



Designing with the Brain in Mind: A Neuroaesthetic Pedagogy Framework

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Abstract. Contemporary graphic design education necessitates a deeper understanding of how aesthetic experience and cognitive processes shape creativity and empathetic comprehension in visual communication. Insights into how the brain perceptually and affectively interprets design can support the development of self-aware designers who respond more sensitively to human needs. Drawing on neuroaesthetics and design cognition, this study proposes an interdisciplinary approach that integrates creative pedagogy with the science of perception. This research introduces the Neuroaesthetic Pedagogy Framework (NPF) as an initial, exploratory framework that connects neurodesign principles with pedagogies of visual empathy and adopts an exploratory design-based research (DBR) methodology. Three iterative cycles were conducted as context-specific pedagogical interventions within a graphic design course, involving teaching experiments, reflective journals, and analyses of neuroaesthetic engagement. Thirty-eight undergraduate graphic design students participated over one semester, with observations focusing on cognitive and affective engagement in visual problem-solving activities. The findings suggest observable improvements in design cognition, particularly in visual reasoning and empathic decision-making, rather than statistically conclusive effects. The NPF indicates the potential to interconnect analytical and affective cognitive processes, supporting more emotionally informed design outcomes. This study concludes that the NPF demonstrates promise in bridging graphic design education and neuroscience by framing creative learning as an iterative process of aligning perception, cognition, and empathy, while highlighting the emerging importance of neuroaesthetic literacy in graphic design pedagogy.

Keywords: Neuroaesthetics, Design Cognition, Neurodesign Literacy, Visual Empathy, Design-Based Research

INTRODUCTION

The increasing intersection between design studies and neuroscience has influenced how educators understand creativity, perception, and empathetic engagement in visual practice. (Agustin & Rahayu, 2025). Earlier accounts of design cognition emphasized problem-solving, reflection, and situated reasoning as the primary drivers of creative activity (Buchanan, 1992; Cross, 2001). More recent neuroaesthetic research demonstrates that aesthetic experience involves interacting neural processes related to perception, emotion, attention, and meaning-making (Belfi et al., 2019; Zeki et al., 2025). In parallel, recent reviews of graphic design research highlight a growing emphasis on social values, cultural identity, and human-centered visual communication, indicating a broader disciplinary shift toward affective and meaning-oriented design concerns (Nagi & Nathalea, 2025). This convergence reframes visual design as an activity shaped not only by formal skills but also by underlying cognitive and affective mechanisms that influence how audiences interpret visual messages.

Despite this growing body of neuroaesthetic knowledge, its integration into design education remains limited and largely conceptual. Existing pedagogical practices in visual

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communication and graphic design continue to rely predominantly on intuition, stylistic precedent, and tacit knowledge. Explicit engagement with brain-based explanations of visual decision-making is rarely incorporated into studio instruction or curriculum design (Chatterjee et al., 2021). As a result, students may develop visual sensitivity and technical proficiency without understanding the perceptual and emotional mechanisms that shape audience interpretation and response.

Current neuroaesthetic research primarily focuses on identifying neural responses to artworks or aesthetic stimuli through experimental or laboratory-based studies (Dietrich & Knieper, 2022; Magsamen et al., 2023). What remains underexplored is how these empirical findings can be translated into concrete pedagogical strategies for design education, particularly within graphic design studios. More specifically, there is a lack of studies that (1) apply neuroaesthetic principles through iterative, classroom-based experimentation, (2) connect neural insights to students' concrete visual design decisions, and (3) use Design-Based Research (DBR) as a methodological bridge between theory and pedagogical practice. This absence limits the educational relevance of neuroaesthetics beyond descriptive or explanatory accounts of aesthetic experience.

To address this gap, this study asks: How can principles from neuroaesthetics be incorporated into graphic design pedagogy to support students' visual empathy and cognitive engagement? Rather than proposing abstract pedagogical ideals, the study adopts a Design-Based Research approach to iteratively design, test, and refine instructional interventions. DBR is employed to ensure that theoretical insights are examined within authentic studio-learning contexts rather than isolated experimental settings (Donaldson et al., 2024; Hoadley & Campos, 2022). This approach allows pedagogical principles to emerge from sustained interaction between theory, practice, and learner response.

