THE INFLUENCE OF WALL COLOR AND LAMP COLOR TEMPERATURE TO STUDENT'S CONCENTRATION AND COGNITION

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ABSTRACT

Concentration has an important role in our life, especially in order to get a quality and productivity in working. With concentration we can achieve the maximum and faster result in our work. Some ways to improve concentration that being researched here is by arranging the wall color and the lamp color temperature of the room. The color used as wall color in this research was the blue 9.8B, 7.4/5.6; and the orange 8.1YR, 8.7/3.7 of the Munsell color palette. Whereas the room lighting was the fluorescent lamp in 6500K (cool daylight) and 2700K (warm white) color temperature. Respondents of this research were 117 undergraduate students, the average GPA was 3.28; and 20,26 years as the mean age. The concentration and cognition tests are the Army Alfa test and IST subtest 9 that conducted in the room with different condition. Found in this research that the blue with cool daylight lamp has significant impact to concentration in 2,526 Lickert scale; and that orange with cool daylight lamp has correlation 0.781 to cognition result; but the other conditions have no significancy toward concentration and cognition.

Keywords: Concentration; color; lamp color temperature.

INTRODUCTION

Concentration can be defined as focusing our mind and maintaining it towards one important object. Concentration has an important role in our life, especially in order to get a quality and productivity in working. With concentration we can achieve the maximum and faster result in our work. We can also control which part of our mind that is needed to get the job done and which part that is not. Concentration is important aspect of learning. For student, sometimes it's easy to be concentrated, but sometimes it's not. That's may caused by internal and external factors. Some internal factors affect concentration, such as the mood, the behavior in receiving the lessons, also the logical and psychological aspects of thinking. Some important external factors are the learning environment; that consists of the thermal, acoustical, and also the interior aspects; in this case, will be researched further is the wall color and color temperature aspect in lighting. It has found that a room with the same dimension and proportion can give different learning environment, when using a different color in interior surface and lighting. In this case, the variable is the wall color and the color temperature of lighting; compared to 'white' as the base condition. The objective of this research is to find which variable can give improvement in student concentration and cognition in learning.

LITERATURE REVIEW

Undergraduate Student Endurance in Learning

Concentration can be defined as focusing our mind and maintaining it towards one important object (Hidayat and Kargenti, 2010). Concentration has preference function, in selecting a suitable information and focusing it toward the objection, while putting out other annoying factors (Ahmadi, 1992). According to Sumartno (in Rachman, 2010) "Concentration in learning has become behavior for students in focusing attention to the lessons in order to get a learning comprehension".

Undergraduate students are university students that have been at the end of their adolescence phase (Santrock, 2003). At this phase, their cognitive have matured so that any information they get not simply accepted by their cognitive scheme (Hidayat & Kargenti, 2010). They had already an ability to find which is the most important thing, organized some cases, ideas or experiences in eliciting new ideas (Santrock, 2003). Finding the maturity of their end adolescence phase, undergrad student considered incapable to concentrate well. Besides having the structure of the brain that has been perfect, students also capable of the sorting, connecting, organizes and processes information received so the idea can be focused on one object to extinguish another disrupting object (Hidayat & Kargenti, 2010).

Test in Measuring Concentration Endurance

According to Linschoten (1983), concentration endurance is the extent to which the individual able to sustain a certain degree of concentration. Individual concentrated according to their needs, using tools to endure from distraction and orientating his/her attention upon the task. This endurance in concentration can be observed by EEG (Electro Ecephalo Graph). EEG is a brain imaging, which serves to describe individual brain wave. Besides using EEG, the concentration endurance can be measured with Army Alpha Test (AA test).

AA is a standardized psychological test that's used for general screening and positioning. (Anastasi, 2006). This test categorized as an intelligence test, which concentration endurance is an aspect measured. The ability of an individual to catch and respond to instruction quickly and properly, influenced by the ability of an individual to concentrate (Aiken, 2008). The AA test measure *verbal ability, numerical ability, ability to follow directions and knowledge of information.* This test applied by Noble, E.L., Arps, G.F., (1920) to 5,950 undergraduate students of Ohio State University. From the test, found 51% student got A grade, 33% got B grade, while 13% got C+. The median is 135. The highest score got from the senior students of law department and the junior student of the department of medicine. Also found that, students from the department of medicine, commerce, journalism and engineering got high scores than other departments. That's why this test is useful in this research.

