



## Purpose-Driven, Shifting Higher Education Epistemology in South Africa

Justin J. Pringle,<sup>1</sup>  Rudi Kimmie<sup>2</sup> 

<sup>1</sup> Environmental Fluid Mechanics Lab, University of Kwa-Zulu Natal, Durban, Republic of South Africa

<sup>2</sup> Aerotropolis Institute Africa, University of Kwa-Zulu Natal, Durban, Republic of South Africa

Corresponding author, email: [pringlej@ukzn.ac.za](mailto:pringlej@ukzn.ac.za)

### Abstract

South Africa's economic, political and social challenges are complex, systemic and pervasive. Failing to address these decisively, innovatively and efficiently will significantly and negatively impact the country's long-term economic sustainability. This study integrated Purpose-driven pedagogy into the engineering curricula through an engineering with a purpose challenge as an intervention method to train students to reflect, ideate, and prototype technology solutions. However, what defines these solutions is that they are framed within a purpose-driven philosophy and epistemology. Twelve 12 students competed in the challenge. However, only 2 completed the challenge. An exit survey found that the students struggled with time management but felt they had learned project management and advanced problem-solving skills to equip them for their future engineering careers. Notably, both finalists were women and academically 'at-risk'. This demonstrates the potential for the Engineering with a Purpose Challenge to attract more women to study engineering and address academic quality concerns within the engineering curricula.

**Keywords:** At-risk students; Engineering education; Purpose-driven pedagogy; South Africa; Women in engineering

### Introduction

South Africa faces increasing natural threats, infrastructure neglect, and socio-economic decline, necessitating innovative educational responses. For example, the Ecological Threat Register reports a dramatic rise in global droughts, floods, and fires (see <https://www.visionofhumanity.org>). This aligns with global observations and predictions of climate change impacts in the Special Report on the Ocean and Cryosphere (IPCC, 2019). Additionally, the prevalence of global pandemics such as the coronavirus further threatens livelihoods. These environmental pressures, combined with infrastructure neglect, including 86% of wastewater treatment plants in critical condition (DWS, 2022) and high youth unemployment (3.5 million people aged 15–34 unemployed) according to StatsSA (2024), negatively affect South Africa's long-term sustainability.

Educational quality directly influences societal well-being and economic progress (Kimenyi, 2011; Krumm & Kimmie, 2013; Sukharev, 2021; Temple, 2000). South Africa's higher education system faces systemic challenges: although 200,000 more students enrolled between 2005 and 2015, throughput rates remain low at 20% (CHE, 2021; Dhunpath & Subbaye, 2018). Rising student-to-staff ratios and poor pass rates place immense pressure on academics to deliver quality education (Milner IV, 2014; Naude & Horne, 2003). Given South Africa's environmental, social, and economic problems, these educational challenges reveal critical gaps in teaching, learning, and the application of science and engineering (Krumm & Kimmie, 2013). These challenges are not unique to South Africa (Biggs & Tang, 2011); therefore, developing solutions for higher education is globally important.

This study investigates the implementation of Purpose-Driven teaching within Civil Engineering at the University of

KwaZulu-Natal. The research addresses the following questions:

1. How does purpose-driven pedagogy affect student engagement and learning outcomes in engineering education?
2. What implementation challenges emerge when integrating societal problem-solving into technical curricula?
3. How do students respond to connecting engineering principles with community needs?

The research setting is the newly established Purpose-Driven Innovation Hub, implemented in 2024 to transform engineering education from job-seeking to problem-solving orientation.

### *Purpose Driven Teaching*

One way to address social impact through epistemology is 'Teaching for Purpose', or 'Purpose-Driven' teaching. This pedagogical approach addresses critical educational gaps in higher education (e.g. Malin, 2018; Milner, 2014; Stuckey, 2007). The 'Purpose-Driven' philosophy begins with ontological awareness, where teaching and learning aim to be meaningful and connect academic content to societal applications, fostering value systems oriented towards service and social entrepreneurship rather than purely economic outcomes (e.g. Junior et al., 2010; Malin, 2018). This approach can enhance creativity among engineering students (Cropley & Cropley, 2000). Purpose-driven teaching integrates societal challenges into curriculum design, creating authentic learning contexts that promote deeper engagement with course material while developing civic responsibility.

Numerous pedagogical strategies demonstrate effectiveness in promoting quality higher education through active learning and community engagement (Cropley & Cropley, 2000; Damon et al., 2024; Junior et al., 2010; Kallemeyn et al., 2021). However, research specifically examining purpose-driven pedagogy in higher education remains limited (Damon et al., 2024). Additionally, while some higher education experiences predict modest changes in purpose development, institutions could do more to

promote and sustain purpose beyond graduation (Damon et al., 2024).

A systematic review of literature reveals no documented applications of purpose-driven pedagogy within the South African higher education context. Engineering education presents a particularly suitable domain for purpose-driven approaches due to its inherently applied nature and emphasis on problem-solving (e.g. Junior et al., 2010). The discipline's focus on addressing societal challenges through technical solutions aligns naturally with purpose-driven pedagogical principles.

Furthermore, action research methodology provides an appropriate framework for implementing and evaluating purpose-driven teaching (e.g. Jensen, 2016). The iterative cycles of action research, planning, implementing, observation and reflection, align naturally with the engineering design process. This process requires students to plan, design a solution, test, analyse and refine. This alignment also enables simultaneous investigation of pedagogical effectiveness while improving teaching practice, consistent with the action research objectives of generating knowledge through reflective processes.

