



(Re)defining Resilience: How Engineering Educators Understand and Teach Resilience

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EMPIRICAL RESEARCH

VIRGINIA TECH.
PUBLISHING

ABSTRACT

Background: In recent years “resilience” has become framed as a positive attribute, contributing to student success within higher education (HE). The need for students to develop and demonstrate resilience seems pertinent within engineering degrees which are often associated with heavy workloads, high rates of attrition and increased mental health issues. Secondly, engineering degrees prepare students for a profession, and likely place emphasis on graduate attributes such as resilience. Finally, the rate of technological advancement and societal change places additional demands on graduates to adapt to career changes.

Purpose/Hypothesis: Despite emphasis on the benefits of demonstrating resilience, there is a lack of research focusing on how it is understood and taught within engineering education. In this work we seek to understand how engineering educators conceptualize resilience, whether they feel responsibility to help students develop resilience, and their approach to this.

Design/Method: Data was collected via semi-structured interviews with thirteen individuals from two UK based universities. Transcripts were analyzed using reflexive thematic analysis (RTA).

Results: Although resilience is considered a desirable attribute for engineering graduates, this work highlights differences in the degree to which educators feel responsible for its development, as well as methods which they may adopt. The significant variation in the way the term is conceptualized (being associated with adaptability, as well as resistance to change) has several implications for intervention design.

Conclusion: Given emphasis on both resilience and student mental health within HE discourse, there is a need for institutions, as well as employers, to provide strong messaging regarding what is meant by the term and how they believe it presents as an attribute of engineering graduates. There should also be sustained, intentional efforts to stop the use of deficit-based language and approaches which fail to recognize wider structural inequalities that exist within institutions and the engineering profession more widely.

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KEYWORDS:

resilience; student
development; reflexive
thematic analysis; professional
skills; engineering educators

TO CITE THIS ARTICLE:

Wint, N., & Direito, I. (2024).
(Re)defining Resilience:
How Engineering Educators
Understand and Teach
Resilience. *Studies in
Engineering Education*, 5(2),
175–195. DOI: [https://doi.
org/10.21061/see.163](https://doi.org/10.21061/see.163)

As a concept, “resilience” appears across a broad spectrum of disciplines from the natural to the social sciences and is thus associated with a multitude of definitions (e.g., Nisioti et al. 2023; Quinlan et al. 2016; Reid & Botterill 2013). Whilst its widespread use is partly attributed to its vagueness and ambiguous nature (Béné et al. 2014), it is likely that increased clarity will result in enhanced usefulness. In recent years the term has been increasingly used within the field of education, with an emphasis on the positive role that resilience can play in student success within higher education (HE) (Beltman et al. 2011; Howe et al. 2012; McAllister & McKinnon 2009; Reyes et al. 2015; UCAS 2018; UNITE 2017), this being exacerbated during the COVID-19 pandemic (Brammer 2020). The need for students to develop and demonstrate resilience seems particularly pertinent within engineering education for several reasons, including the heavy workload involved (Armstrong 1996; Brainard et al. 1999; Godfrey & Parker 2010; Seymour & Hewitt 1997; Stevens et al. 2007; Stevens et al. 2008), high rates of attrition (Hunsu, Carnell & Sochacka 2021), and concerns regarding mental health issues (Danowitz & Beddoes 2018). Secondly, an engineering degree prepares students for a profession. It is therefore likely that courses place additional emphasis on employability, something which is particularly important given the framing of resilience as a graduate attribute (Lucas et al. 2014; Milsom 2024; National Academy of Engineering 2004). Finally, the rate of technological advancement and change in society necessitate “career resilience” (ECITB 2020; National Academy of Engineering 2004; Nieuwsma & Johnson 1996). Despite this, there is a lack of information regarding the way the term is conceptualized, and the interventions utilized to develop engineering students’ resilience. This study makes use of semi-structured interviews with engineering educators to uncover how they conceptualize resilience; whether they feel a responsibility to help students to develop their resilience; and how they do so. In the remainder of the introduction, we discuss the term and its various definitions both generally, and specifically within HE. We will then cover its use within engineering education research (EER).

1.1 PSYCHOLOGICAL RESILIENCE

Most definitions of psychological resilience incorporate two concepts, the first being adversity, and the second, positive adaptation (Fletcher & Sarkar 2013). For example, the American Psychological Association (APA 2018) defines the term as “the process and outcome of successfully adapting to difficult or challenging life experiences, especially through mental, emotional, and behavioral flexibility and adjustment to external and internal demands.”

Resilience is considered as both a process (Brooks & Goldstein 2004), as well as a trait (Maltby et al. 2015; Maltby & Hall 2022), this having implications for its application within engineering education. It is sometimes referred to as “resiliency,” linked to an individual’s characteristics, which can be measured through psychometric tests (e.g., Bartone et al., 1989; Block & Kreman 1996; Connor & Davidson 2003; Smith et al. 2008; Wagnild 2009), or indirectly via proxy assessments, whereby associated psychological concepts (e.g., optimism and emotional stability) are used to explain resilient outcomes. Considering resilience as a process allows one to focus on interactions between an individual and context (Luthar et al. 2000; Tudor & Spray 2017) and suggests that resilience is something to be developed (Fletcher & Sarkar 2013).

1.2 RESILIENCE WITHIN HIGHER EDUCATION

Resilience is increasingly used in relation to HE (Advance HE 2019). For example, in a scoping review of resilience, Brewer et al. (2019) found that it was generally “conceptualized as an effective adaptation to stress, adversity or change” (p. 5), primarily in relation to positive outcomes. Research into resilience has typically focused on protective factors that allow individuals to participate in processes which influence risk factors. The term is commonly used in relation to employability and graduate outcomes (ISE 2018). Various authors have highlighted the need for resilience to be taught and developed (Jackson et al. 2007; McAllister & McKinnon 2009) in order that students develop skills necessary to navigate the workplace (Hart et al. 2014; Jackson et al. 2007), with studies focusing specifically on “graduate resilience” (Morgan 2016; Hodges 2017) and “career resilience” which has been defined as “a person’s resistance to career disruption in a less than optimal environment” (London 1983, p. 621).

Despite an emphasis on the benefits associated with resilience, concerns have been raised regarding such discourse within HE (Russell-Watts & Stringer 2018; Stevenson 2016; Turner et al. 2017). For example, Stevenson (2016) highlights the use of deficit-based approaches which fail to recognize wider structural inequalities. Holdsworth et al. (2017) refer to the role of culture within universities and Turner et al. (2017) discuss the various systems (university, home, work) of which students are a part, and which influence their ability to develop resilience. Such work is important when considering the emphasis now placed on development of individual student resilience and is something which will be discussed specifically in relation to engineering education in the following section.

1.3 RESILIENCE WITHIN ENGINEERING EDUCATION AND ENGINEERING EDUCATION RESEARCH

Resilience has been described as a learning disposition which engineers need (Lucas et al. 2014) and a desirable graduate attribute (Ssegawa & Kasule 2017), being associated with professional success of engineers (Berberat & Goldschmid 1989; Harvey et al. 1994).

In a systematic literature review in the field of EER, Winkens and Leicht-Scholten (2023) found that resilience is either linked to students (as a personal attribute) or to systems (for example infrastructure). In the case of the former, the reasons for being resilient were divided into five categories: persistence in completing studies; adapting to changes to educational settings during COVID-19; learning from failures and errors; coping with stress, adversity, and challenging situations; and resilience as a desired attribute, outcome, or competence. Huerta et al. (2021, p. 652) describes resilience as the “enhanced ability to manage or bounce back from stress,” an intrapersonal, noncognitive competency that is instrumental to becoming a good engineer. Hunsu et al. (2021) introduce “academic resilience” (Martin & Marsh 2006) as a theoretical framework which conceptualizes resilience as a trilateral interaction between risk or adversity, protective factors and positive adaptation. In their study into the attributes of engineering students, Ssegawa and Kasule (2017) list “resiliency” as necessary for managing the self and define it as “coping with stress,” with Paul et al. (2021) demonstrating the role of resilience in buffering the impact of stress on overall GPA. Gesun et al. (2021) define resilience as an “internal thriving competency” and Buckley et al. (2023) describe how resilience can increase sense of belonging. Elsewhere, the resilience of engineering students has been linked to self-regulation (Concannon et al. 2019) and self-efficacy beliefs (Anthony et al. 2016; Concannon et al. 2019).

Although the term resilience is frequently used within EER, few papers detail associated competencies or concrete teaching approaches, and instead point to a lack of knowledge and understanding of associated definitions and explanations (Winkens & Scholten 2023). Teaching approaches described in published work are typically related to problem-based and active learning (Winkens & Leicht-Scholten 2023) and the ability to cope with the uncertainty and difficulties experienced during projects, project management and teamwork (Čavrak et al. 2019; Neumeyer & Santos 2023; Silva et al. 2020). Membrillo-Hernandez et al. (2019) analyzed students’ resilience to failure and errors during challenge-based learning, whilst Simpson et al. (2018) described a course which incorporates learning from failure. Elsewhere, resilience has been linked to entrepreneurship education (Mapaling et al. 2023; Neumeyer & Santos 2023; Täks et al. 2014) and the use of contemplative practices (Huerta 2018; Huerta et al. 2021), mental health and well-being support (Mapaling et al. 2021) and the role of positive psychology (Asghar & Minichiello 2023).

The term is also used in relation to issues of diversity, equity, and inclusion (DEI), with studies focusing on the resilience of mature students (McGivney 2007; Servant-Miklos et al. 2021), women (Khilji & Pumroy 2019), African American and Latino students (Samuelson & Litzlerb 2016) and Black women (Halkiyo & Hailu 2023; Ross et al. 2021). However, when considering resilience in the context of minoritized students, Long and Mejia (2016, p. 214) caution us to frame it as an asset saying that “It is a serious problem when society inaccurately stereotypes minorities as low-income and poorly educated, while ignoring their resilience.”

It is therefore evident that although resilience is considered a desirable attribute for engineering graduates, the way the term is conceptualized within EER, and education research more widely,

varies and there is a lack of information pertaining to interventions utilized. Further research into the way in which educators conceptualize resilience and the context in which it may be taught is thus necessary to understand the risks associated with its inclusion within engineering programs, for example the potential for educators to exacerbate wider structural inequalities. In this work we make use of semi-structured interviews to uncover the way in which resilience is understood and taught by UK based engineering educators. This research addresses the following research questions:

RQ1: How do UK based engineering educators define resilience in relation to engineering student attributes?

RQ2: Do UK-based engineering educators feel responsible for the development of resilience in engineering students, and if so, how do they approach this?

Answers to these questions will help understand the degree to which a common definition of resilience exists and in identifying areas in which research is needed to enable the design of effective resilience interventions.

2 METHODOLOGY

This study is situated within a qualitative research paradigm, adopting an interpretivist constructivist approach (Denzin & Lincoln 2003; Lincoln & Guba 2005; Smith 1992). Data was collected via semi-structured interviews and analyzed using reflexive thematic analysis (RTA).

2.1 QUALITY CONSIDERATIONS

The flexibility of RTA has implications for the research process. RTA is not accompanied by a distinct theoretical framework, meaning researchers must ensure clear communication of methodological decision making. In situating themselves as interpreters of meaning and framing subjectivity as an asset (Braun & Clarke 2019), the authors acknowledge reflexivity as being “about more than just one’s positionality—it is about the role of the researcher as an active agent in the production of knowledge” (Trainor & Bundon 2021, p. 707). They thus make a conscious effort to communicate the role they played in knowledge production, processes that they followed, and the active choices and decisions made throughout the research process. In so doing, they document their reflexive process and consider the roles of personal, functional, disciplinary, introspection and intersubjective reflexivity as well as mutual collaboration.

Below the authors have outlined aspects of their positionality in relation to the six fundamental aspects of research which positionality impacts, as outlined by Secules et al. (2021). Additionally, the authors have documented their reflexive process in relation to data collection and the six-stage analytical process proposed by Braun and Clarke (2006).

Natalie: I am currently an engineering lecturer and therefore consider myself as an “insider”. I was trained and socialized within a positivistic paradigm, having previously focused on materials engineering. I have been encouraged to help students develop their own resilience but have received little response when questioning what colleagues mean by this, why it is perceived to be necessary, and how it may be done. In part, this research was born out of a frustration I feel for the careless use of terms related to complex psychological constructs. I, myself, have been told that I should exhibit increased levels of resilience on numerous occasions, often in reaction to speaking about the upset I feel after experiencing, what I consider to be, injustice. I also feel conflicted knowing that students can feel discontent when faced by challenging situations such as those proposed to development of resilience. This is of concern given the increasing focus on student satisfaction surveys and their influence within HE. Part of my desire to write this paper is a result of a lack of deep engagement with the RTA process when claiming to adopt thematic analysis as defined by Braun and Clarke (2006) during previous work. I acknowledge that my positionality as a female lecturer within engineering has shaped both the research topic and questions, and the process involved in research, including data collection and interpretation. In many ways my identity

helped in understanding participants' perspectives and in building rapport and trust. However, I also recognize the tendency for my views, thoughts, and ideas to become intermixed with those of participants.

Inês: I am an engineering education researcher with a background in Psychology. My university education was heavily focused on positivist approaches to cognition and behavior, and on the measurement of psychological traits with psychometric instruments. More recently, I've been exploring human-centered and positive psychology approaches in engineering education in different studies related to individual attributes such as grit, growth mindsets, emotions, empathy, and resilience. Part of my motivation to engage in this study was to understand how resilience is understood in engineering education, as previous research suggested that psychological concepts are not always well defined in engineering education discourses and research. I am also interested in exploring individual attributes from an asset-based perspective, and their impact on engineering students' development and well-being. In my own development as an engineering education researcher, I also felt the need to engage more deeply with RTA, not only to ensure an adequate adoption of the methodology in my qualitative data analysis, but also to read other works more critically.

2.2 PARTICIPANTS

Ethical approval was obtained from Swansea University Engineering Ethics Committee. A call for participants was distributed via internal departmental mailing lists within two UK-based universities, the first being a public research university located in Wales, UK. As of 2021/2022 the student population was approximately 22,000 students, 81% of which were home students, and 15% of which studied engineering (HESA 2022). The second university was a Russell Group university (a group of the top 24 British research universities), with approximately 47,000 students, 48% of which were home students and 8% of which studied engineering. The entry tariff for engineering courses is higher in the second university than the first, who have a higher percentage of widening participation students. Recipients of the email were asked to identify as being involved in the education of engineering students and were told that the research focused on understanding their interpretation of the term resilience and the role they felt they played in developing student resilience.

Thirteen individuals with varied experiences (as shown in Table 1) gave informed consent to participate.

ID	RELEVANT PARTICIPANT INFORMATION
1	White female academic with industry experience. Involved in curriculum design and student engagement.
2	White male academic acting as Employability Mentor responsible for industry placements.
3	White male academic with industrial background and involved in training of graduate engineers. Employability Mentor responsible for industry placements.
4	Arab male academic Teaches a variety of cohorts of various sizes at different levels. Experience in the UK and internationally.
5	White male research focused professor. Teaches small cohort sizes. Experience teaching in a variety of UK-based universities.
6	White female Programme Director. Teaches variety of students at different levels.
7	White male early career academic, multidisciplinary teaching.
8	White male early career researcher, experienced teaching assistant and involved in supporting research students.
9	White male cross-discipline careers consultant.
10	Asian male research-focused academic. Teaches on a variety of engineering programs and cohorts of varying sizes. Experience in the UK and internationally.
11	White male research-focused professor. Teaches small cohorts of up to 40.
12	White male research-focused professor. Teaches small cohorts of up to 40.
13	White female teaching focused professor with experience in industry.

Table 1 Participant Information.

2.3 DATA COLLECTION

In-depth semi-structured interviews were selected as the method for data collection to ensure coverage of key research questions and dimensions of resilience identified within the literature, and allowed the interviewer to guide discussion in directions not previously considered and/or that were interpreted as meaningful for the interviewee. Participants were asked questions pertaining to: their route into academia; their teaching experience and philosophy; how they would define resilience generally and within the context of engineering education; examples of how resilience presents in engineering education; their general perception of student resilience and the factors which impact it; the degree to which they felt the development of resilience was part of their role; enablers and barriers to teaching resilience; details of any methods they had used to develop resilience; any negative aspects associated with an emphasis on resilience. Interviews lasted between 40 and 90 minutes and were conducted, recorded, and transcribed by the first author. The first author made journal entries throughout data collection. These included details about emotions, as well as any thoughts regarding data interpretation.

2.4 DATA ANALYSIS

Interview transcripts were analyzed by the first author. RTA was utilized for several reasons. Firstly, it is generally considered as a useful method during the study of under-researched areas (Braun & Clarke 2006). Secondly, its flexibility allows for both inductive and deductive theme generation which captures both semantic and latent meaning, this approach helping provide rich and detailed accounts of individual experiences and understand personal meaning, whilst also permitting for the generation of links, similarities, and patterns across the dataset and in the context of existing literature. Finally, it is considered a reasonably accessible method (Braun & Clarke 2022), important given the diverse EER audience and the lack of consensus on acceptable theoretical frameworks or methodologies.

During both transcription and the first reading, journal entries were made by the first author and included any thoughts, ideas and emotions encountered. Whilst re-reading each transcript, notes were made about ways in which they were interpreting and making sense of the data. A summary document outlined thoughts about the dataset as a whole and included information about any potential patterns.

Prior to coding each transcript, the first author read the corresponding journal entries. They then manually tagged data they found interesting or relevant to the research questions with a code label. An abductive approach to data analysis was adopted and thus coding was both driven by data (inductive) and by theory (deductive). During the first round of coding the focus was typically on semantic codes. Code generation initially followed an inductive approach (whilst recognizing that pure induction is impossible). Later, the first author began to notice connections with the literature and started coding around theoretical ideas and concepts. Codes therefore evolved throughout the process. During the second and third round, codes were added, and code labels were refined. A collaborative coding process was used to enhance understanding and interpretation, and to examine the limits of reflexivity. The aim of this was to question and interrogate beliefs regarding what were considered important insights rather than to reach a consensus about data coding. All codes were noted alongside relevant quotes. Codes were then cross checked and, in the case that there were similar codes across interviews, combined, ensuring that nuanced differences were not lost. A list of final codes and associated data items was then compiled. Initial themes were generated. All unallocated codes were collected in a new document for use during further theme development. The final stages involved revisiting data extracts for all codes within each theme, ensuring they provided different manifestations of one clear, central concept, as well as ensuring demarcation of each theme with a clear synopsis and informative title. Data extracts which represented the themes were then selected.

3 FINDINGS

In this section, three overarching themes (summarized in Table 2) are presented to describe how participants conceptualize and help students to develop resilience.

THEME NAME	SUB-THEME NAME	SUB THEME SUMMARY
Theme 1: Contradictions and conflicting views	Sub-theme 1: Extremes in understanding: “People kept telling me that that wasn’t what resilience was.”	Describes extreme differences in the way that resilience was conceptualized by the participants.
	Sub-theme 2: Do emotion and empathy help or hinder resilience?	Concentrates on opposing views regarding the role of emotion, care, and motivation in influencing resilience.
	Sub-theme 3: Being pulled in all directions.	Focuses on the conflicting demands placed on educators and the impact that this has on their ability to promote resilience.
Theme 2: Where to draw the line	Sub-theme 1: Resilience as highly individual but impacted by the system.	Focuses on the degree to which “the system” in which an individual resides limits their ability to develop resilience, and thus the limits placed on educators’ roles.
	Sub-theme 2: Roles and responsibilities of the educator.	Concentrates on the types of resilience which fall under the remit of engineering educators, and the way in which their work is boundaried.
	Sub-theme 3: How far is too far?	Focuses on the extent to which educators should push students and create environments in which students develop resilience.
	Sub-theme 4: Can you be too resilient?	Focuses on where individuals draw a line when deciding how resilient they are willing to be.
Theme 3: Perception versus reality: resilience as invisible		Focuses on the indicators of resilience and the ways in which educators determine and understand the resilience level of students.

Table 2 A summary of the overarching themes and sub themes.

3.1 THEME 1: CONTRADICTIONS AND CONFLICTING VIEWS

Sub-theme 1: Extremes in understanding: “People kept telling me that that wasn’t what resilience was.”

Some participants admitted to not being certain about the definition of resilience with one claiming there was “a lack of literacy about what resilience is” and a need for “a more informed discussions about the dimensions” involved (1).

Most definitions given consisted of two components: the need for failure, adversity, trauma, stress, or rejection; and a reaction which allows you to overcome the issue, sometimes referred to as “bouncing back.” In some cases, participants felt the failure must be unexpected. Some participants spoke of “survival” and “coping,” whereas others used terms such as “thriving” and “flourish.” Resilience was also linked to concepts such as sustainability, persistence, and grit.

In many cases resilience required “changing,” and “adapting,” with one participant saying, “it could be carry on differently... it doesn’t mean carry on the same ... it doesn’t mean carry on the same way, but just carry on somehow” (2). These terms were often mentioned in relation to the changing profession, world of work, capitalism and technological change. One educator suggested that resilience was developed in cases that you ensured that change “becomes a normal part of your existence,” so “then you don’t worry about change anymore” (5). However, there were some contradictory views regarding the relationship between resilience and change. One educator suggested that in engineering projects “your understanding of the problem changes” and resilience is “about overcoming the problem, so the product got finished, the product was made, and the product was changed.” They said that they “try and teach students about changing their ideas and changing the system and trying to get the project to finish.” However, they later went on to say that “some people told me resilience was about the company staying the same, the same shape, not changing to external forces” or “where you push against resistance of your idea being attacked.” The participant claimed that this “you said you’re going to do this now you must do it” attitude could result in disaster because “one, it may not be possible, and two, it may be a bad idea after all” (7).

The stark contrast in these definitions is important as it has implications for the way we promote resilience. For example, the same educator said, “I’m not sure I want to teach the second one that much because it’s not ideal,” this also demonstrating the role that personal values play in decisions regarding teaching methods. They later added that they “do teach sunk cost fallacy” (7), a phenomenon whereby an individual is reluctant to abandon a project or chosen action, even when it may be beneficial to do so, due to the investment they have already made.

The ability to undergo change and be resilient was related to having a growth/flexible or fixed/inflexible mindset, with one participant saying that resilience is developed by “having that growth mindset and that ability to kind of learn and improve and deal with feedback and deal with obstacles” (9), and others speaking of the role of feedback and reflection. It was claimed that if “people have self-limiting beliefs, that will probably hold them back” (8). The majority of participants associated resilience with having a growth mindset. However, the same individual that questioned whether resilience involved changing or staying the same under external pressures commented that the latter definition would be consistent with people who “don’t want to change (...). They’re not really open to the idea. They are very resilient” (7), this suggesting that those with a fixed mindset are more resilient.

They went on to mention several other paradoxes, saying, “we teach them maybe it’s time to let that go, but ironically that’s the opposite of the other kind of resilience where you are meant to teach them to achieve their dreams,” adding that those with a dream have a “fixed idea” and “go do that one thing.” For example, they firstly stated that if a student “could have resilience ... they could become something new and powerful in the subject, a major player,” later alluding to a student who “decided he’s going to be an artist and he’s going to be great at that and he’s not going to let something else get in the way.” However, they admitted that they didn’t teach that mentality “because it normally results in failure” and because it “we’re trying to develop flexible individuals” (7).

Sub-theme 2: Do emotion and empathy help or hinder resilience?

For some participants, caring about something increased motivation levels and resulted in higher levels of resilience during associated tasks and activities. “Build(ing) that empathy” (5) was also considered as supporting students with resilience levels.

On the contrary, for one educator, there was a need to “overcome” and “train against” (7) emotions, with another saying that the most resilient students are those who are “less emotionally involved” (8). A different educator cited “a lack of emotional empathy” (12) as a potential disadvantage of resilience, claiming that if you are resilient, you are typically able to “package your concerns about a particular topic sufficiently that you can move on ...instead of worrying about it for the next two or three days.” A different individual claimed that changing “people’s empathy” and seeing “workers as people” reduced resilience. Overcoming emotion was linked to the idea that resilience required mode 2 thinking or “thinking slow,” which is conscious, logical and deliberate, as opposed to mode 1 thinking or “thinking fast,” which is intuitive and emotional, with some participants referencing the work of Kahneman (2011).

Sub-theme 3: Being pulled in different directions

The data demonstrates the way that educators are expected to meet several, often conflicting, objectives. One participant alluded to how others perceived them in terms of their ability as an educator and claimed that there was a “dichotomy that exists” in relation to helping students develop resilience and questioned “how does it reflect on you if your students are struggling?” (12).

Student satisfaction was brought up several times with respect to students’ development of resilience, with one participant saying that student feedback was considered as part of their PDR (Professional Development Review/Appraisal) and that “You don’t build resilience with student satisfaction on your neck” (6), and another that “we’re almost at the point where we don’t even make constructive criticism because we want to keep students happy, and we want to keep our NSS (National Student Survey) scores high” (12). Student satisfaction was linked to a view

of students as customers, with one participant saying that “nowadays you are adapting to the mentality that we are serving, not training,” and describing a conversation with a student in which they were asking why they had not passed a course: “why not? I’m paying you” (6).

The pressure on both staff and students to help ensure high grades was linked to ability to develop resilience. One participant said “I want to train students to become good students and engineers but unfortunately the higher education system seems to want us to get first class (the highest degree classification). And I think it’s a conflict ... in what I wish to do ... we are under pressure of the university delivering higher grades... a first class ... means better ranking” (6). One educator commented that “we want students to pass the module and want to be able to help them pass the module and we don’t want to have to think too hard about what they’re doing. We want to make sure they can fix an easy problem” (7).

Educational experiences which led to the development of resilience were considered to be resisted by students who were “scared of complexity ...and they want good marks” (1) and one participant suggested a grade be given for “exploring the chaos” and “deal(ing) with complexity” and “not necessarily about the solution” (13). In this sense, the academic context was considered at odds with that of the workplace, something which is significant given the framing of resilience as a graduate attribute. One educator claimed that “when you actually get out into the world and try and build an actual solution, very rarely can you just apply the solution which you learned in class” (7). One participant highlighted the difference between academia and industry in that “in the workplace it’s like enough to do ... an 8 out of 10 job” (9).

3.2 THEME 2: WHERE TO DRAW THE LINE

Sub-theme 1: Resilience as highly individual but impacted by the system.

Participants identified multiple protective and risk factors which influenced resilience levels, with some questioning the role of nature versus nurture, and thus the role of the individual in developing their own resilience versus the role of external factors. Influences included: structures and systems, places and environment; diet, exercise, and general health; socio economic factors; social networks and communities; family; past educational experiences; culture; upbringing; and dispositional traits. The varying factors cited as impacting resilience at any one time contributed to resilience being considered “non-static” and influenced by generational changes. An academic suggested that “maybe there’s been a decline in resilience but...perhaps there’s been a decline in expectations as well, which has fed that” (12), with another claiming that more competition in the workplace had an impact. Multiple participants mentioned the impact of COVID-19, with one saying that “nowadays with the pandemic you need to be more resilient even in the normal” (3). Others believed that the presence of social media impacted resilience as its use led to comparison and impacted mental health. Social media was also linked to students having “really short attention spans” which didn’t help the “ability to be resilient” which involved “sort of like delaying gratification, sitting down and working at something that is difficult, hard and you don’t enjoy” (8).

Of interest given the focus on both engineering education and HE, were comments regarding both how the institution and discipline may impact resilience levels. When speaking about attrition of students, one educator claimed that “once you get into (research intensive institution) you stay in (it)” (13). Similarly, an academic who had worked in several universities claimed his current institution seemed “more relaxed, more healthy,” which would lead to greater student resilience, but that in fact it was “like the opposite,” suggesting that students in their previous university (of higher status and less “relaxed”) “already expect it, and they already have the attitude” (10). This participant highlights the role, not only of institutional culture in resilience levels, but also the prior educational experience and attainment of incoming students. Another individual highlighted differences between school and university level education and the role of prior grades in setting expectations.

The discipline being studied was believed to impact upon resilience with one participant claiming the “engineering degree is notoriously tough” (1), and another seemingly suggesting that resilience was less important for engineers as:

students are less resilient to ideas that might upset them and do not want to discuss those ideas (...) That’s not the nature of engineering education (...) To discuss nuanced political and sociological ideas. We teach things which are more or less, proven facts (11).

One individual claimed that “the engineering subjects are the worst for this, because they are taught, they must do it right, the first time” (7).

There was therefore a general recognition that resilience levels were heavily impacted by context with one educator saying “I really see resilience as not just individual. It’s social, it’s contextual. And I don’t like it when it’s used to discuss individual resilience personally, I think that’s missing a bigger picture” (1). A different participant claimed the existence of “resilience that is related to their time at university in terms of their learning” as well as “resilience in terms of their social life and things that happen beyond education,” concluding that “you can’t separate the two, it’s part of their life” (4). One participant described a “stress bucket... you’ve got things that drain it and then you’ve got things that you put in to replace it, so I guess what I would say about your resilience is, if you don’t keep that sort of topped up or near the top it just eventually drains and sort of wears away” (9), a metaphor which captures the holistic nature of resilience and which raises questions regarding how much responsibility falls within the remit of HE.

Sub-theme 2: Roles and responsibilities of the educator.

This holistic conceptualization of resilience had an impact on actions and beliefs of educators. One participant said they “didn’t always feel like the amount of pressure in an engineering degree is fair. And so, when students are struggling, I often think it’s more of a comment on the system than it is on that individual and their ability to be resilient” (1), a comment which highlights a need to consider resilience holistically as opposed to focusing primarily on individual resilience levels. Similarly, other academics described supporting students applying for industrial placements years by reminding them they are “in the context of a competitive process. It’s bad luck if somebody better turned up” (2).

The multifaceted nature of resilience was generally believed to necessitate a personalized approach whereby contextual factors were considered. For example, when speaking about a third-year project student, one academic said, “I said let him struggle and I looked at his history, he’s a first class, he can struggle a bit ...because I thought he could deliver, I would not do for our other students (...) I think he can do it, so I kept pushing him.” They then went on to speak of another student who “needs a nurturing relationship, some people don’t need that. I just leave. I don’t bother” (6). The need for an individual approach was reiterated by another participant who said “I don’t want to lose those students. So, I have to stay aware of those contextual factors. And not just use this ‘one size fits all.’” However, time was acknowledged as limiting this work, the same educator saying, “I think the biggest constraint is student/staff ratio ... there is just not enough hours in the day to work with that cohort in the individualized way that they need” (1).

The majority of participants acknowledged that HEIs have a responsibility for employability of students, with one individual saying that the development of professional skills such as resilience is, “kind of like the additional value of higher education” which was considered important given that there were “literally tens of thousands of them each year, coming out of university with a degree, and probably with work experience as well” and that engineering graduates therefore needed to ask “what are the extra things that are going to help them to be a value to a company” (9). A different educator said that their “work is about bringing in that experience so that they can build up the capacity for their resilience, so that when they get to industry, they are better prepared to deal with that sort of stuff” (13). It was considered that the university needed to be “clear in terms of what it’s looking to kind of create within its own graduates and ...how does that actually roll down into the curriculum and the teaching and the things that students are asked to do” and that some universities who had done that “had a lot of drive from higher up within the university to do that and then it becomes easier, much easier to kind of implement” (9).

The holistic nature of resilience also raised questions about the role of educators in its development and whether there were boundaries to their work in supporting students. One participant described the decision as to where to draw the line, “a tricky one,” describing discussions with the careers team when they first started introducing resilience as a concept within their courses: “is this our job or is this the job of the well-being team?” Because if we end up having lots of students with well-being issues, what do we do about that?” They claimed that “you just need to be able to explain to the students, this is the limits of my role, and if you do have further things that you need to discuss there are other qualified people in the university that can deal with it” (9) and described their role as limited to “career resilience.” This signposting approach was adopted by several participants with one saying “I think for maybe some resilience related to a psychological issue or depression, it may be some people who have expertise in this area” (10) and another that “we’ve got all the support services for people with family, people with mental health issues...this type of help with resilience isn’t necessarily well signposted” (2). The “types” of resilience that fell within the remit of educators appeared to vary depending upon their role as either a lecturer or academic mentor. Most participants mentioned the role of academic mentors, with one professor saying that their role as mentor was to be a student’s “supporter within the university” and that they acted as a “flag waver” (5). One participant described what was involved in academic mentoring saying, “you get outside the teaching sort of remit and you see the student with their personal life and how that interacts and interferes sometimes with their academic life” (2). However, it was acknowledged that this may not be the approach taken by all, with one participant saying that many academics may consider this “personal” approach as “overstepping the mark of what an academic mentor is meant to do” (1). Two educators involved in employability claimed that their willingness to support students to develop resilience was “part of my personality” (2) and that they saw it as their role “maybe because I don’t consider myself a typical academic,” having come into academia from industry (3). These quotes highlight the different roles that educators may have in different capacities of their work and reveals the complexities associated with determining the limits of educators’ work.

Other educators advocated for “treating students as whole people,” something which was encouraged by the “complexity of the world, and that the mental well-being of our students now is at the forefront of our mind, the student experience is at the forefront of our mind” (13). One participant spoke of limits to the ability to do this saying, “it is absolutely draining, and I don’t know if every teaching staff feels like that, but sometimes you can’t help feeling that, if a student fails, then you’re failing with them...I’ve got to stop engaging emotionally with them...I’m the one who’s going to fall apart” (2).

Sub-theme 3: How far is too far?

There was much discussion about the extent to which resilience could be taught, with one educator claiming that students naturally developed resilience as “we are already challenging them by setting exams, assignments ... and not everyone is going to succeed, so in a way you’re doing it indirectly as part of the learning” (4).

Other participants referred to resilience as a “by product” of teamwork, problem solving, providing students with incomplete information, complexity, and authentic, contextualized tasks. Participants spoke of helping students by equipping them with tools in organization, (time) management, planning and dealing with complexity, all of which would help develop confidence and competence, which were both seen as contributing toward resilience. Some also spoke of helping students to develop their ability to reflect and by supporting their well-being and encouraging them to make “good habits ... like to destress and focus yourself” (8). Others focused, not on the content taught, but rather on the way in which it was taught, saying that accessible, available, inspiring, and enthusiastic lecturers that nurture students help with resilience. Many focused on resilience as coming from practice and experience, with one individual saying “you develop resilience by having stuff go wrong, having setbacks in your life” (11) and another that “it’s just practice really, it’s like you do things that are hard, and you will learn skills from doing them that will make you more resilient” (8). Given the apparent need to struggle with learning to develop resilience, it was questioned as to whether universities supported high achievers, with one educator claiming, “the ones that we’re helping the least are the highly successful students” (2).

Such comments raised questions about the lengths to which educators should go to help students develop resilience. For example, one educator claimed that for those who did not struggle academically, “the only way out is to create some artificial adversity,” questioning, “is it ethical at all (...) Can we just stress our students for the hell of it and come out of it and say you got something out of it, well done” (2).

Others spoke of the risk posed to mental health, with one participant saying that they couldn’t “un-collate” resilience and mental health in their mind (1). One educator suggested that the focus on developing resilience may come across as them saying “you’re not very resilient, a lot of you are struggling with your well-being” to students which may “make them kind of more anxious and more stressed about that, and maybe lead to a bit more than negative spiral” (9). Another spoke of being “careful not to overburden ... we are there to guide them ... as much as you want students to be resilient, if they’re struggling, you help them” (11).

Some participants believed that it was hard to determine how far to push students. They said it was difficult to differentiate between those “with genuine issues” and that “it’s a lot muddier now a lot more difficult”. They thought that this change had brought benefits to those with issues “but it’s also started to cause issues with students who don’t recognize stress as part of life and part of learning. Stress on its own is not a negative thing. Stress is just part of the learning process and there’s a difference between being stressed doing an assignment and having a persistent mental health condition which is clinical” (1). A different educator said that they reacted to student anxiety by “spoon feeding them so that they don’t be resilient, and I recognize that (...) That’s not me helping them be resilient really, is it? That’s me soothing their anxiety,” later saying they were “willing to concede that it’s not their (students’) fault” if they lack resilience as they “haven’t helped the situation by perhaps spoon feeding them too much” (12).

Sub-theme 4: Can you be too resilient?

There were perceived disadvantages to “being too resilient,” which could mean “people will always expect you to adapt and that perhaps you don’t have a very firm opinion or grasp or have a red line.” This belief was linked to ethical behavior, with the same educator saying “I think resilience is about ethics too. It’s about drawing the line on what you will adapt to, or not adapt to” (13). Another spoke about whistle-blowers, and how “history is littered with engineers who stood their ground and were actually proven right but were not treated well in their time” and that that they didn’t get rewarded “for challenging that theory, for being stubborn and trying to overcome” (7).

Such comments demonstrate the personal decisions involved in making choices regarding how flexible you are willing to be.

Other participants spoke about the way in which the burden of developing resilience is placed on the individual, and of how this can lead to a tolerance of adversity in the case of minoritized students:

women have to be resilient to be able to get up to the glass ceiling, right? They have to adapt ... people are going to keep changing the goalposts and that there is an element of power to it, right? That those that don’t have power have to be more resilient, if you like, to be able to get anywhere. And so that’s perhaps the negative side of it that I think students will have to navigate (13).

3.3 THEME 3: PERCEPTION VERSUS REALITY: RESILIENCE AS INVISIBLE

The various factors which affected resilience were considered as contributing toward the “invisible” (8) nature of resilience, with one educator saying that you must understand the “huge unseen side before you actually start talking to students one to one” (2). This was made more difficult by the fact that some students were more vocal than others regarding issues they may face. For example, one educator considered international students to be more resilient but admitted to that being “an intuitive, heuristic kind of judgement but based on the fact that it is normally the home students coming forward to raise issues” (1). A different educator noted that it doesn’t mean that students are “resilient just because they did not express their emotions or how they are feeling” (4).

One educator considered that “we haven’t got a metric for resilience” (12), which made it hard to determine relative levels of resilience, whilst others mentioned that low grades and applying for extenuating circumstances were indicators that a student may lack resilience.

However, there were perceived issues associated with such indicators. For example, some participants claimed that “even the ones that are apparently flying through with firsts, they might actually be working 20 hours a day and stressed out of their eyeballs but just getting on with” (11). A different individual criticized the traditional metrics by which success (which they linked to resilience) was measured, suggesting that fulfillment was a more important indicator of resilience (2).

4 DISCUSSION

The descriptions of resilience provided by participants were broadly consistent with the components of risk or adversity and positive adaptation present within the literature, exemplified by the academic resilience framework utilized by Hunsu et al. (2021). In keeping with previous work that presents both growth mindset and resilience as means to investigate how people respond to failure or adversity (Yeager & Dweck 2012), some educators described resilience in terms of having a growth or fixed mindset. Others admitted to not being fully confident in their ability to define resilience, and there was also evidence of contradictory definitions, with some claiming it was associated with the ability to change, and others, the ability to “stay the same shape.” One participant questioned whether resilience involved persisting in order that a product got finished (even if it involved sunk cost) or being open to changing the process in order to have an output and finish the project. These findings are reminiscent of the work of Rees et al. (2015), who highlight the need to adjust goals in order to avoid burnout, something which appears to take account for resilience in the long term. Although re-setting goals can be considered as akin to adaptability, what is key here is the difference between 1) changing planned outcomes and 2) maintaining a desired outcome but changing the path to the outcome in response to environmental change.

The contrasting and, at times, conflicting definitions of resilience provided by participants are perhaps a consequence of the range of disciplines which make use of the concept, as made evident by work that focuses on understanding the operationalization of resilience within different domains and the subsequent development of typologies and frameworks to navigate ambiguity associated with the concept (e.g., Nisioti et al. 2023; Quinlan et al. 2016; Reid & Botterill 2013). Of particular relevance when considering these findings is work within the field of ecological sciences and sustainability (Dovers & Handmer 1992; Handmer & Dovers 1996), which categorises resilience into three types: resilience as resistance to change; as incremental change or change at the margins; as adaptability and flexibility. This typology, specifically type 1 and type 3, draws parallels to the different ways in which participants described resilience. Elsewhere, Nisioti et al. (2023) consider resilience as the ability of a system to maintain its fitness. In so doing, they make use of two of its properties (structure and function), finding that different disciplines hold different requirements as to which of the two properties is allowed to change.

Understanding what is meant by the term resilience has implications for the way in which educators support its development. In common with Tudor and Spray (2017), who describe the academic stress or risk factors caused by overwhelming course loads, a negative school climate, or transitioning between colleges, some participants considered the development of resilience to be an innate part of HE. For others, and in-keeping with previous work, it was considered a by-product of problem based, active learning approaches (Winkens & Leicht-Scholten 2023), coping with uncertainty and difficulties experienced during projects, project management and teamwork (Čavrak et al. 2019; Neumeyer & Santos 2023; Silva et al. 2020), and the failure and errors experienced during challenge-based learning (Membrillo-Hernandez et al. 2019). As highlighted by one participant, the use of such methods can be challenging within engineering education in which rigidity and positivism (as opposed to adaptability associated with resilience) is promoted by how 1) engineering problems are defined, 2) pedagogical styles adopted, and 3) formal structure of the educational process and which “work against flexibility” (Nieusma & Johnson 1996, p. 66).

Others described a more intentional need to foster a supportive environment and encourage students, this being consistent with framing of motivation as a protective factor (Hunsu et al. 2021). Some educators mentioned the role of empathy, the benefits of which are highlighted by Parker et al. (2004), who discuss the role of processing emotional reactions when faced with academic challenges. Elsewhere, work has described the use of contemplative practices (Huerta 2018; 2021), focus on mental health and well-being (Mapaling et al. 2021) and use of positive psychology (Asghar & Minichiello 2023) in supporting resilience.

At the other end of the spectrum, participants suggested challenging and pushing students, but also questioned the implications this may have on student mental health. Apprehension about this approach was amplified by a perceived lack of ability to confirm the resilience levels of individual students, something which is unsurprising given the lack of direct measurement methods and reliance on inference based on assessment of risk, and judgment of positive adaptation, for example via academic performance (Masten 2001).

These findings raise questions regarding how educators can both help students in viewing stress as a natural part of life and learning, whilst also protecting their mental health, and echo concerns regarding the relationship between student mental health and resilience discussed within the HE literature (Brewer et al. 2019). Such tensions act to challenge the consistency, communication, and operationalization of institutional strategies which include aims associated with both student well-being, positive student feedback, and graduate attributes.

The tensions that educators felt in relation to developing student resilience within a system that values student satisfaction and the achievement of high grades, reflects the context in which this research took place. In recent decades, UK HE has shifted toward a market-based model, where universities treat students as customers and can charge higher fees based on demonstrated “excellence” in teaching and student satisfaction surveys. In some instances, the student satisfaction metrics are included as KPIs of individual academics and can thus be linked to academic pay. Such contextual factors are likely to influence the views that educators have with respect to development of resilience.

Almost all the educators recognized the holistic nature of resilience and, in common with Turner et al. (2017), who focus on the different systems (university, home, work) in which students reside, described numerous contextual factors impacting students. It is for this reason that placing the burden of developing resilience on the individual was viewed as problematic and considered to have the potential to lead to a tolerance of adversity, particularly in the case of underrepresented students. Such views are consistent with those of Pawley (2019), who speaks of the levels of resiliency required to ensure minoritized students obtain the knowledge and cultural capital already acquired by the privileged. She thus proposes a shift in “burden of responsibility away from students and toward higher education as an institution” (p. 21). Such efforts may help address concerns that have been raised regarding the resilience discourse within HE more widely (Russell-Watts & Stringer 2018; Stevenson 2016; Turner et al. 2017), primarily regarding a focus on the use of deficit-based approaches which fail to recognize wider structural inequalities (Stevenson 2016). From a psychological standpoint, Turiel et al. (2016) criticize one-dimensional approaches of “assessing more or less or better and worse possession of a trait by individuals” (p. 6) and the consequence of such approaches on human adaptation and adjustment. The “more or less syndrome” (p. 26) in psychological research of “positive” constructs such as grit and self-control, as well as resilience, works against the promotion of social justice as they serve mostly to justify differences between individuals without considering their broad contexts. It should thus be borne in mind that although resilience is typically associated with positive adaptation, there are potential dangers associated with an emphasis on its development. For example, Mahdiani and Ungar (2021, p. 150) question “whether every adverse context calls for a resilience response” and consider that although “the field of resilience research assumes everyone benefits from the presence of resilience-enhancing qualities, some contexts make these factors harmful to the long-term survival of the individual.” The application of the concept of resilience to a number of disciplines is perhaps the reason for debate around it being descriptive or normative (evaluative) in nature, with Thorén and Olsson (2017), claiming that the application of resilience to a specific

scenario necessitates the use of a normative or ontological framework. For Ferrarello (2021), the normativity of the concept is connected to temporal, as well as epistemological, biases, highlighting a need to understand the reference point to which a resilient system needs to return (e.g., consideration for whether being resilient in the short term has long term implications for health and well-being).

Together, the findings highlight the opposing ways in which educators conceptualize resilience, as well as differences in the degree to which they feel responsible for its development, and methods which they may adopt. The uncertainty and inconsistencies appear to be compounded by tensions between pressure to develop employable graduates whilst ensuring student success and satisfaction, as well as protecting well-being.

5 LIMITATIONS

The authors recognize that the contextualized nature of qualitative data is in tension with notions of extrapolation of findings to other contexts (Polit & Beck 2010) and the need for RTA researchers to resist the urge to frame lack of generalizability as a limitation of research (Braun & Clarke 2022). Despite this, they acknowledge the benefits of reflecting on the way participants' characteristics and context may have shaped findings and interpretations, and of understanding an issue, as well as connecting it to something broader. They have therefore taken effort to demonstrate "sensitivity to context" (Yardley 2017) when reporting research to help allow some degree of transferability.

A limitation of the sampling method is that participants were self-selected and likely to have an interest in helping engineering students to develop resilience. A number of participants were involved in employability activities and, at times, had a remit to teach resilience, specifically career resilience. Some participants were heavily involved in training researchers and their answers were framed by this work. All participants were from UK-based universities. Given the findings pertaining to cultural differences in how resilience is conceptualized, there is a need to understand resilience within engineering education in other geographical locations. It is also important to understand differences and similarities between how resilience is conceptualized, developed, and demonstrated by a range of stakeholders involved in the education of engineers. Interviews with both students and employers will therefore form the next stages of this research.

6 CONCLUSIONS

This work highlights inconsistencies in the way resilience is understood and conceptualized by engineering educators, this having implications for the way in which its development is supported. Disparities in the way the concept is interpreted presents several issues pertaining to DEI, student mental health, as well as persistence and retention within engineering, and some definitions of resilience may risk exacerbating, already existing, structural inequalities. This work acts to surface the implications associated with a lack of clarity around use of the concept of resilience and as a starting point for future conversation. It has several implications:

- There is a need for researchers and educators to identify the aspects of resilience that are most relevant within specific contexts, and subsequently to clearly communicate what is meant by resilience in each instance of use. Given the emphasis on both resilience as a graduate attribute, and on student mental health, there is a need for HEIs and employers to provide strong messaging regarding what is meant by the term and how they believe it presents as a graduate attribute.
- There should be sustained and intentional efforts to stop the use of deficit-based language and approaches which fail to recognize wider structural inequalities within institutions and the engineering profession more widely. Educators may draw upon the literature available to support such work, for example, the ecological model by Ungar (2011).

- There is a need to support students in understanding the normative nature of resilience and thus the situations in which it is desirable to be resilient. This would require ability to assess the short- and long-term benefits and costs of resilience at an individual level, and therefore an understanding of personal values and moral beliefs.
- Further research is needed into the effectiveness of strategies adopted to support the development of resilience, and the way in which resilience-based interventions act to benefit or harm students within different contexts.

FUNDING INFORMATION

This paper was supported by the projects DOI [10.54499/UIDB/00481/2020](https://doi.org/10.54499/UIDB/00481/2020) and DOI [10.54499/UIDP/00481/2020](https://doi.org/10.54499/UIDP/00481/2020)—Fundação para a Ciência e a Tecnologia.

COMPETING INTERESTS

NW is a member of the editorial board for Studies in Engineering Education, which is on a voluntary basis. All other authors have no competing interests.

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TO CITE THIS ARTICLE:

Wint, N., & Direito, I. (2024).
(Re)defining Resilience:
How Engineering Educators
Understand and Teach
Resilience. *Studies in
Engineering Education*, 5(2),
175–195. DOI: [https://doi.
org/10.21061/see.163](https://doi.org/10.21061/see.163)

Submitted: 17 December 2023

Accepted: 10 October 2024

Published: 16 December 2024

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Studies in Engineering Education
is a peer-reviewed open
access journal published by
VT Publishing.