

IMPACT OF COLOURS IN CLASSROOM INTERIORS ON MENTAL HEALTH UNDERGRADUATES WITH REFERENCE TO DEPRESSION, ANXIETY, AND STRESS LEVELS

Insights from a selected university in western province, Sri Lanka

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Abstract: Depression, anxiety, and stress symptoms are alarmingly increasing among university student populations and may have a major impact on achieving their academic and life goals. It is seen that in most cases the student's academic performance, health, and quality of life is negatively impacted as a result. Research suggests that Architectural elements have an impact on mental distresses and individual wellbeing. This research attempted to address the above concern by focusing on the impact of colour, as an Architectural element, on psychiatric imbalances among Undergraduates with special consideration on depression, anxiety, and stress levels. The study was conducted with 36 participants from the Department of Architecture of the University of Moratuwa. Due to the COVID-19 pandemic's travel limitations, the study was conducted remotely through Zoom online conferencing platform and non-immersive virtual mode under three selected colour conditions (tints of green, blue, and red) with the aid of DASS-21 scale to evaluate stress, anxiety, and depression levels. Colour red was found to induce the most adverse impacts on stress, anxiety, and depression levels, whereas green indicated a comparatively low adverse impact. Blue had the slightest adverse impact on depression and anxiety with a slightly favourable impact on reducing stress. The findings of this study suggests that the incorporation of appropriate colours in design interventions could facilitate the creation of better classroom interiors in order to address depression, anxiety and stress related disorders of undergraduates. Further investigations in physical mode, incorporating a larger sample and other subject streams is recommended.

Keywords: Undergraduates, Colour, Anxiety, Stress, Depression

1. Introduction

Maintaining mental health of individuals is vital due to its direct correlation with physical and social health leading to a healthy contented life. Mental well-being is an important indicator among the world population. More than 164.8 million people in the world are affected by mental disorders (Kessler et al., 2012). Due to the contemporary sedentary lifestyle, many individuals are found to be experiencing a poor degree of mental well-being. Figures of the World Health Organization (2017) show that one in every two people worldwide suffer from psychological illnesses. Stress, anxiety, and depression are three leading mental disorders, and have been recognized as negative indicators of mental wellbeing (Bibi et al., 2020). Depression and anxiety disorders are the critical psychological distresses that can be seen highly in society. They have a profound effect on mood, emotions and disrupt physical fitness and these diseases ranges from mild to severe (World Health Organization, 2017). Stress is not as severe as the above two but can have a significant impact on life.

1.1 THE IMPORTANCE OF YOUNG AND ADULT MENTAL HEALTH

Young adulthood is a time of great concern for mental and physical health, being the most crucial period of a person's life. As reported by the United Nations Children's Fund (UNICEF) (2012), 20% of young ones have been diagnosed with problems related to mental health. Poor mental health of adolescence is often associated with health and psychosocial problems like low self-efficacy, failure to achieve academic success, alcohol and drug use etc (Irfan, 2016). As highlighted by Othman et al., (2019), 75% of mental illnesses appear for the first-time during the youth age. Common mental disorders like depression, anxiety, and stress are becoming a global concern for young adults and college students (Othman et al., 2019).

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1.2 MENTAL HEALTH OF UNDERGRADUATES

Due to several factors linked with the higher education system, university students are at a higher risk of developing mental illnesses. As stated by Chen & Lucock (2022), undergraduate's mental health has been a growing concern in recent years even before the COVID-19 pandemic. The stresses and restrictions associated with the pandemic and the economic crisis have put the contemporary undergraduates at a greater risk of developing mental health issues, which may significantly impair their academic success, social interactions and future career and personal opportunities (Chen & Lucock, 2022).

University students as young adults, are more likely to suffer from mental illnesses than the other same ages because of the difficulties and stressors they face (Farrer et al., 2016). For instance, in the process of becoming a person who is capable of being productive in fulfilling the academic requirements aligned with the graduate profile of a particular degree program related to a specific career, an undergraduate should perform effectively, balancing work and life well as a talented and smart individual chosen from a large group of young adults. This pressure of the target oriented competitive nature in handling the academic workload and the hectic lifestyle, exposes some of them to an unbearable load of stress, causing mental distresses and eventually experiencing difficulties in maintaining their psychological wellbeing.