The Concentration

Basically, an individual will not be able to concentrate when he/she too thriller or is under pressure. Instead of individuals also cannot concentrate when were too relaxed (Linschoten, 1983). According to Tabrani (1995), there are 2 factors influence concentration:
a. Internal factors. Some factors from individual internally; such as less determination in learning, the nature of emotion, and reaction to the environment.
b. External factors. Some factors from individual externally; such as noise, annoyance from other people, environmental noise, the unavailability of tools needed, thermal, learning methods, and scheduling. Even, exhaustion of physical activity and mental can be a kind of external factors.

Besides Surya (2009) mention some causes in difficulty of concentration:
a) The lack of the interest and motivation in the lessons.
b) The emergence of a feeling of restlessness depressed, angry, worry, fear, hate, and resentment.
c) The atmosphere of learning environment that is noisy and messy.
d) Physical / health condition.
e) A passive character in learning.
f) Disability in good learning method.

This research focus to the external factor, especially the aspects of learning environment. Chan (1996) mentions 4 main factors of learning environment; the visual, acoustic, aesthetic, and thermal aspect. Visual environment refers to the suitable lighting system. Acoustical aspect requires free from external noise disturbance. Aesthetic environment focuses to suitable pastel color to accommodate learning activities. Thermal aspect requires adequate fresh air for ventilation and refrigerating devices.

Chan (1996) also pointed out that sufficient school facilities give improvement to the learning process. A good learning environment supported properly by visual, acoustic, aesthetic and thermal aspects. A good learning environment will provide freedom from physical constraint, also facilitate students to concentrate on school work. A place that induces student to think logically. A student in a good learning environment will definitely accomplish higher prestige and vice versa.

The result of a study in Georgia America shows that highest performance reached by students who learn in *Modern Learning Environment* while the students who learn in *Obsolete Learning Environment got* the lowest performance. This proof that learning environment contribute to student accomplishment (Chan, 1996).

Therefore, good color preference, lighting, acoustic, and thermal aspects really influence students learning process. Former researches indicated that pastel color can illuminate thinking, good lighting can reduce visual fatigue, acoustical control can support mental concentration; while good ventilation and thermal bring improvement in physical comfort (Chan, 1996).

Perception to Color

Perception is the organization, identification, and interpretation of sensory information in order to represent and understand the environment. Some

factors affect perception, such as: the hope/dream from the past and the psychological condition that bring up to perceptions. It can be defined further as attention process in purpose to do, needs, experiences, hopes and personality/character. The stimuli can be generated by an object, another person, or any incidents. The nature of the stimuli affect person's perception. The latter is the situation where the perception happens; which are the place, time, atmosphere and other conditions. (http://en.wikipedia.org/wiki/Perception)

Colors are everywhere and gives various information. The color of a person or food can affect their mind within 90 seconds. About 62-90 percent of an assessment based on color only. So, the use of colors wisely not just give distinction to the products, but also affect mood and feelings and the attitude of buyers to their products (Singh, 2006).

Kopacz, J. (2004) explained some color description. Firstly is the *Hue* or Color Quality that is the primary character or the essence of color. This defines the wavelength and its relative position in the color wheels. It also describes the reds, yellows or the blues of any color. Whereas the secondary colors are violet, blue, green, yellow, orange, and red.

Value or the Lightness and Darkness of color. If two colors different in their lightness or darkness, mean that they've got different value (Kopacz, 2004). Usually the value is found with black or white adding. Pink, as example, is an increasing lightness of red, whereas maroon extracted from mixing red with black.

The third factor of color is *Saturation* or *Chroma*. Saturation indicating the number of the quality of a color or the degree fullness hue of color. To reduce saturation, a color level can be mixed with the gray color equivalent to genuine quality or color complement of the original color (Kopacz, 2004)

One of the color test adopted widely is the Luscher color test (Luscher, 1969). In this test, conducted a test preference of the person to color using 8 colored cards "Basic Color" [*blue, yellow, red, green*] and "*Auxiliary* color" [*violet, brown, gray, and black*]; sized 10cm x 10cm. Then respondents asked to arrange from the most favored to the least favored and explain about each color. It is found that color perception is objective, whereas color preference can be subjective. Some research on color describes below:

- *Blue: "Depth of Feeling" passive, concentric, tranquility, calm, tenderness*
- *Green: "Elasticity of Will" passive, concentric, defensive, persistence, self-esteem/assertion, pride, control*

