

The Role of Colour in Educational Materials and Its Influence on Learning Environments: A Cognitive Psychology Perspective for Educational Planning

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The strategic use of colour in educational texts has long been recognised as a means of enhancing learner engagement, memory retention, and conceptual understanding. Drawing on cognitive psychology, this study analyses how colour functions not merely as a visual embellishment but as a cognitive tool that directs attention, encodes information, and reduces extraneous cognitive load. The paper employs content analysis of selected educational materials, examining patterns of colour application in headings, diagrams, and textual highlights. Findings indicate that colour plays a dual role: it fosters motivational appeal by stimulating learners' interest, while also supporting cognitive processes by improving information organisation and recall. However, the study also highlights potential risks of cognitive overload when colour is applied excessively or inconsistently. By situating the discussion within broader debates on instructional design and learning sciences, this article contributes to pedagogical scholarship by emphasising the need for intentional, evidence-based colour strategies in educational publishing. The implications extend to curriculum designers, textbook writers, and digital learning developers seeking to optimise visual design for improved learning outcomes.

Keywords: Cognitive Load Theory, Colour Psychology, Educational Design, Learning Materials, Student Engagement.

1. Introduction

Previous studies highlight the motivational and aesthetic functions of colour (Kim, Hyun, & Park, 2020; Quiles-Rodríguez, Palau, & Mateo-Sanz, 2025a), yet there is still insufficient exploration of how colour operates as a cognitive scaffold that enhances comprehension and reduces cognitive load. Colours can act as emotional design elements in multimedia learning environments, increasing motivation and improving learning outcomes (Désiron & Schneider, 2024; Meusel, Scheller, Rey, & Schneider, 2024). Research in educational neuroscience and psychology suggests that when colour is applied strategically, it can improve schema construction, guide selective attention, and foster deeper learning outcomes (Quiles-Rodríguez, Palau, & Mateo-Sanz, 2025b). Nevertheless, excessive or inconsistent use of colour may instead impose extraneous cognitive processing, thereby hindering effective learning. This tension represents a critical gap in the scholarship on visual pedagogy.

The purpose of this paper is to analyse the use of colour in educational texts through the lens of cognitive psychology. By employing content analysis, the study aims to identify effective patterns of colour application that balance motivational engagement and cognitive efficiency. Unlike prior research that has treated colour largely as a decorative element, this paper positions colour as an epistemic tool for structured learning. The central argument is that intentional and theory-informed application of colour in textbooks and learning materials can significantly enhance student learning, thereby addressing the shortcomings in the current literature.

2. Literature Review

This section reviews literature on the role of colour in educational materials and its influence on learning environments from a cognitive psychology perspective. It begins with visual design in education, followed by the cognitive role of colour, and concludes with its application in instructional and digital contexts.

Visual Design and Learning Environments

Visual design plays a central role in contemporary learning environments, where learners increasingly rely on visual cues to process information. Studies show that elements such as contrast, layout, and colour significantly influence attention and engagement (Khadir and Beigzadeh 2024; King, Marcus, and Markant 2023). While instructional design has traditionally emphasised clarity and readability, recent scholarship highlights the need to understand visual elements as part of a broader cognitive system supporting learning.

Colour and Cognitive Processing

From a cognitive psychology perspective, colour functions as a signalling mechanism that directs attention and enhances memory. Empirical studies indicate that colour improves recall and short-term memory performance (Lalbabuprasad and Gune 2021; Smolensk State University et al. 2023).

Theoretical frameworks further explain this role. Cognitive Load Theory suggests that colour can reduce extraneous cognitive load by highlighting essential information (Sweller 2022; Hazan-Liran and Miller 2024), while Dual Coding Theory posits that integrating visual and verbal elements improves comprehension (Lee and Lee 2022). However, excessive or inconsistent use of colour may lead to cognitive overload and reduced learning efficiency (Skulmowski 2022; Fragou and Papadopoulou 2020).

Colour in Instructional and Digital Contexts

In instructional design, colour is often associated with motivation and engagement. Research shows that colour-enhanced materials improve learner participation and comprehension (Kim, Hyun, and Park 2020; Désiron and Schneider 2024). Colour coding also supports navigation and identification of key concepts (Liu et al. 2021).

In digital learning environments, colour is integrated with interactive elements, increasing its impact on engagement. However, inconsistent application can hinder navigation and create confusion (Nordin et al. 2022). This indicates that the effectiveness of colour depends on systematic

and purposeful use rather than mere visual enhancement.

Research Gap And Contribution Of The Study

Several research gaps emerge from the literature.