According to Blanco et al. (2008), 46.7% of the students suffer from mental health problems, and 10% - 84% have severe, moderate, and mild levels of stress (Othman et al., 2019). As a result, the probability of this problem worsening is extremely significant (Griggs, 2017). The majority of university undergraduates suffer from psychological issues due to several reasons such as exams, workload, lack of free time, competition, and social media addictions (McCance-Katz, 2020; Ostovar et al., 2016). Adapting to the new university environment, the breakdown of the mind associated with moving away from home, high academic capacity, new relationships, and perfection or becoming a responsible person in society are also stressors for this competitive age group (Farrer et al., 2016; Irfan, 2016). Stress, anxiety, and depression among students seems to be more prevalent in low-income and middle-income countries compared to high-income countries (January et al., 2018). A study by Amarasuriya et al. (2015) revealed that nearly 10% among undergraduates in Sri Lanka were mentally unwell. Rathnayake and Ekanayaka (2016), found that out of the undergraduates tested in their study 51.1% were depressed, 59.8% were suffering from anxiety and 82.6% were suffering from stress ranging between mild and severe levels. According to some other studies, factors that can affect these mental states are gender, family environment, age level, academic year, subject studied/type of degree, and daily activities whereas in Sri Lanka, it is understood that the issue of gender does not have such an impact on psychological stressors (Amarasuriya et al., 2015). It has been proven that the financial status of the family also can be a factor (Farrer et al., 2016; Othman et al., 2019).

2. Need for the research

Within this backdrop it is vital that due attention is given to the design of conducive learning environments to enhance undergraduates' mental health and well-being to successfully achieve their academic and life goals. This investigation explores the contribution of colour as a significant Architectural design element amongst the overall spatial experience in learning environments to enhance mental wellbeing of undergraduates with special reference to their classroom interiors. It is attempted to identify the most conducive interior colours and their values which could support in reducing undergraduates' depression, anxiety, and stress levels.

3. Review of literature

The built environment and its attributes have both positive and negative effects on mental health of its users (Chandramouli, 2020). As indoor environments stimulate the human senses and alter emotions and memories, it is crucial to consider how Architectural settings affect mentality. Most of the studies which have been executed for more than 20 years have looked at how Architectural elements affect patients' well-being and its impact on disorders. These investigations have discovered that the built environment can either positively or negatively affect mental related ailments (Benedetti et al., 2001; Khanade et al., 2018). In ensuring mental wellbeing of occupants, it is vital to consider Architectural attributes such as easy accessibility, noise control, interior colour, material choice, furniture, light/day light, artwork, scenes of nature and outdoors, circulation, visibility, way finding, legibility and coherence (Chandramouli, 2020; Connellan et al., 2013).

3.1 IMPACT OF ARCHITECTURE ON THE UNIVERSITY LEARNING ENVIRONMENT

A well-designed built environment helps students focus better on academic work, develop logical thinking and increase students' academic attainment (Chan, 1996). When students are dissatisfied and at discomfort with their living environment, it results in mental breakdowns impacting their' results and performance. Studies investigating

the correlation between Architectural attributes and learning process have discovered Architectural components to have an impact on students' motivation for learning and relieving stress. Among them, day light/light, air quality, furniture, noise control, artwork, accessibility, interior colour, materials, and table and chair arrangement were found to have impacts (Lewinski, 2015; Ibem et al., 2017; Wijesundara & Gamage, 2021), with a group of Architecture students and confirmed that their creative abilities and performance can be enhanced by designing carefully with the above-mentioned Architectural elements. Based on another study done by Demirbas (2001), with a group of Architecture students it was revealed that thinking positively about their learning environment aided their academic success. The study also implies that the learning environment could affect students' attention, comprehension, and performance.

3.2 STATEMENT OF RESEARCH GAP

A Well-designed Architectural environment can help university students deal with mental health issues and smoothly progress with a successful learning process. Colours being psychophysiological agents (Mahnke,1996) can play an important role in reducing psychological distress of undergraduates in learning environments. However, studies on the impact of interior colour in learning environments are scarce. How well colours in learning environments influence students' mental health is unknown (AL-Ayash et al., 2015). Hence, this research aims to fill that knowledge gap.

