by the theory that the body produces and dissipates heat equally in order to maintain a normal body temperature can be expressed by the following thermodynamic equation [20]:

$$M-W-R-C-E-S=0 \tag{1}$$

where, S - heat storage capacity, $\mathrm{W/m^2}$, M - metabolic rate of the body, $\mathrm{W/m^2}$, W - mechanical work, $\mathrm{W/m^2}$, E - evaporative heat, $\mathrm{W/m^2}$, C - body convective heat transfer, $\mathrm{W/m^2}$, R - human body radiant heat transfer, $\mathrm{W/m^2}$.

The above equation shows that it is not a single factor but a combination of multiple factors that affects the indoor thermal environment of a building, and the factors are complementary to each other, so if you want to achieve the same comfort, you can change the temperature and humidity, and also increase or decrease the amount of exercise to achieve the same effect.

Overall, when $\Delta S>0$ the body temperature increases, the body feels hot, and when $\Delta S<0$ the body temperature decreases, the body feels cold. With the depth of the study, in order to improve the accuracy of the equation, the heat balance equation of the human body is derived based on three necessary premises: the state of thermal equilibrium, the average skin temperature of the human body should be in a comfortable temperature range and the evaporation rate of sweat should also be in a comfortable evaporation range. When the human body is in a comfortable steady state condition, the energy balance equation is:

$$\begin{aligned}(M-W) &= f_{cl}h_c(t_{cl}-t_a)+3.96\times10^{-8} f_{cl}\left[(t_{cl}+273)^4-(t_r+273)^4\right]\\ &+3.05\left[5.733-0.007(M-W)-p_a\right]+0.42(M-W-58.2)\\ &+0.0173M(5.876-p_a)+0.0014M(34-t_a)\end{aligned} \tag{2}$$

where, M - the metabolic rate of the body, which determines the amount of activity of the body, $\mathrm{W/m^2}$, W - mechanical work of the body, $\mathrm{W/m^2}$, f_{cl} - clothing area coefficient, h_c - convective heat transfer coefficient, $\mathrm{W/(m^2\cdot{}^\circ C)}$, t_{cl} - Clothing outer surface temperature, $^\circ\mathrm{C}$, t_a - Ambient air temperature, $^\circ\mathrm{C}$, p_a - Ambient water vapour partial pressure, kPa.

II. B. Factors affecting thermal comfort

The factors affecting human thermal comfort contain the influence of 6 parameters, namely 4 environmental parameters, namely air temperature, air relative humidity, radiant temperature and airflow velocity, and 2 human factors, namely human metabolic rate and clothing thermal resistance [21].

II. B. 1) Environmental factors

(1) Air temperature

Air temperature is most important for human comfort, indoor air temperature is a comprehensive reflection of indoor convection heat transfer, radiation heat transfer and heat transfer. In the early days, no matter whether single factor (temperature) or multi-factor (effective temperature, heat stress index, expected heat sensation index) was used as the evaluation index for the thermal environment, the temperature was an important measurement value, and it was also an important judgement factor for the energy-saving or not of the building.

According to relevant studies, the optimum temperature in a dormitory is 20℃-25℃. In an artificial environment, it is generally controlled at 18℃-22℃ in winter and 24℃-28℃ in summer.

(2) Relative Humidity

The relative humidity of the air characterises the amount of water vapour contained in the air at a certain temperature, which is close to the degree of saturation, and is related to the temperature and affects the heat dissipation of people.

It is generally believed that the optimum relative humidity of 50% -60%. China's residential and public building code, the relative humidity of the recommended value of 40% -60% in summer, winter does not provide.

(3) Air velocity

Wind speed also affects the body's convective heat loss and moisture evaporation heat loss, is to improve indoor air quality, adjust the indoor thermal comfort of an effective method. Comfortable wind speed can be determined according to the indoor temperature to determine the range, in general, less than 0.3m / s of the wind speed of the college dormitory thermal comfort regulation has a good role.

(4) The average radiation temperature of the wall surface

The radiation temperature of the wall surface is also a reference factor in building design, measuring the thermal performance of the building, energy-saving design. In the 'Thermal Design Code for Civil Buildings', using the room enclosure internal surface temperature to measure the value.