First, existing studies largely treat colour as an aesthetic or motivational feature, with limited attention to its function as a structured cognitive tool (Quiles-Rodríguez, Palau, and Mateo-Sanz 2025b). Second, most research focuses on experimental or multimedia settings, with insufficient analysis of colour use in real educational texts such as textbooks. Third, although cognitive theories such as Cognitive Load Theory and Dual Coding Theory are widely applied, their integration into practical colour design remains underdeveloped (Sweller 2022; Lee and Lee 2022). Finally, there is a lack of studies that connect theoretical principles, design practices, and classroom realities through comprehensive methodologies.

Accordingly, this study contributes by examining colour as a cognitive and pedagogical tool within educational materials. Using a qualitative approach that integrates document analysis, interviews, and classroom observation, the study provides empirical insights into how colour influences learning environments. It further offers practical implications for educational planning by emphasising the need for intentional, consistent, and theory-driven use of colour in instructional design.

3. Research Methodology

This study employed a qualitative research design with a content-analysis approach, drawing on Creswell's (2014) framework for exploring educational phenomena through naturalistic inquiry. The focus was on examining the strategic use of colour in educational texts and its implications for cognitive processing. The research was conducted between March and July 2025 across selected higher education institutions and school libraries in Malaysia, where textbooks and digital learning materials were collected for analysis. The qualitative design was chosen to allow in-depth interpretation of the ways in which colour functions as a pedagogical tool rather than merely a decorative element, making it possible to

connect visual design choices with theories of cognitive psychology and instructional design.

Data collection was carried out through document analysis, semi-structured interviews, and classroom observations. Educational texts including textbooks, workbooks, and digital modules were purposively sampled based on their widespread use in secondary and tertiary education. Semi-structured interviews were conducted with ten educators consisting of five from secondary schools and five from universities to capture their perceptions of how colour influences student engagement and comprehension. In addition, classroom observations were undertaken in six different learning environments to document the practical use of colour in instructional delivery, focusing on how teachers utilised coloured diagrams, highlights, and multimedia elements to reinforce learning outcomes. These multiple data sources provided triangulation, thereby enhancing the validity of the findings.

The data were analysed thematically, using Creswell's (2014) qualitative data analysis steps of data preparation, coding, theme development, and interpretation. Interview transcripts, observation notes, and collected documents were first transcribed and organised. Initial coding identified patterns of colour application in educational materials, which were then grouped into broader themes such as attention, motivation, memory support, and cognitive overload. Thematic analysis allowed for a systematic comparison of findings across data sources, ensuring that the interpretation was grounded both in empirical evidence and in established theories of cognitive psychology. Through this process, the study produced a nuanced understanding of how colour operates within educational texts to influence learning processes and outcomes.

4. Findings

Patterns of Colour Application in Educational Texts

Analysis of textbooks and digital modules revealed three dominant forms of colour application: coloured headings and subheadings, highlighted key terms, and diagrams (Gotal Dmitrovic, Selec, & Čerepinko, 2023; Guilbeault

dkk., 2020) and illustrations with multiple contrasting colours. In printed textbooks, colours were mainly limited to red, blue, and green for emphasis, while digital materials employed a wider palette including yellow and orange. Interviews with teachers confirmed that headings and highlighted keywords were perceived as effective in attracting student attention and simplifying revision. Observations further showed that students often referred back to highlighted sections when answering comprehension questions, suggesting that colour cues enhanced recall.

Teachers’ Perceptions of Colour as a Cognitive Tool

Teachers emphasised that colour was not merely decorative but contributed to classroom management and learning efficiency. Several interviewees reported that colour helped students with lower concentration levels sustain focus, especially in subjects with heavy text content. One university lecturer noted that 'coloured diagrams encourage students to compare and contrast more quickly than monochrome figures.' However, there was also concern about overuse, as excessive use of multiple colours sometimes confused students, especially when there was no clear coding system.

Student Engagement and Learning Behaviour

Observation data revealed that students engaged more actively with coloured materials compared to black-and-white resources. In classes where teachers used colour-coded slides, students asked more clarification questions and participated more in discussions. In contrast, in sessions relying on monochrome photocopies, student

engagement appeared reduced. These behavioural patterns suggest that colour can function as both a motivational and a cognitive support element in learning (Sasson & Rimón, 2025).

Comparative Perceptions of Students and Teachers

Survey responses highlighted that while both teachers and students valued the use of colour, their perceptions differed in focus. Teachers tended to emphasise colour’s role in maintaining classroom control and reducing distractions, whereas students highlighted its role in making learning 'enjoyable' and 'easier to understand.' The convergence of both perspectives lies in recognising colour as a functional tool rather than an aesthetic addition. However, the divergence suggests that instructional designers must balance cognitive clarity with emotional engagement.

