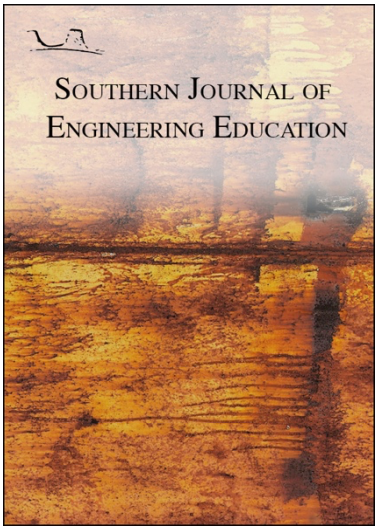

SOUTHERN JOURNAL OF ENGINEERING EDUCATION

Publication details, including instructions for authors and other information can be found at https://journals.uct.ac.za/index.php/sjee

Fostering entrepreneurial mindsets in engineering and science education: a comparative study of Kenya, the Democratic Republic of Congo, and Namibia

Mbela Kalengay[a]
Kaarina Anna Paulus[a]
Boniface Kerima[a]
Alex Wa Mutombo Banze[b]

[a] *Department of Mathematics, Science and Sports Education, University of Namibia, Namibia*

[b] *Institut Supérieur Pédagogique et Technique*

Submission received: 30 June 2025 / Published: 5 January 2026

To cite this article: Kalengay, M., Paulus, K.A., Kerima, B., & Banze, A.M. (2026). Fostering entrepreneurial mindsets in engineering and science education: a comparative study of Kenya, the Democratic Republic of Congo, and Namibia, *Southern Journal of Engineering Education*, *4*, 4–21. DOI:

Southern Journal of Engineering Education, 2026
Vol 4, 4–21

Fostering entrepreneurial mindsets in engineering and science education: a comparative study of Kenya, the Democratic Republic of Congo, and Namibia

Mbela Kalengay*[a]
Kaarina Anna Paulus[a]
Boniface Kerima[a]
Alex Wa Mutombo Banze[b]

[a] *Department of Mathematics, Science and Sports Education, University of Namibia, Namibia*
[b] *Institut Supérieur Pédagogique et Technique, Kinshasa, Democratic Republic of Congo*

The purpose of this study is to examine how engineering and science programs in Kenya, the Democratic Republic of the Congo (DRC), and Namibia conceptualise and incorporate entrepreneurship education. The study explores how educators and students interpret entrepreneurial dispositions in relation to technical fields and how contextual variations influence the implementation of entrepreneurship education across the three nations. To provide a more comprehensive understanding of regional educational practices, a mixed-methods comparative methodology was employed, combining survey data with semi-structured interviews drawn from educators and students. The study adopts an integrated analytical framework that links self-efficacy, social learning processes, and individual goal formation by synthesising Social Cognitive Theory (SCT) with the Theory of Planned Behaviour (TPB). While qualitative themes examined institutional and cultural factors influencing the incorporation of entrepreneurship within curricula, quantitative data were analysed using regression techniques to identify patterns in students' entrepreneurial orientations. The findings indicate that although there is broad support for promoting entrepreneurship within science and engineering disciplines, practical constraints—such as limited mentorship, weak institutional coherence, and uneven curricular emphasis—hinder full realisation. The study proposes an integrated theoretical framework that connects contextual, social, and psychological dimensions involved in shaping an entrepreneurial mindset within African higher education.

Keywords: entrepreneurship education; entrepreneurial intentions; engineering programs; competencies

*Email: mkalengay@unam.na

Introduction

Rapid technological change, youth unemployment, and the growing demand for innovation-driven economies have contributed to a paradigm shift in the higher education sector worldwide. Given the discrepancy between formal education outcomes and the abilities that employers require, it is especially critical to equip graduates in Africa with employability and entrepreneurial skills (Ssekitoleko & Dhliwayo, 2023). Considering this, entrepreneurship education has become important for promoting independence, inventiveness, and creativity in a variety of fields, including those that have historically prioritised technical skills like science, technology, engineering, and mathematics (STEM). According to recent studies, students' problem-solving skills, innovation orientation, and confidence in pursuing self-employment are all improved when entrepreneurship education is incorporated into STEM programs (Mapanga & Faleni, 2025, Pinto et al., 2024).