### **Methods**

This study adopts a case study methodology, one of the most frequently used qualitative research approaches in educational research (Yazan, 2015). A case study is defined as an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-world context, particularly when the boundaries between phenomenon and context are not clearly defined (Yin, 2018). This methodological approach is particularly suitable for exploring complex educational interventions that involve multiple variables interacting within authentic settings (Merriam, 1998; Stake, 1995).

The Engineering with a Purpose Challenge constitutes what Stake (1995) terms an instrumental case study, in which the case provides insight into a broader issue – in this instance, the potential of purpose-driven pedagogy to enhance engineering student engagement and the development of an entrepreneurial mindset. The

intervention represents a bounded system (Merriam, 1998), defined by the specific institutional context of the University of KwaZulu-Natal, the participant cohort of undergraduate engineering students, and the temporal boundaries of the challenge period.

Case study methodology was selected for several reasons relevant to this investigation. First, case studies are particularly valuable when the intervention being evaluated has no clear or single set of outcomes (Yin, 2018), as is typically the case with novel pedagogical approaches, where both intended and emergent outcomes require examination. Second, case study research enables the exploration of not only ‘what’ occurred, but also ‘why’ and ‘how’ (Yin, 2018), which is essential for understanding the mechanisms through which purpose-driven pedagogy may influence student engagement. Third, this approach aligns with the action research orientation of the study, as case study methodology accommodates the iterative, reflective processes inherent in practitioner-led inquiry (Bloomberg, 2018). Finally, case studies generate context-specific knowledge that informs professional practice and policy development (Stake, 2005), which is particularly relevant for an intervention designed to be refined and potentially scaled within the South African higher education context.

As a single-case design with embedded units (Yin, 2018), this study examines the overall intervention while considering sub-units of analysis, including participant demographics, engagement patterns, and completion outcomes. This holistic yet embedded approach allows exploration of the multiple factors that may have influenced participant experiences within the challenge.

### ***The ‘Engineering with a Purpose’ Challenge***

An ‘Engineering with a Purpose’ challenge was implemented during the first semester of 2024 at the University of KwaZulu-Natal, South Africa (UKZN). Participants were recruited through open enrolment across all engineering disciplines. Anonymous demographic data were collected, including gender, academic performance indicators, and engineering specialisation. All participants provided informed

consent for data use in research evaluating purpose-driven pedagogical approaches. The study included only participants who consented to academic use of their data (n = 46). Data were stored on password-protected servers with no personally identifiable information collected to ensure participant confidentiality. Participation was voluntary, and participants could withdraw at any time without penalty to their academic standing.

### ***Student Recruitment***

A secure digital form was emailed to all engineering students at UKZN. The form described the goal of the challenge: to train university students in the concepts of social enterprise and engineering entrepreneurship. Students were challenged to design and construct innovative, low-cost solutions to solve their community’s food, water and energy challenges.

Each entrant had to select a category of either food, water or energy as well as briefly explain:

- a. What the problem was (problem description),
- b. Why the problem was important (motivation),
- c. How they aimed to solve the problem (Solution).

The entrants were then shortlisted and trained in the principles of social enterprise. Postgraduate students within the Department of Civil Engineering mentored them during their design and construction of their solutions.

### ***Research team***

The research team comprised academic staff, postgraduate researchers and undergraduate students following the action research (AR) framework (Jensen & Dikilitas, 2025; Kemmis & McTaggart, 2005).

### ***Peer-to-peer Learning Component***

A key method component involved the undergraduate and postgraduate students mentoring challenge participants. This approach aligns with established research that demonstrates

the effectiveness of AR in education (Dosoftei & Alexa, 2024; Jensen & Dikilitas, 2025; Polkowski et al., 2020; Tullis & Goldstone, 2020). Peer learning is recognised as an innovative teaching and learning strategy in current engineering education (Polkowski et al., 2020).

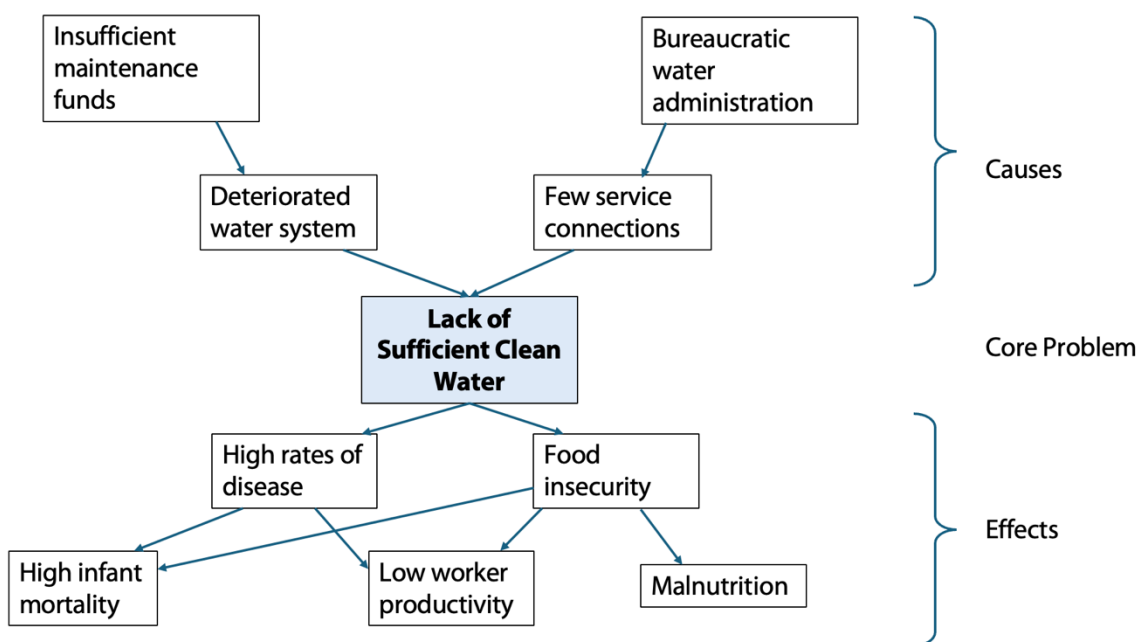
The peer-to-peer method was strategically implemented to prevent typical passive student engagement. This approach facilitated active discussion, critical thinking and collaborative problem solving. The model created authentic learning environments in which postgraduates and undergraduate students facilitated knowledge construction through engagement.