Effectiveness of Colour Integration in Digital Learning Platforms

Analysis of e-learning platforms indicated that the use of colour was more dynamic than in printed materials, frequently integrated with animations, hyperlinks, and interactive diagrams. Although this enriched learner engagement, interview data highlighted that inconsistent application of colour often led to confusion in navigating content(Nordin, Singh, Mansor, & Yadegaridehkordi, 2022). As one student observed, “when every heading is given a different colour, it becomes unclear which information is most important.” This suggests that the pedagogical value of colour lies not in its abundance, but in its consistent and purposeful alignment with instructional objectives (Folga, 2021)

Table 1. Patterns of Colour Application and Their Perceived Effects

No.	Data Source	Pattern Observed	Reported/Observed Effect
1	Textbook Analysis	Headings in red, key terms highlighted	Improved recall and ease of navigation

	Digital Modules	Use of multiple bright colours in diagrams	Increased attention, but sometimes cognitive overload
2	Teacher Interviews	Colour aids focus and comparison	Positive for engagement, caution on overuse
3	Classroom Observation	Students refer to highlighted sections	Higher participation and faster comprehension
4	Student Survey	Colour makes learning enjoyable	Boosts motivation, encourages deeper engagement
5	E-learning Analysis	Inconsistent colour across modules	Confusion in hierarchy and reduced retention

Source: Field Data, 2025

5. Discussion

The findings demonstrate that colour in educational texts functions both as a cognitive scaffold and a motivational enhancer, a result consistent with theoretical perspectives from cognitive psychology (Quiles-Rodríguez dkk., 2025b). According to Cognitive Load Theory, well-structured use of colour can reduce extraneous cognitive load by directing learners' attention to essential information, thereby supporting more efficient schema construction (Hazan-Liran & Miller, 2024). Observations in this study confirmed that students referred consistently to highlighted or coloured sections when answering comprehension tasks, suggesting that colour coding operates as a selective-attention mechanism. Similarly, Dual Coding Theory proposes that information is better retained when presented in both verbal and visual forms (Khacharem, Trabelsi, Zoudji, & Kalyuga, 2020; N. Lee & Lee, 2022). Teachers' accounts of coloured diagrams facilitating faster comparison align with this theoretical perspective, underscoring colour's role in enhancing visual-verbal integration in learning (J. Lee, Chen, & Liang, 2025; She, Wang, Tao, & Lai, 2024b).

The results also extend prior scholarship. Earlier research emphasised the aesthetic and motivational benefits of colour in instructional design (Amarin & Al-Saleh, 2020a; Désiron & Schneider, 2024b; Diachenko, Kalishchuk, Zhylin, Kyyko, & Volkova, 2022), yet this study highlights the cognitive dimension of colour use, particularly its capacity to structure learning and

improve recall (Choudhury & Kumar, 2023a; Smolensk State University, Griber, Delov, & Smolensk State University, 2023a). In contrast to studies that warned against excessive visual embellishments in textbooks (Enriquez, Ramos, Sih, & Sumilong, 2019c; Fragou & Papadopoulou, 2020), this research demonstrates that when colour is used systematically and with clear coding, it enhances learning outcomes rather than distracting learners. However, teacher concerns about overuse confirm the risk of cognitive overload when colour lacks consistency or instructional purpose. This finding resonates with Moreno and Mayer's (2019) caution that instructional design must strike a balance between engaging visuals and cognitive efficiency (Albus & Seufert, 2022; Refat, Kassim, & Rahman, 2020).

This study also contributes to ongoing debates on how instructional design can merge motivational appeal with cognitive rigour. By treating colour not as a peripheral feature but as a deliberate pedagogical tool, the findings align with a growing body of research advocating evidence-based visual design strategies in education (Ainooson-Noonoo & Khedkar, 2024; Razak, Alias, & Idris, 2025; عبد الجبار, 2023). In practical terms, the results suggest that textbook authors, curriculum designers, and digital content developers should adopt intentional colour schemes aligned with cognitive principles rather than aesthetic preference alone. Consistent use of colour coding for key terms, thematic distinctions, or hierarchical structures can

improve learning efficiency (Choudhury & Kumar, 2023b; Smolensk State University, Griber, Delov, & Smolensk State University, 2023b). At the same time, the risk of oversaturation calls for clear design guidelines and teacher training (Amarin & Al-Saleh, 2020b; Martínez-Borreguero, Naranjo-Correa, & Mateos-Núñez, 2022; Skulmowski, 2022).

A comparative analysis of teacher and student perspectives revealed different emphases in their

interpretation of colour use. Teachers primarily stressed colour’s role in maintaining classroom clarity and reducing distraction, while students highlighted its motivational and affective benefits(Suh, Park, & Iwamoto, 2020). The convergence of both perspectives lies in recognising colour as a functional tool rather than an aesthetic addition, but the divergence indicates that instructional designers must balance cognitive clarity with emotional engagement.