II. B. 2) Environmental effects on thermal comfort

Radiation, convection, evaporation and heat conduction are the main modes of heat transfer between the human body and its surroundings when it is in a state of thermal comfort. According to the research, in the process of external heat transfer of the human body, radiation heat transfer is the largest proportion of the three major external heat transfer, about 45% to 50% of the total heat transfer, which is calculated by the formula [22]:

$$R = \varepsilon\sigma f_{eff} f_{cl}\left[(t_{cl}+273)^4-(t_r+273)^4\right] \tag{3}$$

where, R - the amount of radiant heat transfer, $\mathrm{W/m^2}$, f_{cl} - Clothing area coefficient, t_{cl} - surface temperature of the garment, $^\circ\mathrm{C}$, t_r - average radiant temperature, $^\circ\mathrm{C}$, f_{eff} - correction coefficient for the influence of the body posture on the effective surface area, σ - Stephen Boltzmann's constant; for $5.67\times 10-8W/(m^2\cdot K4)$, ε - human body surface emissivity.

The amount of radiant heat transfer depends mainly on the temperature difference between the human body surface and the ambient object, the relative position, the effective radiant area, as well as the reflection and absorption coefficients of the skin and clothes, independently of the atmospheric pressure.

In terms of convective heat transfer, based on the theory of fluid mechanics, it can be seen that the pressure is closely related to the density, the atmospheric pressure decreases, the volume of gas increases, and the density of air becomes smaller, which indicates that there is an inevitable connection between air pressure and convective heat transfer. The relationship between the convective heat transfer coefficient and pressure is derived by substituting the convective heat transfer formula:

$$C = \frac{f_{cl}\times h_{c,o}\left(\frac{P_p}{P_0}\right)^{0.55}\left(t_{sk}-t_a\right)}{f_{cl}\times h_{c,o}\left(\frac{P_p}{P_0}\right)^{0.55}R_{cl}+1} \tag{4}$$

where, $h_{c,o}$ - evaporative heat transfer coefficient at atmospheric pressure $\mathrm{W/(m^2\cdot K)}$, R_{cl} - garment thermal resistance, $\mathrm{W/(m^2\cdot K)}$, f_{cl} - Garment area coefficient, t_{sk} - skin temperature, $^\circ\mathrm{C}$, t_a - room air temperature, $^\circ\mathrm{C}$, p_o - Standard atmospheric pressure, kPa, p_p - Actual atmospheric pressure, kPa.

From the above equation, it can be seen that the atmospheric pressure directly affects the convective heat transfer coefficient and the amount of convective heat transfer, both of which decrease with the decrease of atmospheric pressure.

Similarly, evaporation is also one of the ways for the body to dissipate heat externally, and evaporative heat transfer is also affected by atmospheric pressure. Converting the formula for the convective heat transfer coefficient with the Lewis number atmospheric pressure relation equation, it can be obtained:

$$h_{e,p} = h_{c,p}\times Le_p = h_{c,o}\times\left(\frac{p_p}{p_o}\right)^{0.55}\times L_{eo}\times\left(\frac{p_o}{p_p}\right) = 16.5\times h_{c,o}\left(\frac{p_o}{p_p}\right)^{0.45} \tag{5}$$

where, $h_{c,o}$ - evaporative heat transfer coefficient at atmospheric pressure, $\mathrm{W/(m^2\cdot K)}$, $h_{e,p}$ - evaporative heat transfer coefficient at low pressure, $\mathrm{W/(m^2\cdot K)}$, $h_{c,p}$ - is the convective heat transfer coefficient in low pressure environment, L_{eo} - is the Lewis number at sea level, L_{ep} - is the Lewis number at any altitude, $W/(m^2 \cdot K)$.

As can be seen from the above formula, the evaporative heat transfer coefficient increases with the reduction of atmospheric pressure, evaporative heat dissipation due to the evaporative heat transfer coefficient is proportional to the relationship between the evaporative heat dissipation coefficient will also increase with the reduction of pressure.

III. Optimising the design of university accommodation

This chapter is based on the human thermal comfort model and gives the corresponding optimisation strategies to optimise the indoor thermal environment of college dormitories to enhance the psychological health and academic performance of college students.

III. A. Optimised design options for dormitory units

This paper takes the student dormitory of Z university as a research case, and through the field research, it can be seen that the student dormitory of this university has three main problems in function:

(1) Lack of public space to meet students' needs such as interaction.

(2) Lack of or inconvenience to the necessary basic living functions.

(3) Poor thermal environment.

Taking the above three problems as the starting point, on the basis of the theory of built environment, the dormitory plan space and passive retrofit technology are synergistically optimised.