3.3 COLOURS AND UNIVERSITY LEARNING ENVIRONMENT

Interior colour is an important Architectural component in learning environments. There is a strong link between learners and colours as it influences their behavior, mood, and activation of cognitive responses. Colour helps to convey essential information from short memory to long memory and functions as a clue in remembrance by increasing the learner's attention to specific data (Dzulkifli & Mustafar, 2013). Farhat (2017), with a group of Architecture students, confirmed that out of blue, green, and white, blue has given the most active, attentive, and comfortable experience, while green colour induced the least positive effects and white interior had the most negative effects. Kurt & Osueke, (2014) have mentioned the use of appropriate and/or correct colours in the built environment to enhance university students' smooth functionality.

3.4 COLOUR PREFERENCE OF UNDERGRADUATES

Davis et al. (2021) have illustrated that colour preference differs by culture. A new study has reported that blue is preferred by most individuals all around the world (Banville, 2022). Gender seems to have a significant impact on young people's colour preferences. Majority of male students prefer blue whereas the majority of female students would not (Ellis & Ficek, 2001). Following that, some surveys with undergraduates reveal that blue is the most favored colour, followed by green, yellow, red, violet, gray, black, and brown (Mikellides, 2012, Kurt & Osueke, 2014). Hanafy and Sanad (2015), discovered the same by placing blue second.

3.5 COLOUR AND ASSOCIATION WITH STRESS, ANXIETY, AND DEPRESSION

Colours are found to have a direct association with a person's mental well-being, feelings and emotions and psychiatric imbalances/disorders (Hettiarachchi & Perera, 2022). The existing colour-related therapies attest to this association (Kim, 2010; Withrow, 2004). Green being a cool, pacifying colour was found to be managing depression, anxiety and stress levels of mobility impaired patients compared to blue and yellow (Hettiarachchi & Perera, 2022). Red being an arousing colour (Mahnke,1996) is found to cause the most anxiety in individuals while green and blue causes the least (Jacobs & Suess, 1975). Colour blue has proved to be an effective intervention for anxiety in college students (Azeemi et al., 2018). Colour black is found as a dark colour associated with high levels of anxiety (Hemphill, 1996). Also, low saturation levels can aid in decreasing anxiety, for the reason that low-saturated colours have a limited power to stimulate (Ireland et al., 1992). Another study discovered that those in a red room felt substantially greater anxiety than those in a pink room (Profusek & Rainey, 1987). The same study further revealed that focusing on cool colours rather than warm colours will help to alleviate mental distress. The influence of colours on the anxiety of a group of university students was studied by Hefling (2001), where he discovered that yellow greatly lowered anxiety, red decreased marginally while blue and green did not cause a significant change. Blue colour has a higher effect in the reduction of stress levels of students (Lubos,2012). A study by Kutchma (2003) revealed that, red has a stronger impact on stress than green. In the practice of Chromotherapy, green light can be used to heal depression and stress (Gul et al., 2015). Blue is recognized as a peaceful colour. However some studies have found blue to be negatively associated with depression (Oslie, 2000 as cited in Hasan, 2011) while warm hues aid in the treatment of depression (Mayer & Bhikha, 2014). Contrastingly, Ainsworth et al. (1993) showed that red as a warm colour, blue, green as cool colours and white as a neutral colour have no influence on depression and anxiety. Hanafy (2016) has found that, colours impact on depression differs with the gender. As a conclusion, colours have an impact on mental health, and the influence of the colour on stress, anxiety, and depression can be either positive or negative.

