RESEARCH ARTICLE

"They all offered different support": Integrated support systems for academic resilience among engineering students

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Article history: Received 25 September 2024 | Accepted 5 December 2024 | Published 18 December 2024

ABSTRACT
A critical area of debate in an era of evolving university support systems is how best to offer support to students in challenging disciplines. This study examines the effectiveness of current frameworks in addressing the needs of engineering students. This research employs a mixed-methods approach to identify the experiences of final-year students undertaking bachelor studies in engineering technology at Nelson Mandela University, as well as those of their lecturers and relevant support staff. The study finds a direct relationship between students' stress levels and their resilience, highlighting the importance of well-structured support systems, including orientation programmes and subject-specific tutoring. This article introduces a novel perspective on fostering academic resilience in engineering education, advocating for a comprehensive approach that integrates personal, academic and socio-ecological forms of support. Challenging conventional views of interventions for student success, it proposes a new, holistic framework for the provision of support in higher education institutions. This approach could contribute to enhancing student resilience and success and provide a fresh lens to address student dropout in higher education in South Africa and beyond.

KEYWORDS
Academic resilience, engineering students, holistic student success, interventions, South Africa

Introduction

In the quest to redefine the landscape of student success, numerous evidence-based interventions have emerged, challenging traditional educational paradigms and provoking an important question: Are these approaches actually resonating with the students they aim to serve? The recent significant evolution in student support, while laudable for its innovative spirit, confronts a key hurdle – how to ensure that the new interventions being produced meaningfully connect with the diverse experiences and needs of students.

In other words, there is a need to examine the effectiveness of the new evidence-based strategies that are being implemented. In this regard, it has been found that, while the intentions behind these strategies are often noble, the reality of their implementation frequently reveals a mismatch between what is anticipated by educators, support staff and university managers, and how the students experience these interventions. This discrepancy highlights the intricate balance that must be achieved between meeting

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institutional objectives and addressing actual student needs. Scholars such as Dollinger and D'Angelo (2020) and Scott (2018) delve into this complexity, advocating for the alignment of educational strategies with the authentic experiences and aspirations of students. Their work underscores the need to adapt interventions so that they cater to the evolving landscape of student demographics and expectations; and so that the well-intentioned efforts may be transformed into truly impactful and meaningful educational experiences for students.

Engineering education presents challenges that require intervention. Historically, engineering has been quite male-dominated and characterised by a lack of representation among women who face a range of hurdles in this field (Patrick et al., 2021). Engineering programmes are also known for their demanding course work; heavy workloads; and competitive environments – all of which can contribute to increased stress and relatively high rates of student attrition (Khajeha, 2017; Mapaling, 2023).

Research indicates that the provision of effective support services, such as tutoring, mentoring, coaching and academic advising, plays a crucial role in enhancing student outcomes, including in terms of retention rates, academic performance and overall satisfaction (Campbell & Mogashana, 2024; de Klerk, 2021; Strydom & Loots, 2020; Versfeld & Mapaling, 2024). Student support services should not only assist students in navigating the challenges they face but can also cultivate a sense of community and belonging which helps to promote student success (Stellenbosch University, 2022; University of Cape Town, 2022). However, the academic support services offered by institutions can differ significantly; and some students may lack access to the resources that they need to achieve academic success.

In the recent discourse on student services, well-being has increasingly been defined as a prerequisite for student success (Davey, 2023; Mapaling, 2023). This contemporary view challenges traditional notions that equate student success solely with academic achievement (Alyahyan & Düştegör, 2020) and acknowledges the multifaceted nature of student experiences.

Meanwhile, the concept of student success itself has been a matter of ongoing debate and has evolved in significant ways. Historically, it was closely tied to relatively simple measures of retention and academic performance (Mayet, 2016; Yorke & Longden, 2004). Over time, however, a consensus has emerged that student success should be viewed as a matter of collective responsibility (Bainter, 1998; Bowers, 2015; Wilson et al., 2011). The complexity of the term and its various interpretations are evident in efforts by organizations such as Universities South Africa (USAf) to define and contribute to student success (Greenleaf Walker, 2023).