The house type design of the dormitory unit is shown in Figure 1, which is symmetrical, with the more private living space containing sleeping and bathing functions on both sides, and the public interaction and study space in the middle, and the unit scale is 8.2m*10.5m, which is in line with the modal scale. The intersection of the two living spaces is set up as a public interaction space, which can be used for group gatherings and studies. On the south side, a sunroom with solar passive transformation technology is installed, and the floor and partition walls are paved with heat storage material, which meets the function of drying clothes, which was lacking in the existing dormitory researched before, and at the same time, an activity space is also installed in the middle, which can be used for social activities and sports.

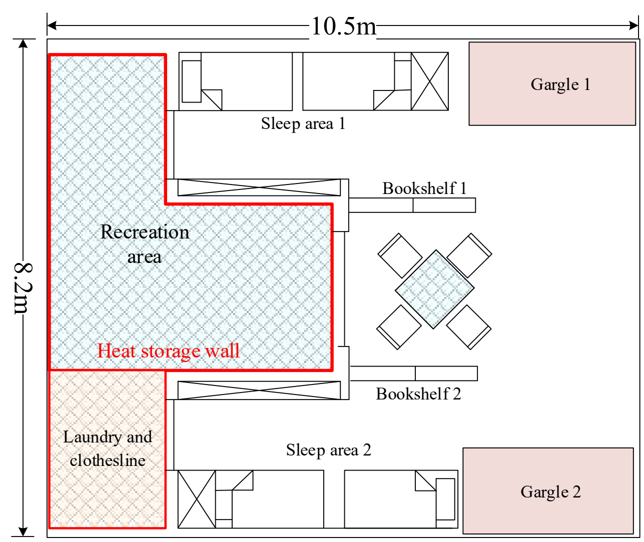


Figure 1: Design of student dormitory unit

For living units with rooms on the top floor, in addition to the addition of a solar passive sunroom, a passive solar thermal storage roof is also added to the top. Solar passive conditioning sunrooms and thermal storage roofs for the purpose of enhancing the heat gain of the building, smoothing the indoor thermal environment, and weakening the variability of each room.

III. B. Application of passive technologies

Solar radiation heat is the most important heat source of the autumn college dormitory in the area where Z-school is located, using passive solar technology, through the design of structural form and then the optimisation of the layout of the plan, maximising the use of the material's heat-absorbing and exothermic properties of absorption, storage during the daytime, and night-time regulation of the distribution of solar radiation energy. And then make full use of its construction form, feedback optimisation of building functional space, in the case of no additional other heating equipment and heating, from the thermal environment and building space to enhance the indoor environment of the student dormitory in autumn in all aspects.

The heat storage wall is used to divide the dormitory space into two parts: living space and sun room, and the sun room is used as a buffer space for heat regulation and at the same time, the plane function is designed as an area for drying clothes and public interaction in the student dormitory. At the same time, the windows are set up with thermal insulation material electric roller blinds, to solve the daytime need for the window opening to get hot at night need thermal insulation time-sharing problem. The advantages of this approach are mainly the following six points:

(1) The heat storage wall and floor in the daytime sunroom can fully collect and store the solar radiation energy brought by the sunlight through the glass windows.

(2) It can effectively reduce the glare of the dormitory's living function space.

(3) The sunroom space after sunset can be used as a buffer space to slow down the heat exchange between the main living function space and the outdoor directly.

(4) While acting as a buffer space, the heat storage component continues to provide heat to the living space;

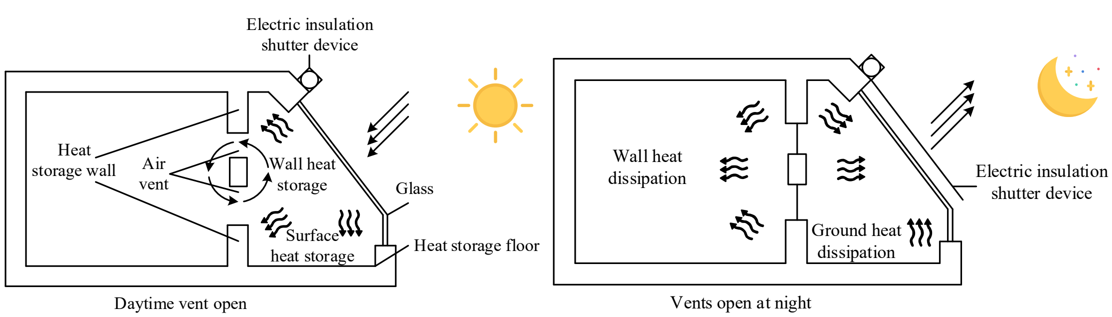
(5) Temperature fluctuation of the main living space can be reduced by its heat time regulation;

(6) At the same time, the sunroom space can be used for drying clothes and public interaction space, which can solve the problem of indoor heat source and thermal stability in autumn, and at the same time, the functional problems existing in the previous research can also be solved at the same time.