4. Theoretical Framework

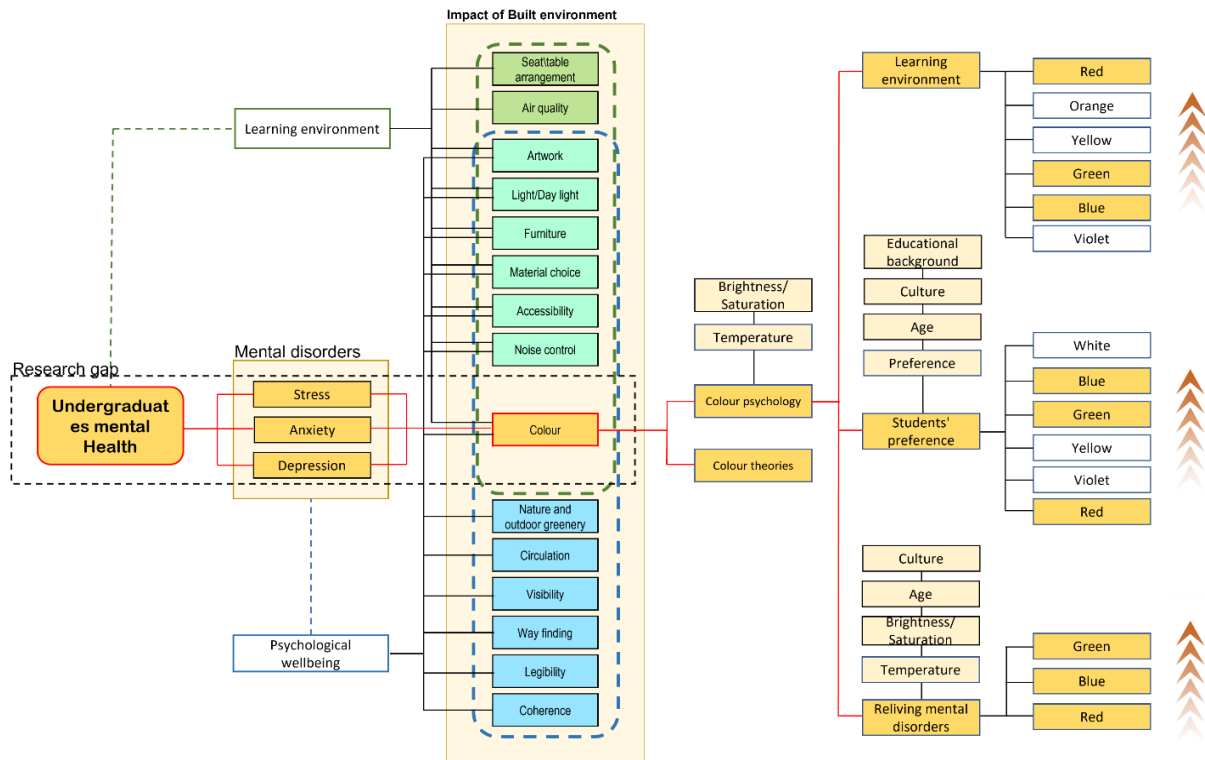


Figure 1: Theoretical framework generated out of literature review

5. Scope and Limitation

The research was limited to the University of Moratuwa, with a case study chosen from the Department of Architecture. The number of participants in the final study was limited to 36 participants aged 23 to 28 who were chosen from the 15', 16', 17', and 18' year batches of the Department of Architecture. Due to the traveling restrictions in pandemic, the study was conducted remotely using non-immersive virtual methods and online conferencing facilities. Due to this reason, type of display (monitor, laptop screen, etc.), display size, display quality, environmental factors in participant's locations like temperature, lighting level, and air movement were not within the control of the researcher.




6. Methodology


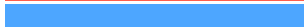



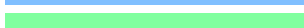
As the initial step, a preliminary study was conducted via an online questionnaire to obtain the consent for the participation on the final study, to select the most comfortable tint levels of the selected colours and to collect data related to the participants; most preferred colour, current condition of mental health, availability of electronic facilities and familiarity with technology. Prior to the final experiment, a pilot study was conducted as a test run with a small sample. According to the results of the test run, certain errors in the questionnaires were discovered and fixed before executing the final experimental study.

7. Selection of Colours

Colour selection was done carefully since some colour conditions can have adverse impacts on individuals. Considering the findings from the literature review as well as the preference of the undergraduates, Blue and Green were selected from the cool colour range and red from the warm colour range. As bright and over stimulating colours can adversely impact psychological health (Mahnke,1996), three levels of tints as vivid (lightness 50%), dim (lightness 65%) and pale (lightness 75%) of green, blue and red were selected from RGB colour model as in TableTable and the pale was chosen as the most comfortable tint level to be incorporated in the created virtual space based on the results from the preliminary study.