**Intervention Design**

Two structured capacity-building workshops were arranged for the students, in which senior leaders of industry introduced students to various social enterprise frameworks.

*Workshop 1: Industry Context and Social Enterprise Foundations.* During this workshop, engineering industry practitioners presented social enterprise solutions in food security and engineering sector operations. This provided a real-world context for participants’ projects. The workshop also included a collaborative ideation session to promote creative thinking amongst the students.

*Workshop 2: Problem Definition and Analysis Training.* In this second workshop, participants received training in systematic problem analysis. This involved introducing the students to the problem tree method as shown in Figure 1. The problem-tree method is an evidence-based tool to identify root causes and effects of problems. This supports a comprehensive understanding of a problem and the solution design that addresses fundamental issues



**Figure 1:** Example of a problem tree developed to identify root causes and effects of lack of sufficient clean water. Adapted from The World Bank Group (2001).

**Results**

The demographic data collected during this study were used to provide a qualitative and quantitative analysis of the impact of the

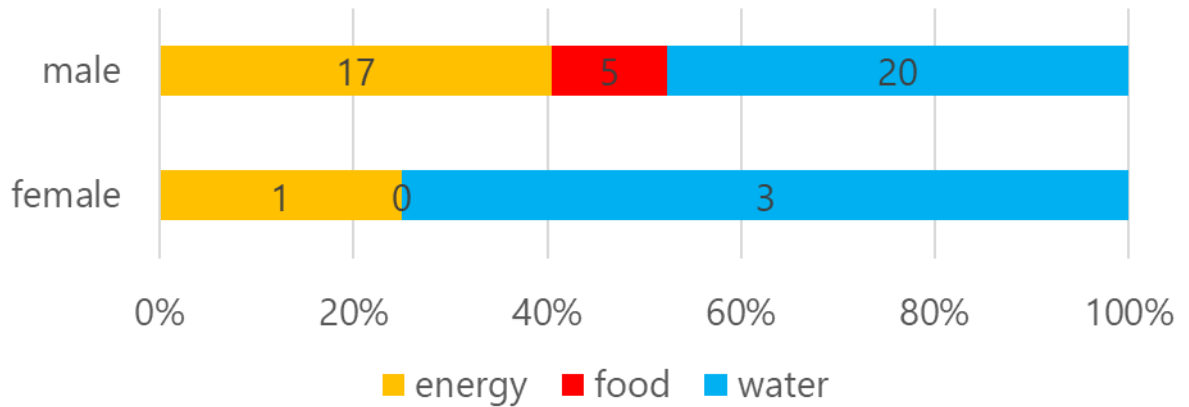
‘Engineering with a Purpose’ challenge in addressing the research questions.

**Entrants Statistics and Shortlisting**

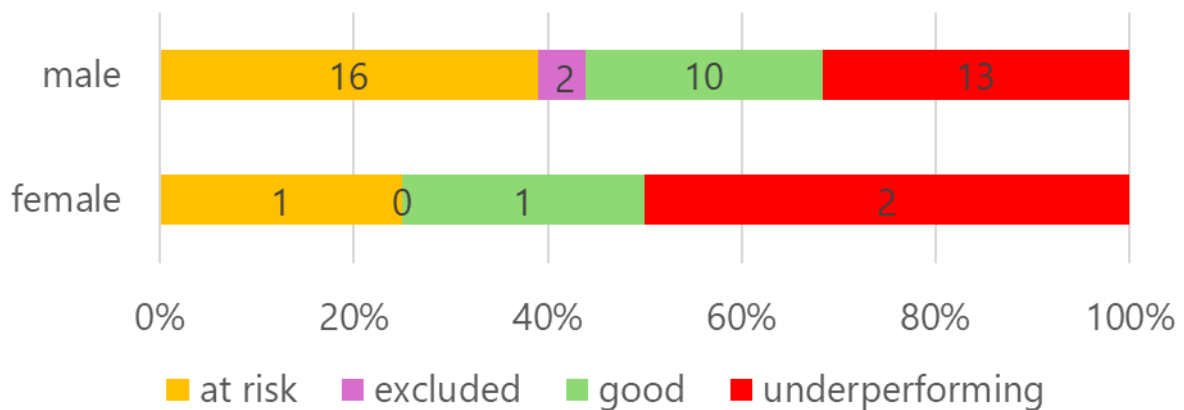
A total of 46 students from various disciplines entered the challenge within the School

of Engineering, representing 2% of the total registered students in Engineering (N=2236). Figure 2 shows the percentage of entrants relative to their gender, classified according to the challenge category. There were very few female entrants (4), representing 8% of the total entrants.