The passive thermal storage wall sunroom is used as shown in Figure 2, the operation process of the solar passive technology sunroom is mainly divided into two time periods: daytime and nighttime.

Daytime operation mode as shown in Figure 2 (a), daytime sunroom for continuous heat absorption time, when the thermal insulation roller shutter rolled up, its space within the heat storage ground, wall and air will continue to collect solar radiation energy gradually heat and warming. When the temperature inside the sunroom is higher than the air temperature in the living space, the doors and windows located in the partition wall will be opened, and the air will flow and circulate between the sunroom space and the living space under the action of the gas pressure difference, and the heat-storage structure will absorb the heat and at the same time, make the air temperature in the living space also rise.

Night operation mode Figure 2 (b) shows that there is no more solar radiation as a heat source, the outdoor temperature begins to gradually become lower, and the interior begins to dissipate heat to the external environment. At this point, the roller shutter toughness insulation is lowered to stop the loss of heat to the outside. At the same time, the windows and doors of the partition walls are closed to maintain the heat radiated from the walls to the interior while further preventing the heat of the living space from being lost to the outside through the sunroom space, and maintaining the comfort of the indoor thermal environment on a full-time basis. By smoothing out the peaks and valleys of temperature, it solves the problem of instability of the thermal environment caused by the large temperature difference between day and night.



(a) Day mode of operation (b) Night operation mode

Figure 2: How to use the passive heat storage wall in the sunlight room

IV. Impact of building thermal comfort on students' psychological and academic performance

IV. A. Purpose of the experiment

Through the optimal design of university accommodation environment proposed in the previous section, we explore the effects on subjective and physiological data related to students' psychological and academic performance. It also explores the effects of colour temperature in the light environment and sound type in the acoustic environment on human comfort and learning efficiency with different cognitive loads at different temperatures, and analyses the effects of multi-environmental factor interactions on comfort and learning efficiency. To explore whether it is possible to improve the comfort and learning efficiency of personnel in environments that deviate from human thermal comfort and to alleviate the effects of thermal discomfort by improving the acoustic and lighting conditions in building interiors.

IV. B. Experimental condition design

This experimental design includes 2 working conditions in summer environment and winter environment. The summer indoor cooling and winter dormitory indoor warming conditions include three constant temperature phases, to ensure that the dormitory indoor temperature is the only variable in the experiment, the indoor relative humidity is controlled at about 55%. During the experimental period, the indoor test environment was kept quiet, and the observer was kept at a certain distance from the subjects to avoid unwanted clutter mixing into the recordings as well as to avoid noise affecting the subjects' ability to concentrate.

The experimental process is shown in Fig. 3. The indoor cooling condition in summer and the indoor warming condition in winter were conducted at 3:00-4:00 p.m. and 9:00-10:00 a.m., respectively. In order to minimise the influence of other interfering factors, the experiments were conducted at the same time period and only one subject was tested at each time.