Table 1, The selected tint levels of colours

Shading level	Hue	RGB values	Lightness/ value	Saturation/ chroma
Vivid red		255, 26, 0	50%	100%
Vivid blue		0, 128, 255	50%	100%
Vivid green		0, 255, 64	50%	100%

Dim red		255, 94, 77	65%	100%
Dim blue		77, 166, 255	65%	100%
Dim green		77, 255, 121	65%	100%
Pale red		255, 140, 128	75%	100%
Pale blue		128, 191, 255	75%	100%
Pale green		128, 255, 59	75%	100%

Note: These colour shading levels were added to questionnaire 01 to obtain the most comfortable shading levels and the pale range was tested in the experimental study due to students' preference.

The final study was conducted in a four-day period (respectively for control/actual; colour of the exposed concrete, green, blue, and red conditions) including a one-day break to avoid the carry-over effects. 3D virtual video space of selected case study with four versions were used for this study. The experimental study was held by using the online conferencing method (zoom platform) due to restrictions of the Covid-19 pandemic situation. To avoid expectation bias, participants were not informed of the expected outcomes of the study. Both the quantitative and qualitative methods were used for data collection. DASS-21 scale was adopted to assess the impact of colours on stress, anxiety, and depression while a questionnaire survey was executed to collect emotional association with selected colours.

Table 2: Scores on the DASS 21 for stress, anxiety, and depression

	Stress	Anxiety	Depression
Normal	0 - 14	0 - 7	0 - 9
Mild	15 - 18	8 - 9	10 - 13
Moderate	19 - 25	10 - 14	14 - 20
Severe	26 - 33	15 - 19	21 - 27
Extremely Severe	34+	20+	28+

Note: The scores were multiplied by 2 to obtain the final score as mentioned in the guidelines of Source: Lovibond, S.H. & Lovibond, P.F. (1995)

The study commenced at 6. p.m. every day. An evening time was selected in order to reduce the impact of the changes of the daylight on the results. The same sample of participants was tested within four days for the test to be successful. The participants were informed about the procedure of the experimental study by a letter and day to day steps and links were given before each day. When developing the methodology, all required ethical requirements were followed. Data was gathered using the existing/actual colour condition as the control condition, and then by exposing to green, blue, and red colour scenarios respectively.

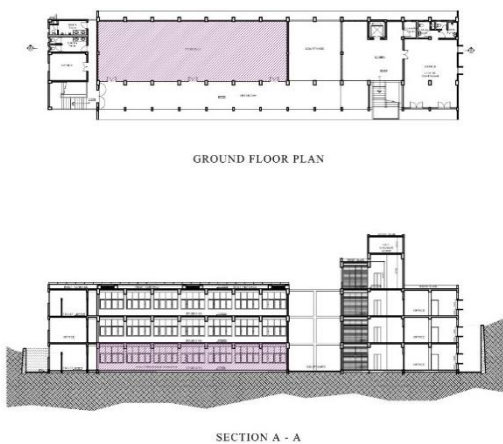


Figure 2: Plan and section of the case study

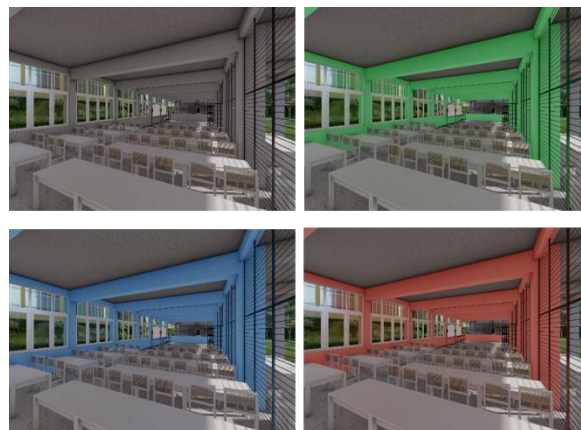


Figure 3: captures from videos of control/existing, green, blue, and red situations

8. Data presentation and analysis

Among the 6 main hues tested (red, orange, yellow, green, blue, violet), blue got the highest percentage (26%) of preference aligned with the findings of Eysenck (1941), Mikellides (2012), and Kurt & Osueke (2014). Green got the next highest preference (24%) followed by orange (17%), violet (13%), yellow (11%) and red (9%). Among the three tint levels tested (vivid, dim, and pale), 69% of students stated to be comfortable under pale, 20% under dim and 11% under vivid tint. These findings signify the idea that the participants could have more positive mental health in low values (tints). Ching and Bingeli (2004) similarly have stated that lower values are more comfortable to individuals than the higher ones.

