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Pedagogical Reform for Entrepreneurial Readiness: Bridging Engineering Education And Entrepreneurship in Nigeria

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ABSTRACT

BACKGROUND & CONTEXT

Engineering education in Nigeria holds the potential to mitigate graduate unemployment and promote economic self-reliance through the integration of entrepreneurial competencies within technical training. However, persistent unemployment among engineering graduates highlights critical pedagogical shortcomings. Prior studies reveal that generic curricula, limited pedagogical innovation, weak mentorship, and inadequate access to start-up capital constrain graduates from becoming job creators. These systemic barriers necessitate pedagogical reform to strengthen entrepreneurial readiness among engineering students.

PURPOSE

The study reviews the current integration of entrepreneurship in Nigerian engineering education and identifies evidence-based strategies for strengthening students' entrepreneurial capacity. Using the Theory of Planned Behavior (TPB), it examines how innovative pedagogies influence students' entrepreneurial attitudes and perceived behavioural control.

METHODOLOGY

A narrative, theory-driven review was conducted using scholarly sources from Google Scholar, ResearchGate, institutional repositories, and peer-reviewed journals. The review focused on Nigeria-based TPB-aligned studies and synthesised evidence across key pedagogical approaches relevant to entrepreneurship in engineering education.

OUTCOMES

Findings indicate that while conventional interventions such as SIWES and entrepreneurship courses enhance technical competence, they have limited influence on entrepreneurial attitudes and innovation. Conversely, approaches like PBL and PrBL foster higher levels of self-efficacy, creative problem-solving, and entrepreneurial intention.

CONCLUSIONS

Experiential and innovation-driven pedagogy emerge as a critical lever for developing entrepreneurial capacity in Nigerian engineering education. Future research should test integrated curricula, scalable innovation ecosystems, and long-term entrepreneurial outcomes.

KEYWORDS

Engineering Education, Entrepreneurial Competencies, Pedagogical Innovation; Nigeria, Theory of Planned Behaviour, Pedagogical Reform.

Introduction

Graduate unemployment remains a pressing concern in Nigeria, with more than 600,000 graduates entering the labor market annually and facing significant barriers to securing formal-sector jobs. This challenge is exacerbated by curricula that privilege certification over the development of practical and entrepreneurial competencies (Fenta, 2024; Godday et al., 2013; NBS, 2024). Although Nigeria ranks as one of Africa's major economies, the country continues to grapple with a persistent 'youth bulge' in which large cohorts of young people enter the workforce without viable pathways to self-employment or innovation (Oyinlola et al., 2024; Virk et al., 2024). The continued reliance on public-sector (White-collar) employment further compounds the issue, particularly among engineering graduates, whose technical expertise remains underutilized (Edokpolor, 2020; Ezeani, 2018).

This paper examines how Nigerian engineering education, when integrated with entrepreneurship training, can enhance employability and support self-reliance. Prior studies suggest that embedding entrepreneurial learning into technical curricula enables students to identify opportunities, innovate, and establish sustainable ventures in dynamic economies (Adegbite et al., 2025; Idris et al., 2021). Yet, the systematic incorporation of such approaches into Nigerian engineering programmes remains insufficiently documented. Addressing this gap, the study asks: How can engineering education in Nigeria employ theoretical frameworks and innovative pedagogical strategies to cultivate entrepreneurial competencies?

The analysis is guided by Ajzen's Theory of Planned Behavior (TPB), which posits that attitudes toward entrepreneurship, subjective norms, and perceived behavioral control jointly shape entrepreneurial intentions (Ajzen, 1991). Empirical studies within Nigerian contexts and beyond, corroborate the relevance of TPB, showing significant correlations between entrepreneurship education and entrepreneurial intentions, mediated through TPB constructs (Ajike et al., 2015; Ayo-Sobowale, 2021; Kolade et al., 2024; Valencia-Arias & Restrepo, 2020). Beyond entrepreneurship, TPB has demonstrated predictive validity across diverse behavioral domains, including health, consumption, sustainability, and technology adoption (Ajzen, 2020; Valencia-Arias & Restrepo, 2020).