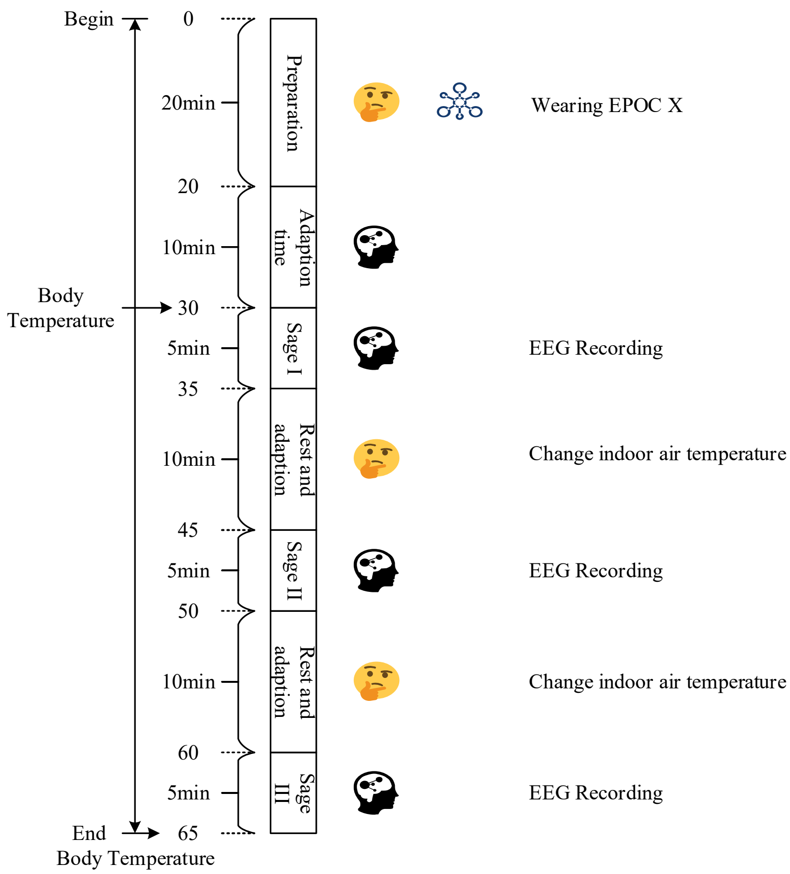


Figure 3: Indoor cooling in summer and indoor heating in winter process

The physical characteristics of the subjects are shown in Table 1, and 30 university students (15 males and 15 females) aged between 20 and 23 years old were selected to participate in the entire experiment at School Z. School Z is located in a temperate monsoon climate, with average winter temperatures of 0°C or above, and in order to quantify the effects of indoor temperature changes on the physiological and psychological activities of the students, the indoor temperatures, skin temperatures, and EEG data were simultaneously Monitoring. The body mass index (BMI) of the selected subjects ranged from 19.5 to 26.7, with a mean value of 21.5, which was normal compared to the standard scale.

Table 1: Physical characteristics of the subject

Physical characteristics	Radius	Mean value	SD
Age	20-23	22.2	0.97
Height (cm)	158-182	168.4	0.13
Weight (kg)	46-72	59.2	10.23
BMI (kg/m2)	19.5-26.7	21.5	2.06

In the preparation stage of the experiment, each subject was informed of the content and precautions of the experiment, and knew the whole procedure of the experiment, in order to mitigate the influence of psychological factors and unskilled operation on the results of the experiment. Prior to the start of the experiment, they were asked to maintain a stable mood and get enough sleep, and not to smoke or drink alcohol, tea or coffee that might stimulate the nerves for 12 hours before the test, and not to exercise strenuously for 3 hours, in order to obtain more accurate experimental data. During the experiment, they were asked to wear a set of summer clothes of nearly 0.5 clo. The subjects were assessed during the sedentary cognitive test and their average metabolic rate was about 1.2 per cent.

IV. C. Research Methodology

IV. C. 1) Mental Health Measurement

The Mental Health Scale for College Students was used to assess the mental health status of the participating students. The scale consists of 60 questions, including 10 dimensions of obsessive-compulsive symptoms, paranoia, hostility, interpersonal tension and sensitivity, depression, anxiety, academic stress, maladjustment, emotional imbalance, and psychological imbalance. The scale was scored on a five-point Likert scale, with “1” none, “2” mild, “3” moderate, “4” severe, and “5” severe. The higher the total score, the lower the mental health level of college students.

IV. C. 2) Measurement of academic performance

A student's academic performance is calculated through the Learning Performance Indicator (LP) with the following formula:

$$LP = \frac{Accuracy}{T} \tag{6}$$

where, accuracy - range 1-100 in %, T - reaction time in s.

In order to better reflect students' academic performance, four types of cognitive task tests were selected for this paper, including visual reaction time test, word-colour interference test, rapid counting test and instantaneous memory ability test.

(1) Visual reaction time test

This task focuses on students' ability to concentrate, and the system records their reaction time and accuracy to evaluate their learning performance, and the test index is AC/RT.

(2) Word and Colour Interference Test

This task focuses on students’ executive ability, and is used to test students’ ability to execute the information they receive and the content they perceive.

(3) Rapid Counting Test

This task focuses on students' perceptual ability and is designed as a numerical test in which subjects are asked to press the number key corresponding to the number of black dots displayed in the screen as quickly as possible.

(4) Instantaneous Memory Test

This task mainly tests students’ instantaneous memory ability, the task is designed as an n-back test, which mainly examines students’ instantaneous memory ability.