8.1 COLOUR PREFERENCE

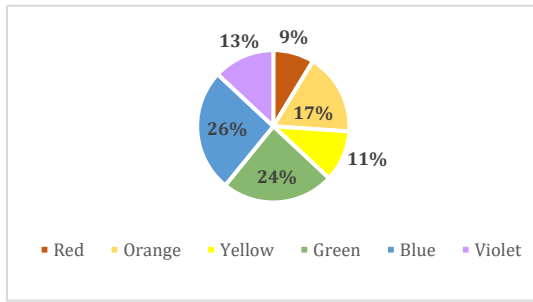


Figure 4: Most preferred colour for interior spaces

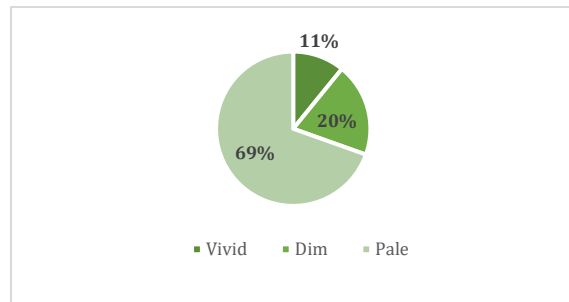


Figure 5: Most comfortable tint level for university interior spaces

8.2 COLOUR EMOTION ASSOCIATIONS

When the four colour scenarios tested were compared, all of them received negative responses over the control colour condition. While red colour scenario received the most unfavorable responses (negative 69.4%, positive 25%), blue colour condition reported the same as the control condition to have positive impacts (63.9%). Compared to positive and negative responses on exposure to colour scenarios, red colour was showing highest adverse impacts with most negative emotions (69.4%) followed by green, and blue (36.1%). When comparing the responses of undergraduates for the colour scenarios it can also be assumed that preference can have an impact on emotional responses when comparing both results.

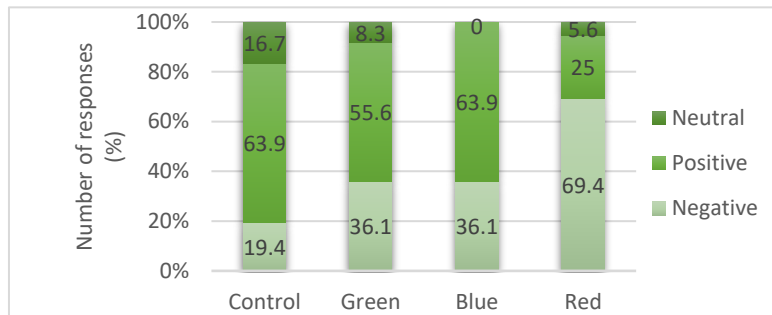


Figure 6: Comparison of percentages of emotional responses for all four conditions