The majority of the female entrants chose to solve water problems. In comparison, the percentage of male entrants for energy and water was very similar, 40% and 48%, respectively, while food only accounted for 12% of the male entrants.



**Figure 2:** Percentage of entrants relative to their gender classified according to challenge category. Numbers of entrants per category are shown as text on the bars.



**Figure 3:** Academic performance and status relative to gender classified according to “at risk”, “excluded”, “good” and “underperforming”. Numbers of entrants per category are shown as text on the bars.

Figure 3 shows the academic performance and status of all the entrants relative to gender and classified according to the UKZN “robot” system. The UKZN “robot” system was developed to identify underperforming students and provide necessary academic support to assist students to graduate in the minimum amount of time. The system classifies students into five categories: excluded, underperforming, at-risk, good and outstanding. Good academic standing applies to new students or those who have passed more than 70% of the normal credit load. At-risk

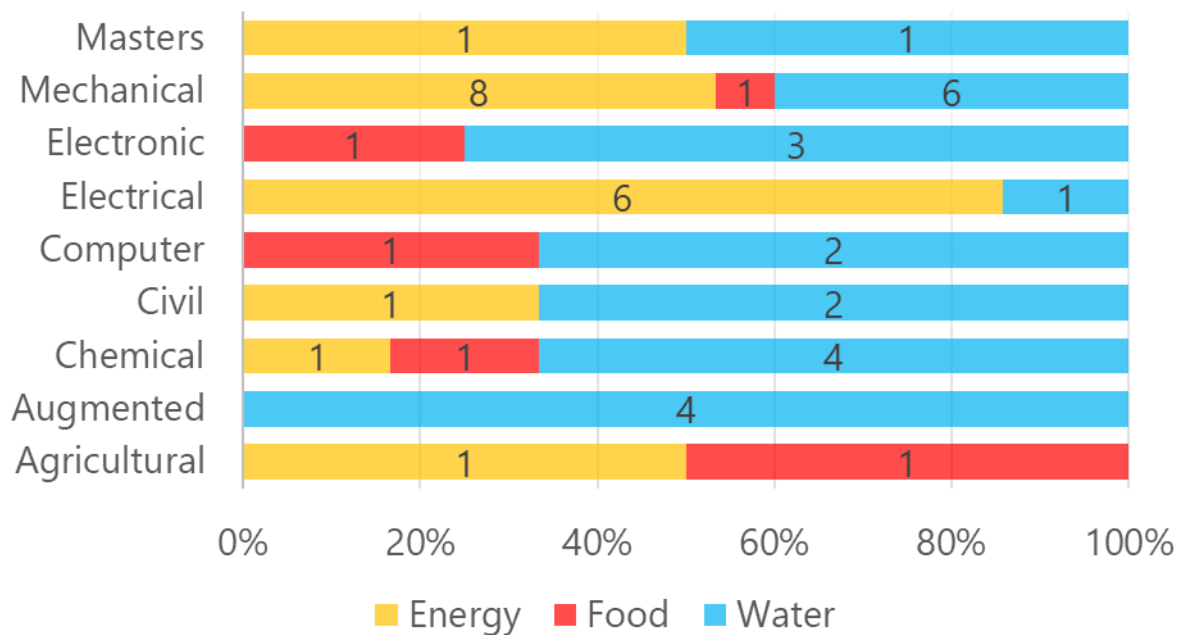
students haven’t been able to pass more than a percentage of their normal credit load, and underperforming students have previously been “at risk” but have not met their probation targets.

Interestingly, most students who entered the competition were either “at-risk” or “underperforming”, according to the UKZN robot system.

Figure 4 shows the categories the students chose according to their registered degree within

the School of Engineering: Mechanical, Electronic, Electrical, Computer, Civil and Agricultural Engineering. Also shown is the number of students registered in the Augmented degree program within Engineering. This program is a bridging program that the School of Engineering offers to assist students from underprivileged schools.

Most entrants were studying Mechanical Engineering, followed by Electrical and Chemical Engineering. Interestingly, there were very few students in Agricultural and Civil Engineering, yet these disciplines are directly involved in the food and water industries of South Africa.



**Figure 4:** Percentage of category chosen by each discipline in the School of Engineering. Numbers of entrants per category are shown as text on the bars

Students were then shortlisted based on the quality of their responses in terms of a) originality, b) impact and c) constructability. The 47 students who entered the competition were shortlisted to 11, three in the food category, three in the energy category and 5 in the water category.

**Participant Completion and Prototype Development.**

Two students completed the challenge, making robust statistical interpretations difficult. Table 1 shows the finalist demographics, gender, academic standing and engineering discipline. Both finalists were female and classified as ‘at-risk’ and ‘underperforming’ according to the UKZN robot scheme.

Both finalists successfully developed prototypes that addressed societal problems they identified in water and energy. Table 2 summarises

the prototypes that each participant developed as well as the key innovations and performance indicators used in the judging criteria.