However, successful implementation is still unequal even as legislative frameworks supporting entrepreneurship have proliferated throughout African higher education systems (World Bank, 2019). The anticipated outcomes of entrepreneurship education continue to be undermined by factors such as inadequate lecturer training, limited institutional support, and insufficient collaboration with industry stakeholders (Nchu et al., 2023). Rather than being integrated into technical programs, entrepreneurship education is frequently provided as an elective or supplementary module at many universities in Sub-Saharan Africa (Omoyajowo et al., 2023). As a result, entrepreneurship is perceived by science and engineering students as unrelated to their fields, with greater emphasis placed on theoretical concepts rather than practical innovation. Furthermore, there is a dearth of comparative data regarding how national policy agendas, institutional culture, and resource limitations influence how entrepreneurship education is perceived and implemented in various African contexts. To this end, Namibia, Kenya, and the Democratic Republic of the Congo (DRC) demonstrate varied national settings with converging challenges in the implementation of entrepreneurship education.

The DRC is gradually implementing entrepreneurial training through donor-supported technical education reforms (UNESCO, 2025), Namibia is continuing to expand its National Innovation Policy into tertiary curricula (Republic of Namibia, 2020), and Kenya has integrated entrepreneurship education into most public universities through competency-based frameworks (Moindi & Nyatuka, 2022). Despite these legislative commitments, it is still unclear how instructors and students in scientific and engineering programs view and interact

with the concept of developing an entrepreneurial mentality despite these legislative commitments. The current study intends to close this gap by investigating and contrasting the institutional realities, experiences, and perceptions influencing entrepreneurship education in the three nations. The study makes use of the Social Cognitive Theory (SCT) (Bandura, 1986) and the Theory of Planned Behaviour (TPB) (Ajzen, 1991), both of which have been extensively used in recent research to explain entrepreneurial intention and learning (Pinto et al., 2024; Omoyajowo et al., 2023). By combining these ideas, it is possible to investigate how self-efficacy, perceived behavioural control, and personal attitudes interact with institutional and contextual elements to affect STEM students' development of an entrepreneurial mentality. Two significant contributions are made by the study. First, it offers unique comparative empirical data from three African nations with varying institutional and national contexts for entrepreneurship education implementation. Second, it suggests a hybrid conceptual model that connects contextual, pedagogical, and psychological factors that influence the development of an entrepreneurial mentality in science and engineering education. Consequently, the study aims to answer the following specific questions:

1) What opinions do instructors and students in science and engineering programs have on the inclusion of entrepreneurship education in Namibia, the DRC, and Kenya?
2) What contextual and institutional elements affect how entrepreneurship education is implemented in these contexts?
3) To effectively encourage entrepreneurial attitudes in technical fields, how may entrepreneurship education practices be improved?

Literature review and theoretical framing

Foundational theory

Social Cognitive Theory (SCT) (Bandura, 1986) and the Theory of Planned Behaviour (TPB) (Ajzen, 1991) can be used to explain the development of an entrepreneurial mindset in higher education. Regarding how contextual, societal, and personal aspects influence entrepreneurial learning and activity, both theories offer complementary viewpoints.

Social Cognitive Theory. SCT emphasises the reciprocal interaction between individual agency, social influences, and environmental context (Bandura, 1986). Learning occurs not

only through direct instruction but also through observation, modelling, and social reinforcement. Within entrepreneurship education, SCT highlights the importance of experiential learning, mentorship, and institutional culture in shaping entrepreneurial competencies (Mapanga & Faleni, 2025; Nchu et al., 2023). The concept of self-efficacy, central to SCT, has been widely associated with students' confidence in applying entrepreneurial skills in practical contexts. Empirical studies show that students who receive mentorship or participate in project-based learning display higher levels of entrepreneurial self-efficacy and innovation engagement (Ssekitoleko & Dhliwayo, 2023). Applied to this study, SCT provides insight into how lecturer modelling, peer collaboration, and institutional support systems contribute to the formation of entrepreneurial mindsets among science and engineering learners.

Theory of Planned Behaviour. TPB complements SCT by positing that human behaviour is guided by three determinants: attitudes toward the behaviour, subjective norms, and perceived behavioural control (Ajzen, 1991). In the context of entrepreneurship education, these determinants influence students' entrepreneurial intentions, which in turn shape the likelihood of entrepreneurial behaviour. Recent research in engineering education emphasises TPB's explanatory power in understanding students' entrepreneurial decision-making. For instance, Pinto et al. (2024) found that engineering students' entrepreneurial orientation is strongly predicted by their perceived control over business creation and the value they assign to innovation. Likewise, Omoyajowo et al. (2023) found that positive entrepreneurial attitudes, supported by enabling learning environments, significantly enhance entrepreneurial intentions in South African universities. TPB is used in this study to interpret how peer and lecturer expectations, perceived control (self-efficacy and resource access), and student attitudes (interest and perceived relevance of entrepreneurship) interact to shape entrepreneurial orientation in science and engineering programs.