IV. D. Analysis of experimental results

IV. D. 1) Subjective evaluation test results

The statistical results of students' thermal sensation voting percentage, actual thermal sensation voting value, thermal satisfaction percentage and thermal discomfort under different temperature conditions are as follows. The relationship between temperature and students' actual thermal sensation (TSV) voting percentage is shown in Fig. 4, and it is easy to see that as the temperature of the experiment rises, about 78% of the students think that the temperature is moderate when the temperature of the experimental environment is 24℃. However, there were still a small number of students (22%) who thought that the current temperature was slightly warmer and therefore more comfortable when the temperature was slightly lower. As the temperature increased from 20°C to 24°C, the students' predominant thermal sensations ranged from slightly cooler to slightly warmer, so the students' thermal comfort temperatures in the experimental environment were in the range of 20 to 24°C.

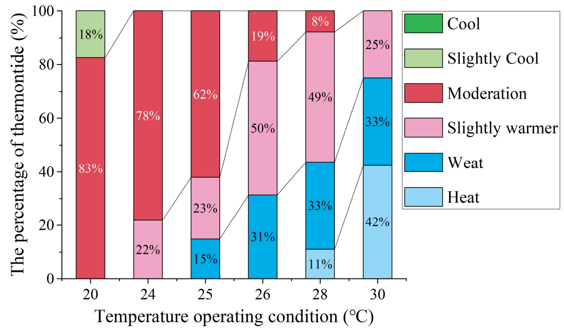


Figure 4: The relationship between temperature and TSV voting percentage

The change rule of the actual thermal sensation voting value with temperature conditions is shown in Fig. 5, when the experimental temperature rises from 20℃ to 30℃, the actual thermal sensation voting value also rises, from -0.85 to 2.06. There is an obvious difference in the actual thermal sensation voting value TSV of human body under different temperature conditions. The linear equation of the actual thermal sensation voting value with temperature was obtained by fitting, and by setting the actual thermal sensation voting value in the equation to zero, the corresponding temperature can be calculated to be 22.78 ℃, which means that the thermo-neutral temperature in this experimental environment is 22.78 ℃.

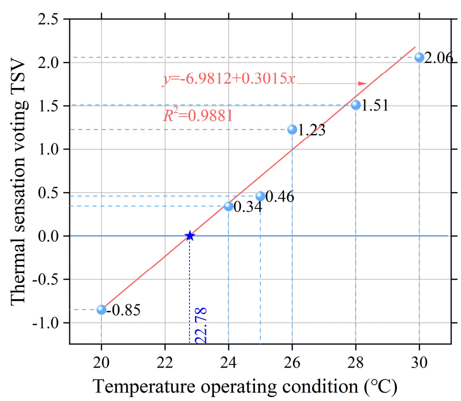


Figure 5: Evaluation of temperature and thermal sensation

The trend of thermal satisfaction percentage with temperature conditions is shown in Figure 6, with the highest unsatisfactory percentage of 81% at 30°C. As the temperature decreases, the percentage of dissatisfaction decreases. The lowest value was reached at 24°C and then the percentage of dissatisfaction increased slightly as the temperature continued to decrease. Thus, the highest percentage of heat satisfaction among students was found at 24°C.

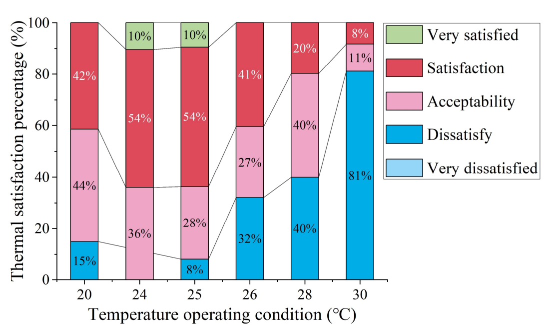


Figure 6: The relationship between temperature and thermal satisfaction

The law of change of thermal discomfort with temperature conditions is shown in Figure 7, and the curve equation of thermal discomfort with temperature is obtained by polynomial fitting. It can be seen that the curve has a maximum value when it is slightly lower than 24°C. Through calculation, it can be obtained that the students are most satisfied with the current temperature at 23.30°C.