Methodologically, this paper employs a narrative, theory-informed literature review, using TPB as the organizing framework. Rather than adhering to systematic search protocols, the review synthesizes representative Nigerian-focused studies using sources from Google Scholar, ResearchGate, institutional repositories, and peer-reviewed journals, to illuminate key themes concerning education, barriers, and entrepreneurial mindsets, while recognizing that it does not provide exhaustive coverage of all available literature (Sukhera, 2022). Narrative literature review provides the flexibility needed to integrate context-specific evidence and interpret emerging patterns that may not fit within the constraints of systematic review protocols.

Concept of Engineering Education Towards Entrepreneurial Readiness

Engineering is an interdisciplinary discipline that integrates scientific and mathematical foundations to design, construct, and maintain structures, machines, systems, and processes. Its primary purpose is to address complex challenges and foster innovation across various sectors through technical proficiency (Ivanov et al., 2024). Engineering education, in turn, denotes the systematic process of equipping individuals with the knowledge, skills, and competencies required for effective professional practice in engineering fields. Typically delivered in universities, polytechnics, or technical institutions, it combines theoretical instruction with practical training to ensure both conceptual understanding and hands-on competence (Ivanov et al., 2024). Beyond academic preparation, engineering education plays a vital role in technological advancement and industrial growth by cultivating problem-solving abilities and technical proficiency essential for national economic transformation. Countries that have prioritized engineering education, such as South Korea and Singapore, have demonstrated rapid industrialization and global competitiveness (Ozor & Mbohwa, 2019). Does this training automatically translate into entrepreneurial readiness? This question needs to be

answered urgently in order to reposition engineering education in Nigeria for global impact. Over the years, engineering education system in Nigeria has not received the necessary support it deserves (Azubuike et al., 2019), contributing to high graduate unemployment and 'brain drain', a situation referring to the process by which a country loses its highly educated and skilled workforce to other nations through migration (Anetoh & Onwudinjo, 2020; Jacob & Atobauka, 2021). This paper highlights the entrepreneurial potential of engineering education, and how Nigeria can leverage engineering graduates for national development. Reforming engineering education may contribute to reducing unemployment rate in Nigeria an effort recently been recorded by the federal government.

Reforms and Global Alignment in Nigerian Engineering Education

Engineering education in Nigeria has undergone significant transformation, shaped by economic, social, and historical forces. These changes parallel global efforts to strengthen STEM education, as Nigeria increasingly aligns its engineering programs with international standards. A notable milestone was Nigeria's accession as a provisional signatory to the Washington Accord in June 2024, facilitated by the Council for the Regulation of Engineering in Nigeria (COREN). This development is anticipated to raise accreditation benchmarks, enhance curriculum quality, and improve global recognition of Nigerian engineering qualifications (Adekoya, 2024; Omisore, 2025; Sadiq, 2023). Experiences from other signatory countries such as China and Malaysia suggest that Washington Accord membership can catalyse governance reforms, strengthen quality assurance systems, and accelerate the adoption of international best practices in engineering education (Li, 2023). Despite these advancements, gaps remain in embedding entrepreneurship within Nigerian engineering education curricula. While these reforms have strengthened technical standards, less emphasis has been placed on innovative pedagogical approaches that cultivate entrepreneurial mindsets and self-employment capacities, leaving engineering graduates with technical competence, but lacking entrepreneurial capacity. Thus, integrating frameworks such as the TPB and innovative learning approaches offers a pathway to reorient Nigerian engineering education toward producing graduates who are both technically competent and innovation driven.