Integrating TPB and SCT: the hybrid framework

While TPB explains the formation of entrepreneurial intentions, SCT accounts for the learning processes and contextual enablers that sustain entrepreneurial engagement. Integrating these two theories yields a hybrid conceptual model that recognizes the interplay between: *cognitive factors* (attitudes, intentions, and beliefs); *affective factors* (self-efficacy, motivation, and resilience); and *contextual factors* (institutional culture, curriculum design, mentorship, and socio-economic environment).

This model assumes that entrepreneurial mindset development in STEM education extends beyond cognitive training to include socially mediated learning processes involving interaction, modelling, and contextual reinforcement. The integration further aligns with recent research advocating for multi-theoretical approaches in entrepreneurship education to address the complexity of cultural and institutional variation across the Global South (Mapanga & Faleni, 2025).

Conceptual model for the study

The conceptual framework guiding this research is provided in Figure 1 and illustrates how students' entrepreneurial mindset formation results from the interaction between individual factors (attitudes, intentions, and self-efficacy) and contextual factors (learning environment, mentorship, and institutional culture). This conceptualization provides a theoretical anchor for both the quantitative and qualitative phases of the study: survey instruments measure cognitive and attitudinal constructs derived from TPB, while interview protocols explore social and contextual themes informed by SCT.

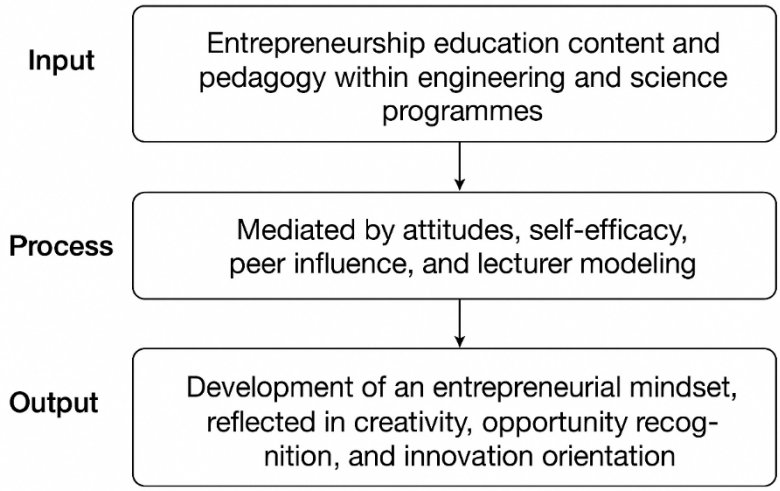

Figure 1: *Conceptual framework of the study*

Summary

The integrated TPB-SCT framework provides a robust analytical lens for examining the interaction between cognitive, social, and contextual factors shaping entrepreneurship education within science and engineering disciplines. It allows the study to assess both individual cognitive processes and institutional contextual influences, thereby providing a

richer understanding of how entrepreneurial mindsets are fostered in diverse African higher-education environments.

Research Methodology

Research Design

This study employed a convergent parallel mixed-methods design, whereby quantitative survey data and qualitative interview data were collected simultaneously, analysed independently, and merged during interpretation to provide a comprehensive examination of entrepreneurial mindset development among final-year engineering and science students in Kenya, the DRC, and Namibia. This design allows the simultaneous collection and analysis of quantitative and qualitative data, providing both numerical measurement of constructs such as entrepreneurial intention, self-efficacy, and competences, as well as narrative insights into students' experiences and contextual challenges (Creswell & Clark, 2018; Tashakkori & Teddlie, 2010). The study was guided by the conceptual model described above. TPB was used to examine students' attitudes, perceived behavioural control, and subjective norms in relation to entrepreneurship, while SCT highlighted the role of peer networks, mentorship, and self-efficacy in shaping entrepreneurial engagement. Integrating these theories provided a coherent justification for combining quantitative measurement with qualitative exploration, directly aligning with the study's research objectives.

