It's stress, Jim, but not as we know it: the mental health and wellbeing of engineering students.

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“IT’S STRESS, JIM, BUT NOT AS WE KNOW IT”
THE MENTAL HEALTH AND WELLBEING
OF ENGINEERING STUDENTS

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Jo-Anne Tait

"It's stress, Jim, but not as we know it":

The Mental Health and Wellbeing of Engineering Students

Abstract

Introduction: Until recently, engineering students have not been well represented in student mental health and wellbeing literature and because of their demographic (primarily young men) may be at higher risk of poor mental health and wellbeing. **Aim:** The aim of this research was to establish the mental wellbeing of engineering students in the UK and to identify which help-seeking behaviours engineering students demonstrate when experiencing poor mental wellbeing. An overview of literature on the subjects of mental health and wellbeing in students generally and in engineering students specifically is provided. **Methods:** a mixed-methods research sequential explanatory design project with a salutogenic approach focussing on the engineering student population in the UK. An online survey was completed by 417 engineering students and 27 students additionally participated in semi-structured interviews analysed by thematic framework analysis. **Results:** Mental wellbeing in engineering students is significantly lower than the general population and lower than other students and prefer not to seek help from engineering staff due to poor experiences and stigma. Those who reported good mental wellbeing felt they spent time looking after their mental wellbeing. Lack of time was a key issue in supporting their own mental health and wellbeing. Analysis of interviews also indicated lack of time/time management as a problem in terms of maintaining good mental health and wellbeing. Principal themes developed were – Curriculum, Identity, and Mental Health and Wellbeing. A further theme collated participants' suggestions for engineering schools. **Conclusions:** Engineering students experienced continuous stress throughout their degree programmes and discussed the barriers preventing them from seeking help when suffering from poor mental health or wellbeing. A new framework for supporting mental health and wellbeing in engineering students was proposed. Strengths and limitations of the project are discussed, and recommendations made for future research.

Keywords: Mental Wellbeing, Engineering Students, Helpseeking, Health-Seeking, mixed methods

Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

1.1 Overview

This thesis is the report of a body of work investigating the mental health and wellbeing of engineering students. The research took the form of a mixed-methods study, using a sequential explanatory design. This introduction will set the scene for the research, explore the rationale for studying this topic, introduce key points, and provide an overview of the rest of the thesis.

1.2 The Future of Engineering

Engineers make things work. They possess a unique set of skills such as the ability to creatively solve complex problems, analyse data and work innovatively within restrictions, to name a few. These skills feed directly into solving some of the world's biggest challenges such as providing access to clean water, carbon capture and storage, improving urban infrastructure and much more. Engineers also have a special role to play in the energy transition from oil and gas to renewables. In short, engineers are in demand.

However, internationally, more engineers are leaving the sector due to burnout (Phillips, 2022), aging workforces (Wright, 2022) and in the USA it has been noted that students are increasingly moving towards computer science over electrical engineering subjects (Atwell, 2022). The annual deficit caused by retirements and engineers leaving the sector is compounded by fewer school leavers selecting engineering as a degree, and even further by fewer school pupils undertaking the subjects needed to gain entry to an engineering degree (Engineering UK, 2020).

Closer to home, the European engineering skills gap is a significant barrier to addressing global challenges (Bergman and Ogunshakin, 2022) and concerns are being raised about the mental health of engineering professionals in the UK (Flaig, 2022), with over half of engineers reporting experiencing negative effects of workplace stress on their mental health or wellbeing, and two thirds describing presenteeism: going to work despite feeling mentally unwell (Flaig, 2022). Another challenge in the UK appears to be retention of a diverse range of engineers with notable career moves out of engineering by disabled people, ethnic minorities, and women (O'Connor, 2021, Institute for Employment Studies, 2021).

In addition to increasing demand for engineers, employers are increasing their expectations of graduate engineers- to have an enhanced skill set beyond the remit of the traditional degree qualification. Some of these skills include making informed decisions that go beyond specific engineering challenges, applying emotional intelligence in approaching complex problems, actively listening to and influencing stakeholders, and using enhanced adaptive leadership skills (OPITO, 2019).

These critical ‘soft skills’ are, in reality, quite hard to master. In order to develop these skills in the next generation of engineers, professional bodies and universities are calling for radical changes in the engineering curriculum (RAENG, 2019, Sorby, Fortenberry, and Bertoline, 2021, IET, 2022a, IET, 2022b, McDonald, 2022). Calls for education reform to address the problem have been growing (RAENG and MIT 2012, Hamacher, 2017, Das, Kleinke and Pistrui, 2020, Poole, 2022, Al-Hashimi, 2023).

UK universities are responding to this call by ensuring their courses fit with the demands of professional bodies in the UK and beyond. Engineering degree courses are often accredited by professional bodies to provide quality assurance that graduates are prepared to enter their respective workforces and also become Chartered Engineers. In the UK, professional bodies are accountable to the Engineering Council which sets out the requirements of professional engineers and therefore the requirements of accredited courses (Engineering Council, 2020) . Universities also maintain regular connections with industry through consultation events, bringing industry and academia together to solve complex problems.

Despite these advances however, the engineering sector is still facing a massive skills crisis –with an annual shortfall of around 20,000 engineers in the UK alone (Engineering UK, 2020, Wright, 2022). A government study (UKCES, 2016) has identified that the global engineering sector needs 186,000 skilled recruits each year until 2024, however the number of students studying engineering at university in 2021/2022 was around 185,725 (HESA, 2023). Engineering graduates do not always move into engineering jobs and therefore the shortfall continues. This means that engineering universities, employers, and professional bodies must support and develop new and existing engineers, to ensure they are ready to resiliently face continually changing challenges in an uncertain landscape. This uncertainty can impact health and wellbeing and supporting engineering students as they develop their skills may go some way to improving attraction and retention in engineering industries.

1.3 Mental Health and Mental Wellbeing in University Students

The mental health and wellbeing of students has, in recent years, become a priority for higher education institutions (HEIs), particularly in the UK (UUK, 2020, UK Government, 2022, Sampson et al, 2022, University Mental Health Charter, 2022) due to reports of significant deterioration in student mental wellbeing (Campbell et al, 2022, Lewis and Bolton, 2023). Increasingly, student support services in HEI’s are overloaded and this pressure on resources does not appear to be easing (Remskar et al, 2022). Student mental health has been reported to be poorer than the general population (MacAskill, 2012, Thorley, 2017, Alterline, 2017, Yap,

2018) and has caused increased concern in institutions (Storrie et al, 2010). Around 20% of students in the UK considered themselves to have a mental health problem (NUS, 2013, Nightline, 2014) with 13% reporting suicidal thoughts, and 75%-92% of respondents identifying as having had feelings of mental distress. Sadly, it appears that the mental health of students has worsened since these reports were published, with 57% recently reporting a mental health problem (Student Minds, 2023).

Internationally, mental health and wellbeing in higher education student populations have been reported to be both poorer than the general population and worsening (Storrie et al., 2010, Education Policy Institute, 2018, Shackle, 2019, Bonsaksen et al., 2022, Limone and Toto, 2022, Campbell et al., 2022, World Economic Forum, 2022). It has also been widely acknowledged that higher education students can face challenges in the move from school to university. The transition to higher education requires navigation of academic workloads, managing exam anxieties, adopting successful time-management strategies, and managing financial implications of higher education (UUK, 2015). Young adults are at high risk of developing a serious mental illness (Khan, 2016, Solmi et al, 2022). The risk of development or onset of schizophrenia or bipolar disorder is highest when young adults (aged 18-25 years) are entering higher education. More specifically, incidence of schizophrenia in males is significantly higher than in females (McGrath, 2006, Royal College of Psychiatrists, 2010), and the suicide rate for males in Scotland is more than three times than that for females (SPHO, 2017). This is supported by UK data with 15.8 male deaths per 100,000 compared with 5.5 female deaths per 100,000 (Office for National Statistics, 2022, Samaritans, 2022). By these measures, the engineering student population have demographic characteristics that fall into a high risk category.

More broadly, it has been reported that there is a growing number of young adults with a probable mental disorder in England (NHS England, 2023) continuing a rising prevalence over the past few years. In Scotland (Scottish Health Survey, 2022) it was reported that young adults between the ages of 16-25 had the poorest mental wellbeing of all the reported age ranges. As Children and Adolescent Mental Health Services are increasingly in demand (Public Health Scotland, 2024) so too is there a growing demand on student counselling services in Scotland, and the UK (Bell, 2022, Weale, 2023)

However, in terms of help-seeking, low rates of mental health helpseeking and service or treatment utilisation have been reported in young adults internationally (Salaheddin and Mason, 2016, Mitchell C, McMillan B, Hagan, 2017, Osborn et al, 2022, National Institute of Mental Health, 2024).

It has also been reported that students and engineering students in particular have even lower rates of mental health helpseeking and service or treatment utilisation (Lipson et al, 2016, Wright et al 2023, Whitwer, Wilson, and Hammer, 2023). Additionally, while helpseeking has been reported to be higher in women engineering students than their male counterparts (Whitwer, Wilson, and Hammer, 2023) it is still lower than that of non-engineering students, which may indicate a disciplinary socialisation towards reduced rates of helpseeking.

While it is noted that young adults more generally are experiencing poorer mental health and wellbeing than other age groups, university students and in particular engineering students are the focus of this study. Universities have a duty of care for students and the student experience is a key performance indicator for a successful institution (Office for Students, 2023). Being at university can lead to greater exposure to poor health behaviors such as poor sleep patterns, poor dietary intake, increased alcohol use, smoking, drug use, and being less physically active as well as isolation and cultural challenges (Deasy et al., 2015, Skromanis et al., 2018, Whatnall et al., 2019). As a result of these challenges, students can suffer poor mental wellbeing, anxiety, stress, and mental health problems which can also contribute to discontinuation of studies for students and course dropout rates (Pereira et al., 2018).

Reported mental health conditions by students have risen globally from 1.4% to 3.5% between 2012 to 2018 in the UK (Office for Students, 2019), affecting one in four people aged between 15-24 in Australia (Orygen, 2017). In the USA, Lipson (2022) reported a 50% increase in mental health conditions in American students from 2013 to 2021 and the Healthy Minds Network 2021-22 (2022) reported that 60% of students in the study had a mental health problem in the past year. This was an increase from the 52% highlighted in the Healthy Minds Network Winter 2021 report. This situation calls for a considered and focused response from those tasked with supporting students at university, namely those services which provide academic, wellbeing, and psychological support to students.

In recognition of the increasing awareness of poor mental health and wellbeing in student populations, the impact on student success, mental health, and economic impacts (to institutions, students, and society), higher education institutions have moved to address these issues. This has been actioned through development of wellbeing strategies and mental health awareness initiatives for students as well as international Health Promoting University approaches (UUK, 2015, Swannell, 2016, Baik et al., 2016, and Holt and Powell, 2017, UCL, 2020).

Traditionally, the state of mental health and wellbeing for higher education students has been reported as a group. More recently, results have been categorised in some countries into academic disciplines such as engineering and HE reporting standards now use a range of personal characteristics in order to better understand the phenomenon of mental illness among higher education students. The impact of gender and cultures on mental health and wellbeing needs of higher education students has been reported in the USA but this still requires greater reporting globally (Lipson et al., 2016, Browning et al., 2021). MacAskill (2012) reported that students who completed the GHQ-28 (General Health Questionnaire) (Sterling, 2011) in their second year of study were experiencing raised anxiety, depression and social dysfunction. Respondents who reported feelings of mental distress experienced them once a month or more (74%, n=1037) with 30% (n=311) experiencing feelings of mental distress once a week or more (Student Minds, 2023). Additionally, students generally do not disclose mental health issues with their institutions, reporting stigma as a key barrier therefore these figures may be under-reported (NUS, 2010, NUS, 2013, Gaddis, 2018, Jack, 2022).

Results from studies in the US (Eisenberg et al, 2007), Scotland in 2016 (Laidlaw et al, 2016), and globally (Ebert, 2019), report low treatment utilisation rates in students with mental disorder. Normalisation of student stress has been identified as a barrier to mental health and wellbeing help-seeking (Beukema et al, 2019). Additionally, low rates of help-seeking have been reported widely across publications relating to student mental health and wellbeing (Hunt and Eisenberg, 2010, NUS, 2010, Onabule and Boes, 2013, Kearns et al. 2015, Salaheddin and Mason, 2016).