8.3 OUTCOMES OF DASS 21

8.3.1 Depression Level

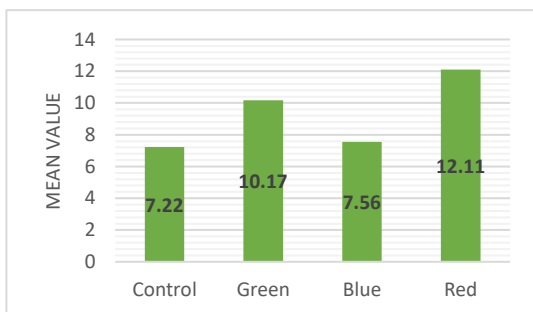


Figure 7: Mean values for depression under four colour scenarios

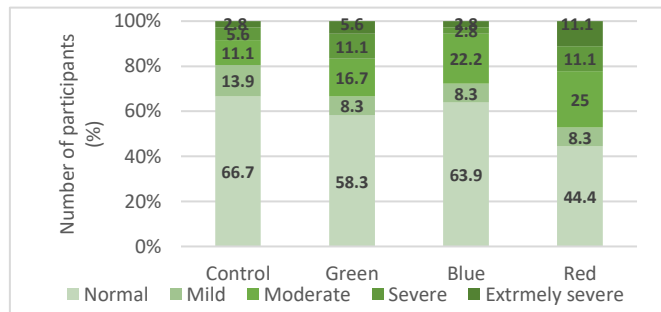


Figure 8: A summary of participants' depression levels under four colour scenarios

In comparison to the control condition (7.22), all three scenarios had an uncondusive impact on depression levels of participants, as shown by the mean values. The highest mean (12.11) for depression was reported in the red colour scenario, followed by green (10.17) and blue (7.56). Other than the existing condition (66.7%), blue scenario was found to be more conducive in maintaining a normal healthy mindset with no depression (63.9%) followed by green (58.3%) aligned with the findings from Mayer & Bhikha, (2014) and Gul et al (2015). Red was found to be inducing the most unfavorable impacts where 55.6% of the participants experienced some form of depression compared to other colour scenarios. 41.7 % participants were experiencing depression in varying degrees in the green scenario, exposure to blue had reduced the depressed participants to 36.1%, though Oslie (2000) has signified the potential of blue colour to have depressing impacts on individuals. Accordingly, out of the three colours tested, blue exposure was found to be more supportive for a depression free learning environment, followed by green.

8.3.2 Anxiety Level

Based on mean values, all three scenarios tested showed an uncondusive impact on anxiety when compared to the control condition (3.5). Red was found to induce a significantly adverse effect (10.44) than green (4.56) and blue (3.61). Blue was reported to maintain an anxiety free mind in the majority of participants (83.3%), followed by green (75%) highlighting a positive impact on reducing stress aligned with the findings by Kutchma ,(2003) and Gul et al., (2015). A majority of participants experienced some level of anxiety (47.2%) when getting exposed to red over all the other colours (Kutchma , 2003). The percentage of anxious participants caused by red could have been more had the tint of red was a 'vivid' one instead of 'pale' tint adopted in the study (Ireland et al., 1992). Consequently, the tested blue and green colours were found to be most supportive in managing anxiety of undergraduates over red.

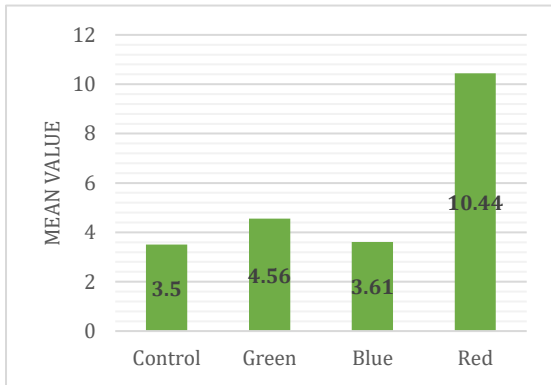


Figure 9: Mean values for Anxiety under four

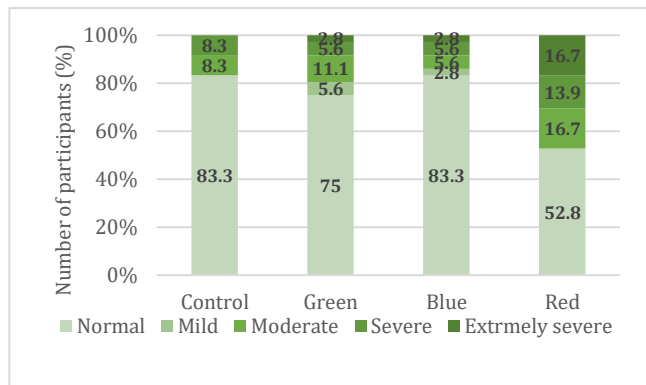


Figure10: A summary of participants' Anxiety levels under four colour scenarios

8.3.3 Stress Level

Comparing mean values of stress, blue (7.44) depicted conducive impacts for participants followed by control scenario (7.72), green (10.78) and red (17.28). Blue was significant in maintaining a stress-free mental state in the majority (88.9%) over the control (83.3 %), green (63.9 %) and red (50%) respectively. As highlighted by Kutchma (2003), the strong impact of red in increasing stress levels of participants (50%) over other colours (green : 36.1%, control: 16.7%, blue: 11.1%) was evident. Much aligned with the findings of Lubos (2012), the impact of blue in managing stress in students was revealed by the study.