Population and sampling

The target population consisted of approximately 6,000 final-year undergraduate engineering and science students at selected public universities in Kenya, the DRC, and Namibia. Participants were chosen because they had substantial exposure to entrepreneurship education, either through coursework, incubator programs, or capstone projects, ensuring informed perspectives on the effectiveness and practical impact of entrepreneurial programs. Using Yamane's (1967) formula, a sample size of 450 students was determined to ensure statistical validity at a 95% confidence level and a 5% margin of error (150 students per country). A purposive sampling approach was employed to select students with prior entrepreneurial education, allowing the study to focus on participants with relevant experience. Additionally, qualitative data were collected from 45 students (15 per country) through interviews and focus groups to capture in-depth perceptions, experiences, and socio-cultural influences.

Data Collection Instruments

Quantitative data. A structured questionnaire consisting of five sections was used. These sections are: demographic information (gender, age, discipline, and university); exposure to entrepreneurship education, including class participation, training hours, and engagement in competitions or incubators; entrepreneurial intentions, adapted from Liñán & Chen (2009); perceived behavioural control and self-efficacy, derived from Zhao et al. (2005); and entrepreneurial skills (innovativeness, creativity, leadership, risk-taking, and problem-solving). All these items were measured on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Reliability testing indicated high internal consistency (Cronbach's alpha = 0.89).

Qualitative data. Interview guides were used to conduct semi-structured interviews and focus groups to explore students lived experiences and contextual influences on entrepreneurship. Open-ended questions addressed four aspects: individual experiences with entrepreneurship modules; challenges in applying entrepreneurial knowledge; the role of mentors and peer networks; and perceptions of the institutional entrepreneurial ecosystem.

Theoretical alignment of qualitative instruments. The development of the interview and focus group protocols was explicitly guided by the hybrid theoretical framework combining TPB and SCT. Questions were designed to capture constructs derived from these theories: entrepreneurial attitudes, perceived behavioural control, and subjective norms were informed by TPB; mentorship, peer influence, and observational learning were informed by SCT. This approach ensured that the qualitative instruments were theoretically aligned, allowing for coherent interpretation of the data within the study's conceptual framework.

Procedures. Interviews were conducted in English or French, recorded with permission, transcribed, and translated where necessary. Semi-structured questions ensured flexibility for probing while maintaining theoretical consistency across all participants and countries.

Data collection procedures

Data were collected over three months in early 2024. The research team collaborated with entrepreneurship centres and faculty coordinators at participating universities. Quantitative surveys were distributed via student mailing lists and WhatsApp groups using Google Forms. After screening, 378 completed questionnaires (84% response rate) were retained for analysis.

Qualitative interviews involved 5–7 students per focus group (lasting approximately 90 minutes) and individual interviews (30–45 minutes each). Participants were recruited from:

- Namibia: University of Namibia and Namibia University of Science and Technology
- Kenya: University of Nairobi and Jomo Kenyatta University of Agriculture and Technology
- DRC: Institut Supérieur Pédagogique et Technique de Kinshasa and University of Kinshasa

All transcripts were anonymized to ensure confidentiality.

Data analysis

Quantitative analysis. Using SPSS Version 27, descriptive statistics summarised demographic and general trends. One-way ANOVA compared entrepreneurial intention and competence levels across students with differing exposure to entrepreneurship education (none, basic, advanced), with Tukey's HSD post-hoc tests identifying significant group differences. Multiple regression analyses, controlling for age, gender, and prior entrepreneurial experience, examined the predictive influence of entrepreneurship education on competences. Analyses were grounded in the TPB and SCT constructs, linking self-efficacy, attitudes, and norms to entrepreneurial outcomes.

Qualitative analysis. Thematic analysis (Braun & Clarke, 2006) was applied to interview and focus group data. The coding process included familiarization with transcripts, generating initial codes, identifying themes (e.g., experiential learning, systemic barriers, social scaffolding), reviewing themes, and producing a narrative synthesis illustrated with participant quotations. Inter-coder reliability was verified with a Cohen's Kappa of 0.82.

Validity, reliability, and trustworthiness

Validity and reliability were ensured through multiple strategies: pilot testing with 20 students across the three countries; use of validated scales adapted from prior studies; triangulation of data sources (questionnaires, interviews, focus groups); member checking to validate qualitative interpretations; peer debriefing, audit trails, and reflexivity diaries to enhance credibility.