1.3.1 Engineering Students

Particularly, low rates of male student mental health helpseeking has been identified as a significant issue (Sagar-Ouriaghli et al, 2020) and considering the overrepresentation of men in engineering courses, this may indicate a particular challenge in supporting engineering students with their mental health and wellbeing. While poor mental health and wellbeing has been reported for higher education students generally, there have been specific reports on the perceived stress (Prakash, 2015, Balaji et al, 2019, Jensen and Cross, 2021), difficulty of an engineering degree (Jensen and Cross, 2019, Engineering UK, 2020) and an increasing body of evidence highlighting significant mental health and wellbeing problems experienced specifically by engineering students.

Investigating the mental health and wellbeing of engineering students specifically is important due to the aforementioned global lack of engineers and increased need for engineering graduates (Pozniack, 2017, Donelly, 2018, Engineering X, 2020). The demographic of engineering students may also add risk as a subject studied predominantly by men (Wilson and Goldberg 2023). Young people (Addington et al, 2017) and particularly young males (Rice, Purcell and McGorry, 2018) are at higher risk of mental health problems. Engineering is an academic discipline where there are significant challenges in supporting mental health and wellbeing including a full curriculum, an overrepresentation of men and increasing expectation of enhanced graduate skills. These challenges will in turn be impacting industry which is already seeing a reduction in the numbers of graduates entering and staying in the profession.

Mental ill health is increasingly being identified in students internationally and higher education institutions are focusing more on it as a result. Exploring the mental health and wellbeing helpseeking behaviours of engineering students will support higher education institutions and departments of engineering to implement enhanced approaches to student support.

1.4 Key Concepts

Throughout this thesis references will be made to a number of concepts related to mental health and wellbeing in engineering students. This section provides an overview of these concepts.

1.4.1 Definitions of Mental Health and Mental Wellbeing

Global definitions of mental health and mental wellbeing vary widely including interchangeable use of the terms. “Mental health” can be considered an absence of illness or disease (Felman, 2020), whereas for others the term is more inclusive, covering mental wellbeing (MIND, 2007, Mental Health, 2020, WHO, 2022). Similarly, there is no one accepted definition of mental wellbeing (WHO, 2004, Department of Health, 2010). In higher education, mental health has been considered as one aspect within overall mental wellbeing (Universities UK, 2015). It is important to recognize that the term mental health has different connotations for different people and people’s attitudes to mental health may depend on the culture of the population who are defining the term (WHO, 2004). It is also important to note that definitions have evolved over time (Manderscheid, 2010, Venters, 2018) and it is anticipated that these definitions may evolve in the future. Consequently, for the purposes of this work, it is important that both mental health and mental wellbeing are defined here.

While there is variation in the definitions of mental health (Mental Health, 2019, Gega, 2022) this thesis has adopted the definition of mental health from the World Health Organization (WHO, 2022). WHO (2022) describes mental health as:

“a *state of mental well-being that enables people to cope with the stresses of life, realize their abilities, learn well and work well, and contribute to their community. It is an integral component of health and well-being that underpins our individual and collective abilities to make decisions, build relationships and shape the world we live in.”* (WHO, 2022).

The concept of mental wellbeing also has various descriptions with some sources positioning it at one end of a continuum with mental illness at one end and mental wellbeing at the other and others presenting wellbeing as the overarching concept that includes mental health. However mental wellbeing is not something that can only be experienced by people with no mental disorders. Huppert (2009) describes mental wellbeing as a “combination of feeling good and functioning effectively”. A government report (Government Office for Science, 2008) describes mental wellbeing as a “dynamic state” where a person can flourish and “achieve a sense of purpose in society”. Similarly, Gega (2022) describes mental wellbeing as a state of our “sense of self” and that good mental wellbeing is supported by “meeting our potential, developing strong relationships and doing things that we consider important and worthwhile”. While mental wellbeing is an individual experience, positive mental wellbeing definitions include descriptions of strong relationships with others and contributing to community. Baldwin, Sinclair and Simons (2021) note that the term “mental wellbeing” is described differently depending on the describer’s philosophy, whether it be eudaimonic,(sense of purpose, self-acceptance) or hedonic (happiness, life-satisfaction) (Seligman, 2004), and that this can become problematic when researchers investigate and measure mental wellbeing.

For the purposes of this research the following definition of mental wellbeing has been adopted:

“Mental wellbeing can be described as a combination of how we feel (our emotions and life satisfaction) and how we function (relationships with others, personal control, purpose in life and independence).” (Paul Hamlyn Foundation, 2023. pp1).

1.4.2 Mental Health and Wellbeing (MHW) as an inclusive term

For the purpose of this review, the term “mental health and wellbeing” has been used to ensure inclusivity for with the aim of encapsulating the whole of a person’s mental experience and also recognising that there is still inconsistency (Ashgar and Minichello, 2022) with which terms are applied in different environments, institutions, social or occupational circles. While the researcher has been using this term from early on in the research, more recently it has been proposed as the formal term stakeholders in engineering education should use, due to its inclusivity and balance (Ashgar and Minichello, 2022). The definition of the term comes from Brown (2016) and is as follows:

“Having the emotional resilience to cope with everyday pressures, enjoy life, and undertake productive work while having a belief in one's own and others' worth. It is not just the absence of a mental illness: one can have good mental wellbeing yet have a diagnosed mental illness” (p.1, Brown, 2016).

While it is useful to have a definition of mental health and wellbeing combined, the following work does measure presence of mental health problems (self-reported) and mental wellbeing separately. This is in order to be able to make comparisons with the general population and other student groups.

1.4.3 Determinants of Mental Health and Mental Wellbeing

Poor mental health has a serious impact on the economy and amounted to 14.7 million sick days being taken due to mental health related problems in 2022 (ONS, 2023). Published literature highlights that some of the social determinants of mental health and wellbeing include poverty, social inequality, gender and institutions (Allen, 2014, Scottish Government, 2020). There are reports of a corresponding relationship between economic vulnerability and poor mental health and wellbeing (Codagnone et al, 2020, Scottish Health Survey, 2021), and the potential stress of an uncertain future may also be a contributor to poor mental wellbeing (Chowdhury et al, 2022, Zhou et al, 2022). In 2008, the UK Government published the Foresight Mental Capital and Wellbeing Project Report (Government Office for Science, 2008) which included an informative model of mental wellbeing over a person's lifetime. It depicts a complex set of contributors to mental wellbeing at a critical stage in a young adult's life.

1.4.4 Mental Health and Wellbeing Terminology

Stress

Stress is one of the mental health problems linked to engineering students' mental health and wellbeing in literature (Bork, 2022). But it is important to identify what is meant by the term stress, particularly in relation to short term, potentially stressful, events such as examinations. Severe stress can harm cell communication on learning and memory (Sandi, and Pinelo-Nava, 2007) and this can play a part in the academic performance and feelings of overwhelmedness for some engineering students (Storrie, 2010). Overall, however, the body is generally well equipped to deal with short term stress (Scott, 2023).

For the purposes of this research, stress will defined as: "*how we react when we feel under pressure or threatened. It usually happens when we are in a situation that we don't feel we can manage or control"* (Mind, 2022).

Everyone will experience stress at some point, and it is not necessarily something that should be avoided at all costs, indeed, stress may even enhance academic performance. (Rudland, Golding and Wilkinson, 2019). However, prolonged stress can have a serious negative impact on a person's mental and physical health and wellbeing (Scott, 2023).

Chronic stress is described as *“a **prolonged and constant feeling of stress** that can negatively affect your health if it goes untreated. It can be caused by the everyday pressures of family and work (or studying) or by traumatic situations.”* (Scott, 2023).

In addition to the typical stresses experienced by university students, engineering students are subject to added stress of normalization of stress culture (Sallai et al, 2022) with 60% of study participants experienced stress from poor mental health during their studies. Over 60% of the women in the study experienced systemic stressors. The study notes that coping mechanisms, such as reframing, of sexism, racism and harassment was used to turn poor experiences into learning opportunities. Reframing can be a useful coping tool (Sallai et al, 2022) but it supports normalization of poor behaviour in engineering.

Managing Stress

Stress management techniques reported by graduate engineering students in the US (Troutman, Riley and Mallouk, 2022) range from passive i.e. disengagement from or avoidance of stressors (Little, 2018) to active i.e. solving or reframing the meaning of a problem (Carroll, 2013). Those who feel they successfully managed their stress used friends and family for support. The paper also noted that engineering students who used more passive techniques (watching TV, playing video games) felt less able to manage their stress effectively (Troutman, Riley and Mallouk, 2022).

Anxiety

Storrie (2010) cited stress and anxiety are predictors of poor academic performance in university students. But it is important to acknowledge that anxiety in itself is not necessarily an illness. For the purposes of this research the following definition is adopted:

“Anxiety is what we feel when we are worried, tense or afraid – particularly about things that are about to happen, or which we think could happen in the future. Anxiety is a natural human response when we feel that we are under threat. It can be experienced through our thoughts, feelings and physical sensations.” (Mind, 2021).

Although it is acknowledged that occasional feelings of anxiety can be considered a normal part of life, chronic longer lasting anxiety may develop into an anxiety disorder, where these feelings persist and impact on daily life. It is also important to recognise there are two main contributors to anxiety, ; these are described as State Anxiety and Trait anxiety. State Anxiety refers to transitory i.e. short-lived feelings of tension (Jouvent et al, 1999) and Trait Anxiety refers to the tendency of a person to experience anxiety in a stressful situation (Jouvent et al, 1999).

Anxiety disorders are conditions whereby specific issues impact on a person's daily life (National Institute of Mental Health, 2023). Examples include Generalised Anxiety Disorder, Phobia Related Anxiety Disorder and Panic Disorder (National Institute of Mental Health, 2023).

Depression

"Depression is a mental health problem that involves having a low mood or losing interest and enjoyment in things. It can also cause a range of other changes to how you feel or behave" (Mind, 2023).

Depression in engineering students has been reported in literature having been measured using a variety of tools (Ali et al, 2014, Lee and Wan Adam, 2016, Aree et al, 2020, Cheung et al, 2020, Siddiqui et al, 2020, Coley and Jennings, 2019, Wilkins-Yel, 2021, Chowdhury et al, 2022, Wang et al, 2022, Danowitz and Beddoes, 2022). Symptoms can range from mild to severe in terms of diagnostic criteria but it is important to acknowledge that even a mild disorder can have major impact on a person in terms of physical, biological and psychological wellbeing. Impact is not explored in Ali, (2014), Lee and Wan Adam (2016) Aree et al (2020) Cheung et al (2020).

Self-Efficacy

Self-efficacy is the belief in one's ability to succeed in a particular challenge or goal (Bandura, 1987, 1996) and is a way of describing a persons' ability to cope with situations. Conversely Self-Inefficacy or negative self-efficacy is a concept that describes a person's inability to cope with adverse situations (Bandura,1987). It can be described as a feeling or lack of capacity to produce a desired effect (Tacke, 2022) and can contribute to burnout (Schaufeli and Salanova, 2007). Burnout is a serious issue in the technology workforce with 33% feeling ineffective at their job (BurnoutIndex, 2022).

Self-efficacy has been correlated with academic achievement (Aleta, 2016, Ganguly, Kulkarni and Gupta, 2017, Baiq et al, 2020). Cech et al (2011) found that professional role confidence predicts persistence (Cech et al, 2011). Self-efficacy is associated with persistence in female engineering students (Marra, 2002), but not necessarily academic achievement as female engineering students have been found to perform well regardless of low self-efficacy (Vogt, 2007). Naphan-Kingery and Elliot (2018) reported that gendered micro-aggressions increased the self-rated importance of being a woman over being an engineer and that engineering identity predicted increased self-efficacy and persistence. This supports earlier findings that women in engineering rate themselves to have a lower ability than men

(Jagacinski 2013) and this may in part be contributing to the attrition rates of women leaving engineering programmes. Improving academic self-efficacy may improve poor mental health and wellbeing (Yupanqui-Lorenzo et al (2023) and vice versa.