In the South African context, Van der Merwe and Maharaj (2018) identify four major factors that influence the prospects of academic success for engineering students: challenges within the school system, high dropout rates, the cost of engineering programmes, and stringent professional accreditation requirements. These factors resonate globally, as is evidenced by Wang et al.'s (2022) study across 14 undergraduate engineering programmes in the United States (US). This study aimed to fill the gap in research on holistic support systems and academic resilience among engineering

students, highlighting the need for comprehensive support for diverse student populations, including those from low-income, first-generation and international backgrounds; and also addressed gender disparities within the field.

Against this background, the present study employed a mixed-methods approach in an effort to provide a comprehensive, nuanced understanding of academic resilience among engineering students. Through a combination of quantitative data and qualitative insights garnered from interactions with students, lecturers and support staff, the research underscores the critical nature of, and need for, holistic support systems. The hope is that the approach adopted facilitates a deeper understanding of the factors influencing academic success and highlights the vital role of comprehensive support in bolstering the resilience of students navigating the complex landscape of higher education. The multifaceted nature of academic resilience and the interconnectedness of various support mechanisms indicate a need for integrated, student-centric strategies in fostering sustainable and holistic student success.

Perspectives on risk, resilience, and wellness: Theoretical foundations for holistic student success in engineering education

Educational interventions have traditionally targeted 'at-risk' students, that is, those facing potential academic failure or dropout. This risk-averse approach aims to prevent negative outcomes but often overlooks the broader concept of resilience. In this regard, it is important to note that academic resilience comprises more than an absence of risk; it requires overcoming adversity and is a key component of a holistic approach to promoting student success (Cassidy, 2016; Mapaling, 2023; Morales, 2008).

A holistic approach that covers not only academic achievement but also well-being and personal development is vital to promoting effective education in engineering, which is a particularly academically rigorous discipline. Academic resilience for those studying engineering encompasses academic accomplishment and mental and emotional well-being so that students can foster meaningful relationships and prepare themselves properly to address the challenges they will face after university. In this context, concepts of risk and resilience should be integrated into the understanding of student success so that a comprehensive view of student experiences and needs may be reached, and more effective and empathetic educational practices and policies may be implemented.

Against this background, the present literature review begins with an examination of how environmental factors and individual differences contribute to resilience. For example, Rutter's (1979, 2006) work highlights the significant role that environment plays in shaping resilience and the way in which multiple exposures to risk can affect the likelihood of psychiatric disorders.

Building on the foundations laid by Rutter (1979), Werner and Smith's Kauai study (1982) illustrates how resilience can persist despite severe stressors. The Kauai study emphasises the dynamic balance between risk and protective factors during individual developmental trajectories (Werner & Smith, 1982). The study further sets the stage for understanding resilience as a process that evolves across different life phases. Building

Journal of Student Affairs in Africa, 12(2), 19–36
DOI: 10.24085/jsaa.v12i2.5448 | ISSN 2307-6267 | www.jsaa.ac.za

on this idea, Garmezy's (1991) 'functional adequacy' concept explores protective and risk factors in stress-resistant children, highlighting resilience as a trait that is shaped by both individual and environmental factors. Garmezy's work paved the way for a more nuanced view of resilience as a phenomenon shaped by a confluence of internal and external elements.

Luthar et al.'s (2000) work on the multidimensional nature of resilience complements and extends the ideas previously developed, emphasising the complexity of the concept of resilience and exploring risk and protective factors as distinct yet interconnected influences. Luthar's approach underlines the idea that resilience cannot be viewed in isolation but should rather be seen as part of the broader, multifaceted spectrum of human experience (Luthar et al., 2000).

Masten and Reed (2002), building on Garmezy's (1991) foundational work, view resilience as the capacity to adapt and change in response to risk. They place a significant emphasis on the importance of assets and protective factors in fostering a supportive environment for resilience (Masten & Reed, 2002). Masten and Reed's perspective thus advances the conversation by focusing on how individuals and environments interact dynamically, suggesting that resilience is not merely about enduring adversity but rather about evolving in response to it (Masten & Reed, 2002).