Operational definition of entrepreneurship education exposure

For analytical clarity, entrepreneurship education exposure was categorised into three levels. *Basic* entrepreneurship education refers to standalone theoretical modules with limited assessment or practical engagement. *Advanced* entrepreneurship education includes multiple entrepreneurship-related modules embedded within engineering or science curricula and assessed through formal coursework. *Experiential* entrepreneurship education extends advanced instruction by incorporating hands-on learning activities such as incubator participation, capstone projects, start-up simulations, industry mentorship, or community-based innovation projects. This classification enables distinction between instructional input and contextual support structures.

Ethical considerations

All participating universities' Institutional Review Boards (IRBs) granted their ethical approval. Important factors included:

- Prior to participation, all individuals signed informed consent forms.
- Voluntary involvement: participants were made aware of their freedom to discontinue participation at any moment and without consequence.
- Only the research team had access to all anonymised personal data.
- Hard copies were kept in secured cabinets, while digital data was kept in password-protected folders.

To guarantee cultural sensitivity, tools and questions were modified to consider the language and contextual reality of each nation

Results

This section presents the study's findings from the mixed-methods approach, structured to highlight quantitative results, qualitative themes, and their integration using the conceptual model that combines SCT and TPB.

Quantitative results

Sample characteristics. After cleaning the dataset, 432 valid responses were analysed: 137 from the DRC, 150 from Kenya, and 145 from Namibia. The sample comprised 43% female and 57% male students. 68% had completed entrepreneurship courses, and 29% had

participated in real-world entrepreneurship activities such as incubators, internships, or start-up competitions. This balanced distribution enabled robust cross-country comparisons.

Descriptive statistics. Students' exposure to entrepreneurship education varied by country:

- Kenya: 82% advanced training (≥3 modules plus experiential learning)
- Namibia: 64% advanced training
- DRC: 41% advanced training

These results are shown in Table 1, illustrating clear cross-country variation in experiential exposure, with Kenya demonstrating the highest level of practice-based engagement and the DRC showing limited access to experiential learning opportunities. Mean entrepreneurial intention scores (5-point scale) with standard deviation were: Kenya ($M = 4.25$, $SD = 0.56$), Namibia ($M = 3.67$, $SD = 0.69$), DRC ($M = 3.10$, $SD = 0.75$), indicating a positive correlation between training intensity and entrepreneurial intention.

Table 1: *Entrepreneurship education exposure by country*

Country	Basic (%)	Advanced (%)	Experiential (%)
Kenya	6	12	82
Namibia	18	18	64
DRC	31	28	41

Impact of education level on entrepreneurial intention. A one-way ANOVA revealed significant differences in entrepreneurial intention across education levels: $F(2, 429) = 12.34$, $p < 0.001$, $\eta^2 = 0.103$. Tukey HSD post-hoc tests indicated:

- No education vs. advanced education: $p < 0.001$
- Basic vs. advanced education: $p = 0.019$
- No education vs. basic education: $p = 0.08$ (not significant)

This suggests advanced experiential education significantly enhances entrepreneurial intention, whereas basic exposure may be insufficient.

Country comparisons. Comparative entrepreneurial intention scores are shown in Table 2. Country-level ANOVAs confirmed significant differences: $F(2, 429) = 18.45$, $p < 0.001$. Pairwise comparisons:

- Kenya vs. DRC: $p < 0.001$, Cohen's $d = 1.51$ (large effect)
- Kenya vs. Namibia: $p = 0.032$, Cohen's $d = 0.68$ (medium effect)
- Namibia vs. DRC: $p = 0.011$, Cohen's $d = 0.82$ (medium-to-large effect)

These differences reflect variations in institutional support, mentorship availability, and practical learning opportunities.

Table 2: *Mean entrepreneurial intention scores by country*

Country	Mean (M)	SD	Interpretation
Kenya	4.25	0.56	High
Namibia	3.67	0.69	Moderate
DRC	3.10	0.75	Low-moderate

Predicting entrepreneurial competencies. Although regression coefficients are reported with country controls, Kenya emerges as the strongest predictor due to higher variance in experiential exposure, while Namibia and the DRC show weaker but directionally consistent effects. Multiple regression analysis (controlling for age, gender, prior experience, and country) indicated that entrepreneurship education significantly predicted entrepreneurial competences (creativity, problem-solving, innovation, risk-taking): Model: $F(5, 426) = 22.67$, $p < 0.001$, adjusted $R^2 = 0.21$. Significant predictors:

- Education level: $\beta = 0.45$, $p < 0.001$
- Prior experience: $\beta = 0.23$, $p = 0.015$
- Kenya: $\beta = 0.19$, $p = 0.032$

Demographic factors (age, gender) were not significant, emphasising the importance of experience and practical exposure.