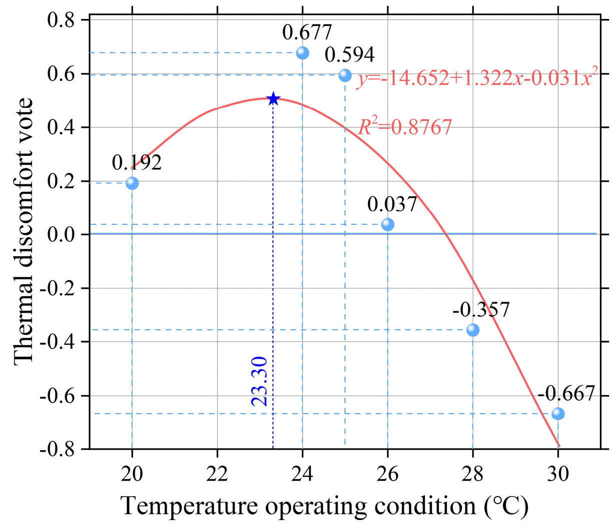


Figure 7: Evaluation of temperature and thermal discomfort

IV. D. 2) Effectiveness of academic performance improvement

The changes in Learning Performance Indicator (LP) and Academic Achievement with temperature are shown in Figure 8. The Learning Performance Indicator (LP) increased with temperature and began to decline after 24°C. Academic performance increased with temperature and again showed a decline after 24°C. It then continued to decline after a small increase at 25°C.

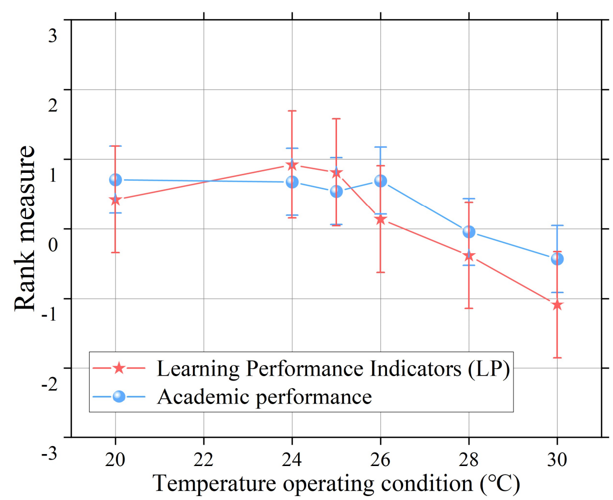


Figure 8: LP and academic achievement change with temperature

In summary, the Learning Performance Indicator (LP) and Academic Achievement both reached the maximum value at 24℃, and the general trend of change is the same, i.e., when the air temperature is colder or hotter, both of them show different degrees of decreasing trend. Through actual measurements, it can be seen that through the optimal design of the university accommodation environment, the dormitory of the university can be stabilised at around 24°C under two working conditions, namely, summer environment and winter environment, which can maximise the academic performance of students through the accommodation environment.

IV. D. 3) Effectiveness of mental health enhancement

The human physiological adaptation temperature partition is shown in Figure 9, where a comfort temperature zone exists when the ambient temperature is moderate. In this zone, the human metabolism level is very low, and it is enough to maintain the normal physiological activities of the body. When the ambient temperature increases to the upper limit of the comfort temperature zone or decreases to the lower limit of the comfort temperature zone, it enters the adaptation temperature zone. At this time, the metabolism begins to accelerate, the human body through a series of physiological reactions to automatically regulate the body heat balance, to adapt to changes in temperature. Within this zone, the difference in thermal perception of different individuals is not obvious. Once the temperature further decreases or increases beyond the range of the adaptable temperature zone, most people will adopt external regulatory behaviours to cope with the cold or heat and, at the same time, form inconsistent thermal perception. In the adaptive to non-adaptable temperature zone, the level of physiological adaptation reaches its peak when subjected to a strong thermal environmental stimulus. According to the theory of thermal homeostasis, the thermal perception of an individual should also reach a threshold. However, there are usually significant differences between individuals, which is where psychological adaptation comes into play.