These theoretical perspectives highlight the fluid nature of resilience and how it can be shaped by an intricate web of personal traits; familial dynamics; educational settings; societal resources; and cultural influences. In a similar vein, it is important to acknowledge the wide array of factors shaping student life if one is to develop educational strategies that not only foster academic prowess but also nurture the comprehensive growth and well-being of students.

The focus on student and staff wellness takes on heightened significance in an era of global health crises and student protests. The importance of fostering student well-being, including in terms of emotional and academic support; personal empowerment and self-care; interpersonal interactions; and future-oriented goals, becomes more pronounced during challenging times (Eloff et al., 2022) when the need for robust support systems that can address both mental health and academic achievement becomes quite achievement.

Meanwhile, there has also been an increasing focus in the literature on the importance of tailoring wellness initiatives to individual needs in higher education institutions (Henrico, 2022). This notion of customising wellness interventions aligns with the view of well-being as a core component of academic success, challenging traditional academia-centric views (Alyahyan & Düştegör, 2020; Davey, 2023; Mapaling, 2023). In addition, the call for comprehensive, personalised wellness programmes (Henrico, 2022) mirrors the rise of a broader educational narrative that emphasises the importance of integrated, student-focused strategies. Under this view, such strategies are considered vital for nurturing the multidimensional resilience upon which academic and personal success depends (Van der Merwe & Maharaj, 2018; Wang et al., 2022).

Hossain et al. (2022) argue that it is essential to expand the understanding of student well-being to include a broad spectrum of academic and life experiences. This broader

view of student success, which frames it as a shared responsibility to be undertaken by a range of educational stakeholders (Bainter, 1998; Bowers, 2015; Wilson et al., 2011), is critical to the effective establishment of interventions that holistically address student needs.

Conceptual frameworks guiding the study

This study was primarily informed by two conceptual frameworks that were deemed particularly relevant to engineering education in South Africa. First, it drew from Ungar's (2008, 2011) socio-ecological approach to resilience, which emphasises that resilience processes operate across the micro-meso-macro continuum and are not solely rooted within the individual. This perspective allowed for a more holistic examination of the factors enabling and constraining academic resilience among engineering students. The second conceptual position that guided this study was Ebersöhn's flocking theory (2019), which is grounded in an indigenous psychology of resilience in the Southern African context. This framework is particularly relevant as it illustrates how collective support mechanisms that are deeply embedded in cultural practices can foster resilience, particularly in resource-limited settings such as South Africa (Ebersöhn, 2019).

By incorporating these two conceptual lenses, the present study was able to capture the multifaceted and contextually situated nature of academic resilience among the engineering student population. The integration of Ungar's socio-ecological approach and Ebersöhn's flocking theory provided a robust foundation for exploring the complex interplay of individual, relational, and contextual factors influencing the academic resilience of engineering students in South Africa.

Research methodology

Research design and approach

This study utilised an exploratory case study design (Yin, 2018) and mixed-methods approach (Creswell & Plano Clark, 2018). The exploratory case study design has been considered suitable for an in-depth investigation of academic resilience in a new context (Rule & John, 2011; Yin, 2018), enabling the exploration of novel themes and perspectives. The mixed-methods approach, which integrates both qualitative and quantitative data, enabled a comprehensive understanding of academic resilience through data triangulation and validation, enhancing the trustworthiness of the findings (Tashakkori & Creswell, 2007).

Participants and sampling

The present research focused on final-year students pursuing a three-year Bachelor of Engineering Technology degree at Nelson Mandela University and their lecturers and support staff. The engineering technology degree spans multiple engineering disciplines including industrial, civil, electrical, marine and mechanical engineering. For the quantitative aspect of the study, 47 out of a possible 66 students (74.6%) were recruited from these disciplines. They participated by completing various measuring instruments. The sample size of 47 students is considered representative, as it exceeds

Journal of Student Affairs in Africa, 12(2), 19–36
DOI: 10.24085/jsaa.v12i2.5448 | ISSN 2307-6267 | www.jsaa.ac.za

the recommended minimum sample size of 40, calculated using Yamane's (1967) formula for a population of 66 with a 90% confidence level and a 10% margin of error. Simple random sampling was employed to select the students for this study, ensuring a representative cross-section of the cohort.