Perceived behavioural control and social norms. Another critical construct in TPB is perceived behavioural control which is the degree to which individuals believe they can perform the behaviour in question. A scale adapted from Krueger et al. (2000) was used to assess this, and its correlation with education level was analysed. Following Cohen's (1988) conventions, correlation coefficients of 0.30–0.49 are considered moderate, while values above 0.50 indicate strong associations. The correlation between education level and perceived behavioural control ($r = 0.56$, $p < 0.001$) therefore represents a strong positive relationship. This supports Ajzen's assertion that perceived behavioural control directly influences entrepreneurial intention, especially in contexts where external barriers (e.g., resources, mentorship) are variable. Students with access to hands-on experiences reported stronger control over launching a business, even in challenging economies like the DRC.

Qualitative findings

Thematic analysis of 45 interviews and focus groups uncovered three key themes, offering qualitative insight that complements and contextualizes the quantitative findings.

Experiential learning and entrepreneurial confidence. Students reported that hands-on experiences, capstone projects, incubators, and start-up challenges enhanced self-efficacy and perceived control. 'I learned things from working on a real microbusiness for six months that I could never have learned from a lecture' (Kenyan student); and 'Our capstone project involved rural electricity solutions pitched to investors; it made me feel prepared' (Namibian student). Conversely, DRC students lacked such experiences and reported uncertainty and fear of failure, reflecting their lower perceived behavioural control.

Systemic barriers and unequal access. Structural challenges such as limited facilities, sparse mentorship, and geographic isolation were frequently cited, particularly in rural Kenya and the DRC. 'We learned lean startup theory but have no labs, no funding, no mentors' (DRC student); and 'You miss opportunities if you are far from the city campus incubator' (Kenyan rural student). These barriers highlight that intention is not limited by motivation but by systemic constraints, consistent with TPB's perceived behavioural control concept.

Social support and normative influence. Mentorship, peer networks, and faculty support emerged as key enablers of entrepreneurial intention. Positive role modelling and social encouragement enhanced confidence, whereas discouraging social norms (common in the DRC) inhibited entrepreneurial engagement. 'I believed because they believed in me'

(Namibian intern); and 'Support made things seem doable' (Kenyan peer group). These observations demonstrate SCT's emphasis on observational learning and social reinforcement, as well as TPB's subjective norms.

Synthesis: integrating quantitative and qualitative findings

The combination of quantitative and qualitative findings shows that advanced, experiential entrepreneurship education significantly enhances entrepreneurial intention and competencies. *SCT lens*: observational learning, mentorship, and role models reinforce competence and confidence. *TPB lens*: attitudes, perceived behavioural control, and subjective norms mediate intention. *Country-specific contexts explain variation*: Kenya had high intention scores due to robust institutional support; Namibia showed moderate outcomes; DRC had lower outcomes because of limited resources and negative social norms.

Summary

- Advanced experiential education produces superior entrepreneurial outcomes compared to basic or no training.
- Social and institutional environments moderate the effect of education.
- Perceived behavioural control and self-efficacy are key mechanisms linking learning to intention.
- Country-specific differences highlight the importance of contextualized program design.

These findings provide actionable insights for designing inclusive, practical, and socially supported entrepreneurship programs in Sub-Saharan Africa.

Discussion

This study examined how entrepreneurship education within engineering and science programs in Kenya, Namibia, and the DRC influences students' entrepreneurial intentions and competencies. By triangulating quantitative data from 432 students and qualitative insights from 45 interviews and focus groups, the findings provide both statistical evidence and contextual understanding of the mechanisms shaping entrepreneurial outcomes.

Triangulating quantitative and qualitative evidence

The quantitative results demonstrated that advanced and experiential entrepreneurship education significantly increases entrepreneurial intentions and competencies, as measured by ANOVA, regression, and correlational analyses. Regression analysis indicated that education level and prior practical experience were the strongest predictors of competencies such as creativity, problem-solving, innovation, and risk-taking. Perceived behavioural control and subjective norms further mediated these relationships, confirming the applicability of TPB. Qualitative findings complemented these results by showing that hands-on experiences, mentorship, and peer support fostered self-efficacy and confidence, essential elements of Bandura's SCT. Students emphasised that real-world projects, capstone initiatives, and incubator participation enhanced their ability to translate theoretical knowledge into actionable entrepreneurial behaviour. Conversely, structural barriers such as limited access to facilities, mentorship gaps, and negative social norms (especially in the DRC) constrained intention and competencies, despite positive attitudes toward entrepreneurship.