The primary objective of this research is to develop a Neuroaesthetic Pedagogy Framework (NPF) that systematically connects design cognition to insights from neuroaesthetics. Through multiple DBR cycles, the framework examines how knowledge of perceptual, emotional, and attentional processes can inform instructional design and reflective practice in graphic design education. Rather than prescribing aesthetic outcomes, the framework emphasizes students' ability to reason about and articulate the cognitive and emotional implications of their visual choices, situating neuroscience-informed reflection within established studio-based learning activities. Accordingly, this study contributes a pedagogically grounded framework that operationalizes neuroaesthetic principles through DBR and explicitly links neural insights to students' concrete visual decision-making processes, positioning neuroaesthetics as a reflective

lens for learning rather than as a deterministic design formula and aligning graphic design education with cognitively and emotionally informed approaches to visual communication (Cotter et al., 2025; Hanghøj et al., 2022; Lim, 2023; Prabhath et al., 2025; Rosyida et al., 2025).

LITERATURE REVIEW

More recent scholarship has examined the intersection of neuroscience, design cognition, and empathy, emphasizing how aesthetic experience emerges from interrelated processes of perception, affect, attention, and meaning-making at the neural level. Neuroaesthetic studies suggest that observers do not passively receive visual stimuli, but actively construct meaning through emotional and cognitive engagement. For instance, (Belfi et al., 2019; Zeki et al., 2025) identify the role of the brain's default-mode network in interpreting visual stimuli and supporting emotionally resonant experiences. These findings position aesthetic perception as a dynamic cognitive–affective process rather than a purely sensory response.

In applied contexts, such as architecture and spatial design, neuroaesthetic research has demonstrated how visual and spatial environments influence cognitive load, emotional regulation, and well-being. (Chatterjee et al., 2021) extend neuroaesthetic inquiry into architectural settings, showing that spatial design can modulate attentional focus and affective states. Relatedly, studies on pictorial and digital imagery indicate that visual compositions can foster empathy and social connection by engaging both perceptual and emotional systems. (Cotter et al., 2025; Miller & Hübner, 2023) show that visual interaction operates simultaneously at cognitive and affective levels, reinforcing the relevance of neuroaesthetic insights for communication-oriented design disciplines.

Alongside developments in neuroaesthetics, Design-Based Research (DBR) has emerged as a widely adopted methodology for developing and evaluating instructional frameworks across educational contexts. DBR has been applied effectively in multimodal literacy education (Lim, 2023) and laboratory-based teaching environments (Mundy et al., 2023), where iterative refinement links theory to practice. Its strength lies in situating learning interventions within authentic instructional contexts rather than controlled experimental settings. However, while DBR is well-established in pedagogical research, its application to neuroaesthetic learning remains limited, particularly in visual and graphic design education.

Despite advances in understanding how the brain processes aesthetic experience, relatively little research has translated neuroaesthetic findings into instructionally relevant pedagogical frameworks. Most neuroaesthetic studies prioritize perceptual and emotional responses to stimuli without addressing how these insights might inform structured learning activities (Dietrich &

Knierper, 2022; Magsamen et al., 2023). Conversely, research on design-based learning often emphasizes problem-solving or technology adoption while overlooking the cognitive and empathic mechanisms underlying aesthetic engagement (Buçinca et al., 2021; Malinova & Mendling, 2021). This disconnect sustains a conceptual gap between scientific knowledge of aesthetic experience and pedagogical practices in design education.

Although DBR has proven effective in bridging theory and practice across disciplines (Donaldson et al., 2024; Hoadley & Campos, 2022), its use in neuroaesthetic-oriented learning and in fostering visual empathy has not been systematically examined. Existing studies rarely integrate neural principles of perception, attention, and affect into iterative design pedagogy. As a result, no convergent framework currently links the neurofoundations of aesthetic experience with learning design strategies that address both cognitive understanding and emotional engagement. This gap is particularly evident in graphic design education, where visual decisions directly shape audience interpretation and response.