- *Red: "Force of Will" ex-centric, active, aggressive, competitive, action, desire, excitement, sexuality*
- *Yellow: "Spontaneity" ex-centric, active, projective, aspiring, expectancy, exhilaration*
- *Violet: "Identification" unrealistic/wishful fulfilment, charm, enchantment*
- *Brown: Bodily senses, indicates the body's condition*
- *Black: Nothingness, renunciation, surrender or relinquishment*
- *Gray: Non-involvement and concealment*

Blue makes body releases *tranquilizing hormones; especially the strong sky blue*. This *soothing effect* obtained when people viewing a wide bodies of water or open sky. Cardiac Blue often used in the cardiovascular unit to calm the patient (Kopacz, 2004)

Blue induce *comfort*, *coolness*, *peace and tranquillity*, *spirituality*. It also has been predicted that blue can lower blood pressure, send down heart rate, increase body temperature. Blue can also *reduce appetite*. Besides, blue also associated to *wetness and cleanliness*. It also gives *sensations of security*, *orderliness*, *reliability*, *contemplation*, *solitude*, *isolation* . (Kopacz, 2004)

Orange has similar character as red and or yellow. As red, orange also a *stimulating color*, *exciting, cheerful*, *warm*, *inviting*, inviting hungry. *It inspires lively, energetic behavior in the viewer*. Because orange increases the pulse speed not the blood pressure, even the blood current (Kopacz, 2004)

Elliot & Maier (2007) reveal some connection of red with love, spirit and sexual readiness. While green associated with money and it facilitates consumer expenditure, meanwhile blue-green associated with hunger. The black regarded the color of death and brought up aggression, eroticism and increase sexual passionate. Elliot et al., found that color has been associated to culture as well; a United States civilization in this case. In his research, using A4 color cards as sample, he found that the respondent facing the red at the beginning of IQ test, has been defeated in the test; on the contrary, the respondent seeing gray performs better.

Color is an important environmental element that influences person's behavior. Jalil et al. (2012) found that many researches have been done in major colors such as: red (53%), blue (30%), white (25%) and green (19%). In this case, the wall color being researched is the blue 9.8B, 7.4/5.6; and the orange 8.1YR, 8.7/3.7 of the Munsell color pallette. This color selection is the result of a former research that

the blue and the orange uses here has become the option of most respondents (91%). The room lighting is the tubular lamp in 6500°K (cool daylight) and 2700°K (warm white) color temperature. All respondents in this research are usually used classroom with white as wall color; that's why, this research wanted to find, which color gives the useful impact to improve students concentration and cognition in learning.

Color Influence toward Learning Activity

Jalil et al. (2012) reveal that color gives important impact to student's learning activities and their well-being. Methods and measurement factor can be suited in investigating color influence. Some common measurement is student awareness or attention in the learning process, efficiency and motivation of the undergraduate students. Also needs to be considered are the filtering factors such as the annoying factors in learning, most and least favorite color, and the reality context of the study room. A suitable color contributes to longer concentration in learning, increase performance, give positive emotion and perception. Contrary, certain color can give negative impact, such as decreasing reading ability, mistaken in any kind of task, getting sleepy and lack of concentration as well. The learning environment should visually attract and motivate the students to be a good learner.

Gaines & Curry (2011) also show color impact to students in an educational environment. The color will influence student's attention, behavior, and achievement. The suitable color application, especially for the inclusive classes, will improve students' performance. It was found that the disable students had been more sensitive to color in the classroom. Gaines & Curry (2011) also affirmed that color selection in educational environment should be conducted with minds, because over-stimulation of color will burden the senses. Contrary, a room interior without color stimulation will cause no productivity. Both conditions should be avoided. Another study found that different individual will select different colors for their learning environment; that's why an adaptation to room color is needed.

Color and Lighting

Veitch (2001) found six human needs from lighting environment: *visibility, task performance, communication and social behavior, health and safety, mood and comfort, aesthetic and judgments.*

Jago & Tenner (2005) found a correlation between lighting quality and productivity. Some improvement in visual performance as a result from the room lighting improvement as follows: *Visual performance* that means give suitable illumination not an excessive brightness; *Visual comfort* by eliminating glare and increasing concentration, *Interpersonal relationship* achieved by proper lighting to facilitate the eye to see clearly and produce quality in working together.

Phillips (2000) said that visual clarity is an important requirement in learning and reading. This clarity will decrease at the area with low level of illumination. That's why, the higher visual task, the higher level of illumination needed.