Stigma

A culture of mental health stigma has been identified in higher education (Kearns, 2015, Gaddis, Ramirez, and Hernandez, 2018, Cheung et al, 2020) but also more specifically it is reported to be particularly evident in engineering programmes (Sandhu, Arora, and Brasch 2021, Wright, 2021, Sanchez-Pena, 2021, Conceicao, 2022, Jensen, 2023). There is a negative relationship between stigma and helpseeking attitude in engineering students (Sandhu, Arora, and Brasch, 2021, Sanchez Pena, 2021, Conceicao, 2022) and perhaps unsurprisingly even higher in male engineering students (Sandhu, Arora, and Brasch, 2021). Higher stigma levels have been associated strongly with a student's identification with an institution, or sense of belonging (Kearns, 2015). Engineering students who screened positive for a mental health condition also screened for panic disorder 5 times more frequently than the general population (Danowitz and Beddoes, 2023). They also reported less likely to get help, trivialised mental health concerns due to the normalization of stress and reported a culture of stigma and silence (Danowitz and Beddoes, 2023). It has also been reported having depression was a predictor for lower wellbeing (Cruwys and Gunaseelan, 2016). Helpseeking was found to be associated with public shame for US engineering students and that students would wait until breaking point before seeking help (Wright, 2021). Reducing stigma is likely to be key in breaking the silence. Dzemaili (2023) has reported that giving university students mental health first aid training reduces stigma/stigmatizing attitude, and increased confidence in students to offer help. It is possible that providing mental health first aid training to engineering students and staff might reduce stigma.

Helpseeking

The concept of help-seeking is important for this research as, particularly in the UK, it is generally accepted that men are less likely to seek help for a mental health issue (Galdas, Cheater and Marshall, 2004, Oliver, 2005, Yousaf, Grunfeld and Hunter, 2015, Staiger, 2020, Budzynski, 2022). It has also been reported that people suffering with mental health problems are less likely to seek help (Maagard et al, 2017) in some cases only seeking help when the problem is very severe (Oliver et al, 2005) with young men in particular (Best, Manktelow and Taylor, 2016), and young men from affluent areas (Oliver et al, 2005) being less likely to seek professional help. Sullivan, Camic, and Brown (2015) attributed attitudes to mental health helpseeking to masculine ideologies (western) alexithymia and education. Alexithymia refers to difficulty in expressing and describing emotions (Luminet, Nielson and Ridout, 2021) and is often considered to be a difficulty associated with men.

McLafferty (2022) suggests that discipline specific support may be warranted as engineering students are least likely to have received treatments or felt need to seek help (Salahedin, 2016, Bork and Mondisa, 2022, McLafferty, 2022). This may be due to poor symptom awareness or reluctance to disclose because of stigma, but delayed helpseeking causes issues not just for the student who will experience their symptoms for longer but also for the academic institution. Low rates of help-seeking have been reported widely across publications relating to general student mental health and wellbeing (Hunt and Eisenberg, 2010, NUS, 2010, Onabule and Boes, 2013, Kearns et al. 2015, Sagar-Ouriaghli et al, 2020) and, as mentioned in the previous section on Stigma, a strong sense of belonging was reported to be positively associated with high levels of stigma in the general student population (Kearns et al, 2015). It may be that the very same induction activities designed to promote university belonging and support wellbeing may inadvertently be contributing to increased stigma.

Anecdotally, delayed helpseeking will be accompanied by failed or missed assessments and missed classes, resulting in complex administrative work to minimise impact for the student causing a knock-on effect of additional workload for staff.

1.5 The Engineering Discipline

For those unfamiliar with the world of engineering, this section provides a brief overview of the history and philosophies of engineering, which may perhaps provide some insight into the stereotypical mindset of the modern engineer and further support the need for targeted exploration of mental health and wellbeing in engineering students.

1.5.1 The History and Philosophy of Engineering

"Engineers use their knowledge of science, maths and engineering science in order to develop products, processes, systems for society" (Moses, 2006). 1:09:04).

As long as there have been humans, there have been engineers. From the invention of the wheel to simple machines and devices to make life easier, engineers all over the world have been practicing their craft. While modern engineering might be attributed to the era of James Watt, in the 1800's, the origins of the engineer stem from thousands of years of human ingenuity. *"Engineers apply the knowledge of the mathematical and natural sciences (biological and physical), with judgment and creativity to develop ways to utilize the materials and forces of nature for the benefit of mankind."* (IAENG, 2023, pp.1)

The rise of the "engineer" as a celebrity in western culture came some years after the invention of the steam engine by Newcomen in 1712, with the inventions of Watt and Boulton, Cartwright, Arkwright and others driving the industrial revolution (White, 2009). Thousands of people (Ziolowski, 1984, Florman, 1994) would turn out to see openings of bridges, new inventions and curiosities, in essence there was huge interest in both innovation, technology and the engineer themselves (Petrovski, 1992).

"To be an engineer in 1902, or at any time between 1850 and 1950, was to be a participant in a great adventure, a leader in a great crusade." (Florman, 1994, pp4).

Engineers have been revered until relatively recently, where the word engineer has been arguably diluted by its use in wider role descriptions. This is particularly evident in the UK and the USA, where the word Engineer implies someone who works with engines and is not a protected or regulated title (Engineering Council, 2012, Moskvitch, 2017, Freeney, 2018, Toofan, 2021). More widely, people seem unable to articulate what an engineer is or really does and it appears that the engineering community appear to have a similar problem, as they argue over semantics (Florman, 1994), resulting in poor messaging to the non-engineering community.

It is possible that this may partially explain the sense or feeling of injustice or underappreciation in the modern engineer, particularly in the UK (IMechE, 2015) with only 24% of engineers feeling they are valued by wider society. Given that the engineer used to be worshipped (Nyamapfene, 2018, Florman, 1994) and is now less revered (Nyamapfene, 2018) it is perhaps understandable that there is a culture of gatekeeping mentality (Cosgrove, 2022) in engineering, particularly in relation to perceived intelligence (Carrol, Kramer and Dringenberg, 2019). The impact of a gatekeeping mentality or culture – essentially controlling access by the use of exclusionary language, elitism, or actions. (Pollock,2022) may be contributing in part to a lack of diversity in the engineering profession.

Nowadays, engineering products are expected to be perfect, by not only adhering to or exceeding quality regulations and standards but also with no bugs or errors and with seamless future proofed functionality. Employers may demand additional features to a product that require a complete remodel if the request is even achievable at all. These types of expectations add colossal pressure to engineers who are often considered to be perfectionists (Sun et al, 2013, Dicturel, 2019, Piper, 2022) leading to unrealistic expectations in innovative development, and likely a great deal of pressure for engineers.

This pressure is perhaps most keenly felt in those engineers designing and building vehicles, particularly aircraft as it is imperative that an aircraft be as safe as absolutely possible. Thus, the engineer's now built- in or nurtured desire and compulsion to be without fault in design and build can never truly be achieved (Piper, 2022). And so regardless of how amazing, innovative (and indeed safe) an invention is: it may never come up to scratch in the engineer's eye.

1.5.2 The Great Engineering Shortage

Despite the importance placed on the role of the engineer for our future, the UK has a serious shortage of engineers. This phenomenon is echoed in the U.S., China, South Africa, and Germany with reports of demand far outstripping supply. Calls for education reform are growing in order to attract and retain engineers and there has been an increase in the diversification of and access to engineering education through degree apprenticeships and widening participation activities. This well-documented global engineering shortage (See Section 1.2) (Lucas et al, 2012, Pozniak, 2017, Donelly, 2018) has led to calls for education reform (Graham, 2012, EngineeringUK, 2022, SEFI, 2022). However, reform has been slow in UK HEIs with relatively few new methodologies being utilised. According to a report by the Offshore Petroleum Industry Training Organization (OPITO, 2019) - the 2019 Skills Landscape Report, by 2025 there will be approximately 4,500 new people in the UK employed in roles that do not currently exist. These new roles will require a different set of skills and competencies, which means an emphasis on upskilling the existing workforce: this has been described as the engineering skills gap (IET, 2021 Engineering UK, 2021, IMechE, 2022, CIHT, 2022)) and so the rationale for education reform is stronger than ever.

Yet, barring a couple of examples of more radical moves (NMITE, Dyson Institute) the engineering curricula in universities across the UK have seen little change over the last 20 years. Indeed, as early as 1977 (Richardson, 1977) there has been an appetite for significant change in engineering education while describing a comparable situation to today (high attrition, lack of women). This slowness may be in part due to the rigid regulatory requirements (See section 1.2) of the various professional accrediting bodies, anecdotally often a reason to maintain the status quo, but even these bodies are recognising that change must come in order to address the global shortfall of engineers (RAENG, 2019, Sorby, Fortenberry, and Bertoline, 2021, IET, 2022a, IET, 2022b, McDonald, 2022).

The Philosophy of Engineering

In the history of modern engineering at least, there have been some efforts to ascribe or define a Philosophy of Engineering, much like a Philosophy of Science. Unlike science though, which aims to discover and understand the world and beyond, the engineering industry is driven by commercial and societal demands and therefore subject to the philosophies of the countries where the engineer has studied. Moses (2006) considers the attitude of people towards engineering is different in different countries, citing Japan and Germany as being engineering positive, and the UK as being engineering negative. Moses (2006) described the philosophy of engineering as a balance of two philosophical foundations, the Platonic and the Aristotelean, abstraction and reductionism, and that different countries approached engineering with an emphasis on one or the other. He asserted that in the UK, the Aristotelean, empiricist, reductionist philosophy was strong, and this was borne out in an over emphasis of the importance of laws and equations over abstraction. Engineering philosophy is considered to be an emerging field (Bulleit et al, 2014, Dias, 2019) and that consideration of engineering philosophy will support and enhance engineering judgement. Dias (2019) considered practice to be the most important engineering philosophical issue but acknowledged the tension between theory and practice. Dias also considered the concept of failure as central to engineering but that engineers are "looking to create things that don't fail". This engineering aspiration contradicts Petroski (1985) who proposes that "failure… is central to understanding engineering" (Petroski, 1985, viii).

Dias (2019) suggested that the combination of the works of:

- Popper (1983) supporting the view that failure is key to engineering design calculation
- Kuhn (1970), asserting that scientific theories are a human construct and may not reflect truth (which led to his developing the Kuhn Paradigm Cycle (McLeod, 2023)
- Polanyi (1958) who considered problem solving to be something that humans are "driven to by a heuristic passion" (Dias, 2019, pp 66.)
- and Heidegger (1962) championing practice over theory in the context of engineering

were key in developing the field of engineering philosophy.

While it is not the aim of this thesis to comment on engineering philosophy, these philosophical roots may provide some illumination or context when considering the research findings and making recommendations. Indeed, the very pragmatic nature of this research aligns well with Dias's pragmatic approach to building a philosophy for engineering, combining the epistemology of Polanyi and the ontology of Heidegger (Dias, 2019). Understanding why engineers "engineer" and how engineering judgements are arrived at may be key to understanding some of the cultures and habits exhibited by engineers, engineering academics, and engineering students.

1.5.3 Occupational Socialisation

The idea that engineers might have a specific set of behaviours that are distinct from the rest of the population is not a new one. As early as 1966 researchers have been writing about distinct characteristics displayed by engineers and have discussed having observed engineering students from different universities displaying more similar characteristics to each other than to non-engineering students in their own institutions (Rosette et al). Since then, engineers and engineering students have been attributed a myriad of undesirable traits, negative or even neurotic perfectionism (Mitchell, 2017, Brotherton and Orr, 2021), authoritarianism (Beall and Borden, 1964, Athansiou, 1968, de Pillis and de Pillis, 2008, Banks, 2016) and downright rudeness (White, 2013, Cook, 2017) . Some researchers have used the Herrmann Brain Dominance Index to identify that engineering students and engineers demonstrate signature thinking preferences. They reported that engineering students (Lumsdaine and Lumsdaine 1995, Horak and du Toit, 2002) and engineers (Heffner, 2012) demonstrated key features that fit in with these negative stereotypes, but they also found that there was a preference for holistic thinking. This contrasts with the perception that engineers are largely reductive in their work, breaking problems down to component parts and building up again.

More recently, Lucas, Hanson and Claxton (2014), described signature disciplinary characteristics that engineering students generally demonstrate in relation to learning and teaching, possibly distinguishing engineering students further. These are outlined in Fig 1.

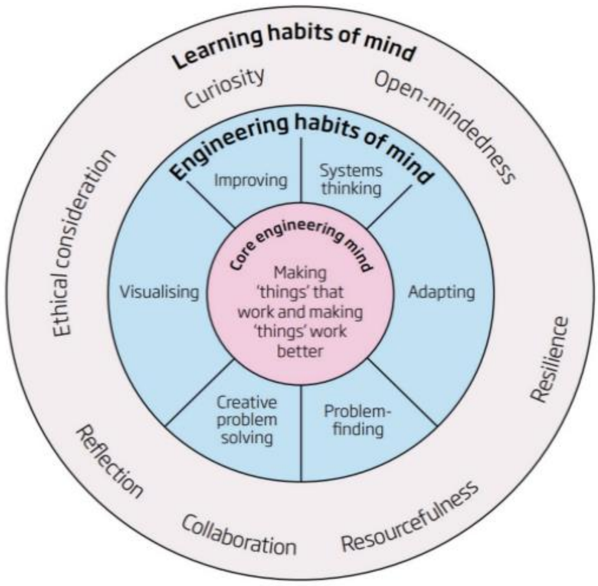

Figure 1. Engineering Habits of Mind (Lucas, Hanson, and Claxton, 2014).