Country-specific insights

Country-level analysis highlighted significant variation:

- *Kenya*: Students had the highest entrepreneurial intentions (M = 4.25) and benefitted from a mature ecosystem, including industry collaborations, mentorship programs, and accessible incubators. Perceived behavioural control and positive subjective norms were reinforced through these structures, facilitating both intention and action.
- *Namibia*: Students had moderate entrepreneurial intentions, with opportunities concentrated in urban centres. Peer support and faculty involvement enhanced outcomes, but disparities between satellite campuses and urban institutions limited broader access.
- *DRC*: Students exhibited the lowest intentions (M = 3.10), reflecting limited practical opportunities, weak institutional support, and negative social reinforcement. Attitudes toward entrepreneurship were positive, but perceived behavioural control and SCT mechanisms were constrained, preventing translation into actionable behaviour.

These variations underscore the importance of contextualized program design, recognizing that national and institutional ecosystems critically shape entrepreneurship education outcomes.

Integrating TPB and SCT perspectives

The study's findings reinforce the complementary roles of TPB and SCT as shown in Table 3.

- *TPB*: Attitudes toward entrepreneurship, subjective norms, and perceived behavioural control mediate the relationship between education and entrepreneurial intention. Positive reinforcement from peers, mentors, and communities strengthens intention.
- *SCT*: Self-efficacy and observational learning, derived from experiential engagement and exposure to role models, enhance competence and confidence in entrepreneurial behaviour.

The interplay between these frameworks explains how education, social support, and experience collectively influence entrepreneurial outcomes. For instance, Kenyan students' high intentions were driven by both perceived behavioural control and robust social modelling, whereas DRC students' lower intentions reflected structural and normative constraints.

Table 3: *Integrated TPB-SCT entrepreneurial mindset framework*

Dimension	**TPB Construct**	**SCT Construct**	**Educational Implication**
Cognitive	Attitudes	Outcome expectations	Curriculum relevance
Control	Perceived behavioural control	Self-efficacy	Experiential learning
Social	Subjective norms	Modelling and mentorship	Peer and industry support
Context	—	Institutional environment	Policy and infrastructure

Implications for policy and curriculum

The integrated findings suggest several actionable strategies:

Curriculum design:

- Emphasise experiential, project-based learning over theoretical instruction.
- Integrate design thinking, lean startup approaches, and regionally relevant problems into modules.
- Include entrepreneurship across disciplines, not solely in business programs.

Institutional support:

- Establish incubators, makerspaces, and innovation hubs, particularly in rural or under-resourced universities.
- Facilitate access to labs, funding, and online resources to reduce entry barriers.
- Strengthen industry-academia partnerships to align education with market realities.

Social networks and mentorship:

- Develop structured mentorship programs with alumni and industry experts.
- Promote peer-led incubators, venture challenges, and collaborative platforms.
- Highlight successful role models through case studies, storytelling, and campus media.

Country-specific priorities:

- Kenya: Expand rural incubator hubs and digital entrepreneurship platforms.
- Namibia: Extend support to satellite campuses and integrate local economic challenges.
- DRC: Focus on low-cost mentorship initiatives and foundational entrepreneurial infrastructure.

Broader implications for African higher education

The findings highlight that entrepreneurship education is not only an academic endeavour but a social and experiential process. Universities can foster innovation, reduce youth unemployment, and contribute to equitable economic growth by creating inclusive, context-sensitive, and mentor-supported entrepreneurial ecosystems. Success depends on integrating cognitive, social, and structural components rather than relying solely on theoretical instruction.

Conclusion

This study demonstrates that integrating entrepreneurship education into engineering and science curricula in Kenya, Namibia, and the DRC enhances students' entrepreneurial intentions and competencies, particularly when programs are experiential, relational, and context sensitive. Key conclusions include:

- Experiential, practice-oriented entrepreneurship education, supported by institutional and social contexts, significantly enhances entrepreneurial mindset and competencies; basic or theoretical instruction alone is insufficient.
- Social support and mentorship amplify the effects of education, reinforcing self-efficacy and normative approval.
- Contextual and systemic factors including institutional resources, geographic location, and national policy moderate the effectiveness of entrepreneurship programs.
- TPB and SCT provide a robust framework for understanding how education, experience, and social reinforcement shape entrepreneurial behaviour.