**Prototype Assessment**

A six-criterion rubric was used to assess each prototype. Each criterion was scored out of five, with five being the best. The criteria are listed below:

1. Clearly identifying the problem and showing how it is highly relevant and significant to the chosen category.
2. Demonstrating a deep understanding of how the proposed solution solves the problem in the chosen category.
3. Clearly explaining the importance of the proposed solution.

4. The originality of the prototype.
5. The affordability of the solution.
6. Prototype functionality.

The finalists prepared brief pitches for the judges, explaining how their solutions addressed the problems they identified. This reflective

presentation constitutes an important step in the action research methodology.

Figure 5 shows the two finalists (permission given) who constructed a) an innovative bio-based water filter to purify water and b) an oscillating wind energy device to power schools in Richards Bay.

**Table 1:** Finalist demographics, gender and academic standing

Participant ID	Gender	Discipline	Academic Standing	Category
P001	Female	Civil Engineering	At risk	Water
P002	Female	Electrical Engineering	Underperforming	Energy

**Table 2:** Summary of prototypes that each participant developed.

Participant ID	Category	Key-Innovation	Validation Method	Performance indicator
P001	Water	Bio-based water filtration device.	Chemical validation kit.	Contaminant removal demonstrated
P002	Energy	Oscillatory wind energy device	Electrical metering	Measurable power output

Participant 2 scored the highest due to the prototype's ability to make a significant impact on society and because it utilised a multidisciplinary approach to solving the problem, i.e. the electrical engineering student who built the device had to learn about aerodynamics, something beyond the scope of her electrical engineering curriculum.

### **Student Reflections**

Students were invited to complete an anonymous survey at the end of the challenge to reflect on their experience, the challenges they faced and how they overcame them. Three out of the 46 students (6.5%) completed the survey; therefore, a robust statistical analysis was not possible. The student's responses are summarised below:

*Problem Identification Capability.* Two students rated their problem identification skills as good (4/5), while one student assessed their performance as average (3/5).

*Prototype Development.* One student rated their prototype development as good (4/5), the other two considered their prototype development as average (3/5). This is interesting as only two students presented their prototype, suggesting that one student possibly built a prototype but never completed it or never understood the question.

*Workshop Effectiveness.* All students (3) rated the workshops as very beneficial to their learning experience and expressed interest in additional workshop sessions, and indicated they would have liked to do more workshops. This suggested that the workshop format was well received and that it was effective for skill development.

*Challenge and Learning Outcomes.* Students identified several challenges they experienced during the competition. These were related to time management, technical challenges in prototype construction and balancing the

competition requirements with their academic workload.

Significant learning outcomes included enhanced problem-identification skills, improved ability to deconstruct a problem into smaller,

manageable components and systematic problem-solving methods. These outcomes align with the pedagogical objectives of fostering analytical thinking and developing solution-oriented mindsets.



**Figure 5:** Engineering with a Purpose finalists showcasing their prototypes: bio-based water filter (top left) and wind energy device (top right). The bottom panel shows the finalists with the 'Purpose Driven team' comprising senior postgraduate and undergraduate students.

### Discussion

Innovation, higher education, and economic growth are closely linked in developing countries (see Kimenyi, 2011, for a review). This relationship is particularly significant in Africa, where higher education institutions are increasingly recognised as engines of innovation and sustainable development (UNESCO, 2024). Integrating innovation into higher education can thus provide a framework to drive positive economic growth in South Africa. Research demonstrates that higher education contributes directly to economic development through employment and the production of skilled graduates who can enter the labour market (Gillard & Bailey, 2014). Accordingly, this article presents

an innovative teaching methodology, supported by activities to train engineering students in social enterprise and engineering entrepreneurship principles through the Engineering with a Purpose Challenge. Our initiative offers a novel and practical approach to promoting innovation, engineering, and entrepreneurship at higher education institutions in South Africa.

Innovation and entrepreneurship among young adults arise from personal interactions with their environment as they transition to adulthood (Geldhof et al., 2014). For example, the presence of entrepreneurial adults can foster entrepreneurial intent among young adults (Geldhof et al., 2014). Research confirms that access to entrepreneurial role models is associated with higher

entrepreneurial competence, emphasising resource mobilisation and fostering a growth mindset (Alkaabi et al., 2024). Furthermore, mentorship is crucial in helping aspiring entrepreneurs develop the skills and knowledge needed to start and manage ventures, with mentors providing direction, guidance, and moral support to help navigate challenges (Yani & Zaakiyyah, 2024). Therefore, universities and related higher education institutions can play a crucial role in developing entrepreneurs within society. However, developing countries appear to under-appreciate the contribution of higher education to social development (Kimenyi, 2011). The Engineering with a Purpose Challenge was intentionally designed to incorporate industry practitioners and peer mentors to cultivate an entrepreneurial mindset among participants. This design aligns with evidence that entrepreneurship education programmes are most effective when they include exposure to successful entrepreneurial role models, which significantly stimulates students' confidence in their ability to start ventures and improves their attitudes towards entrepreneurship (Boldureanu et al., 2020). Thus, the Engineering with a Purpose Challenge can be used to raise awareness and promote the role of higher education in social advancement and economic growth. The challenge requires university engineering students to apply the mathematics, physics, and engineering tools they learn to solve societal challenges innovatively, regardless of their academic performance. Additionally, they are recognised and rewarded for their innovation and commended by prospective employers at a prestigious awards evening, which benefits future employment opportunities. This approach is consistent with Self-Determination Theory (Ryan & Deci, 2000), which posits that when students experience autonomy over their learning choices, competence in tackling meaningful challenges, and relatedness to their peers and the wider community, their intrinsic motivation flourishes. Purpose-driven pedagogy inherently supports these three basic psychological needs, thereby enhancing student engagement and persistence (Niemic & Ryan, 2009).