Individual interviews with a diverse group of participants, including 13 engineering students, six lecturers and six support staff, were conducted for the qualitative component of the study. This sample size was determined based on the concept of data saturation, under which interviews continued until no new themes or insights emerged from the data (Saunders et al., 2018). The interviews aimed to delve into the respondents' perceptions and experiences of academic resilience. The participants were selected using purposive sampling, targeting individuals who could provide rich, relevant and varied perspectives on the topic.

The criteria for participation in the study were that the students needed to be in their final year of the Bachelor of Engineering Technology programme; aged 18 or above; and enrolled in civil, electrical, industrial, marine or mechanical engineering. The lecturers needed to have a minimum three years of teaching experience in these disciplines from 2018 to 2020. The support staff needed to have undertaken academic and counselling activities for the specified student groups.

Phase 1: Quantitative data collection

During phase 1, quantitative data were collected, analysed and tested for reliability and validity.

Data collection

Five instruments for data collection were employed: a self-designed demographic questionnaire; the *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition*, 'self-rated Level 1 cross-cutting symptom measure-adult' (DSM-5 CCSM-A) (American Psychiatric Association, DSM-5 Task Force, 2013); a 10-item Kessler psychological distress scale (K10) (Kessler et al., 2002); the adult resilience measure (ARM-28) (Resilience Research Centre, 2018); and the academic resilience scale (ARS-30) (Cassidy, 2016). These tools measured demographic variables; individual and contextual risks; and resilience factors.

Data analysis

The statistical package for the social sciences (SPSS) Version 29 was utilised for data analysis, ensuring only complete responses were analysed. The quantitative data were analysed through two kinds of statistical analyses: descriptive statistics (Fisher & Marshall, 2009) and inferential statistics (Allua & Thompson, 2009). Descriptive statistics were generated from each of the instruments that were administered. The frequency of admission and academic support information was also presented using descriptive statistics. Inferential statistical methods, such as the non-parametric Mann-Whitney test, were used to assess whether there was a statistically significant relationship between the categorical variables in this study, including academic resilience; personal resilience; and psychological distress.

Reliability and validity

The DSM-5 CCSM-A, a 23-item self-report scale covering 13 mental health domains, has demonstrated internal, convergent and criterion-related validity for assessing psychopathology among university students in a non-clinical setting (Bravo, 2018). The K10, a 10-item scale for psychological distress, has shown strong correlations with clinical diagnoses of anxiety and affective disorders (Andrews & Slade, 2001) and satisfactory internal reliability in studies with foreign students (Chiara et al., 2021) and medical students (Qamar et al., 2014). The ARM-28 assesses protective resources across individual, relational, and contextual domains. However, notwithstanding its use to explore resilience in diverse cultural contexts (Clark et al., 2022), its factor structure may need further validation to capture context-specific nuances. The ARS-30, which was designed specifically for academic settings, has shown acceptable internal consistency (Cronbach's alpha = 0.90) and accounts for significant variance in academic resilience scores (Cassidy, 2016). However, its generalisability to diverse student populations, particularly males, requires further investigation.

Phase 2: Qualitative data gathering

During phase 2, qualitative data were gathered, analysed by theme and assessed for trustworthiness.

Data gathering

Qualitative data were gathered through semi-structured interviews using Zoom, in response to the constraints imposed by the COVID-19 pandemic. Separate interview schedules for students, lecturers and support staff were developed to enable them to focus on their experiences and perceptions of academic resilience.