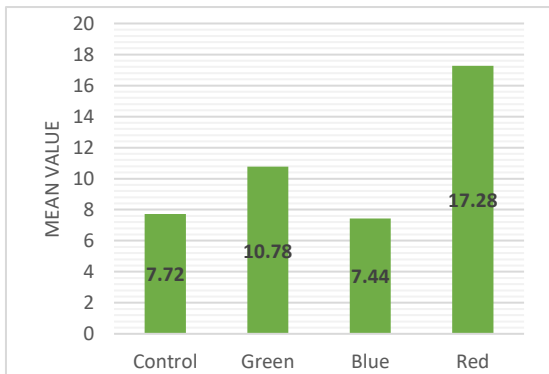


Figure 11: A summary of the mean values for stress under current and selected conditions

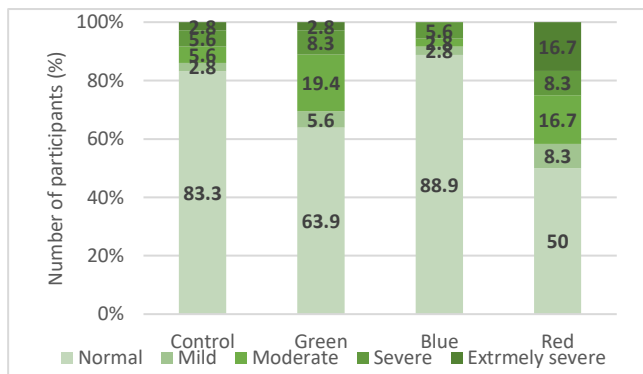


Figure 12: A summary of participants' stress levels under current and selected colour conditions

When comparing mean values and participant's levels of stress, anxiety, and depression, adverse impact of red colour is visible to be greater. The reason can be the higher arousal quality of red as a warm colour (Mahnka,1996). This result supports the findings of Jacobs and Suess (1975) and Kutchma (2003). As in other findings, the impact of green to help relieve mental illness is not evident in the considerable increase of the mean values of the participant's response with reference to all three disorders. This supports the findings of Kutchma (2003) and Hefling (2001) but opposes the findings of Jacobs and Suess (1975) and Gul et al. (2015). Blue contributes more positively on reduction of stress compared to the impacts on anxiety and depression. Based on the mean values and participant's levels of stress, anxiety, and depression in relation to blue colour, it appears to not differ significantly from the control condition aligned with Ainsworth et al. (1993) and Hefling's (2001) findings. However, the remote research method adopted, selected dimensions of blue and green colour, the time of exposure, the emotional relationship with the actual condition of the selected case study, and the quality of the 3D virtual video may be some factors that may have influenced these findings.

9. Conclusions and future recommendations

Considering overall findings of this study, the impact of colours in classroom spaces on the anxiety, stress and depression levels of undergraduates was revealed. Impact varied with the colour selection. Overall, the findings suggest that selection of colours in learning spaces needs to be done carefully due to the impact on mental health. The use of red in learning spaces is revealed to be inappropriate due to its negative influence on undergraduates' mental health and comfort. Red, having high energy arousal, can be incorporated in spaces where more energy is required, such as gyms or dancing studios in academic establishments. Though colour green is beneficial in a healing atmosphere, it should be used with caution in learning spaces as it might trigger psychological imbalances in some individuals. Due to the least impact of blue on depression, anxiety and stress as found here, it can be suggested as the best colour to be incorporated in learning environments. In order to generalize these findings, further research is needed by expanding the sample selection to other courses of study and conducting the research in an actual environment with participants physically attending, increasing time of exposure, colour range and participant count, covering the other professions, universities and different socio-cultural backgrounds.

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