Despite limited female representation (8.6%), both finalists were women. This represents a 50% completion rate for women and 0% for men.

This finding suggests different engagements with purpose-driven principles between genders. This observation aligns with substantial research demonstrating that women in engineering tend to place greater value on social responsibility and are often motivated to pursue engineering as a means of contributing to the greater social good (Canney & Bielefeldt, 2015). Studies have found that women give more attention to environmental impacts and social responsibility in engineering work than men, while men tend to assign higher importance to technical skills (Park et al., 2022). Furthermore, framing engineering in terms of its communal and societal impact has been shown to positively influence women's attitudes and behavioural intentions towards engineering pursuits (Collins et al., 2024). Purpose-driven approaches that emphasise the social value of engineering work may therefore resonate more strongly with women students, potentially explaining their higher completion rates in this challenge. However, the sample size in this study was too small, although it warrants systematic investigation in future action research cycles. This is particularly important given the documented gender disparities within engineering. Globally, women comprise only 28% of the STEM workforce (UNESCO, 2023), with engineering and computer science exhibiting the largest gender imbalances (AAUW, 2024). In the United States, approximately 21% of engineering majors are women (AAUW, 2024). These persistent disparities, together with evidence that socially oriented pedagogies may differentially engage women, underscore the importance of investigating how purpose-driven interventions might serve as retention strategies for underrepresented groups.

Many of the entrants, including both finalists, were classified as 'at-risk' or 'underperforming' according to the UKZN academic performance robot system. This suggests that academic performance may have affected the number of entrants who completed the challenge. It also suggests that purpose-driven pedagogy may provide alternative pathways for student engagement that transcend traditional academic performance indicators. This finding aligns with research indicating that at-risk students often prefer pedagogical approaches emphasising group

work and active engagement over traditional instruction (Science.gov, 2023). Research on student engagement demonstrates that intrinsic motivation – driven by interest, purpose, and personal meaning – is more effective for sustained engagement than extrinsic motivators such as grades (Ryan & Deci, 2020). Students who struggle in traditional academic environments may flourish when learning is connected to authentic purposes and real-world applications (Yeager et al., 2014). The success of at-risk students in the Engineering with a Purpose Challenge suggests that alternative assessment pathways emphasising innovation and societal contribution may unlock potential that remains hidden within conventional academic evaluation systems. However, the relationship between academic status and completion rates requires systematic analysis to provide statistically significant findings.

Preliminary feedback from non-participating engineering students indicated increased interest in future challenge participation, suggesting potential scalability of the intervention. This interest aligns with broader evidence that students are more engaged and perform better academically when they see a clear connection between their studies and real-world applications (Farrington et al., 2012; Johansen et al., 2019). Research on student engagement demonstrates that behavioural, emotional, and cognitive engagement are interconnected, with meaningful learning experiences contributing to positive peer communities and enhanced retention (Li & Xue, 2023). However, this feedback lacks a systematic collection method and requires formal evaluation to establish statistically significant findings. Future research cycles should incorporate validated instruments to assess changes in entrepreneurial mindset, social responsibility attitudes, and engineering identity development, enabling comparison with established benchmarks in the literature.

### Limitations

The absence of control groups for comparison prevents attributing observed outcomes to the impact of the purpose-driven intervention. This limitation is characteristic of the one-group pretest- and post-test design, a pre-

experimental approach in which the lack of a comparison group makes it impossible to attribute changes definitively to the intervention rather than to maturation, history, testing effects, or other confounding variables (Cook & Campbell, 1979; Schweizer et al., 2016). As quasi-experimental research methodology emphasises, without randomisation or appropriate control conditions, threats to internal validity cannot be adequately addressed (Campbell & Stanley, 1963; Shadish et al., 2002). The main disadvantage of quasi-experimental studies without control groups is the inability to conclude a causal association between an intervention and an outcome (Harris et al., 2016). Including pre- and post-survey instruments will strengthen future evaluations. Despite these limitations, the study provides valuable contributions consistent with the legitimate purposes of pilot and feasibility research.

### Conclusion

This action research study presents empirical evidence for implementing purpose-driven pedagogy in South African higher education systems. The inaugural Engineering with a Purpose Challenge intervention that was carried out at the University of KwaZulu-Natal's Department of Civil Engineering is significant for a number of reasons: (a) it pioneered a new teaching and learning epistemology that prioritised problem-solving; (b) it centralised innovation and social entrepreneurship, and (c) it encouraged students to learn independently. These are vital skills needed within a professional environment. The action research method was used as it aligns naturally with the engineering design method. This process requires students to plan, design a solution, test, analyse and refine.

The action research method used herein provided practical insights into pedagogical improvements in engineering and contributed to purpose-driven education literature. The Engineering with a Purpose Challenge is a novel way of instilling needed professional attributes. Valuable lessons on planning, managing and executing the challenge were learnt. However, bearing in mind that graduates will enter an increasingly complex and fast-changing professional context, this study provides evidence

to expand the implementation of experiential learning across engineering disciplines.