Thematic analysis

The interview transcripts were analysed using Braun and Clarke's (2006, 2020) six-phase thematic analysis in an effort to ensure a reflective and inductive approach. The data were initially subjected to careful reading, transcribing, and memoing so that a nuanced understanding of academic resilience and the effectiveness of support strategies could be acquired. Key patterns relating to student support strategies and their real-world impact were identified and coded; and these formed preliminary themes around the challenges faced in engineering education and the nature of the available support systems. In the subsequent phases, these themes were critically reviewed and validated against the original data, with the aim of ensuring they accurately reflected the intricate relationship between institutional objectives and student experiences. This process involved refining the themes to capture the multidimensional nature of academic resilience and support mechanisms. Finally, the refined themes were synthesised into a cohesive narrative, portraying the current landscape of academic resilience in engineering education. This narrative addressed the core research question and sought to contribute meaningfully to the discourse on student success and well-being in the dynamic field of higher education.

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DOI: 10.24085/jsaa.v12i2.5448 | ISSN 2307-6267 | www.jsaa.ac.za

Trustworthiness

Several strategies were employed as part of the thematic analysis process to ensure the trustworthiness of the findings (Nowell et al., 2017). These strategies included prolonged engagement with the data, triangulation, an audit trail, thick descriptions, member-checking, and reflexivity. There was prolonged engagement with the data to develop a deep understanding of the context and participant perspectives. Triangulation was achieved through the deployment of a number of data generation modes, involving an independent co-coder; and data were triangulated using various research methods. An audit trail of code generation was maintained; and thick descriptions of context were developed through memoing (reflexive journaling). This detailed documentation of the research process allowed for transparency and reproducibility. Member-checking was undertaken by providing each participant with a password-protected transcript of their interview via email for review and approval. Participants had the opportunity to omit sensitive information or indicate if they would rather not be quoted on specific matters. All participants approved the use of their interviews as transcribed. The author practised reflexivity throughout the study using memoing, which also served as a means of maintaining a clear audit trail.

Ethical considerations

Participation in the study was voluntary, and all participants provided informed consent electronically before the interviews commenced. Measures were taken to ensure confidentiality and anonymity, including the use of pseudonyms during data analysis. The potential risks and benefits of participation were clearly communicated to the participants. Counselling support was offered to participants in case they required this. Informed consent also covered the use of data for educational and research publication purposes and covered the recording and transcription of interviews. Confidentiality agreements were signed by the research team, and data were stored securely in both physical and electronic formats.

Research findings and discussion

This research generated extensive data, parts of which have been disseminated in publications (Mapaling, 2023; Mapaling, 2024; Mapaling et al., 2021; Mapaling et al., 2022; Mapaling et al., 2024a; Mapaling et al., 2024b; Mapaling & Wint, 2024).

Resilience amid risk

This study considered the experiences of 47 final-year students studying for a bachelor's in engineering technology at Nelson Mandela University. This group, who were 23.3 years-old on average and predominantly hailed from South Africa (92%), were ethnically diverse – comprising black (61%), white (24%) and coloured (15%) students – and communicated primarily in Xhosa (43%), Afrikaans and English. Their academic pursuits varied, with mechanical engineering (35%) and civil engineering (32%) being the most common specialisations.

The success of these individuals, half of whom were first-generation university students, was supported in various ways. Financial aid was a key component, with 41% benefitting from the National Student Financial Aid Scheme (NSFAS); and 17% benefitting from family funding or bursaries. Only 11% were self-funded. Notably, 21% of the students relied on the Meal-A-Day project as a resource for daily sustenance.

The analysis uncovered significant relationships within the data. Table 1 indicates a clear correlation between stress levels and resilience: 86% of students reporting low stress exhibited higher personal resilience, while only 61% of those experiencing moderate to severe stress exhibited relatively high personal resilience.

Table 1: Contingency table – Kessler distress category and personal resilience

	Personal resilience					
Kessler distress category	**<=60**		**>60**		**Total**	
Well/mild	5	14%	30	86%	35	100%
Moderate/severe	7	39%	11	61%	18	100%
Total	12	23%	41	77%	53	100%
Chi² (d.f. = 1, n = 53) = 4.11; p = .043; V = 0.28 Small						

Table 2 highlights the impact of orientation programmes on resilience. A total of 97% of students who attended the How2@Mandela programme demonstrated increased adult resilience, significantly higher than the 61% resilience rate among non-attendees.