Taxonomy of Pedagogical Models in Nigerian Engineering Education

Figure 1 maps five pedagogical models in Nigerian engineering education. The apprenticeship-based, lecture-based, project-based, problem-based, and blended/ICT-enhanced learning against their core learning modes and entrepreneurial competence outcomes. Together, these approaches highlight the diverse but uneven ways in which pedagogy contributes to entrepreneurial readiness. The apprenticeship model, rooted in traditional systems such as the Igbo "Igba-Boi," emphasizes mentorship and settlement, thereby enhancing self-efficacy and innovation-linked attitudes (Agu & Margaça, 2025; Ifeanyi et al., 2020). In contrast, the lecture-based model remains theory-heavy and classroom-bound, building technical knowledge but contributing little to entrepreneurial orientation (Nweke et al., 2025; Sørensen et al., 2022; Sorensen & Kuada, 2022). More interactive models are the project-based and problem-based learning (PBL) which shift the focus toward authentic, real-world challenges. These innovative pedagogies strengthen perceived behavioral control through confidence-building, while also reinforcing collaborative norms and interest in entrepreneurial practice (Helmi et al., 2017; Kristiawan et al., 2021; Orji, 2021; Tugwell, 2020). Blended and ICT-enhanced instruction on the other hand, leverages digital platforms and simulations to cultivate adaptability, tech literacy, and an innovation mindset critical for contemporary entrepreneurial ecosystems (Udeozor et al., 2025). Collectively, this taxonomy illustrates how pedagogical models interface with the Theory of Planned Behavior (TPB): by shaping attitudes (innovation and creativity), reinforcing norms (collaboration and enterprise culture), and enhancing perceived behavioral control (confidence and applied competence). While traces of all five models exist within Nigerian universities, structural barriers limit the 'full' adoption and popularity of PBL and blended/ICT-enhanced approaches in Nigeria. However, embedding these innovative models

more systematically holds promise for strengthening entrepreneurial competence development among engineering graduates.

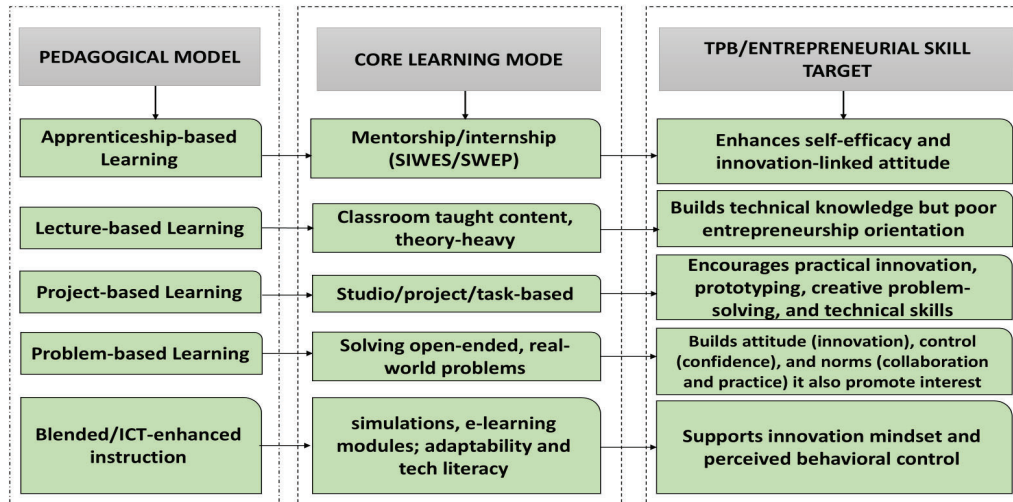


Figure 1: Taxonomy of pedagogical models in Nigerian engineering education and their implications for entrepreneurial competence development (author-developed).

Practical Skills and Entrepreneurial Readiness

Engineering education aims to develop practical competencies in areas such as design, programming, project management, laboratory practice, and equipment handling. Engineering students are expected to acquire these skills as they pass through engineering studio activities, workshop practice/SWEP, engineering laboratory practicals and the Student Industrial Work Experience Scheme (SIWES). Yet in Nigeria, the effectiveness of initiatives like the SIWES and workshop/SWEP training is limited by poor teaching methods, poor supervision, under-equipped workshops and laboratories and misaligned SIWES placements, which diminish their capacity to foster entrepreneurial readiness (Adebite et al., 2025; Nweke et al., 2025; Oladimeji, 2024). Although these initiatives enhance technical proficiency and perceived behavioural control, they contribute less effectively to shaping entrepreneurial attitudes and opportunity recognition, which are central to the Theory of Planned Behaviour in explaining intention formation (Bubou et al., 2015). Evidence increasingly suggests that pedagogical innovations such as Project-Based Learning play a more significant role in advancing entrepreneurial competence by strengthening self-efficacy, creative problem-solving, and applied skills, highlighting the need for restructured teaching models that explicitly link practical training with entrepreneurship development (Kristiawan et al., 2021; Obada et al., 2021). It is important to acknowledge that practical competence is easily developed when students are assigned project to do by themselves, they learn faster, trust their abilities, develop confidence and the eagerness to try new things. Uzor (2024) found out that while practical content of engineering programs has influence on students' entrepreneurial readiness, recommend that teaching methods that emphasize practice over theory such as "project-based learning" should be fully adopted.