### Disclosure

### Conflict of interest

The author declares no conflict of interest.

### ORCID

<https://orcid.org/0000-0001-5303-822X>

### References

- Alkaabi, A. et al. (2024). Student entrepreneurship competency and mindset: examining the influence of education, role models, and gender. *Journal of Innovation and Entrepreneurship*, 13, 393. <https://doi.org/10.1186/s13731-024-00393-5>
- American Association of University Women (AAUW). (2024). *The STEM gap: Women and girls in science, technology, engineering and mathematics*. <https://www.aauw.org/resources/research/the-stem-gap/>
- Boldureanu, G. et al. (2020). Entrepreneurship Education through Successful Entrepreneurial Models in Higher Education Institutions. *Sustainability*, 12(3), 1267. <https://doi.org/10.3390/su12031267>
- Biggs, J., & Tang, C. (2011). *Teaching for quality learning at university* (4th ed.). Open University Press.
- Bloomberg, L. D. (2018). Case study method. In B. B. Frey (Ed.), *The SAGE encyclopedia of educational research, measurement, and evaluation* (pp. 237–239). Sage.
- Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research*. Rand McNally.
- Canney, N. & Bielefeldt, A. (2015). Gender differences in the social responsibility attitudes of engineering students and how they change over time. *Journal of Women and Minorities in Science and Engineering*, 21(3), 215-237. <https://doi.org/10.1615/JWomenMinorScienEng.2015011109>
- Collins, B. et al. (2024). The impact of changing engineering perceptions on women's attitudes and behavioral intentions towards engineering pursuits. *International Journal of STEM Education*, 11, 476. <https://doi.org/10.1186/s40594-024-00476-5>
- Cook, T. D., & Campbell, D. T. (1979). *Quasi-experimentation: Design and analysis issues for field settings*. Houghton Mifflin.
- Council on Higher Education. (2021). *VitalStats: Public and private higher education 2021*. CHE.
- Cropley, D. H., & Cropley, A. J. (2000). Fostering creativity in engineering undergraduates. *High Ability Studies*, 11(2), 207–219. <https://doi.org/10.1080/13598130020001223>
- Damon, W., Malin, H., & Colby, A. (2024). Purpose development in the context of higher education. *Applied Developmental Science*. Advance online publication. <https://doi.org/10.1080/10888691.2024.2403535>
- Department of Water and Sanitation. (2022). *Green Drop report*. DWS.
- Dhunpath, R., & Subbaya, R. (2018). Student success and curriculum reform in post-apartheid South Africa. *International Journal of Chinese Education*, 7(1), 85–106. <https://doi.org/10.1163/22125868-12340091>
- Dosoftei, C. C., & Alexa, L. (2024). Students' perception of peer teaching in engineering education: A mixed-method case study. *Humanities and Social Sciences Communications*, 11, Article

756. <https://doi.org/10.1057/s41599-024-03349-y>

<https://doi.org/10.1016/j.jclepro.2015.09.088>

- Farrington, C.A. et al. (2012). *Teaching adolescents to become learners*. University of Chicago Consortium on Chicago School Research.
- Geldhof, G. J., Malin, H., Johnson, S. K., Porter, T., Bronk, K. C., Weiner, M. B., Agans, J. P., Mueller, M. K., Hunt, D., Colby, A., Lerner, R. M., & Damon, W. (2014). Entrepreneurship in young adults: Initial findings from the young entrepreneurs study. *Journal of Applied Developmental Psychology, 35*(5), 410–421. <https://doi.org/10.1016/j.appdev.2014.07.003>
- Gillard, E. & Bailey, T. (2014). The contribution of higher education institutions to the South African economy. *South African Journal of Science, 110*(2), 1-10. <https://doi.org/10.1590/sajs.2014/a0050>
- Harris, A. D., McGregor, J. C., Perencevich, E. N., Furuno, J. P., Zhu, J., Peterson, D. E., & Finkelstein, J. (2006). The use and interpretation of quasi-experimental studies in medical informatics. *Journal of the American Medical Informatics Association, 13*(1), 16–23. <https://doi.org/10.1197/jamia.M1749>
- Intergovernmental Panel on Climate Change. (2019). Summary for policymakers. In H. O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, & N. M. Weyer (Eds.), *IPCC special report on the ocean and cryosphere in a changing climate*. IPCC. <https://www.ipcc.ch/srocc/>
- Jensen, C. D. (2016). Action research to support development of engineering for sustainable development degree programs, part I: Collaborative community action research vignettes. *Journal of Cleaner Production, 122*, 164–175.
- Jensen, I. B., & Dikilitas, K. (2025). A scoping review of action research in higher education: Implications for research-based teaching. *Teaching in Higher Education, 30*(1), 84–101. <https://doi.org/10.1080/13562517.2023.222066>
- Junior, E. H., Raedani, A., Nthambeleni, G., Brown-Glazner, R., Gutierrez, V., Mathoma, K., & Swap, R. (2010). Student-led, community driven improvement of the drinking supply in a rural village in South Africa. *International Journal for Service Learning in Engineering, 5*(1), 94–110. <https://doi.org/10.24908/ijlse.v5i1.3234>
- Kallemeyn, L., Grabarek, J., Livas, M. P., Kallemeyn, L. M., Baura, G., & Fils-Aime, F. (2021). *Engineering curriculum rooted in active learning: Does it promote engagement and persistence for women?* [Paper presentation]. 2021 ASEE Annual Conference, Virtual. <https://peer.asee.org/37299>
- Kemmis, S., & McTaggart, R. (2005). Participatory action research: Communicative action and the public sphere. In N. K. Denzin & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (3rd ed., pp. 559–603). Sage.
- Kimenyi, M. S. (2011). Contribution of higher education to economic development: A survey of international evidence. *Journal of African Economies, 20*(Suppl. 3), iii68–iii106. <https://doi.org/10.1093/jae/ejr018>
- Krumm, P., & Kimmie, R. (2013). Science education: The urgent need for critical reflection. *South African Journal of Science, 109*(3/4), Article a0031. <https://doi.org/10.1590/sajs.2013/a0031>
- Li, J., & Xue, E. (2023). Dynamic Interaction between student learning behaviour and