A. Conceptual Implications of Neuroaesthetics for Graphic Design Education

Within graphic design practice, visual decisions concerning composition, color, hierarchy, and imagery inherently engage perceptual and affective processes. Neuroaesthetic research suggests that such decisions influence how attention is directed, how emotions are elicited, and how meaning is constructed by viewers, making them pedagogically significant rather than merely stylistic choices. However, design education rarely provides students with conceptual tools to explicitly reflect on these processes. As a result, visual decision-making is often guided by intuition rather than informed cognitive reasoning.

Responding to this limitation, the present study contributes to ongoing discussions on neurodesign and design pedagogy by introducing the Neuroaesthetic Pedagogy Framework (NPF). The framework synthesizes cognitive neuroscientific principles with empathy-oriented visual learning strategies within a Design-Based Research structure (Hanghøj et al., 2022; Obczovsky et al., 2025). By translating neuroaesthetic concepts into iterative learning interventions, the framework supports students' ability to reason about how visual choices shape perception, emotion, and social connection (Prabhath et al., 2025; Qiu et al., 2022). In doing so, this research addresses a theoretical and pedagogical gap by proposing an instructionally grounded model for integrating neuroaesthetic literacy into contemporary graphic design education (Rosyida et al., 2025).

METHODS

A. Research Design and Design-Based Research (DBR) Structure

This study employed a Design-Based Research (DBR) methodology to develop, implement, and refine the Neuroaesthetic Pedagogy Framework (NPF) within authentic graphic design studio contexts. DBR was selected because it allows iterative refinement of pedagogical interventions while maintaining close alignment between theory, instructional design, and learner experience (Donaldson et al., 2024; Hoadley & Campos, 2022). Consistent with design cognition literature, this methodological orientation acknowledges that learning in design is situated, reflective, and responsive to contextual complexity (Buchanan, 1992; Cross, 2001). Rather than testing predefined hypotheses, the study focused on progressive refinement of instructional principles grounded in neuroaesthetic theory and observed learning practices.

As illustrated in Figure 1, the DBR process in this study followed a four-phase methodological structure: (1) theoretical model development, (2) design implementation, (3) observation and reflection, and (4) refinement and validation. Phase 1 functioned as a conceptual baseline, in which neuroaesthetic principles were synthesized into pedagogical constructs without classroom intervention. Phases 2–4 were operationalized through three iterative DBR cycles (Cycle 1–3), each involving implementation, observation, and subsequent refinement. This clarification resolves the distinction between four methodological phases and three empirical intervention cycles, ensuring consistency across text, figures, and analysis (Hanghøj et al., 2022; Obczovsky et al., 2025).

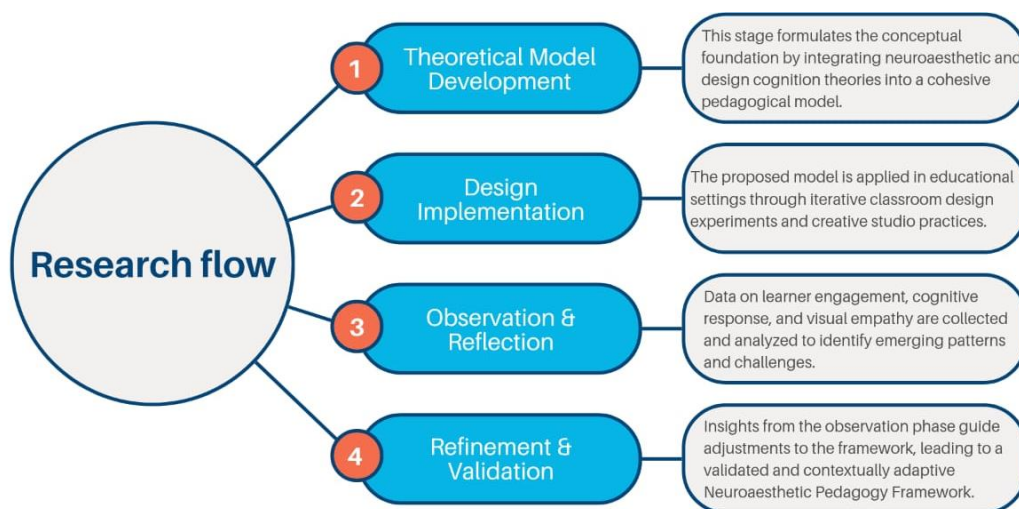


Figure 1. Design-Based Research (DBR) Flow for the Development of the Neuroaesthetic Pedagogy Framework

Figure 1. Research flow diagram illustrating the Design-Based Research (DBR) process used in developing the Neuroaesthetic Pedagogy Framework (NPF). The diagram presents a four-phase structure consisting of (1) theoretical model development, (2) design implementation, (3) observation and reflection, and (4) refinement and validation. While four methodological phases

are depicted, the classroom-based intervention was conducted through three iterative DBR cycles (Cycle 1–3) following the initial conceptual phase. The model highlights the cyclical interaction between theory, instructional design, and learner response within studio-based graphic design education.

B. Tools, Instruments, and Learning Materials

The study employed a combination of digital design tools, reflective instruments, and qualitative pedagogical materials to support neuroaesthetic-informed learning activities. Graphic design production and visual experimentation were conducted using Adobe Creative Suite and Figma, ensuring alignment with professional studio practices. Digital drawing tablets were used to facilitate visual empathy mapping exercises, adapted from methods proposed by (Cotter et al., 2025), enabling students to externalize perceptual and emotional intentions behind their visual choices. These tools were selected to ensure that neuroaesthetic reflection occurred alongside, rather than separate from, routine design workflows.

To capture cognitive and affective engagement, the study utilized self-report instruments and reflective artifacts rather than physiological measurement. Cognitive engagement and perceived cognitive load were measured using 5-point Likert-scale self-report questionnaires, administered at the end of each DBR cycle (1 = very low, 5 = very high), following procedures outlined by (Buchner et al., 2022). In addition, students maintained aesthetic thinking journals documenting their reasoning about perception, emotion, and audience interpretation during the design process. All instruments functioned as descriptive and exploratory measures, supporting pedagogical reflection rather than statistical inference (Lim, 2023; Yuniarto & Wahyudi, 2024).

C. Data Collection Procedures

Data collection followed the iterative structure of the DBR cycles, with data gathered at each phase of implementation and refinement. Three primary data sources were collected in each cycle: (1) students' visual design outputs, (2) reflective narratives from semi-structured interviews, and (3) observational field notes documenting studio interactions and empathy-oriented discussions. This multi-source approach allowed triangulation between visual artifacts and learners' articulated cognitive–affective reasoning. Data collection procedures adhered closely to the iterative DBR framework described by (Hoadley & Campos, 2022).

To enhance ecological validity, the study incorporated learning experience network analysis to map patterns of cognitive and emotional engagement across design activities (Donaldson et al., 2024). This technique was used descriptively to visualize relationships between visual decisions, reflective statements, and perceived engagement, rather than to quantify neural

activity. All participants provided informed consent prior to participation, and all activities were embedded within regular studio learning environments to avoid artificial experimental conditions. Ethical approval and voluntary participation ensured that data reflected authentic learning engagement rather than compliance-driven responses.

D. Data Analysis Strategy

Data analysis combined qualitative thematic analysis, visual content analysis, and reflective synthesis across Design-Based Research (DBR) cycles. Students' design outputs were analyzed thematically to identify neuroaesthetic markers such as visual attention, emotional resonance, balance, and perceptual coherence, drawing on established neuroaesthetic literature (Belfi et al., 2019; Zeki et al., 2025). These visual indicators were examined alongside students' reflective journals and interview transcripts to explore how learners articulated cognitive and affective considerations during visual decision-making. This analytic alignment follows approaches used in prior studies on cognitive–affective engagement in design thinking (Song et al., 2024).