Pedagogical Reform and Entrepreneurship-Oriented Instruction Delivery

This paper contributes to the broader discourse on engineering education reform in Nigeria, particularly in relation to addressing graduate unemployment and promoting economic self-reliance through entrepreneurship by examining entrepreneurial readiness through the lens of TPB, emphasizing the importance of students' attitudes, subjective norms, and perceived behavioral control. The current lecture-dominated instruction has been shown to inadequately foster the self-efficacy and entrepreneurial mindset necessary for self-reliance, constraining

students perceived behavioral control and diminishing entrepreneurial intention (Idris et al., 2021). Nigerian scholars have constantly point out how lecture-based method which is teacher-centered, has dominate teaching practices in Nigerian despite its weakness in engaging students in active-learning that promote outcome-based education (OBE). While Idris et al. (2021) introduces an entrepreneurship-integrated Workshop Technology model validated primarily through expert review, and Kolade et al. (2021) highlight the potential of university–industry–government partnerships via the Triple Helix framework, empirical evidence on practical implementation and measurable outcomes remains sparse. Complementary to these perspectives, Udeozor et al. (2025) and advocates for experiential teaching methods such as role plays, simulations, and project-based activities over traditional lectures; the experiential pedagogy, particularly through faculty engagement and out-of-class experiences (OCE), plays an important role in shaping entrepreneurial attitudes and behaviors across diverse university contexts.

Evidence have shown that OCE enhance intention to innovate, primarily mediated by perceived behavioral control, highlighting the value of experiential learning in strengthening entrepreneurial competencies, especially within resource-limited environments like Nigeria (Udeozor et al., 2025). However, longitudinal data on their impact on entrepreneurial outcomes is lacking. Internationally, Project-Based Learning (PBL) has demonstrated efficacy in enhancing entrepreneurial Confidence and determination (Kassim et al., 2024; Sun et al., 2017), and experiential teaching approaches have been linked to positive shifts in entrepreneurial attitudes and normative beliefs, aligning closely with TPB constructs. Notwithstanding, the integration of these innovative pedagogies within Nigerian engineering curricula remains understudied, particularly concerning how institutional supports including faculty training, AI-facilitated tools, and collaborative partnerships interactively reinforce TPB antecedents. Addressing this gap necessitates rigorous mixed-methods and longitudinal research to elucidate how combined pedagogical reforms and institutional enablers foster entrepreneurial intention and actual venture creation, thereby providing actionable pathways to strengthen entrepreneurship education in Nigerian engineering programs.

Setbacks Hindering Entrepreneurship among Engineering Graduates

Although entrepreneurship education is valuable for preparing graduates to function effectively within established industries, it is particularly significant for engineering students who intend to launch their own enterprises after graduation (Santos, 2023). However, several studies have highlighted factors that constrain the development of effective entrepreneurship education and hinder venture creation in Nigeria, including: inadequate facility, under-funding, weak awareness and motivation within institutions and faculties (Rowell, 2023). Numerous interrelated factors undermine entrepreneurship among Nigerian engineering graduates, including ineffective entrepreneurship instruction, weak enterprise spirit, and ill-adapted curricula that fall short of nurturing innovation, creativity, and technical readiness (Nwite, 2016). Additionally, Adebakin (2023) identifies the absence of intentional entrepreneurship orientation, fear of failure, insufficient practical training, and adverse socio-economic factors such as political instability, inadequate funding, and security threats as major barriers to youth entrepreneurial intent. These challenges reduce students' readiness for self-employment and highlight the urgent need to reform curricula, enhance pedagogy and instructor capacity, and build supportive ecosystems to promote engineering ventures in Nigeria. Drawing on empirical and qualitative findings, the authors discussed three prevalent themes in the Nigerian context that consistently emerge across literature and suggest the way forward.

