The Impact of Colour Saturation on Physiological Stress and Cognitive Performance in Digital Testing Environments

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Abstract:
Post-pandemic, digital assessment has become the standard [4], yet the impact of platform colour saturation on performance remains under-examined. While existing literature explores the impact of specific colours on stress, the role of their intensity remains an important research gap. This proposal aims to investigate the effect of colour saturation on stress during testing. Utilizing a between-subjects experimental design, the study determines if high-saturation blue coloured interfaces impair cognitive performance. Employing the State-Anxiety Scale [2] to participants as a quantification of stress across a large-scale digital sample, the research maximizes generalizability. The findings aim to establish a stress-neutral saturation standard, like "Safe Saturation Mode", to promote educational equity in digital testing [11].

Introduction:

The global education landscape has undergone a shift toward primarily digital assessment, with high-stakes examinations now delivered almost exclusively through screens using online interfaces [1, 4]. The digital environment of online testing remains a neglected variable. Specifically, the role of colour saturation in regards to intensity used in the interfaces presents a potential barrier in student achievement. Unintended high-saturation colours present in digital testing platforms may trigger a stress response [7], which impairs a student's working memory during a test [9]. If certain digital designs are more stressful than others, digital tests are not truly measuring a student's knowledge, but their executive function and ability to handle visual overstimulation. This creates a problem for educational equity, as students with high test anxiety or sensory sensitivities may be unfairly disadvantaged by vivid digital interfaces. This research seeks to create a more inclusive and fair standard for the future of digital testing asking the question: To what extent does high-saturation blue impact the state anxiety and cognitive accuracy of students in comparison to low-saturated blue?

Literature Review:

The global education landscape has undergone a rapid, permanent shift toward digital-first assessment, with high-stakes examinations such as the SAT and AP exams now delivered almost exclusively online [4]. While this transition offers efficiency, it introduces unexamined environmental variables that may hinder student equity. Current research in Human-Computer Interaction indicates that blue light and high-intensity screen stimuli can significantly alter circadian physiology and psychological arousal [1, 6]. According to the Color-in-Context Theory [5], visual stimuli can trigger specific psychological states. In an assessment environment, high-intensity visual stimuli can increase Cognitive Load [9] and act as extraneous load, distracting the brain from germane processing forcing the brain to dedicate neural resources to processing visuals rather than the test content. While the colour red has been documented, previous research seeing impaired performance in the presence of red from danger signalling, the specific role of saturation remains a gap in educational technology research [10]. Following the

Yerkes-Dodson Law, which suggests that overstimulation leads to a decline in performance, this study investigates the threshold where blue saturation moves from calming to overstimulating.

Methodology:

To investigate the correlation between colour saturation and cognitive function, this study will employ a between-subjects digital experimental design. This method aims to ensure that each participant is exposed to only one stimulus, therefore preventing participants getting tired, or practice effects skewing stress data.

(1) Participants and Randomization
The study aims to recruit a diverse sample of 100 high school students through social media and academic environments. Participants will access a link and be randomly assigned through URL to one of three testing conditions: Control Group: A neutral interface (White Background), Low Saturation Group: A muted blue interface (HEX: #ccdaed), High Saturation Group: A vivid blue interface (HEX: 0000FF).

(2) Environmental Controls
After accessing the link, students will be asked to turn their brightness on to a standardized level of minimum 80% and disable Night Shift or blue-light filtering software. This aims to account for hardware variance in a remote setting

(3) Cognitive Task
Participants will complete a 10-minute timed assessment consisting of logic puzzles, basic math questions, and reading comprehension questions. The task is made to simulate the high pressure stakes of digital exams.

(4) State-Anxiety scale and Visual Analogue Scale
Following the cognitive tests, participants will complete The State-Anxiety scale self-report questionnaire to measure state anxiety [2]. Additionally, a 10-point Visual Analogue Scale (VAS) will measure perceived eye strain and discomfort [15].

(5) Data Analysis
This study will use the One-Way Analysis of Variance [14] statistical method to compare the mean stress scores and accuracy rates across the three groups. This statistical test will determine if the differences in performance were significant or due to random chance.

Conclusion:

With the shift toward primarily digital education, the colour saturation palette of testing platforms can no longer be ignored. This research addresses the oversight in educational technology in regards to visual overstimulation and its impact on cognitive ability and stress. By examining a correlation between colour saturation and stress, this study advocates for universal design standards that protect students from unnecessary cognitive load. This project seeks to ensure that a student's success is determined by their intellectual abilities, not inhibited by the intensity of the colour pixels on their screen.

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