Phillips (2000) also stated that glare is the opponent of good lighting. Later, visual comfort and visual perception affect the emotional and intellectual of each individual.

Some of environment aspects during the day that affect the emotional quality of people are (Phillips, 2000): *Light path* that influence by sun position and sky exposure; *Contacts with exterior,* including the view through windows and weather experience; *Color from the natural environment*, and the *Dynamic of lighting from time to time*.

Color temperature and *color rendition* are some aspects that need to research further in improving the visual performance. Good color not only associated with good lighting quality, but also give an energy saving. Some room ambience in accordance with lighting method is as follows (Phillips, 2000).

- *Comfortable: Pleasant, colorful, light, modelled, restful, quiet, soft, cozy, relaxing, warm, cool (in warm climates);*
- *Bland: Flat, featureless, uniform, monotonous, soporific, boring;*
- *Gloomy: Dark, dim, dull, dreary, depressing, oppressive, shady, threatening;*
- *Dramatic: Stimulating, theatrical, exciting, bright, interesting, sparkling, glittering, brilliant, varied, concentrated, focussed, intense, glowing, radiant, moody, lively.*

Samani & Samani (2012) found that improvement in the lighting, gives better learning environment and motivating the students to study more, so that improve the students performance. Pulay method (2010) is used to measure the influence of room lighting to student's performance in learning in Alpha course, Malay. This study found a significant impact to 150 students as their respondents. In the good room lighting environment, students tend to more relax, did not feel sleepy, more motivated in learning and more concentrated as well. *Applied lighting* and *standing lighting* need as combination of room lighting, as of

the visual activity can be differentiated. The lower illumination makes the students feel sleepy and did not able to focus easily. By this research, also found that combination of daylight and warm fluorescent lighting has been the optimal lighting, besides the lighting control to avoid glare.

Erwine & Heschong (2002) affirmed that good lighting quality derived from the combination of daylight and electric light.

The lighting condition that studied here was the fluorescent lighting with different color temperature; the warm white 2700 K and cool daylight 6500 K; whereas the mean illumination is 432,27 Lux.

RESEARH METHOD

This research conducted quantitatively. Respondents are totally 117 undergraduate students; from several disciplines of Petra Christian University (PCU). The step by step research is the literature study, respondents collection, room preparation in wall color and lighting, room documentation, and questionnaire preparation.

ANALYSIS AND FINDINGS

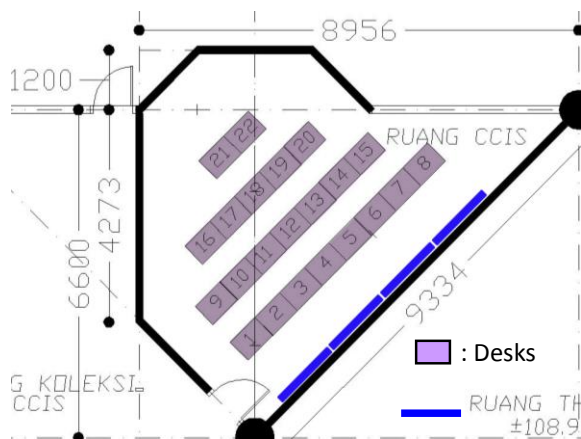This research conducted in CCIS room, with room layout as follows:

Figure 1. Room Layout

The condition of wall color and lighting are:

Table 1. Wall color and Lighting

Wall color	Lighting color temperature
Blue	Warm White
Orange	Warm White
Blue	Cool Daylight
Orange	Cool Daylight

Figure 2. Study room

This research conducted at precisely the same hour and condition to maintain the validity. The white is the base color, while the blue and the orange are the color to study. The color applied to front wall of 12 m2 of the study room. Each test followed by 18-22 respondents. The students are from several disciplines of PCU but can be classified into two groups, the Art department, and the Science department. The mean age was 20.26 years; the average GPA was 3.28.

In different wall color and lighting condition, the respondents did the *Army Alpha* as concentration test and *IST subtest 9* as cognition/ memorizing test. Before the test conducted, the students being in the room in 30 minutes. While adapting to the study room, they fill in the questionnaire of their feeling about the room ambience. After that the Army Alpha conducted in 5 minutes, followed by the *IST subtest 9* in 20 minutes. So, totally at about 55-60 minutes the students were in the study room.