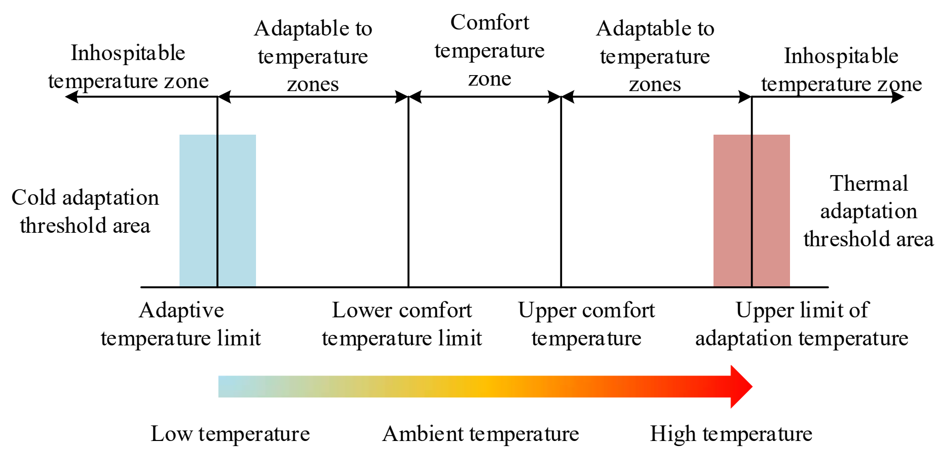


Figure 9: Human physiological adaptation to temperature zones

The relationship between the standard effective temperature (SET) and the psychological composite index (PSY) was obtained by setting the students' actual thermal sensation (TSV) at 0 and ±0.5 as shown in Fig. 10. In this study, a field survey was conducted to obtain the maximum PSY value of 3.05 and the minimum value of -1.60 for university students with optimised university accommodation environment, and these two values were set as the limit values of the psychological composite index of the dormitory indoor thermal comfort model, which resulted in the upper limit of 35.0°C and the lower limit of 7.13°C for the neutral SET.

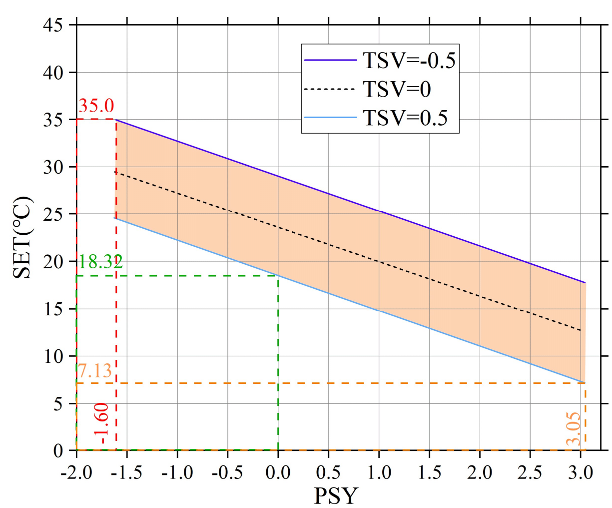


Figure 10: Relationship between neutral SET and PSY

It is generally assumed that most people will feel thermally neutral within the above temperature range. However, the range extends well beyond the neutral temperatures when psychological acclimatisation is not taken into account, mainly due to three reasons.

First, students' mental health contributes significantly to thermal comfort.

Secondly, the level of mental health of individuals varies greatly, and even in the same thermal environment, thermal sensations can vary from subject to subject due to fluctuations in the subjects' mental state. For example, when conducting indoor thermal comfort studies, the temperature, humidity, wind speed, and radiation intensity of the experimental chamber are constant, and the subjects are uniformly dressed and their activity levels are kept the same, but there are still differences in the thermal sensation polls obtained. Therefore, at lower or higher SETs, it can be considered reasonable for college students to be in a thermally neutral state, influenced by mental health factors.

Third, the standard effective temperature (SET) is a comprehensive thermal environment parameter, which is not simply a function of the indoor air temperature of the dormitory.

In conclusion, through the optimal design of college accommodation environment, the degree of students' psychological adaptation is obviously improved, and the level of students' mental health is indirectly improved.

V. Conclusion

This paper establishes a human thermal comfort model for residential students in colleges and universities, analyses the effects of thermal environment parameters on college students' mental health and academic performance through real-life experiments, and obtains the recommended ranges of indoor temperature parameters in dormitories for different thermal comfort and learning efficiency needs. It was found that the thermo-neutral temperature for students in college dormitory environments was 22.78°C. By analysing the academic performance with the actual thermal sensation TSV of the students, the relational equation for the variation of academic performance with thermal sensation was obtained and it was found that the highest academic performance was achieved when the thermal sensation was 24°C. Environmental preference, thermal expectation, thermal preference, mood, health status and satisfaction level all affect the mental health of college students. In this paper, the demand for indoor temperature in college dormitories is considered comprehensively, and the optimal design of college accommodation environment is completed, which improves the students' learning efficiency and mental health on the basis of ensuring the thermal comfort of the human body, and at the same time provides a reference for determining the design of reasonable indoor environmental parameters of educational buildings.

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