- learning environment: Meta-analysis of student engagement and its influencing factors. *Behavioral Sciences*, 13(1), 59. <https://doi.org/10.3390/bs13010059>
- Malin, H. (2018). *Teaching for purpose: Preparing students for lives of meaning*. Harvard Education Press.
- Merriam, S. B. (1998). *Qualitative research and case study applications in education*. Jossey-Bass.
- Milner, H. R., IV. (2014). Culturally relevant, purpose-driven learning & teaching in a middle school social studies classroom. *Multicultural Education*, 24(2), 9–17. <https://files.eric.ed.gov/fulltext/EJ1045837.pdf>
- Naude, E., & Horne, T. (2003). Investigating suggestions for increasing the throughput rate of IS students. In *Proceedings of the 2003 InSITE Conference*. Informing Science Institute. <https://doi.org/10.28945/2678>
- Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, competence, and relatedness in the classroom: Applying self-determination theory to educational practice. *Theory and Research in Education*, 7(2), 133–144. <https://doi.org/10.1177/1477878509104318>
- Park, S. et al. (2022). Gender differences in engineering students' understanding of professional competences and career development. *International Journal of Technology and Design Education*, 33, 1305–1329. <https://doi.org/10.1007/s10798-022-09759-w>
- Polkowski, Z., Jadeja, R., & Dutta, N. (2020). Peer learning in technical education and its worthiness: Some facts based on implementation. *Procedia Computer Science*, 172, 247–252. <https://doi.org/10.1016/j.procs.2020.05.039>
- Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68–78. <https://doi.org/10.1037/0003-066X.55.1.68>
- Ryan, R.M. & Deci, E.L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, 61, 101860. <https://doi.org/10.1016/j.cedpsych.2020.101860>
- Schweizer, M. L., Braun, B. I., & Milstone, A. M. (2016). Research methods in healthcare epidemiology and antimicrobial stewardship—Quasi-experimental designs. *Infection Control & Hospital Epidemiology*, 37(10), 1135–1140. <https://doi.org/10.1017/ice.2016.117>
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Houghton Mifflin.
- Stake, R. E. (1995). *The art of case study research*. Sage.
- Stake, R. E. (2005). Qualitative case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (3rd ed., pp. 443–466). Sage.
- Statistics South Africa. (2024). *Quarterly labour force survey*. StatsSA. <https://www.statssa.gov.za/>
- Stuckey, R. (2007). Teaching with purpose: Defining and achieving desired outcomes in clinical law courses. *Clinical Law Review*, 14(1), 19–57. <https://www.law.nyu.edu/journals/clinicalawreview>
- Sukharev, O. (2021). Measuring the contribution of the “knowledge economy” to the economic growth rate: Comparative analysis. *Journal of the Knowledge Economy*, 12(4), 1809–1829.

- <https://doi.org/10.1007/s13132-020-00690-w>
- Temple, J. (2000). *Growth effects of education and social capital in the OECD countries* (OECD Economics Department Working Papers No. 263). Organisation for Economic Co-operation and Development.  
<https://doi.org/10.1787/882344562861>
- Tullis, J. G., & Goldstone, R. L. (2020). Why does peer instruction benefit student learning? *Cognitive Research: Principles and Implications*, 5, Article 15.  
<https://doi.org/10.1186/s41235-020-00218-5>
- UNESCO. (2024). *What you need to know about higher education in Africa*.  
<https://www.unesco.org/en/articles/what-you-need-know-about-higher-education-africa>
- World Bank Group. (2001). *Problem tree analysis tool*.  
<https://web.mit.edu/urbanUpgrading/upgrading/issues-tools/tools/problem-tree.html>
- Yani, A. & Zaakiyyah, N. (2024). The Importance of Mentorship in Stimulating the Growth and Success of Entrepreneurial Business Entities. *Journal of Entrepreneurship Education*, 2(1), 337-342.  
<https://doi.org/10.61100/adman.v2i1.129>
- Yazan, B. (2015). Three approaches to case study methods in education: Yin, Merriam, and Stake. *The Qualitative Report*, 20(2), 134–152. <https://doi.org/10.46743/2160-3715/2015.2102>
- Yeager, D. S., Henderson, M. D., Paunesku, D., Walton, G. M., D’Mello, S., Spitzer, B. J., & Duckworth, A. L. (2014). Boring but important: A self-transcendent purpose for learning fosters academic self-regulation. *Journal of Personality and Social Psychology*, 107(4), 559–580.  
<https://psycnet.apa.org/doi/10.1037/a0037637>
- Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage.