

Brain-Driven Opportunity Validation: A Multimodal Design-Based Framework for Entrepreneurial Education

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Abstract: Entrepreneurship education has traditionally framed opportunity validation as a rational, market-oriented process centred on analytical reasoning and persuasive argumentation. However, validation scenarios in real entrepreneurial contexts are cognitively demanding and emotionally charged, requiring students to regulate their attention, manage stress, and adapt their communication under uncertainty. Despite growing interest in brain-driven approaches to entrepreneurial learning, the cognitive-emotional dynamics underpinning opportunity validation remain underexplored in entrepreneurial pedagogy. This work-in-progress paper proposes a brain-driven redesign of opportunity validation grounded in cognitive performance, emotional regulation, and embodied learning. Adopting a Design-Based Research (DBR) methodology, the study implemented and iteratively refined a multimodal pedagogical framework across two student groups in an undergraduate entrepreneurship programme at a private Mexican university. The intervention integrated four design principles: authentic validation contexts using real target-market audiences; neurophysiological observation tools including EEG headbands and eye-tracking glasses; emotional design assessment grounded in the visceral-behavioural-reflective model proposed by Norman (2005); and guided reflection protocols to support metacognitive processing under pressure. Rather than focusing solely on market feasibility, the framework reconceptualises desirability as a cognitive-emotional construct, positioning validation as an embodied interaction among the entrepreneur, audience, and opportunity. Preliminary qualitative observations suggest improvements in communicative clarity, strategic argumentation, and empathic connection with the audience, dimensions rarely captured by conventional evaluation instruments. Quantitative data collected using neurophysiological devices are currently being analysed and will inform future empirical publications. By bridging brain-driven entrepreneurship and educational design, this study contributes a replicable framework for rethinking opportunity validation in higher education.

Keywords: Brain-driven Entrepreneurship, Opportunity Validation, Design-based Research, Emotional Regulation, Cognitive Performance

1. Introduction

Opportunity validation in entrepreneurship education has predominantly been assessed through rational, market-oriented criteria: feasibility analysis, competitive positioning, and logical argumentation. Yet in authentic entrepreneurial settings, validation is a high-stakes cognitive-emotional event. The entrepreneur must simultaneously regulate attentional demands, manage stress responses, and adapt communication in real time before an audience with genuine expectations. These dimensions, encompassing cognitive load, emotional regulation, and embodied interaction, are rarely visible through conventional assessment instruments.

Despite growing interest in brain-driven entrepreneurship (Silitonga et al., 2025) and the neurophysiological dimensions of learning and emotion regulation (Egana-delSol et al., 2023; Rehman et al., 2025), the pedagogical design of validation experiences in higher education has not kept pace. Most pitch exercises remain evaluator-centred and outcome-focused, overlooking how students regulate their cognitive-emotional performance in real time.

This paper presents a work-in-progress, design-based intervention addressing this gap. Developed within the Bachelor in Entrepreneurship at Tecnológico de Monterrey, the framework repositions opportunity validation as a brain-aligned, emotionally intentional pedagogical event that can be observed, reflected upon, and iteratively redesigned.

2. Theoretical Background

Brain-driven entrepreneurship proposes that entrepreneurial behaviour is fundamentally shaped by cognitive and affective processes: attention regulation, neuroplasticity, emotional resilience, and embodied decision-making (Silitonga et al., 2025). This aligns with Lackéus (2020), who argues that emotionally significant learning events produce deeper entrepreneurial competencies than content-centred instruction alone.

The present work draws on three theoretical pillars. First, the emotional design model proposed by Norman (2005) identifies three levels of user response: visceral (immediate affective reaction), behavioural (functional interaction), and reflective (attributed meaning). Applied here, desirability is reconceptualised as a cognitive-emotional construct shaped by the quality of interaction between entrepreneur, idea, and audience, rather than as a binary market judgment.

Second, Fredricks, Blumenfeld and Paris (2004) conceptualise student engagement as multidimensional, encompassing behavioural, cognitive, and emotional components. This framework informs both the design of the intervention and its observational strategy, since neurophysiological tools allow these dimensions to become simultaneously visible.

Third, Design-Based Research (DBR) (McKenney and Reeves, 2012) provides the methodological rationale for iterative educational design informed by practitioner observation and theory. DBR legitimises work-in-progress contributions because the value lies in the progressive refinement of the design, not solely in its final outcomes.

3. Methodology

The intervention was implemented within the unit “Evaluation and Communication of Opportunities” (fourth semester, Bachelor in Entrepreneurship, Tecnológico de Monterrey). Twenty-eight students across two groups participated, organised into teams of three to four members. The brain-driven validation framework is structured around four interconnected design principles, summarised in Table 1.

Table 1: Four design principles of the brain-driven validation framework

Design Principle	Component	Instrument / Tool	Function
Authentic Context	Real target-market audience	External stakeholder recruitment	Simulates genuine validation pressure
Neurophysiological Observation	EEG (presenters); eye-tracking and physiological sensors (audience)	Muse 2; Tobii Pro Glasses 3; Empatica Embrace Plus	Captures EEG-derived attentional activity, gaze fixation patterns, electrodermal activation, and physiological arousal; processed to estimate cognitive-emotional performance indicators
Emotional Design Assessment	Visceral, behavioural, reflective dimensions (audience); dedication, vigor, absorption (students)	Norman (2005) desirability instrument; UWES-S 9 (Schaufeli et al., 2002)	Assesses perceived desirability from the audience and engagement from student presenters
Guided Reflection Protocol	Metacognitive processing post-event	Structured prompts and post-activity questionnaire	Supports self-regulation and iterative learning

The activity unfolded in three phases: preparation (40 min) for device installation, consent, and protocol explanation; execution (110 min) of team presentations up to seven minutes with real-time audience feedback; and closure (30 min) for collective reflection and post-activity questionnaire administration. All sessions took place in the Living Lab Experiential Classroom (Morán et al., 2025).