These insights suggest that universities should design entrepreneurship programs that combine hands-on practice, mentorship, peer networks, and contextually relevant projects. Such interventions can equip graduates not only with technical skills but also with the entrepreneurial competencies and confidence needed to navigate increasingly complex and innovation-driven economies in Africa. While the convergent mixed-methods design strengthens validity through triangulation, the cross-sectional nature of the data limits causal inference. Future studies could incorporate longitudinal designs and employer outcome data to further validate entrepreneurial impact.

References

Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T.

Ajzen, I. (2020). The theory of planned behaviour: Frequently asked questions. *Human Behaviour and Emerging Technologies, 2*, 314–324. https://doi.org/10.1002/hbe2.195.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Prentice-Hall.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa.

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Creswell, J. W., & Clark, V. L. P. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.

Krueger, A. B., Reilly, M., & Carsrud, A. L. (2000). Competing models of entrepreneurial intentions. *Journal of Business Venturing*, *15*(5–6), 411–432. https://doi.org/10.1016/S0883-9026(98)00033-0.

Liñán, F., & Chen, Y. W. (2009). Development and cross-cultural application of a specific instrument to measure entrepreneurial intentions. *Entrepreneurship Theory and Practice*, *33*(3), 593–617. https://doi.org/10.1111/j.1540-6520.2009.00318.x.

Mapanga, A., & Faleni, N. (2025). Integrating entrepreneurship education into STEM curricula in global South higher education institutions. *Discover Education*, *4*, 335. https://doi.org/10.1007/s44217-025-00798-8.

Moindi, R., & Nyatuka, B. (2022). Competency-Based Assessment in Entrepreneurship Education in Kenya's Tertiary Institutions. *African Journal of Teacher Education, 11*(1), 100–120. https://doi.org/10.21083/ajote.v11i1.7052.

Nchu, A., Tengeh, R., & Cronje, G. (2023). A call for more entrepreneurship education in non-business programs at South African TVET colleges. *EUREKA: Social and Humanities*, *3*, 67–78. https://doi.org/10.21303/2504-5571.2023.003062.

Omoyajowo, J., Iwu, C. G., & Tengeh, R. (2023). Entrepreneurship programmes' effectiveness in fostering entrepreneurship. A South African university of technology inquiry. *EUREKA: Social and Humanities*, *6*, 42–60. https://doi.org/10.21303/2504-5571.2023.002982.

Pinto, P., Pallikkara, V., Pinto, S., & Hawaldar, I. T. (2024). Unveiling the entrepreneurial mindset: exploring orientation and intentions among students of prominent engineering disciplines. *Journal of Innovation and Entrepreneurship, 13*, 33. https://doi.org/10.1186/s13731-024-00390-8.

Republic of Namibia. (2020). *National Science, Technology and Innovation Policy (NSTIP) 2020–2030*. Ministry of Higher Education, Training and Innovation. Windhoek, Namibia.

Ssekitoleko, P., & Dhliwayo, S. (2023). Elevating South Africa's Entrepreneurial Activity in the Fourth Industrial Revolution Era. *Administrative Sciences*, *13*(9), 195. https://doi.org/10.3390/admsci13090195

Tashakkori, A., & Teddlie, C. (2010). *Sage handbook of mixed methods in social & behavioural research* (2nd ed.). Sage Publications.

UNESCO. (2025). *Strengthened partnership between UNESCO and the DRC for Technical and Vocational Education and Training.* UNESCO. https://www.unesco.org/en/articles/strengthened-partnership-between-unesco-and-drc-technical-and-vocational-education-and-training-tvet.

World Bank. (2019). *The Skills Balancing Act in Sub-Saharan Africa*. Washington, DC: World Bank.

Yamane, T. (1967). *Statistics: An introductory analysis* (2nd ed.). Harper & Row.

Zhao, H., Seibert, S. E., & Hills, G. E. (2005). The mediating role of self-efficacy in the development of entrepreneurial intentions. *Journal of Applied Psychology*, *90*(6), 1265–1272. https://doi.org/10.1037/0021-9010.90.6.1265.