Table 2: Contingency table – Attended How2@Mandela orientation programme and adult resilience

	Adult resilience					
Attended How2@Mandela orientation programme	**<=60**		**>60**		**Total**	
Yes	1	3%	34	97%	35	100%
No	7	39%	11	61%	18	100%
Total	8	15%	45	85%	53	100%
Chi² (d.f. = 1, n = 53) = 12.04; p = .001; V = 0.48 Medium						

These data points highlight the complexity of academic resilience and student success, particularly in the context of risk exposure, with demographic factors, financial support and participation in university-led support programmes all having an influence.

Unveiling perceptions and experiences

The perceptions and experiences of students, lecturers and support staff are categorised under three themes: well-being; support from relationships and the socio-ecological environment; and the role of support and resources. To ensure anonymity, pseudonyms were assigned and coded for each sample group during data analysis. Engineering

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students' pseudonyms began with their discipline's initial (e.g. "C" for Civil – Chris); lecturers were coded with "Prof" followed by an initial (e.g. "Prof A" for Adams); and support staff were identified by an acronym indicating their role (e.g. "AS Aaron" for academic support – Aaron). Representative quotes from each group under each theme are included to offer perspectives and deepen the understanding of academic resilience and student success in engineering education.

Table 3: Well-being

Sample group	Pseudonym	Quote
Engineering students	Isaac	*I would say what was available was student counselling, especially for the mental health side of things.*
	Chido	*… hope is very powerful because … knowing that eventually like you're gonna … make it through anything.*
Engineering lecturers	Prof I	*A lot more is expected with online learning, and I think that causes a lot of stress.*
	Prof E	*… there are other important factors in rounding off a person completely, not just academic studies. How is COVID going to affect the next four to five years of students studying now?*
Support staff	AS Rosie	*… stressors in them that can trigger many times and open up many things that they need extra support through Emthonjeni [student counselling]*
	CS Ruby	*I would sell them [lecturers] a psychological approach and so it was new to them initially and what I found was that we couldn't even talk to them about things like well-being because they wanted to talk about student success, about academics.*

Table 3 indicates a shift in the engineering education community towards acknowledging the importance of well-being. While the initial focus was predominantly on academic achievement (Alyahyan & Düştegör, 2020), a growing recognition of the importance of well-being among students and staff is evident. Students value counselling and psychological support, a perspective that aligns with Peterson and Seligman's (2004) emphasis on character strengths such as hope and persistence. This alignment is particularly evident in the way student participants express hope, viewing it as central to overcoming challenges and persevering through adversity. Support staff's advocacy for personalised support mechanisms reflects the socio-ecological model developed by Ungar (2008, 2011), under which the interaction between individual and environmental factors in stress management is highlighted. Meanwhile, an evolving understanding among lecturers about the impact of various stressors, including online learning, resonates with Ebersöhn's (2019) perspective on the role of external support systems in fostering resilience.

Table 4: Support from relationships and the socio-ecological environment

Sample group	Pseudonym	Quote
Engineering students	Cliff	*There was a tutor in my first year that was helping out with Excel.*
	Eleanor	*I would say the study centre was also helpful. Even the library was helpful.*
Engineering lecturers	Prof M	*I've been busy this whole week answering WhatsApp from the students and emails and assisting them and sending them videos, additional videos to explain.*
	Prof I	*The IT [information technology] helpdesk is probably the biggest referring factor that I as lecturer do.*
Support staff	AS Yanga	*We offer academic advice … because when I meet you for the first time, I need to understand what your goals are and where you see yourself, in the next three, four years.*
	MS Lee	*I basically deal with a lot of the students and help them with any queries that they have regarding the bursary funds.*