The room lighting is in the existing position as in the schematic, fulfill the 20% uniformity of illumine-tion at mean 432,27 Lux.
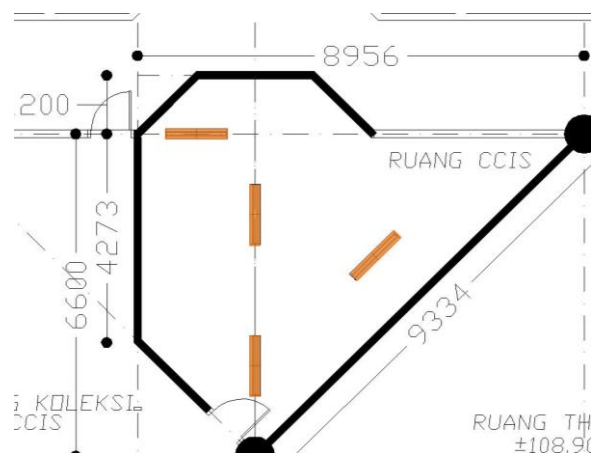

Figure 3. Lamp position

The data analyzed using Lickert scale to find the student's preference of good learning environment and correlation simulation to get a correlation of room environment to concentration and cognition of the student. The Lickert's scale range from 1 to 3 represent *the least to the most* impacted aspects. Some impacted aspects of learning environment assessed by the respondents are the *calmness, enthusiasm, inspiration* and *speed.* The following table shown the Lickert's scale of the student's preference regarding the different test conditions:

Table 2. Lickert's scale

Conditions	Calm.	Ent.	Ins.	Sp.
Blue-cool daylight	2.53	2.16	2.0	2.05
Orange-cool daylight	2.24	1.82	1.71	1.82
Blue-warm white	2.78	2.06	1.94	1.28
Orange-warm white	2.25	2.4	1.85	1.9

The result represents that the Blue-cool daylight condition is the most impacting condition of student's good learning environment. It has the highest impact in almost all aspects. The Blue- warm white condition, despite having the highest scale (2.78) for calmness, the speed scale is low (1.28); so it can be assumed that the students are too relaxed in this condition. The Orange-warm white has also good result; shown that this condition gives enthusiasm scale (2.4); higher than other conditions. While the Orange-cool daylight condition in this case gives the least impact to almost all aspects.

The following table resumes all the correlation factors that have been simulated. A factor tendency to 1 means strong correlation; whereas factor tendency to 0 or negative points means less or no correlation.

Table 3. Correlation aspects result

Correlation of blue wall color, cool daylight lamp with Army Alpha test	0.163907509
Correlation of blue wall color, cool daylight lamp with Memorizing test	0.34153767
Correlation of blue wall color, warm white lamp with Army Alpha test	-0.290402655
Correlation of blue wall color, warm white lamp with Memorizing test	-0.214585103
Correlation of orange wall color, cool daylight lamp with Army Alpha test	0.781811228
Correlation of orange wall color, cool daylight lamp with Memorizing test	-0.663993553
Correlation of orange wall color, warm white lamp with Army Alpha test	-0.30290109
Correlation of orange wall color, warm white lamp with Memorizing test	-0.254619082

CONCLUSION AND RECOMMENDATION

By this research, found that the blue color in the front wall with cool daylight lamp color temperature of lighting brought up the most calming condition to students. Data collection of students' opinion regarding room calmness, by Lickert scale that range from 1-3, the result for calmness was 2.5263158. But by correlation simulation, this condition brought up to 0.34153767 correlation factor to cognition test, means a little significancy to student's memorizing ability. While the orange front wall with cool daylight lamp color temperature have significant correlation with Army Alfa test, at 0.781811228 correlation factor. That means by this ambient room color and lighting, the concentration of students was improved.

It was also found that, the blue and orange front wall with warm white lamp color temperature has less or no significance to students concentration and cognition.

Some factors that need to be considered in later research are:
- All room surfaces should be intervened with color not only the front wall; so that the room ambience will be more influencing.
- The Army Alpha and memorizing test make the student focus more to the table, that's why the table top surface, other adjacent furniture and room equipment needs to be intervened as they may affect the environment as well.
- The w*arm white* lamp color temperature is not suitable to blue as the wall color. That's why, the study of lamp color spectrum influence to color as pigment should have been done before the application.

In order to develop more comfortable and conducive study room, the acoustic and thermal aspects as Chan's (1996) recommendation for learning environment can be researched further

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