Entrepreneurship Mind-Set Among Engineering Educators and Students

The concept of “mindset” has been widely understood as a set of unquestioning beliefs that form how individuals perceive their abilities and react to challenges. Dweck (2006) clarifies that a ‘fixed mindset’ reflects the belief that intelligence and abilities are unchangeable traits, whereas a ‘growth mindset’ is based on the assumption that capabilities can be enhanced

through dedication, practice, and continuous learning. This distinction has proven central to understanding motivation, resilience, and learning outcomes across educational settings. Building on this foundation, Daspit (2023) describe the “entrepreneurial mindset” as a mix of cognitive and behavioral orientations that help people spot opportunities, handle uncertainty, and keep going when faced with challenge. It is a combination of attitudes, skills, and thought processes that support innovation, adaptability, and opportunity recognition.

Empirical research consistently demonstrates that entrepreneurial mindset mediates the relationship between entrepreneurship education and entrepreneurial intentions. For example, Mukhtar (2021) show that entrepreneurial mindset strengthens the effect of entrepreneurship education on intention, while Wu et al. (2022) and Vamvaka (2020) highlight the moderating role of self-efficacy in this process. Likewise, Sun et al. (2023) found that entrepreneurship education significantly enhances students’ entrepreneurial mindset, which in turn positively influenced their intention to engage in entrepreneurship. In the Nigerian context, Nwibe and Bakare (2022) provide complementary evidence, showing that self-efficacy beliefs significantly predict entrepreneurial intention among Electrical/Electronic Technology Education students, underscoring the importance of mindset-related constructs in resource-constrained environments like Nigeria. Bui et al. (2023) highlight that mindset is a significant predictor of academic achievement, influencing how students perceive their own abilities. Furthermore, cultivating an entrepreneurial mindset has been found to significantly strengthen students’ tendency toward entrepreneurship (Ben-Caleb, 2025; Ibrahim & David, 2019; Sörensen et al., 2022). This shift can be initiated by lecturers in the classroom, inspiring self-reliance and entrepreneurial thinking among students. Francis (2020) identifies educators’ attitudes and perceived teaching efficacy as foundational to the success of entrepreneurship education; without a positive disposition and strong self-efficacy (perceived behavioral control) by both students and educators, achieving the objectives of entrepreneurship may unlikely be possible. Therefore, to foster effective entrepreneurship among engineering graduates, educators must first undergo a mindset shift themselves, as their attitudes and beliefs significantly shape student outcomes.

Inadequate Engineering-Focused Entrepreneurship Education

Although in 2006, the National University Commission (NUC) mandated entrepreneurship education across all Nigerian universities, scholars argued that implementation remains superficial, generic and with a lot of flaws (Ben-Caleb, 2025). Most institutions still deliver entrepreneurship through general studies (GS) courses attended by diverse student groups spanning agriculture, management, psychology, and engineering resulting in curriculum content and teaching methods that are misaligned with engineering-specific needs (Francis, 2020; Nwite, 2016). This approach has proven ineffective in fostering entrepreneurial mindsets among engineering students. Oyinola et al. (2024) note that while entrepreneurship education is widely supported in Nigerian policy, its implementation across universities remains fragmented, necessitating curriculum reform through stakeholder collaboration. Nwufo and Nwosu (2024) emphasize that entrepreneurship within engineering faces systemic challenges, notably its treatment as an elective rather than a core requirement, alongside a shortage of qualified faculty. These limitations restrict students’ entrepreneurial capacity. Embedding entrepreneurship directly into engineering curricula is therefore essential. As Santos (2023) argues, integrating entrepreneurship equips engineering students to identify, pursue, and compete effectively for business opportunities.

Limited Access to Funding Engineering Enterprise

Engineering ventures typically require substantial capital due to equipment and facility costs as shown in table 1. This has always created a significant barrier for fresh graduates lacking collateral.