Qualitative data collection involved four faculty members who documented student performance using predefined reflective categories aligned with Norman’s (2005) emotional design dimensions and Fredricks et al.’s (2004) multidimensional engagement framework. Observational notes were consensually validated through structured post-session debriefs. Data triangulation drew on three sources: faculty observations, audiovisual recordings of student-audience interactions, and two post-activity self-report instruments. Student presenters

completed the Utrecht Work Engagement Scale, Student version (UWES-S 9; Schaufeli et al., 2002), capturing vigor, dedication, and absorption (n=23; 100% response rate). Market-audience participants completed a desirability instrument based on Norman's (2005) visceral, behavioural, and reflective levels, with guided verbal feedback. Both instruments were adapted and validated by the IFE Experiential Classroom research team at Tecnológico de Monterrey. Quantitative neurophysiological data are under analysis and will inform a forthcoming publication.

4. Preliminary Findings

4.1 Student Dimension

Across the three qualitative data sources, preliminary patterns emerged in two interrelated areas: perceived engagement and observed performance during validation. Relocating the activity to the Experiential Classroom produced a notable shift in student disposition, with participants describing the environment as more professional and cognitively demanding than conventional routines. Several students reported heightened awareness of the mind-body-communication connection when equipped with EEG devices, consistent with Silitonga et al. (2025). In some cases, device use appeared to provoke mild performance anxiety, identified by the teaching team as a target for iterative redesign.

Faculty observations, corroborated by audiovisual review, suggested patterns of structured argumentation, reduced reliance on memorised scripts, and increased responsiveness to audience feedback. The independent recruitment of real market representatives appeared to function as a formative experience in itself, prompting students to practise proactivity and value communication beyond the classroom. UWES-S 9 self-reports will be triangulated with these observations in subsequent cycles to examine whether perceived vigor, dedication, and absorption align with externally observed performance.

4.2 Faculty Dimension

The intervention required substantive pedagogical reconfiguration. Aligning learning objectives, formative evaluation criteria, and technical protocols demanded interdisciplinary coordination across academic, research, and technical staff. Faculty reported a qualitative shift in their observational capacity, noticing how students managed stage anxiety, adjusted verbal and non-verbal communication, and responded emotionally under validation pressure. These observations align with Nabi et al. (2017), who argue that entrepreneurship education must integrate content, context, and process in a unified pedagogical logic.

5. Discussion and Implications

This study reframes opportunity validation in entrepreneurship education as a cognitive-emotional performance shaped in real time, rather than as a rational and market-oriented process. The framework contributes on two interrelated levels. Theoretically, it extends the concept of desirability beyond market fit by positioning it as a cognitive-emotional construct that requires the entrepreneur to engage with the audience at the visceral, behavioural, and reflective levels (Norman, 2005; Fredricks et al., 2004). Methodologically, it offers a replicable design that can be adapted by educators with varying levels of technological access, provided the core principles of authenticity, emotional intentionality, and reflective practice are preserved.

A key implication is that opportunity validation can be redesigned to generate richer formative data without requiring full technological infrastructure. Neurophysiological tools function as observation instruments, not as ends in themselves. Educators in resource-constrained settings can preserve the framework's logic by substituting digital tools with structured observational protocols and emotionally grounded rubrics.

Ongoing analysis of neurophysiological data will enrich the qualitative account with empirical evidence of cognitive and emotional patterns during student performance. Consistent with Egana-delSol et al. (2023), who showed that neurophysiological markers capture programme impact missed by self-reported measures, this study positions physiological observation as a complement to conventional assessment. As a work-in-progress study, findings are based on triangulated qualitative observations, while neurophysiological data remain under analysis. Subsequent cycles will examine the relationship between neurophysiological indicators, communication quality, and perceived desirability.

6. Conclusion

This work-in-progress paper proposes a brain-driven, design-based framework for reconceptualising opportunity validation in entrepreneurship education. By integrating authentic validation contexts, neurophysiological observation, emotional design assessment, and guided reflection, the framework is designed to make visible dimensions of student performance, including cognitive load, emotional regulation, and empathic communication, that conventional instruments rarely capture. It offers educators and researchers a replicable model for brain-aligned validation in higher-education entrepreneurship programmes. Rather than evaluating whether an idea is convincing, this framework enables educators to understand how students become convincing under real cognitive and emotional pressure.

Ethics Declaration

Ethical clearance was obtained from Tecnológico de Monterrey prior to data collection. All student participants and invited audience members provided written informed consent. The neurophysiological data collection protocol received institutional approval under the Novus Experiential Classroom 2024 grant (Project ID 833146). Participant anonymity and data confidentiality have been maintained throughout, with data stored securely under institutional policy.

AI Declaration

AI-assisted writing tools were used for language editing and structural feedback. All theoretical framing, design decisions, data collection, and arguments were developed by the authors. The pedagogical intervention and research design were carried out independently.

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