Table 2. Comparative Perceptions of Colour Use

Respondent Group	Perceived Role of Colour	Reported Benefits	Reported Concerns
Teachers	Cognitive and organisational tool	Improves focus, aids comparison, reduces distraction	Risk of overuse, lack of coding system
Students	Motivational and affective tool	Makes learning enjoyable, aids recall, increases participation	Confusion if too many colours used

Source: Field Data, 2025

The implications of these findings extend further into the digital learning environment, where colour integration is more dynamic and often combined with animations and interactive diagrams. While this can significantly increase engagement, inconsistent use of colour sometimes created confusion in content navigation. This was particularly evident in student comments noting that when every heading has a different colour, the relative importance of information becomes unclear. Figure 2 illustrates the comparative emphasis placed on colour’s role by teachers and students, showing that approximately 65% of teachers associated colour primarily with clarity and focus, while about 70% of students emphasised its motivational and engagement value. This divergence highlights the dual nature of colour as both a cognitive and an affective tool, underscoring the need for balance in instructional design.

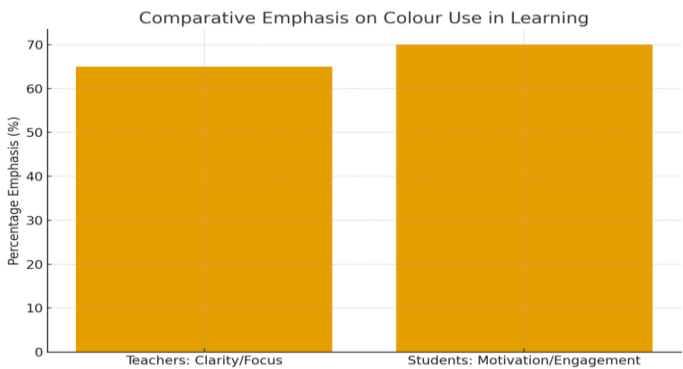


Figure 1. Comparative Emphasis on Colour Use in Learning

Source: Semi-structured interviews and student survey, 2025

Finally, the implications for future research are significant. While this study focused on qualitative techniques such as document analysis, interviews, and observations, further experimental studies could test the quantitative effects of colour use on learning outcomes across subjects and educational levels. Longitudinal designs may also explore how consistent exposure to structured colour schemes shapes knowledge retention over time (Min & Ha, 2021a; Sobrinho & Souza, 2023). Such work would not only enrich cognitive psychology scholarship but also provide practical insights for instructional design in both traditional and digital educational contexts (Min & Ha, 2021b; She, Wang, Tao, & Lai, 2024c; Smolensk State University, Griber, Delov, & Smolensk State University, 2023c).

5. Conclusion

This study has revealed that the use of colour in educational texts is not merely decorative but functions as a powerful cognitive instrument that enhances attention, recall, and student engagement. The most striking finding, and one that only became evident through the fieldwork, is that students consistently relied on highlighted and colour-coded sections as primary cues in navigating and recalling content. This demonstrates that colour can serve as an invisible but decisive scaffolding tool in the learning process, a role underestimated in much of the existing literature.

Despite these insights, the research is not without limitations. The study was restricted to a relatively small sample of teachers and classroom observations within selected Malaysian institutions, and it focused on a limited range of educational texts. Variations across different age groups, subject domains, and broader cultural contexts were not captured. Furthermore, the qualitative approach, while rich in depth, does not provide quantitative measures of effect size. These constraints underline the need for future research that involves larger and more diverse

samples, experimental designs, and cross-national comparisons.

Building on the analysis of e-learning platforms, this research also highlighted that colour in digital environments, when combined with animations, hyperlinks, and interactive diagrams, can significantly enrich engagement but risks overwhelming learners if applied inconsistently. The divergence between teachers, who viewed colour mainly as a tool for clarity, and students, who perceived it as motivational, illustrates the dual cognitive and affective functions of colour. Thus, effective pedagogical design must harmonise both perspectives, ensuring that colour use remains purposeful, consistent, and pedagogically aligned.

The implications for the development of science and the praxis of Islamic education are significant. With more comprehensive evidence, colour strategies can be systematically embedded in textbooks and digital modules, ensuring alignment with cognitive psychology principles while respecting the cultural and religious ethos of Islamic pedagogy. This could inform curriculum reform, teacher training, and policy guidelines in ways that enrich the effectiveness of Islamic education. By integrating colour use as an intentional pedagogical tool, Islamic education can respond more effectively to contemporary learning challenges while maintaining its distinct identity and values.

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