Table 1: Basic starter workshop shopping list for a Nigeria-based welding and fabrication enterprise

S/N	EQUIPMENT/TOOLS	QTY	APPROX. COST (₦)	APPROX. COST (\$)
1	Welding Machine (315 amps)	1	450,000	280.535
2	Angle Grinder	1	95,000	59.227
3	Hand Drilling Machine	1	50,000	31.172
4	Heavy Duty Bench Vice	1	65,000	40.524
5	Heavy Duty Workbench (locally fabricated)	1	175,000	109.102
6	Electric Service Cable (for power supply)	2 Rolls	120,000	74.813
7	Electric Meter/Circuit Breakers (3 Phase)	1	145,000	90.399
8	Welding Cables & Ground Clamps	2	45,000	28.054
9	Measuring & Marking Tools (Tape/Steel Rule,)		50,000	31.172
10	Cutting & Grinding Tools (Hacksaw, Chisels)		45,000	28.054
11	Safety Equipment (Goggles, Earplugs)		120,000	74.812
12	Fabrication Tools (Clamps, Metal Bender, etc)		480,000	299.252
13	Consumables (Electrodes, Discs, filler wires etc)		35,000	21.820
14	Renting Small Workshop Space/Set-up		300,000	187.032
15	Transportation/Installation		150,000	93.516
16	Miscellaneous		120,000	74.812
17	Total		2,445,000	1,524.314

The basic shopping list presented in Table 1 was developed from the professional experience of one of the co-authors, who operates a small-scale engineering welding and fabrication enterprise in Nigeria. The listed prices were obtained from online marketplaces (jiji.ng and Jumia Nigeria) and converted using the April 2025 exchange rate (₦1 = \$1,604). The source of the compiled list is D'gurusbwala's Standard Concept Nigeria Limited.

National entrepreneurship programs often overlook these capital-intensive requirements, limiting graduates' ability to translate ideas into viable businesses (Isiaka et al., 2023). Empirical surveys consistently list financial constraint as a top impediment to entrepreneurial action among university graduates (Gumel & Bardai, 2021). Must of the government policies and programmes such as the National Enterprise Development Programme (NAPEP), YOUWIN, N-power among others, fades away with the administration that brought them. Furthermore, government agencies such as the Bank of Industry (BOI), Small and Medium Enterprise Development Agency of Nigeria (SMEDAN); Industrial Training Fund (ITF) among others, always complained of poor funding, inconsistency in monitoring and government policies, poor execution and bureaucracy (Umar et al., 2022). Consequently, access to finance remain a major challenge especially fresh graduates with entrepreneurial intentions.

Conclusion

This review demonstrates that restructuring engineering education in Nigeria through TPB-aligned and innovative pedagogical approaches is essential for developing entrepreneurial competencies among graduates. While conventional interventions strengthen perceived behavioural control, they fall short in shaping entrepreneurial attitudes and opportunity recognition, whereas models like PBL and indigenous apprenticeship systems more effectively enhance self-efficacy and creative problem-solving. The findings underscore the need for intentionally designed entrepreneurship-focused engineering curricula, strengthened faculty capacity, and alignment with broader socio-economic ecosystems to support innovation-driven graduate outcomes.

Recommendation

To strengthen entrepreneurial readiness in Nigerian engineering education, several reforms are recommended. Entrepreneurship curricula should shift from generic courses to engineering-specific modules grounded in local innovation opportunities. Blended project-based entrepreneurial learning (PBEL) should be institutionalised to support ideation, prototyping, and venture initiation. Faculty capacity must be enhanced through sustained pedagogical development programs, supported by longitudinal evaluation of graduate entrepreneurial outcomes. Finally, government-backed financing schemes like the Youth Enterprise with Innovation in Nigeria (YOUWIN) program should be reinstated to provide structured, interest-free start-up capital for graduates with viable ventures.

Limitations and Future Research Directions

This review advances understanding of Nigerian engineering entrepreneurship education but is limited by methodological and contextual constraints. Its narrative design reduces transparency and reproducibility, and reliance on single-site, short-term studies limits generalisability across Nigeria's diverse higher education system. The absence of longitudinal evidence obscures long-term entrepreneurial outcomes, while infrastructural challenges particularly the digital divide remain insufficiently examined. Future research should adopt multi-institutional, longitudinal, and quasi-experimental designs, evaluate infrastructure readiness for blended learning, and assess faculty development and incubator-linked pedagogies using implementation science frameworks.

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