Edward and Middleton (2007) described engineering students' development as a form of occupational socialisation, and self-image in engineering students was disturbed when they were asked to deal with problems involving the use of what they perceived to be soft skills (communication, teamworking, adaptability, leadership). Sun (2003) reported identifying the phenomenon of negative perfectionism in engineering students. Where the gap between the real and ideal self is too large, (Sun, 2013) frustration increases, resulting in distress. Jensen and Cross (2019) reported that engineering students considered engineering programmes as “distinct from other academic disciplines” (Jensen and Cross, 2019) and that they experienced more stress than other students.

Heffner (2012) also asserted that engineers demonstrate a “pessimistic explanatory style”. Explanatory styles are used in the increasingly popular positive psychology lexicon (Peterson and Steen, 2016, Houston, 2019). Supporters consider them to be the way a person explains an experience (Wadey, 2010, Scott, 2020) and that this style can influence a person’s expectations of future events or experiences. In a pessimistic explanatory style, a person will *“see the bad experience or event as one that was their fault, will not change in the future and is generally problematic rather than specific to that particular event.”* (Wadey, 2010 pp1). It has been suggested (Peterson, Seligman and Valiant, 1988, Jackson, Sellers and Peterson, 2002, Maruta et al, 2002) that having a pessimistic explanatory style is a risk factor for poorer health outcomes than someone with an optimistic explanatory style. Heffner (2012) notes that engineers *“must operate under the assumption that failure will happen if they do not accurately set the expectations”.* The potential for this useful engineering thought habit to spill into everyday life should not be underestimated given the potential health implications.

A report on masculinity in engineering (Equal Engineers, 2019) highlighted over a fifth of respondents reporting having had to take time off work because of mental ill health. The report also notes that nearly a fifth of respondents stated they had lost an engineering colleague to suicide. When asked if they experienced stress, sleeping issues, thoughts on self-harm or being bothered by feeling anxious, depressed, irritable or sad, 77% of participants answered yes (Sheedy, 2022).

1.6 The Engineering Curriculum

Engineering programmes are typically academically challenging (Foster and Spencer, 2003, Jensen and Cross, 2021, Ashgar, Minichiello and Iqbal, 2022, Wilson et al, 2022), assessment heavy, intensive (Jensen and Cross, 2018, Joshi, 2020, Wilson and Goldberg, 2023), male-dominated (Wilson and Goldberg 2023) and exam focussed. They are perceived to be stressful in nature, and as there is a significant negative correlation between mental wellbeing and academic stress, and mental wellbeing and suicide ideation in engineering subjects (Banerjee and Chatterjee, 2015) and it is possible that the very methods used to teach engineering may cause poor mental wellbeing. Additionally, engineering programmes are often accredited by professional regulatory and statutory bodies (such as the Institution of

Mechanical Engineers, the Institution of Engineering and Technology in the UK, the Accreditation Board for Engineering and Technology in the USA and the National Board of Education in India) that have a strong influence over types and frequency of assessments which restricts educators to arguably limited options for meaningful change. In an effort to drive advancement of engineering education, Lucas et al, (2014) developed a model of engineering learning “habits of mind” to highlight the key desirable thinking attributes of an engineer. It describes the ideal scenario, and is useful for curriculum development, however it is unlikely most engineering programmes in the truly provide meaningful experiences in all of these areas. Engineers are vital to achieve the goals in addressing many global challenges: energy, sustainability, transport, infrastructure, and medication (National Academy of Engineering, 2022) are just a few of these. A key issue in supporting engineering students is likely to be enhancing the capabilities of engineering teaching staff. (Wilson and Goldberg, 2023). However, Morrish, 2019, Carr (2022) and Wilkinson (2023), have reported universities experiencing rising staff mental health and wellbeing problems. This increase in mental health and wellbeing problems in academic staff combined with what might be considered “continuity embracing” attitudes to curricular enhancement (Berger, Lampe and Carrucio, 2015, Cropley, 2015, Lee, Lund, and Yerrick, 2021) will likely make additional support demands an unwelcome load.

1.7 Engineering Student Life: “We’re in a crisis, and no one is looking” (Ravijolan, 2020)

When this research began in 2017 there was very little literature published on the mental health and or mental wellbeing of engineering students. During the course of this research there has been a rapid increase in publication on the topic possibly due in part to the COVID-19 impact and also the recognition of increasing reports and observations of poor mental health and wellbeing rates in the engineering student population. Ravijolan (2020) wrote for the Eyeopener that engineering students in Canada tend towards glorifying stress and that the culture is that if an engineering student is not stressed, then they are viewed as being lazy.

This is supported by Wright (2021) who identified unsupportive learning environments and severely delayed helpseeking. Anecdotally, there is also a snobbery over other disciplines. Yet while there is evidence of poor mental health and wellbeing in engineering students, they have instilled in themselves a sense of pride and community of being an engineer, they still would not change course, they are proud to be an engineer (Ravijolan, 2020). Globally, most engineering students are male (Imasogie, Oyatogun and Taiwo, 2018, Martin, 2021, Bosworth, 2022, Engineers Canada, 2021, Catalyst, 2022, HESA, 2023), and young men (typically aged 18-25) have been recognised to have higher risk factors for mental illness (SPHO, 2017).

Suicide in males (ONS, 2016, SPHO, 2017) and the incidence of schizophrenia in males is significantly higher than in females (McGrath, 2006) and young adult males are at higher risk of developing serious mental illnesses (Royal College of Psychiatrists, 2011).

Engineering is widely perceived to be one of the most challenging subjects to undertake at university (Fleming et al., 2006, Think Student, 2020, Maples, 2021, World Scholars Hub, 2022, Chidera, 2022, Ban et al, 2022). Engineering requires mathematical competence and as such, engineering programs focus heavily on mathematical concepts and principles in the early years (Metje, 2007, Chron, 2021) in the form of entire modules or courses in mathematics (Moran and Benson, 2016). Additionally, engineering programs still use traditional forms of teaching with a lecture-based approach (Mills and Treagust, 2003, Nyamapfene, 2019, McGowan and Bell, 2020). In some countries, the phenomenon of "weeding out" is also prevalent in engineering programmes (Seymour and Hewitt, 1997, Seymour and Hunter, 2019). This process is used to "weed out" students by creating unnecessary academic barriers but this also induces stress for students.

Women in engineering programmes are identified in literature as having poor experiences (Wilkins, Simpson and Sparks, 2019, Ravijolan, 2020, Wilkins-Yel, 2021, Wang et al, 2022), leading to increased dropout rates, feelings of being viewed negatively (Beddoes and Danowitz, 2022) and increased stress, anxiety, suicidal ideation, and depression (Wilkins-Yel, 2021, Akhtar et al, 2021, Wang et al, 2022). Female engineering students also have reported poorer mental wellbeing than their male counterparts (Deziel et al, 2013, Pozniak, 2017, Negi et al., 2019, Jensen and Cross, 2021).

1.8 Research Questions

The research questions are:

- What is the mental health and wellbeing of engineering students in the UK?
- What are the mental health and wellbeing help-seeking behaviours of engineering students in the UK?
- What are the approaches or strategies to support or facilitate mental health and wellbeing utilised by engineering students in the UK?

1.8.1 Research Aims and Objectives

The overarching research aims were to:

- Establish the mental health and wellbeing of engineering students and compare it with the general population and student population to identify if there is an unmet need in relation to mental health support;
- Identify key mental health and wellbeing help-seeking behaviours and mental health and wellbeing strategies of engineering students in order for institutions to be able to make strategic decisions around teaching approaches, pastoral support, and curriculum design in relation to students of engineering.

By investigating the mental health and wellbeing of engineering students it is hoped that the study will provide a comprehensive overview and unique insight into a population that to date has been overlooked and may be at increased or increasing risk.

1.9 Contribution to Knowledge

Until fairly recently there was little published research in the area of mental health and wellbeing of UK based engineering students. In the past three years interest has grown rapidly and the topic has been the subject of several types of research, largely in mono-institutional settings, with a variety of research methods. This thesis is the culmination of 6 years of part-time research by the author and while there has been a notable increase in publications from other countries (USA and India in particular) this work provides a novel baseline of mental health and wellbeing in engineering students and a unique insight into the thoughts, feelings, and help seeking behaviours of this population in the UK. In addition, some contribution to knowledge of the experiences of engineering students during the COVID-19 lockdown was identified as an unplanned outcome of the study.

1.10 Methodological Overview

To answer the research questions a transformative pragmatic paradigm with a mixed method methodology was adopted, specifically sequential explanatory design. Figure 2 provides a visual overview of the research.

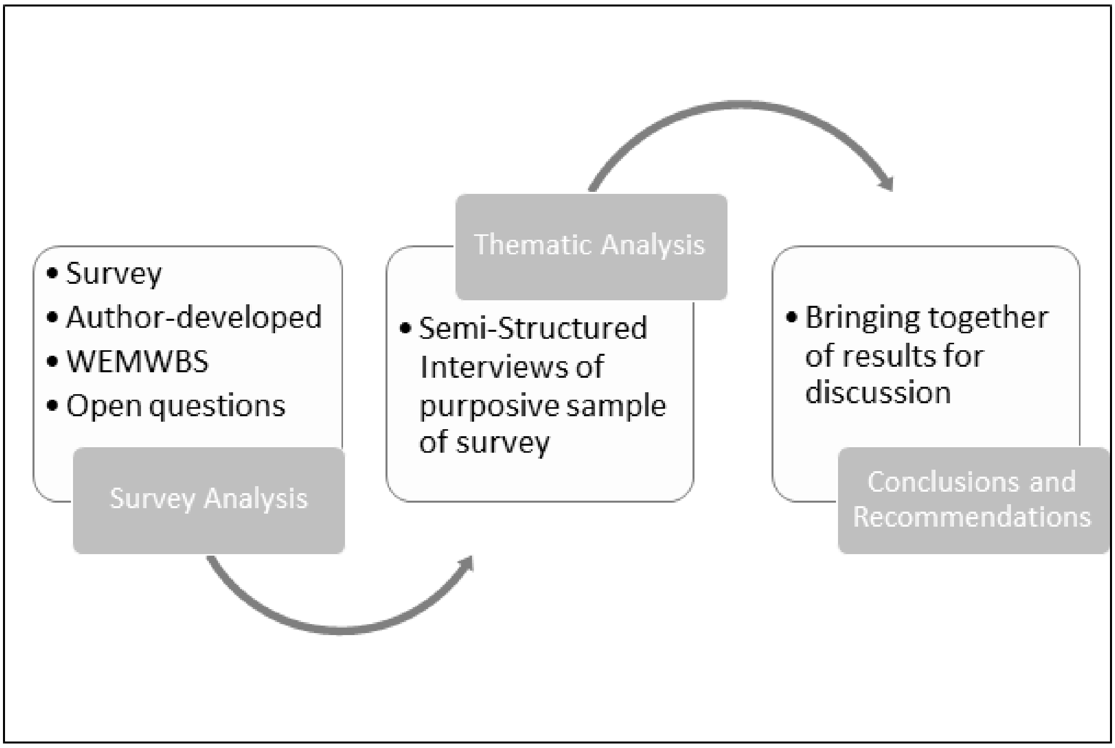

Figure 2. High Level Overview of the Research Methods.

The research activity included:

- A systematic scoping review of interventions supporting the mental health and wellbeing of engineering students;
- A survey of UK engineering student population using convenience sampling including WEMWBS and content analysis;
- One to one semi-structured interviews with a subset of surveyed students - purposive sampling to cover each stage and available sub-discipline.

1.11 Chapter Synopses/Thesis Structure

The structure of this thesis is designed to lead the reader through the approaches used in the study with accompanying justification and discussion throughout.

Chapter 1: Introduction of the research topic with references to supporting evidence and rationale for the study. The aims and objectives were set out along with an overview of the research design.

Chapter 2: Part One of the literature review, which includes a description of the engineering student population, discussion of existing literature and a systematic scoping review focusing on interventions in the engineering student population.

Chapter 3: Methodology including discussion of the philosophical paradigm and lens through which the research is being viewed, and a review of models of mental health and wellbeing. Chapter 4 also details the high-level research methodology.

Chapter 4: Phase One including the methods, results, and discussion of the first research phase, which comprises an electronic survey. The results from Phase One informed the second research phase.

Chapter 5: Phase Two including the methods, results, and findings of the second research phase which comprised semi-structured interviews with a subset of participants from the first research phase. Findings are considered through abstraction and interpretation and a framework to support engineering student mental health and wellbeing proposed.

Chapter 6: Integrated discussion presenting the findings of both phases of the mixed method study and considering them in relation to the research questions, limitations are discussed and a case for future work built.

Chapter 7: Conclusions of the research and a breakdown of recommendations for different stakeholders is presented with a summary of the work and its contribution to knowledge.

1.12 Chapter Summary

The engineering industry is reporting large shortfalls in engineering recruitment and retention, the cause of which may be in part to a high stress work environment. Globally, there is an urgent need for more engineers therefore developing an understanding of how engineering student mental health and wellbeing can be better supported may go some way to increasing the overall number of engineers entering and staying in the profession. This chapter introduced the engineering gap, an overview of mental health and wellbeing in higher education students, and key concepts to support the reader in the following chapters. Mental health and wellbeing of engineering students also appears to be of concern to HEI's and there is a lack of UK based research in this area, supporting the rationale for carrying out this work. The following chapter is a literature review, looking at mental health and wellbeing in engineering students, how mental health and wellbeing has been evaluated in engineering students, models of mental health and wellbeing and includes a systematic scoping review on interventions supporting mental health and wellbeing in engineering students.

Chapter 2: Literature Review

2.1 Overview

The literature review chapter will explore key areas in the topic of mental health and wellbeing of engineering students. Firstly, the engineering student population will be described as a distinct occupational and social group with an overview of the current knowledge on their existing mental health and wellbeing. Models of mental health and wellbeing will be explored with a view to supporting a rationale for the model of salutogenesis that overarches this research. Finally, a systematic scoping review on interventions supporting the mental health and wellbeing of engineering students will be presented. The final literature search update was concluded on 30th June 2023.

2.2 The Engineering Student

While the focus of this research is UK engineering students, there is very little published literature on their mental health and wellbeing. Therefore, the literature presented in this review includes international sources, primarily from the USA and India, both of which have many universities offering engineering. In 2021/22, 185,725 students were registered as studying an engineering subject in the UK (HESA, 2023). As described in Section 1.7, most engineering students are young men (Imasogie, Oyatogun and Taiwo, 2018, Martin, 2021, Bosworth, 2022, Engineers Canada, 2021, Catalyst, 2022, HESA, 2023), and as such carry a higher risk for mental illnesses like schizophrenia (McGrath, 2020) and young men (typically aged 18-25) have been recognised to have higher risk factors for mental illness (SPHO, 2017). Suicide in males (ONS, 2016, SPHO, 2017) and the incidence of schizophrenia in males is significantly higher than in females (McGrath, 2006, Royal College of Psychiatrists, 2011).

Research that has been published in relation to the mental health and wellbeing of engineering students highlights worrying data (Deziel, 2013, Vats and Sharma, 2017, Danowitz and Beddoes, 2018), and as reported in section 1.6 it has been reported that female engineering students report even poorer mental health and wellbeing than their male counterparts (Deziel, 2013, Negi et al., 2019, Jensen and Cross, 2021). Embedded sexism has been reported as being experienced by female engineering students, who are often talked over and ignored in group assignments and treated differently by engineering staff (Ravijolan, 2020). This marginalisation increases risk of poor mental health and wellbeing (Beddoes, 2022) and contributes further to academic engineering culture where “common” is being conflated with “unproblematic” (Beddoes, 2022).

In the College of Engineering, Michigan, students had a higher prevalence of mental health problems at around 40% compared to 32% in the general student population surveyed at the time. In the past few years, the focus on engineering student mental health and wellbeing has increased significantly (Bork and Mondisa, 2022). Lipson et al (2016), carried out a comparison of treatment utilisation by students across academic disciplines in 81 colleges and universities in the USA. It was noted that engineering students were "significantly less likely to report suicidal ideation" (p. 31) and there was a "significantly decreased likelihood of seeking help". Further to this the low rate of help-seeking for engineering doctoral students was 27.73% (n=160). Helpseeking for mental health and wellbeing issues may be a challenge for male engineering students as men are considerably less likely to seek help (Möller-Leimkühler, 2002, Galdas, Cheater and Marshall, 2005, Yousaf, Grunfeld and Hunter, 2015, Bork and Mondisa, 2022).

A correlation between high levels of anxiety and low academic performance among engineering students has also been reported (Vitasari et al., 2011). This correlation which aligns with (Storrie, 2010). More recently Balaji et al (2019) reported a statistically significant association between perceived stress and academic performance in university students: the higher the perceived stress, the lower the performance. Stress has been attributed to long hours sitting in front of computers, worries about future prospects, financial worries, health concerns and concerns about academic performance (Vitasari et al., 2011). While these factors may affect other university students, the reported low rates of helpseeking by engineering students may mean that these factors have a greater impact. Beddoes and Danowitz (2022) reported hostile learning environments influence students' helpseeking intentions.

Engineering students' coping mechanisms have been reported to include the use of music or movies, physical activity, reading, meditation, yoga and motivational lectures; however, the most effective strategies to support good mental health and wellbeing have not yet been identified (Negi et al, 2019).

Andrews and Clark (2017) reported 65% of 96 students who had failed one module or more perceived their poor mental health was the underlying reason for failing. Interviews conducted with these engineering students revealed a high number of students disclosing mental health issues. The study targeted students the researchers felt to be at risk of poor mental health and therefore the high result may perhaps be expected in this study. However, another study (Tarabrina et al, 2020) found engineering students in Russia to be very positive with a high degree of self-satisfaction. While they noted that engineering students experienced higher anxiety, the paper did find that engineering students were not as negative as other studies have concluded. This may be due to cultural differences in engineering education internationally, however most literature points towards there being a mental health and wellbeing problem in engineering education in a number of different countries including the USA (Danowitz and Beddoes, 2018, 2022, Jensen and Cross, 2021, Jensen, 2023), India (Lal, 2019, Joshi and Kiran, 2020) Spain (Paniagua, 2019, Rodriguez-Jiminez, 2022).

Turner et al (2007) noted 64% (n=44) of engineering respondents reported symptoms of poor mental health over a 12-month period. While in this study, engineering students made up the lowest proportion of students reporting poor mental health, this is still considerable and concerning for higher education institutions. A discipline comparison study undertaken by (Waghachavare et al, 2013) used the DASS-21 to look at stress in engineering and reported 5.3% respondents reported moderate stress and 5.3% reported severe stress (as opposed to mild or absent stress). As with the findings of Turner et al (2007), engineering students reported fewer symptoms than those of the compared disciplines. There is a possibility that there is under reporting of mental health and wellbeing problems in the engineering discipline, perhaps due to higher stigma (Sandhu, Arora, and Brasch, 2021).

As most engineering students are male, it is reasonable to assume that help-seeking behaviours are not dissimilar to the general male population. Reported barriers to help-seeking by men describes consistent gender differences in mental health help-seeking where men are considerably less likely to seek help (Möller-Leimkühler, 2002, Galdas, Cheater and Marshall, 2005, Yousaf, Grunfeld and Hunter, 2015, Bork and Mondisa, 2022). In contrast a systematic review of observational quantitative studies looking at helpseeking in people with major depression (Magaard et al, 2017) reported this phenomenon in fewer than half the articles included. However, the review noted delayed mental-health help-seeking generally and acknowledged that there were attitudinal barriers to men seeking help. Other barriers include difficulty in defining or expressing their challenges, self-medicating in the first instance, possibly presenting with different symptoms, medical biases, and in trans men there are further barriers relating to body issues, loneliness and experiencing hostile environments (Budzynski, 2022).

There has been increasing interest in the mental health and wellbeing of engineering students, particularly over the past 2 years. Published research has begun to evolve from early steps of recognising there appears to be an issue, to more advanced research recognising variation within the engineering discipline. Danowitz and Beddoes (2022) reported engineering students with a physical disability were more likely to screen positively for a mental health disorder. Similar to measurements of the general population, female engineering students were far more likely than male engineering students who to screen positively for anxiety-related disorders and Hispanic engineering students were significantly more likely to suffer from depressive disorders and PTSD compared to their White peers. Delayed or no help-seeking was also reported, along with their results showing that while 16% of their respondents had shared a mental health disorder diagnosis, 28% screened for a diagnosable mental health condition (Danowitz and Beddoes, 2022). Work by Reta et al (2020) and Siddiqui et al (2020) identified significant rates of mental illness in addition to poor mental wellbeing in engineering students. Conversely, a study in Romania (Cioca and Bratu, 2021) found their engineering students reported a mental wellbeing mean similar to the general population in the UK.

Korsten, Wolff and Booysen (2021) have called for mentally healthy engineering students and oppose and challenge the traditional view that loading students with vast amounts of work better prepares them for the world of engineering in the workplace. They also reported on the lower likelihood of engineering students to seek mental health help which echoes reports from Maxon and Tomasko (2020), Coley and Jennings, (2019) and Leahy et al, (2010). In summary, it appears that the demographic of the engineering student population is very similar to those at higher risk of serious mental illnesses, and suicide or suicidal behaviours: predominantly male, aged 18-25. While there are studies of mental health in engineering students they are often included as the comparator for another course such as law or nursing and not in their own right as a population. There has been no mapping of existing research available to inform development of an intervention to support the specific mental health and wellbeing of engineering students.

Perceptions of Stress

While some amount of stress in life may be considered normal, chronic, long-term stress can increase risk of mental and physical problems (Mariotti, 2015, APA, 2022, CAMH, 2023). Engineering programme workload is a major stressor (Bellinger, DeCaro and Ralston, 2015, Jensen, 2023) with unsupportive training environments, challenges in time management, academic performance expectations (Ban et al, 2022), unsympathetic lecturers and celebration of stress (Beddoes, 2022) all adding stress to engineering students.

Written exams are reported to be very stressful (Korsten, Wolff and Booysen (2021)), with particular exam formats increasing anxiety and are not inclusive (Beddoes and Danowitz 2022). Compressed or Fast Track courses also were associated with increased anxiety (Beddoes and Danowitz, 2022).

2.2.1 Measurement of Engineering Student Mental Health and Wellbeing

Several dimensions of Engineering wellbeing have been measured or evaluated in within the literature. This section aims to provide a comprehensive overview of measures used in studies of the engineering population in order to support future synthesis. A literature search was conducted to identify all literature with an engineering student focus relating to aspects of mental health and wellbeing. This was a wide-ranging search in an effort to capture as many research papers in the area as possible.

A range of research methods have been used to study the engineering student population. Of the literature using quantitative measures, some authors utilised existing validated measures and others used either adapted existing measures or self-authored measures some of which they validated themselves as part of the research. This heterogeneity makes it challenging to carry out meta-analyses on results across studies. Most quantitative measures focussed on a medical model/medical approach (Ashgar and Minichiello, 2022), seeking to diagnose or identify levels of illness within the population, for examples using DASS 21 or 42 (Lovibond and Lovibond, 1995, Cheung et al, 2020). The most used (other than a self-developed tool) was the DASS-21 (Depression, Anxiety, and Stress Scale) used by Waghachavare et al (2013), Naveen et al (2015), Lee and Wan Adam (2016), Negi, Khanna and Aggarwal (2019), Jensen and Cross (2021), Wang et al (2021). The DASS-21 (Lovibond and Lovibond, 1995) is the short form of the DASS-42 and is used as a routine clinical outcome measure (Ng et al, 2007).

Of the seven studies who used the DASS-21, only three reported in a way that allowed for direct comparison: Foong and Ahmad, 2016, Lee and Wan Adam, 2016, and Jensen and Cross, 2021. Waghachavare et al, 2013 did present results for anxiety in a similar format. Table 1 presents the results from these studies for comparison. The DASS-21 results represented 2400 engineering students from India, Malaysia, and Pakistan and the USA. There was significant heterogeneity in results, which may be as a result of different national, cultural, or curricular settings, but this has not yet been investigated.

Other studies utilised attitudinal scales or perception scales, and a further subset of studies sought to identify examples of habits in engineering students, e.g., smoking, drinking, drug taking, internet addiction, phone addiction. Sallai et al (2022) reported over 60% of study participants (engineering students, n=42) suffered from poor mental health in the previous 12 months.

Statement of anxieties as opposed to reporting an anxiety disorder including maths, communication (public speaking and foreign language) and test anxiety were all measured in the literature. Danowitz and Beddoes (2022) reported that Engineering students have worse mental health than general populations. Modern engineering courses report chronically low retention, foster stress culture, 50% screened positively (4 times as likely to suffer from panic disorder and 2 times as likely to suffer from anxiety disorder than the general population) for a mental health condition but also reported 16% diagnosis within the study population. This indicates potentially under diagnosis of engineering students' mental health problems.

Conversely, Cioca (2021) reported above average mental wellbeing scores in engineering students using the Scottish mean as a guideline.

Table 1. Comparisons of Results of DASS-21 in Engineering Students.

Author	Title	Date	N	Depression	Anxiety	Stress
Foong and Ahmad	Mind Matters: An approach to Increase Understanding of Mental Illness among the Engineering Students	2016	133	Normal 61.7%, Mild, 19.5%, Moderate, 18%, Severe 0.8%.	Normal, 34.6% Mild, 12% Moderate 35.3%, Severe,12% Extreme, 6%	Normal, 76.7%, Mild 18.8% Moderate, 3% Severe 1.5%
Jensen and Cross	Engineering stress culture: Relationships among mental health, engineering identity, and sense of inclusion	2021	1173	Normal, 50.3%, Mild, 14.78%, Moderate 18.55%, Severe, 7.14%, Extreme, 9.23%	Normal, 56.45%, Mild, 7.74%, Moderate, 16.96%, Severe, 7.34%, Extreme, 11.51%	Normal, 58.83%, Mild, 12.50%, Moderate, 14.98%, Severe, 11.21%, Extreme, 2.78%
Negi, Khannan, & Aggarwal	Psychological health, stressors and coping mechanism of engineering students	2019	76	Normal, 17.11%, Mild, 77.63%, Moderate, 5.26%,	Mild, 1.31%, Moderate, 73.68% Severe, 22.37% Extreme, 2.63%	Mild, 1.31%, Moderate, 25%, Severe, 65.79%, Extreme,7.89%
Lee and Wan Adam	A Comparison Study of Methods to Solve the Mental Health Problem between the Engineering and Non-Engineering Students	2016	311	Normal, 62.7%, Mild, 12.9%, Moderate, 11.3%, Severe, 10.9%, Extreme, 2.3%	Normal, 38.6%, Mild, 20.3%, Moderate, 16.4%, Severe, 10.3%, Extreme, 14.5%	Normal, 58.5% Mild 13.8% Moderate, 22.5% Severe 5.1%
Naveen et al	Stress, Anxiety and Depression Among Students of Selected Medical and Engineering Colleges, Bangalore- A Comparative Study.	2015	79	Normal 0%, Mild, 19.3%, Moderate, 43.86%, Severe, 36.84%,	Normal, 0% Mild, 24%, Moderate, 40.51%, Severe, 35.44%,	Normal, 0%, Mild, 34.62%, Moderate, 42.3%, Severe, 23.08%,
Akhtar et al	Mental Health of postgraduate medical and engineering students in Pakistan	2021	211	Normal, 30%, Mild, 11.8%, Moderate, 36.5%, Severe, 9.5%, Extreme, 11.8%	Normal, 22.7%, Mild, 10%, Moderate, 22.3%, Severe, 21.3%, Extreme, 23.7%	Normal, 47.9%, Mild, 32.7%, Moderate, 10%, Severe, 9.5%, Extreme, 0%
Waghachavare et al	A Study of Stress among Students of Professional Colleges from an Urban area in India	2013	417	Not presented	Not presented	Normal: 80.3% Mild: 9.1% Moderate: 5.3% Severe: 5.3%
ALL (Ranges		2013-2021	2400	Normal: 0-62.7% Mild: 11.8-77.63% Moderate: 5.26-43.86% Severe: 0.8-36.84% Extreme: 0-11.8%	Normal: 0-56.45% Mild: 7.74-24% Moderate: 16.4-73.68% Severe: 7.34-35.44% Extreme: 2.63-23.7%	Normal: 0-80.3% Mild: 9.1-34.62% Moderate: 3-42.3% Severe: 1.5-65.79% Extreme: 0-7.89%

Qualitative research has also been conducted, although to a lesser extent, with a variety of methods used including focus group and interview analysis and analysis of journals and web posts. The lack of robust qualitative research in this population may be a result of the relative infancy of the topic but also there has been a wariness of qualitative research within the engineering community (Szajnfarber and Gralla, 2017, Gonzalez-Prieto et al, 2021). Another subset of research compared disciplines with each other including engineering, medicine, law, and nursing. A small number compared subdisciplines of engineering (Danowitz and Beddoes, 2018, 2022) .

The most used approach was "author-developed" surveys, with several research projects reporting having designed their own. In some cases, their surveys adapted existing measures in the public domain to support and complement their research questions, in others the use of existing institutional measures were used. In some instances, conversions were used to deliver the measure in a local language. Some authors reported validation work alongside the reporting of results, whereas others did not report validation work.

2.2.2 Engineering Student Mental Health and Wellbeing Helpseeking

Engineering students are considerably less likely to seek help when experiencing mental health problems or poor mental wellbeing (Eisenberg et al. 2007, Lipson, 2016, Salahedin, 2016, Bork and Mondisa, 2022, McLafferty, 2022). This assertion is supported across literature with Lipson et al (2016) reporting that engineering students are "significantly less likely to report suicidal ideation" and there is a "significantly decreased likelihood of seeking help" (Ibid. 2016, p. 31). Sandhu, Arora, and Brasch (2021) reported higher rates of self-report than formally diagnosed mental illness (31% diagnosis over 68% reporting having a mental illness). There is also a marked low rate of help-seeking for engineering doctoral students and even lower rate for Masters students (Lipson, 2016); see Table 2. The lower rate for Masters students might be attributed to the shorter course duration (typically 1-2 years) rather than doctorate or undergraduate degrees which are expected to take longer. Equally, it is possible that those who progress to higher degrees have by this point adopted coping strategies throughout their undergraduate degree. In any case Lipson et al identified that engineering students had the lowest treatment utilisation of all the disciplines they evaluated.

Table 2. Mental Health Problems and Treatment Utilisation. Lipson et al (2016).

Subject	Undergraduate		Masters		Doctorate	
	Total	Treatment Utilization	Total	Treatment Utilization	Total	Treatment Utilisation
Engineering (n=4,287)	31.66%	25.09%	30.56%	20.23%	26.16%	27.73%
Law (n=1,142)	36.22%	26.36%	26.80%	29.21%	25.20%	48.81%
Medicine (n=1,873)	37.92%	30.89%	29.38%	48.38%	20.49%	39.61%
Nursing (n=2,111)	29.12%	39.10%	17.64%	47.39%	13.72%	56.22%

In another study, Laidlaw et al (2016) drew attention to the potential for there to be variations in students' attitudes to mental health depending on the subject they were studying, but the results found no evidence to suggest this. However, the population was very small and disciplinary characteristics were not the main focus of the work. If, as mentioned earlier, there are signature disciplinary characteristics demonstrated by engineering students, it is possible that they may also use signature disciplinary characteristics of health help-seeking. These may form a set of disciplinary protective factors in relation to mental health and wellbeing.

The literature suggests an unmet need in the engineering student population and some results suggest that engineering students are at risk of poor mental health and poor mental wellbeing. This is a worrying finding, particularly in the context of the shortage of engineers, and underpins the value of carrying out research to add to the body of knowledge in this area.

Wright et al (2021) identified several themes relating to engineering students' attitudes to mental health help-seeking: unsupportive environment, time constraints, supportive input improves likelihood of help-seeking, delay to point of breaking, and notion of shame associated with seeking help. Some of these themes chime with similar work in a study of UK University students, particularly in relation to stigma, (Broglia et al, 2021) but interestingly their study results showed that participating engineering students showed low levels of social or general anxiety in comparison to their peers in other subjects. This may be an impact of what Wright et al (2021) noted as a tendency to "suck it up" to breaking point or high levels of stigma preventing disclosure (Sanchez-Pena et al, 2021, Eisenberg et al. 2009). This normalisation of expectations in relation to engineering courses is unhelpful given that it is evident that engineering students are at higher risk of suffering from poor mental wellbeing and are also less likely to seek assistance than students of other disciplines.

2.2.3 Mental Health and Wellbeing Strategies Used by Engineering Students

Across the literature there were some references to strategies and behaviours that some students adopt to support their mental health and wellbeing, such as exercise. More recently there has been an increase in studies using mindfulness techniques for engineering students to improve mental wellbeing and a positive outlook. Ashgar et al (2022) described several perceived factors supporting subjective wellbeing in engineering students. Their study is one of few looking at wellbeing from a positive stance rather than a deficit approach (Ashgar et al, 2022). A "deficit" approach is one that considers the weaknesses of an individual with a view to "making them better" (Meyer and Strevens, 2022) and this would position the engineering student as someone in need and in turn potentially discourage helpseeking (Meyer and Strevens, 2022).

Good support networks, and health and wellness activities such as socialising, gardening (Ban et al, 2022) and mindfulness (Huerta, 2021, Ban et al, 2022) among other things are coping strategies that engineering students find work for them. Time management was identified as supporting self-discipline and boundaries (Gelles, 2020), improving the chances of better mental health and wellbeing (Gelles, 2020, Aeon, Faber, and Panaccio, 2021) and academic performance (Razali et al, 2017, Adams and Blair, 2019). Time management could be a significant difficulty for many engineering students given the heavy workloads described earlier and is something that doesn't come naturally to everyone (Twehues, 2013, Adams and Blair, 2019).

Mental Health and Wellbeing Strategies Identified in Literature

Korsten, Wolff and Booysen (2021) found that engineering students primarily used sport/exercise/ sleeping/ and talking to someone as their key coping mechanisms. Less positive coping activities included increased eating and consuming drugs and alcohol (Korsten, Wolff and Booysen, 2021).

Mindfulness supported improved academic performance for tests (Bellinger, DeCaro and Ralston, 2015). Student led support has been developed at Russ College of Engineering (Millard, 2022) in the form of a dedicated organisation for engineering student support but to date no report of impact on mental health and wellbeing has been published.

2.3 Models of Mental Health and Wellbeing

Throughout this research, the researcher has experienced an evolution of thought and a mental shift from pathogenesis towards salutogenesis. In the beginning, the desire by the researcher to essentially diagnose and therefore "cure" engineering students was framed by a medical model of mental health i.e., viewing *“problematic thoughts, feelings and behaviours as mental health problems or as mental disorders”* (Huda, 2021, pp.463). This pathogenic stance was limiting for the researcher in that it was leading to an assumption that engineering students were either ill nor not ill and did not include socio cultural or pedagogical factors that may relate to mental health and wellbeing. Additionally, a “mild” disorder can still have significant impact on a person’s day to day life, and so the medical model in this context is not appropriate. An exploration of different models, approaches, and frameworks was carried out in order to both clarify the goal and determine the approach that would best reach that goal for this study.

There are several models of mental illness rather than health which lead to different attitudes and treatments depending on the model. Figure 3 outlines a few of these models. While this is not an exhaustive list, it gives a good overview of the variety of approaches to mental illness that are documented.

Model	Description	Evidence base	Impact
Medical (AKA ‘Biological’, ‘Biomedical’)	Assumes that mental disorder is the result of biological problems or ‘imbalances’.	Biological brain disorders like Alzheimer’s disease or drug induced psychosis.	Leads to less well evidenced assumptions such as the dopamine theory of schizophrenia. Treats assumed biological problems with biological treatments (a pill for every ill).
Social	Assumes that mental disorders result from social pressures & inequalities.	Correlation between poverty, prejudices, poor education & mental ill health.	Leads to inclusive social policy & legislation as well as individual support to integrate into society.
Psychological	Assumes that mental disorder is the result of faulty thinking or unhelpful belief systems.	Well evidenced links & theoretical explanations of psychological processes & beliefs leading to predictable emotions & behaviour.	Leads to a range of talking therapies & behavioural treatment regimes.
Metaphysical	Assumes that mental disorder comes from supernatural causes such as demons or God’s judgement.	Relies upon the claims made by various religious or spiritual writers and gurus.	Leads to potentially dangerous (in some cases fatal) attempt to cure people via exorcism, prayer or religiously motivated abuse.
Stress and vulnerability	Assumes that mental disorder results from overwhelming stressors that the individual is unable to cope with.	The same evidence that supports to all the above (although ‘metaphysical’ issues tend to be interpreted in ‘psychological’ terms).	Leads to formulation of stressors & vulnerabilities regarding: • Biology; • Psychology; • Socio-cultural; • Environment; • Developmental changes.
©Stuart Sorensen 2014			**www.TheCareGuy.com**

Figure 3. Models of Mental Health and Disorder (Sorensen, 2014). Used with permission.

2.3.1 The Biopsychosocial Model

The biopsychosocial model (Figure 4) was developed by Engel (1977) as a philosophy of clinical care and practical guide (Borrell-Carrio et al, 2004), and acknowledges wider influences on a person's resulting mental health. While it is perhaps a useful overview to highlight different influencing factors it has been described as lacking in underpinning theoretical framework and philosophy and that it is not clear how the different factors interact and manifest in disease (Papadimitrou, 2017). The biopsychosocial model does recognise non-medical factors in a person's mental health however it is still focussed on a description of appropriate mental health that is considered to be absence of disease (Bolton and Gillet, 2019). The challenge of using this model for this research is that it is not yet established if there is evidence of widespread mental illness in the engineering students of the UK.

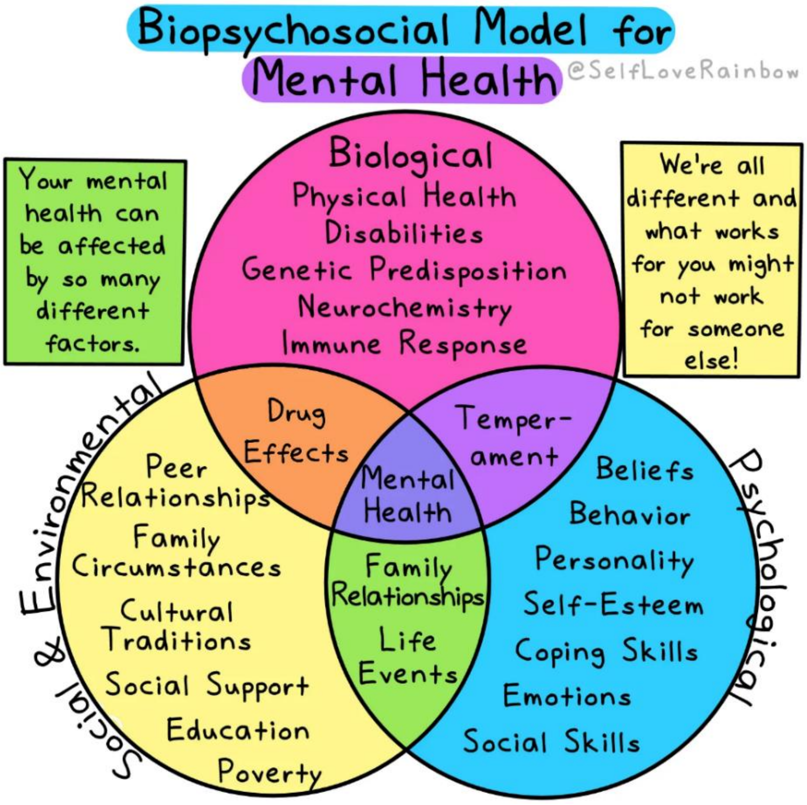

Figure 4. Biopsychosocial Model of Mental Health. (Calderon, 2021). Used with permission.

2.3.2 The Dual Factor Model of Mental Health

The dual factor model (Figure 5) presents mental health and subjective wellbeing as two distinct concepts each measured differently (Tudor, 1995, Suldo et al, 2008, Keyes, 2005, Xiao et al, 2021). It represents the acceptance that someone may have good mental "health" i.e., no mental illness, but have poor mental wellbeing. While the model is, like the biopsychosocial model, a useful tool for high level understanding of a person's state of mind, the notion of wellbeing or subjective wellbeing is not well defined (Wang, 2011).

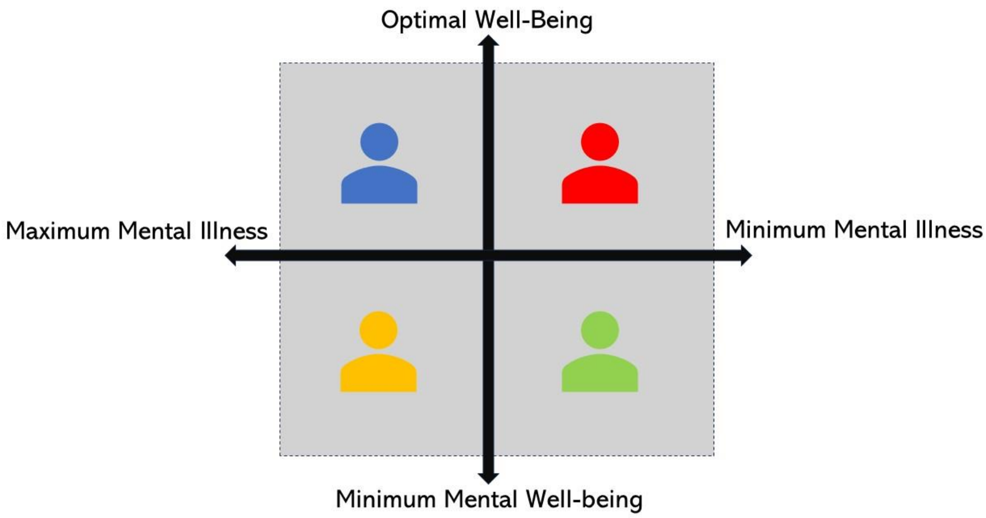

Figure 5. The Dual Factor Model of Mental Health and Wellbeing (after First Discoverers, 2019). Used with permission.

2.3.3 The Dynamic Model

Figure 6 depicts a Dynamic Model of Mental Health and Wellbeing developed by Campion and Nurse (2007) and later developed by Coggins et al (2011). The model originally placed mental wellbeing in the centre, latterly mental health and wellbeing and includes a variety of factors that can impact a person’s mental state. The model was intended to support public health promotion developments.

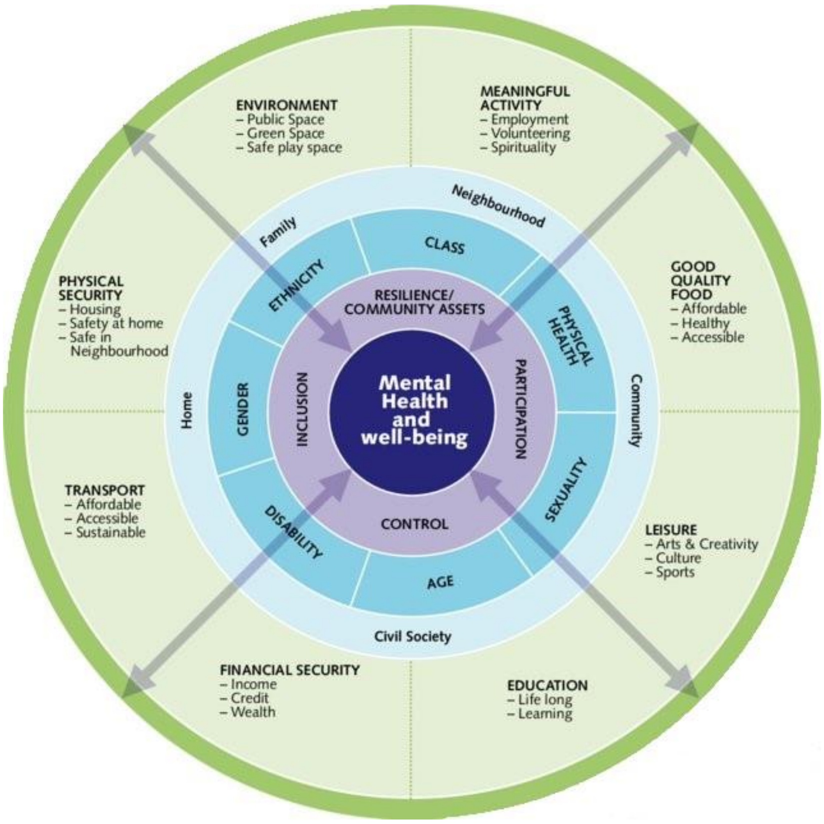

Figure 6. Friedli's Dynamic Model of Mental Well-Being for Assessing Mental Well-Being Impact. (Coggins et al, 2011) Used with Permission.

2.3.4 PERMA+4 model

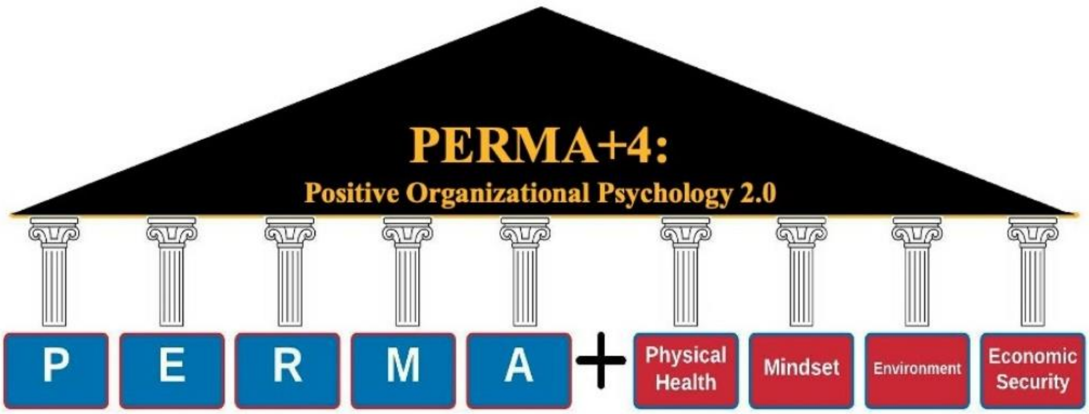

Figure 7. The PERMA+4 model (Donaldson, van Zyl and Donaldson (2022). Used with permission.

Seligman (2011) published a model of wellbeing through a series of building blocks described as PERMA (Positive Emotion, Engagement, Relationships, Meaning, and Accomplishment). Wong (2018) has criticised the model's shortcomings in relation to existential suffering and underpinning western values, but it is a model that has been used in relation to student wellbeing (Kovich et al, 2023, Chue et al, 2023). More recently, PERMA+4

(Figure 7) was developed (Donaldson, van Zyl and Donaldson, 2022) acknowledging additional contribution factors for work-related wellbeing, and it is being recommended for higher education students as a tool to build wellbeing (Koci and Donaldson, 2023).

2.3.5 The Salutogenic Model

Salutogenesis is a model (Fig 8) developed by Aaron Antonovsky (1996). Antonovsky challenged the existing paradigm of pathogenesis (Joseph and Sagy, 2016) where people were viewed as healthy or ill and put forward the concept of a continuum (Fig 9) that goes from "health ease" to "dis-ease" (Joseph and Sagy, 2016. Fries, 2020). The salutogenic approach enables a holistic view of mental health and wellbeing where illness can be considered but not be a distraction from the wellness optimisation possibilities. With the salutogenic model, it is possible to view mental wellbeing as part of a system where all engineering students can move along a wellbeing continuum.