Table 4 showcases a range of support strategies within the socio-ecological environment of engineering education. Engineering students emphasise the benefit of varied academic assistance, reflecting a need for personalised and systemic support that caters to their specific educational challenges. The students' appreciation for varied forms of support illustrates the relational dimension of resilience-building, directly resonating with Ebersöhn's (2019) emphasis on the importance of interpersonal relationships in fostering resilience. At the same time, the focus on individualised strategies as a way of meeting unique student needs reflects Ungar's (2008) perspective, which underscores the necessity of customising assistance to enhance student well-being and success. Lecturers described how they contribute through proactive communication and the provision of resources, which aligns with Liebenberg and Moore's (2018) findings on the importance of adaptable and responsive support systems. The role identified by the support staff, who tend to focus on broader aspects of student needs from academic advice to financial guidance, illustrates the comprehensive nature of the support required. The varied approaches to support, as indicated by these groups, align with Masten's (2015) perspective on resilience as the capacity for dynamic adaptation and change in the face of risk.

Table 5: Role of support and resources

Sample group	Pseudonym	Quote
Engineering students	Mike	*I did attend the uhm I think it was called the How2 Buddy [first-year orientation] programme … I had a really good time.*
	Esona	*I went for mentoring. It did help me a lot. I went for tutoring. It helped me a lot.*

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DOI: 10.24085/jsaa.v12i2.5448 | ISSN 2307-6267 | www.jsaa.ac.za

Sample group	Pseudonym	Quote
Engineering lecturers	Prof C	*We would actually buy groceries for them.*
	Prof E	*Sometimes if it's a potentially serious medical problem, then I will pay for them to go to my private doctor.*
Support staff	AS Uyanda	*Students coming from rural areas, who, as I said, do not know how a laptop works, do not have internet access, do not have the right resources – and what I did I was act as a middleman.*
	AS Mary	*We developed online material … time management, goal setting, motivation, uhm, study skills, stress management.*

Table 5 reveals the diverse, multifaceted nature of the support and resource strategies deployed in engineering education. It highlights students' appreciation for peer-led initiatives (Versfeld & Vinson, 2024), reflecting the effectiveness of such strategies in enhancing their success. This appreciation for peer-led initiatives aligns with Ebersöhn's (2019) flocking theory. Meanwhile, the lecturers' support efforts appear to extend beyond conventional academic boundaries to include various forms of care and assistance, resonating with Sarafino and Smith's (2014) definition of support. Support staff describe how they contribute by addressing students' immediate and long-term needs, exemplifying Rutter's (2006) concept that resilience is bolstered through appropriate resource provision.

Synthesis: Unifying quantitative and qualitative insights

The analysis of the quantitative and qualitative data sheds light on the complexity of the support systems in engineering education. Quantitative correlations show a link between stress levels and personal resilience, as well as the positive impact of developmental programmes. Qualitative insights complement this finding, with students, lecturers and support staff expressing appreciation for a range of different forms of support, from peer-led initiatives to more comprehensive care. Overall, the analysis indicates that resilience and student success are products of a dynamic interplay among systemic support, individual needs and socio-ecological elements. This finding underscores the importance of a holistic student-support approach that integrates emotional, mental, academic and practical aspects to enhance overall well-being and student success.

Conclusion

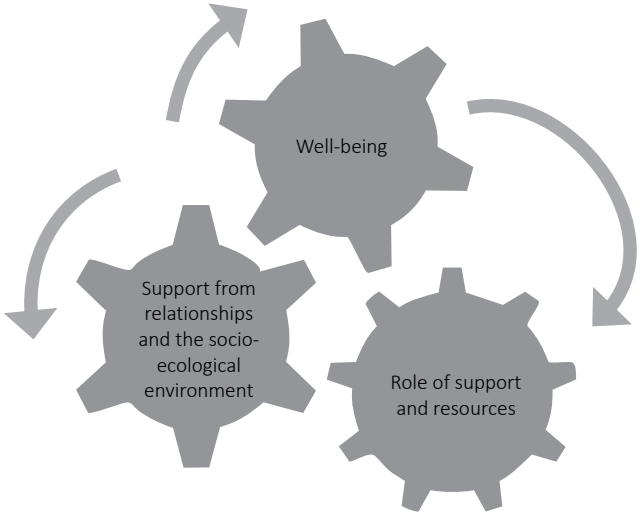
This study explored diverse support mechanisms essential for student success, as captured by the participants' words in the title of this article: "*They all offered different support*". This diversity challenges the traditional concept of 'interventions', which is a term that can be laden with stigmatic connotations. In place of this term, it is proposed that a more inclusive phrase – 'gears of connectivity' – be promoted. This phrase better reflects the dynamic, adaptable nature of the provision of support in higher education.

Traditionally, student support in higher education has been viewed on a linear continuum, from remedial to developmental strategies (McConney, 2023) (as seen in Figure 1).

Figure 1: Linear continuum of interventions

However, the findings of this study indicate that a more interconnected approach should be adopted – as embodied by the three interconnected gears of connectivity: well-being; support from relationships and the socio-ecological environment; and the role of support and resources (see Figure 2 below). These gears, which are essential to fostering academic resilience and success, highlight the need for support mechanisms that are adaptable and responsive to the diverse needs of university students.

Figure 2: Interconnected gears of connectivity



The 'gears of connectivity' framework emphasises the importance of a holistic approach to student support. It recognises that effective support in higher education must shift and adapt, just as mechanical gears move and interlock, to meet the evolving academic, social, and personal needs of students. The approach goes beyond merely addressing deficiencies and seeks instead to nurture students in a comprehensive fashion.

Journal of Student Affairs in Africa, 12(2), 19–36
DOI: 10.24085/jsaa.v12i2.5448 | ISSN 2307-6267 | www.jsaa.ac.za

Incorporating Ungar's (2008, 2011) socio-ecological approach to resilience, which emphasises how resilience processes operate across the micro-meso-macro continuum, the 'gears of connectivity' framework serves to underscore the multifaceted nature of support mechanisms. This alignment with Ungar's (2008, 2011) perspective also highlights the importance of considering individual, relational and contextual factors when designing support systems for students.

Furthermore, the interconnectedness of the 'gears of connectivity' framework resonates with the collective support mechanisms promoted under Ebersöhn's (2019) flocking theory. This study's findings reinforce the significance of culturally embedded support systems, particularly in the context of resource-constrained South African higher education institutions, as suggested by Ebersöhn's (2019) work.

This study contributes to a growing body of research that recognises the importance of collective support mechanisms in fostering resilience and success among university students, as suggested by Ebersöhn's (2019) flocking theory. In this context, future research should aim to extend the insights presented here by undertaking comparative studies across different universities and countries, exploring the impact of cultural and economic differences, as well as differences among education systems, on student success, resilience and well-being.

In addition, this study's findings offer important insights for university support staff and practitioners, particularly in relation to the need to forge and implement culturally sensitive, context-specific support strategies; and incorporate a broad spectrum of student experiences into these strategies so that effective resilience and well-being programmes are developed.

While this study provides valuable insights into the academic resilience of engineering students, it is important to note several limitations. The findings are specific to the context of Nelson Mandela University and may not be generalisable to other institutions or countries. Additionally, the sample size and composition may have limited the breadth of perspectives captured.

Ethics statement

Ethical approval for this study was secured from the Nelson Mandela University Research Ethics Committee: Human (approval reference number: H20-EDU-ERE-026). Informed consent was obtained from all participants in the study and ethical standards were observed throughout the study thereby safeguarding the integrity of the research process.

Potential conflict of interest

The author declares that there are no conflicts of interest associated with this publication.

Funding acknowledgement

This research received substantial support from the German Academic Exchange Service (DAAD) and the East and South African-German Centre of Excellence in Educational Research Methodologies and Management (CERM-ESA).

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How to cite:

Mapaling, C. (2024). "They all offered different support": Integrated support systems for academic resilience among engineering students. *Journal of Student Affairs in Africa, 12*(2), 19–36. DOI: 10.24085/jsaa.v12i2.5448.