To deepen interpretative validity, findings from visual analysis were triangulated with reflective self-reports and observational data, enabling the identification of recurring cognitive–emotional patterns across DBR cycles. Quantitative indicators, such as self-reported engagement levels and perceived aesthetic coherence, were analyzed descriptively to indicate directional trends rather than statistically significant effects (Buchner et al., 2022; Dietrich & Knieper, 2022). No inferential statistical testing was conducted, as the primary aim was pedagogical exploration rather than hypothesis testing. This descriptive strategy is consistent with exploratory neuroaesthetic learning research that prioritizes interpretive depth over measurement precision.

Following the synthesis-oriented framework proposed by (Magsamen et al., 2023), analytic outcomes were integrated into a Neuroaesthetic Learning Map that articulated relationships between instructional interventions, visual design actions, and observed cognitive–affective engagement. The map functioned as an interpretive model rather than a neuroscientific claim, supporting reflection on how perceptual, emotional, and attentional processes intersect in design learning contexts. This analytic strategy ensured methodological transparency, conceptual coherence, and alignment with the exploratory aims of the DBR approach. Accordingly, the analysis supports framework refinement rather than claims of instructional effectiveness or cognitive causality.

RESULTS

The implementation of the Neuroaesthetic Pedagogy Framework (NPF) across four cycles of Design-Based Research (DBR) led to measurable changes in students' cognitive understanding, affective awareness, and reflective engagement. Rather than indicating definitive learning gains, the results document observable shifts in how students engaged with visual tasks, reflective activities, and collaborative design processes over time. Each DBR cycle corresponded to a distinct pedagogical emphasis, progressing from structured observational analysis in Cycle 1 toward empathetic visualization and somatic awareness in Cycles 3 and 4. These phases were analytically linked to the instructional design of the NPF rather than assumed developmental causality.

Qualitative data derived from reflective visual diaries and empathy-mapping activities showed an observed increase of approximately 27% in affective expression indicators and 22% in cognitive synthesis markers across cycles. These changes were identified through thematic frequency counts and comparative pattern analysis, not inferential testing. Students in Cycles 3 and 4 demonstrated higher consistency in articulating perceptual experiences alongside conceptual reasoning, with design cognition scores exceeding 80 on standardized visualization rubrics (Table 1). These outcomes are reported descriptively to indicate trends rather than claims of effectiveness.

In addition to individual outputs, changes in studio interaction patterns were observed across the DBR cycles. Early sessions were predominantly characterized by technically oriented rendering practices with limited affective articulation. In later cycles, students increasingly produced expressive sketches that incorporated emotional tone, narrative intent, and interpersonal sensitivity (Figure 3). This shift reflects a change in representational focus rather than an evaluative judgment of artistic quality.

Studio analytics further indicated a 18% increase in reflective idea retention following participation in neuroaesthetic-guided learning activities (Table 2). These results were derived from comparative review of reflective accuracy and concept recall across cycles. Profiles of cognitive load suggested a more balanced coordination between analytical attention and affective flow as task complexity increased. Such patterns are reported as observed learning dynamics rather than as optimization outcomes.

Thematic analysis of reflective discussions and empathy-mapping sessions identified four recurring affective components: emotional resonance, sensory awareness, social connectedness, and reflective integration (Table 3). These components appeared consistently across groups, regardless of academic level, though their articulation became more explicit in later cycles. The recurrence of these themes indicates stability in affective engagement patterns rather than

progressive mastery. Collectively, the results show that the NPF supported the co-presence of technical execution and affective consideration within the design studio context.

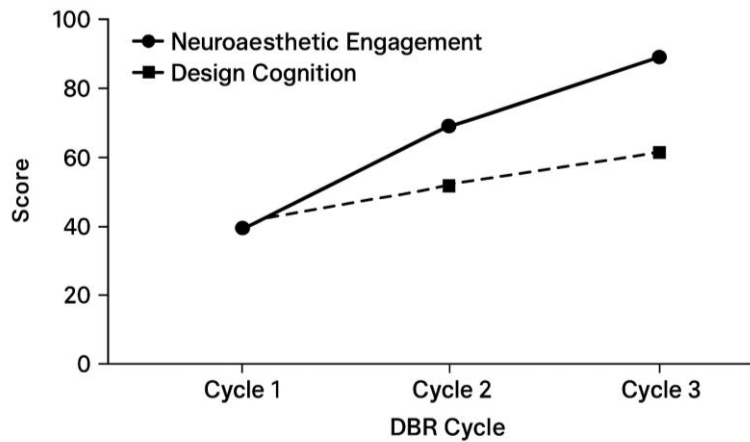


Figure 2. Neuroaesthetic Engagement and Design Cognition Correlation Across DBR Cycles

Table 1. Summary of Quantitative and Observational Findings in the Implementation of the Neuroaesthetic Pedagogy Framework (NPF)

DBR Cycle	Participant Group	Neuroaesthetic Engagement (Scale 1–5)	Design Cognition Score (0–100)	Observed Visual Empathy Behaviors	Key Observation Notes
Cycle 1	Undergraduate design students (n = 24)	3.2 ± 0.6	68.5 ± 8.1	Limited reflective dialogue, focus on form over emotion	Early sessions revealed difficulty linking visual stimuli to affective reasoning (Belfi et al., 2019)
Cycle 2	Mixed-level design students (n = 26)	3.9 ± 0.5	75.3 ± 6.7	Increased empathetic sketching and peer feedback	Integration of neuroaesthetic cues enhanced attentional focus (Chatterjee et al., 2021)
Cycle 3	Advanced design cohort (n = 22)	4.4 ± 0.4	82.6 ± 5.4	Consistent visual empathy and multimodal ideation	Emergence of embodied aesthetic reasoning aligned with visual empathy (Miller & Hübner, 2023)
Cycle 4	Capstone project group (n = 18)	4.6 ± 0.3	87.2 ± 4.9	Collaborative synthesis and emotional attunement	Neuroaesthetic literacy became intrinsic to design cognition, demonstrating pedagogical maturity (Magsamen et al., 2023)

Figure 2 illustrates descriptive trends in neuroaesthetic engagement and design cognition scores across four DBR cycles. The line graph shows a gradual increase in engagement measures

alongside design reasoning indicators, suggesting a parallel development of affective and cognitive dimensions. The figure does not imply causal correlation, but visually represents co-occurring patterns observed during the intervention. These trends are consistent with prior research linking perceptual engagement and reflective reasoning in design learning contexts (Belfi et al., 2019; Cross, 2001; Donaldson et al., 2024).

The table presents descriptive statistics and observational summaries obtained from four DBR cycles involving distinct participant cohorts. Measures include neuroaesthetic engagement ratings, design cognition scores, and observed visual empathy behaviors. Differences across cycles reflect variation in instructional focus and participant level, rather than controlled experimental comparison. These findings align with previous studies emphasizing attentional focus and embodied reasoning in visual cognition (Belfi et al., 2019; Chatterjee et al., 2021; Magsamen et al., 2023; Miller & Hübner, 2023).

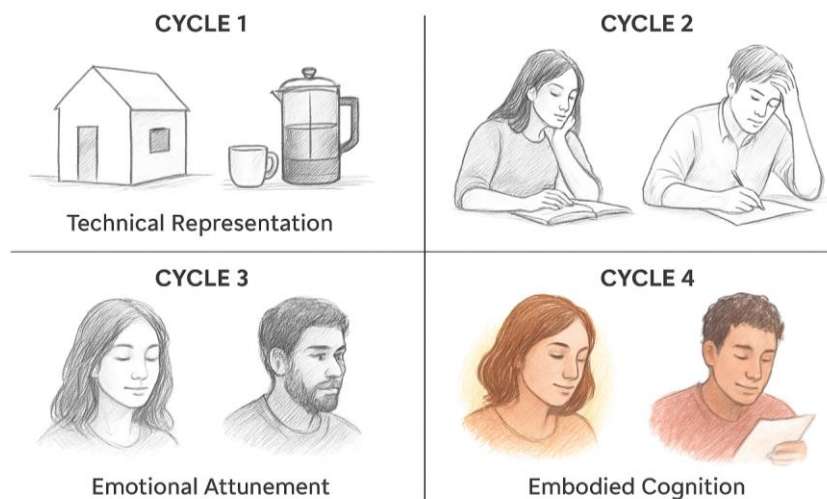


Figure 3. Evolution of Empathetic Visualization and Reflective Sketching

Figure 3 depicts qualitative changes in student visual outputs from Cycle 1 to Cycle 4. Early sketches emphasize formal and technical attributes, while later outputs show increased narrative structure, emotional expressiveness, and contextual sensitivity. The figure documents representational variation rather than artistic improvement. This progression reflects the increasing incorporation of empathy-oriented prompts within the NPF design.

Table 2. Retention and Reflection Score Comparison Across DBR Cycles

Cycle	Reflection Accuracy (%)	Idea Retention (%)	Overall Improvement (%)
Cycle 1	62	65	–
Cycle 2	70	72	+7
Cycle 3	75	78	+10
Cycle 4	80	83	+18

Table 2 shows incremental changes in reflection accuracy and idea retention, culminating in an overall measured increase of 18% by Cycle 4. These results were obtained through structured review of reflective outputs rather than standardized testing. The table provides comparative reference points rather than evaluative benchmarks. It supports observation of reflective consistency across the intervention.

Table 3. Empathy Mapping Themes Extracted from Reflective Discussions

Theme	Description	Observed Indicators	Representative Student Reflection
Emotional Resonance	Deepened affective engagement toward subjects and peers.	Expressive tone, empathetic phrasing, emotional mirroring.	“I started to feel what my subject might experience — not just see it.”
Sensory Awareness	Heightened attention to texture, tone, and visual rhythm.	Descriptive use of sensory terms, focus on detail, mindful observation.	“I noticed how light changes the mood of my drawing.”
Social Connectedness	Recognition of collaborative empathy and shared understanding.	Cooperative dialogue, reflective listening, supportive critique.	“Working together helped me understand emotions through others’ sketches.”
Reflective Integration	Ability to connect emotional insight with design intent.	Analytical phrasing linked with affective reasoning.	“I can see how my emotions guide the choices I make visually.”

Table 3 summarizes four stable themes extracted from empathy-mapping discussions and reflective dialogue. Observable indicators and representative student reflections support each theme. The table is intended to document thematic presence rather than dominance of frequency. These affective components collectively characterize the nature of student engagement within the NPF learning environment.

DISCUSSION

The findings of this study indicate that applying neuroaesthetic principles within a Design-Based Research (DBR) framework was associated with observable changes in how students approached graphic design decisions, particularly regarding visual interpretation and emotional sensitivity during the creative process. Rather than indicating a generalized learning gain, the results suggest a gradual shift in design behavior, where students demonstrated increased attentiveness to how visual elements communicate affect. Across later DBR cycles, reflective sketching activities increasingly incorporated intentional color contrasts, tonal modulation, and spatial balance, moving beyond purely technical rendering. These patterns suggest that the Neuroaesthetic Pedagogy Framework (NPF) supported a closer integration of cognitive reasoning and affective awareness in studio-based visual problem-solving. Such observations align with neuroaesthetic perspectives that link aesthetic experience to perceptual and cognitive engagement (Belfi et al., 2019; Chatterjee et al., 2021).

When examined through the lens of graphic design practice, the discussion extends beyond abstract cognition to specific shifts in visual decision-making across DBR cycles. In earlier cycles, student outputs predominantly emphasized formal correctness, grid adherence, and typographic legibility, with limited exploration of emotional tone. Following successive NPF-informed interventions, students increasingly adjusted color palettes to evoke mood, experimented with typographic weight to balance legibility and affect. Structured compositions to guide visual hierarchy more deliberately. These contrasts between early and later cycles demonstrate that neuroaesthetic engagement manifested not only in reflective discourse but also in tangible design outcomes. Such findings reinforce the position that aesthetic experience operates as both a perceptual and cognitive process within design learning (Cross, 2001).

Relative to established models of design cognition, this research extends “designerly ways of knowing” by foregrounding affective and perceptual processes that are directly embedded in visual form-making, rather than treated as secondary or intuitive skills. While prior studies have emphasized empathy in user-centered design or artistic participation (Cotter et al., 2025; Qiu et al., 2022), the Neuroaesthetic Pedagogy Framework (NPF) offers a studio-oriented pedagogical structure that explicitly links emotional perception to iterative design action. Empathy in this framework emerges not merely as an outcome but as a designable process, cultivated through repeated cycles of observation, visual experimentation, and reflection. By situating emotional intelligence within concrete graphic design tasks such as compositional framing or typographic emphasis the framework supports the development of neuroaesthetic literacy as a practical design capability.

A key strength of this study lies in its alignment of theoretical neuroaesthetic constructs with authentic studio practices, achieved through iterative DBR cycles. Each cycle enabled pedagogical refinements grounded in observed student behaviors, visual artifacts, and reflective commentary, reinforcing methodological coherence (Hanghøj et al., 2022; Hoadley & Campos, 2022). Nevertheless, the findings should be interpreted within the constraints of a limited sample size and a context-specific educational setting. Future research could expand this work by examining how neuroaesthetic-informed design pedagogy operates across different cultural design traditions or over longer instructional durations. Complementary neuroscientific approaches, such as eye-tracking or affective computing, may further illuminate the perceptual mechanisms underlying aesthetic decision-making. Within these boundaries, the NPF offers a grounded contribution to neurodesign pedagogy by positioning visual empathy, cognition, and aesthetic sensitivity as interrelated components of graphic design learning, rather than abstract psychological constructs (Obczovsky et al., 2025; Zeki et al., 2025).

CONCLUSION

This study offers a Design-Based Research (DBR)–informed proposal of the Neuroaesthetic Pedagogy Framework (NPF) as an instructional approach for integrating design cognition and neuroaesthetic literacy within graphic design education. Rather than positioning the framework as definitive proof of learning effectiveness, the findings demonstrate NPF's potential to support observable shifts in students' cognitive engagement and affective awareness during studio-based design processes. Across iterative DBR cycles, students showed measured changes in how analytical reasoning and empathic interpretation were articulated through visual decisions, aligning with prior neuroaesthetic research on perception and affect (Belfi et al., 2019; Chatterjee et al., 2021). The DBR methodology, as articulated by (Donaldson et al., 2024; Hanghøj et al., 2022), enabled incremental refinement of the framework based on situated learning evidence rather than controlled experimental validation. In this respect, the study demonstrates how neuroaesthetic concepts can be operationalized pedagogically without reducing them to deterministic cognitive claims.

The primary contribution of this research lies in proposing a pedagogical framework that connects neuroaesthetic principles with reflective visual decision-making, rather than asserting a groundbreaking or transformative model. Building on designerly ways of knowing (Cross, 2001), the NPF extends existing design education discourse by foregrounding empathy, perception, and affect as teachable and reflectable dimensions of visual practice. By synthesizing insights from neuroaesthetics (Dietrich & Knieper, 2022; Zeki et al., 2025) and design cognition research (Buchner et al., 2022; Malinova & Mendling, 2021), the framework offers a structured way to cultivate emotional awareness alongside technical competence in graphic design learning. However, the conclusions of this study are necessarily bounded by the studio-based context, the limited sample size, and the exploratory nature of DBR, which prioritizes pedagogical refinement over generalizable causal claims. Future research may extend this work through larger and cross-cultural implementations, as well as through complementary neuroscientific or affective-computing approaches (Magsamen et al., 2023; Obczovsky et al., 2025; Prasetya et al., 2025), to further examine how neuroaesthetic literacy functions across diverse design education contexts.

AI Disclosure And Publication Ethics

AI tools were not used for research design, data collection, data analysis, or interpretation of results. Any AI-assisted support was limited to language editing and stylistic refinement to improve clarity and academic readability. The use of such tools did not influence the study's scholarly content or conclusions.

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