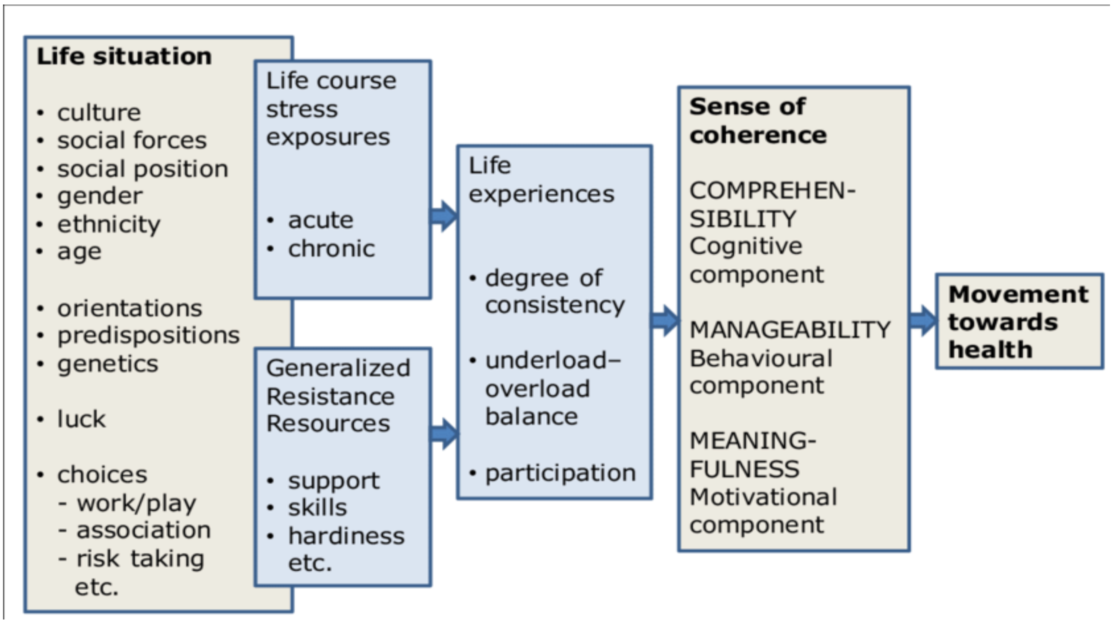

Figure 8. The salutogenic model based on Antonovsky, 1996. (Benz et al, 2014). Used with permission

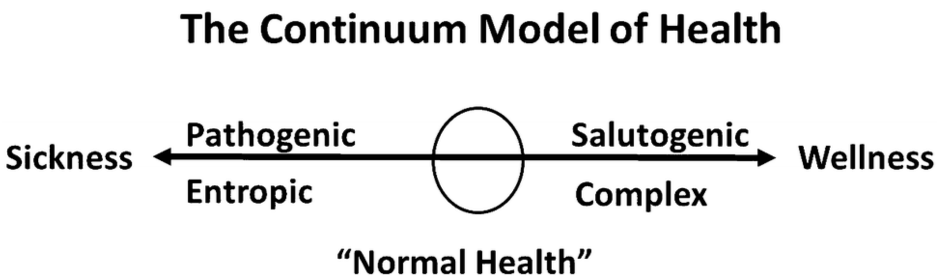

Figure 9. The Salutogenic Continuum. (Fries, 2020). Used with permission.

2.3.6 Summary of Models of Mental Health and Wellbeing

Developing an appreciation of the different models that are used to view mental health and wellbeing is helpful in identifying potentially appropriate and effective ways to improve mental health and wellbeing. This overview of some key models is not exhaustive but is intended to demonstrate the different approaches it is possible to take in researching mental health and wellbeing. The salutogenic model was selected as the one best placed to meet the needs of the research, albeit at a high level. Therefore, salutogenesis is considered to be the overarching lens with which this research is being viewed and is discussed in more detail in the Methodology chapter (Chapter 3).

2.4 Interventions Systematic Scoping Review

One of the major difficulties in developing a plan for enhancement of mental health and wellbeing in engineering students is the massive variation between studies in terms of the types of outcome measures used, and the terminology and the definitions of mental health or wellbeing. This section is intended to further explore the types of intervention research being carried out on the mental health and wellbeing of engineering students. This is to critically identify existing work in this area, with an aspiration to synthesize results and findings. This review is presented below and covers literature published up to March 2022. A summary update is included at the end of the review to acknowledge work carried out after this time and before submission of this thesis.

2.4.1 Mapping the Literature on Interventions

To inform engineering education reform and support engineering student mental health and wellbeing, it was important to conduct a thorough mapping of the current evidence base on mental health and wellbeing interventions. Mapping of the evidence on mental health and wellbeing interventions for engineering students can detect research gaps for subsequent studies and identify effective interventions to inform engineering education practice. Before identifying the effectiveness of interventions to support good mental health and wellbeing it is important to establish what evidence is available for synthesis.

2.4.2 Scoping Review Questions

The focus of this scoping review was to identify and map what mental health and wellbeing research has been conducted in engineering student populations. More specifically, the scoping review focused on the following questions:

- What types of mental health and wellbeing research designs have been conducted in engineering student populations?
- What mental health and wellbeing interventions have been carried out with engineering students?
- What outcomes have been reported for mental health and wellbeing interventions among engineering students?

2.4.3 Inclusion Criteria

This review considered mental health or mental wellbeing intervention studies that included participants over the age of 17 who were engineering students at any stage of higher education. Where possible, the types of engineers were assessed for inclusion using the principal subject codes outlined by HESA (Higher Education Statistics Agency, 2013):

(H0) Broadly-based programs within engineering and technology

(H1) General engineering

(H2) Civil engineering

(H3) Mechanical engineering

(H4) Aerospace engineering

(H5) Naval architecture

(H6) Electronic and electrical engineering

(H7) Production and manufacturing engineering

(H8) Chemical, process and energy engineering

(H9) Others in engineering

The search strategy included the term engineer in addition to “engineering student” to ensure all available literature was identified. The focus of the review however is engineering students or student engineers and therefore papers only looking at professional engineers were excluded.

Concept

Sources with a focus on mental health and wellbeing in the engineering student population were included in this review. The focus of this scoping review was on mental wellbeing rather than a diagnosed mental health disorder. As there can be overlap in the use of terminology, particularly where it is likely research has been conducted by an engineering academic rather than a health professional; a variety of terms relating to mental health and wellbeing were utilised to capture all literature that may be relevant.

Context

This scoping review included literature within the context of engineering student populations in any country.

Types of Sources

Published and unpublished sources of evidence were to be considered for this review including both experimental and quasi-experimental study designs such as randomized controlled trials and non-randomized controlled trials. In addition, descriptive and analytical observational studies including prospective and retrospective cohort studies and descriptive cross-sectional studies were considered for this review. Qualitative study designs were also considered for inclusion. Protocols for studies or systematic reviews were not included as they did not present any data to extract.

2.5 Methods

The systematic scoping review was selected as an appropriate way to map the existing body of literature in this area.

Researchers have a range of information synthesis methods at their disposal and the rationale for the selection of a scoping review over, say, a systematic review, mapping review or evidence gap map (EGM), relates to the type of question being asked and the type of answer needed. Scoping review methodology is robust, inclusive, and involves developing a comprehensive search strategy to map the evidence base on this topic. Munn et al (2022) describe scoping reviews as a “common approach to synthesising evidence” (Munn et al, 2022, pp. 950) that “aim to systematically identify and map the breadth of evidence available on a particular topic” (Munn et al, 2022, pp 950). A scoping review can support the examination of emerging evidence (Munn et al, 2018) and provide a robust base from which to explore more specific research questions. For a review to be considered a systematic scoping review, an a priori protocol is required along with adherence to established reporting guidelines such as the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for Scoping Reviews). This is a more robust approach than a generic scoping review for which an a priori protocol is not explicitly required (Campbell et al, 2023).

Mapping reviews are also robust and systematic, but the evidence collated in such a review is typically descriptive and have a broader focus (Campbell et al, 2023) or are concerned primarily with effectiveness of an intervention (Khalil and Tricco, 2022). Evidence gap maps are graphical representations of evidence synthesis which shows available evidence in answer to a research question (Campbell, 2023) using a pre-designed framework.

While the systematic scoping review is the approach selected for this part of the literature review, the approach is not without challenges, including the challenge of which data to extract, how to analyse results, and how to ensure review conclusions are not "overstretched" in terms of recommendations for practice (Khalil et al, 2022). In mitigation of these challenges, the researcher undertook JBI Systematic Review training, and the principal supervisor is an accredited systematic review trainer. A systematic scoping review is an appropriate way to synthesise evidence, identify related concepts and provide a way to map evidence on the area of interest including a wide range of sources (Munn et al, 2022). Although a recent systematic scoping review of higher education student wellbeing has been conducted (Worsley et al., 2020), an initial search for existing scoping reviews and/or systematic reviews on engineering student wellbeing interventions published in JBI Evidence Synthesis, Cochrane Database of Systematic Reviews, International Prospective Register of Systematic Reviews (PROSPERO), Medline and CINAHL did not identify any reviews specific to engineering students (published or in progress). Therefore, this scoping review aimed to map the global evidence on interventions supporting good mental health and wellbeing in engineering students.

The scoping review was conducted in accordance with the Joanna Briggs Institute (JBI) methodology for scoping reviews (Peters et al., 2020). JBI has published the most recent framework for scoping reviews (Peters et al., 2022), which has updated and developed the seminal work by Arksey and O'Malley (2005) and Levac, Colquhoun, and O'Brien (2010). An *a priori* protocol was registered in Open Science Framework (Tait et al., 2020) (See Appendix 1) and reporting was guided by the PRISMA Extension for Scoping Reviews (Tricco et al., 2018). All reviewers are trained in JBI scoping review methods with one being a member of the international JBI Scoping Review Methodology Group. Each stage in the scoping review process was piloted with the reviewers to ensure the process was robust and manageable.

2.5.1 Search Strategy

A three-step search strategy was undertaken to identify published and unpublished sources of evidence in line with JBI Scoping Review Methodology (Peters et al., 2020). Initially a limited search was conducted in Medline, CINAHL, JBI Evidence Synthesis and Cochrane Library using the terms “engineers AND mental health” and “engineering students AND mental health”. Following analysis of text words from titles identified in the initial search, a full search strategy was developed in line with the PCC (Population, Concept, and Context) requirements, discussed by the review team, piloted, and the finalized search was then applied across all included databases (Tait et al, 2020). Additionally, the institutional research librarian supported the development of the search strategy.

Finally, a search of the reference lists of all included sources of evidence was conducted to identify any additional evidence. The databases searched included: MEDLINE, CINAHL, PsycARTICLES, Emerald, Epistemonikos, ERIC, Compendex, SocINDEX, JBI Database, Cochrane Central Register of Controlled Trials and Systematic Reviews, Compendex, Web of Science, and Business Source Complete. Databases were accessed via the authors' institutional access to EBSCoHost or direct link.

The search for unpublished sources of evidence included Google, Google Scholar, the British Library Thesis Index (EThOS), World Health Organization's library database (WHOLIS), The System for Information on Grey Literature in Europe (SIGLE), ProQuest Digital Dissertations, OpenGrey and The Conference Papers Index using modified search terms (engineers AND “mental health” OR “mental wellbeing”, “engineering students” AND “mental health” OR “mental wellbeing).

The full search strategy for all sources is presented in Appendix 2. Search strings were modified where required for each database. Searches included English language studies only due to lack of financial support for translation. No date range was imposed, and all study designs were considered for inclusion to enable a thorough mapping of the area. All search results were uploaded to RefWorks ProQuest and following de-duplication were exported to Microsoft Excel for screening. Two authors independently screened all titles and abstracts and full text sources in this review. Due to the variety of terminology and sometimes misleading titles, a screening at abstract stage was carried out between title screen and full-text screen. This provided a large time saving as the term stress is common in engineering and unrelated to mental health and wellbeing. The search results included publications with titles that were clearly not related to the search topic. Any conflicts between reviewers were resolved via discussion with a third author. Main conflicts related to identifying the correct population of interest and classifying the interventions. The search was carried out in January 2019, with updated searches completed in January 2020, and March 2022. Sources of evidence that were excluded at full text are reported and the reasons for exclusion noted in the PRISMA (Fig.10).

Authors of studies included for full text review were contacted to obtain papers that were not freely available or fully accessible via the authors' institutional access. Full text papers that did not meet the inclusion criteria were excluded and reasons for their exclusion are reported in the results.

2.5.2 Data Extraction

Two authors independently extracted data from included sources of evidence using a pre-determined extraction form developed for this review (Tait et al, 2020). Any disagreements that arose during data extraction were resolved via discussion. The data extraction forms were uploaded onto a Microsoft Excel spreadsheet for subsequent analysis and tabulation. The data relevant to this scoping review that underwent extraction were author(s), year of publication, country of origin, aims of study, study population, methodology/study design, context, intervention (delivery method, content, frequency, length, who delivered it), outcomes and conclusions.

As per methodological guidance for JBI scoping reviews, no critical appraisal of included sources of evidence was conducted (Peters et al., 2020), however a quality evaluation of intervention reporting was conducted and is presented in the results section.

2.6 Results

The results of the scoping review are presented as follows: description of included studies and rationale for any exclusions, presentation of a PRISMA flowchart (Moher et al, 2009, BMJ, 2020), presentation of included studies, description of the types of research conducted, types of interventions carried out, outcome measures used, and reported outcomes.

2.6.1 Included Studies

As presented in the PRISMA flowchart (Moher et al., 2009), (Figure 10), the searches identified 7301 sources of evidence (after de-duplication). After title and abstract screening, which excluded many sources related to stress as an engineering concept rather than the experience of stress, 191 full texts were assessed for eligibility. Reasons for exclusion at full text included: No intervention stated (133), not the concept of interest (12), not the population or the population of engineering students unclear (13). Thirty-three sources of evidence relating to 30 studies were then included for final data extraction and analysis.

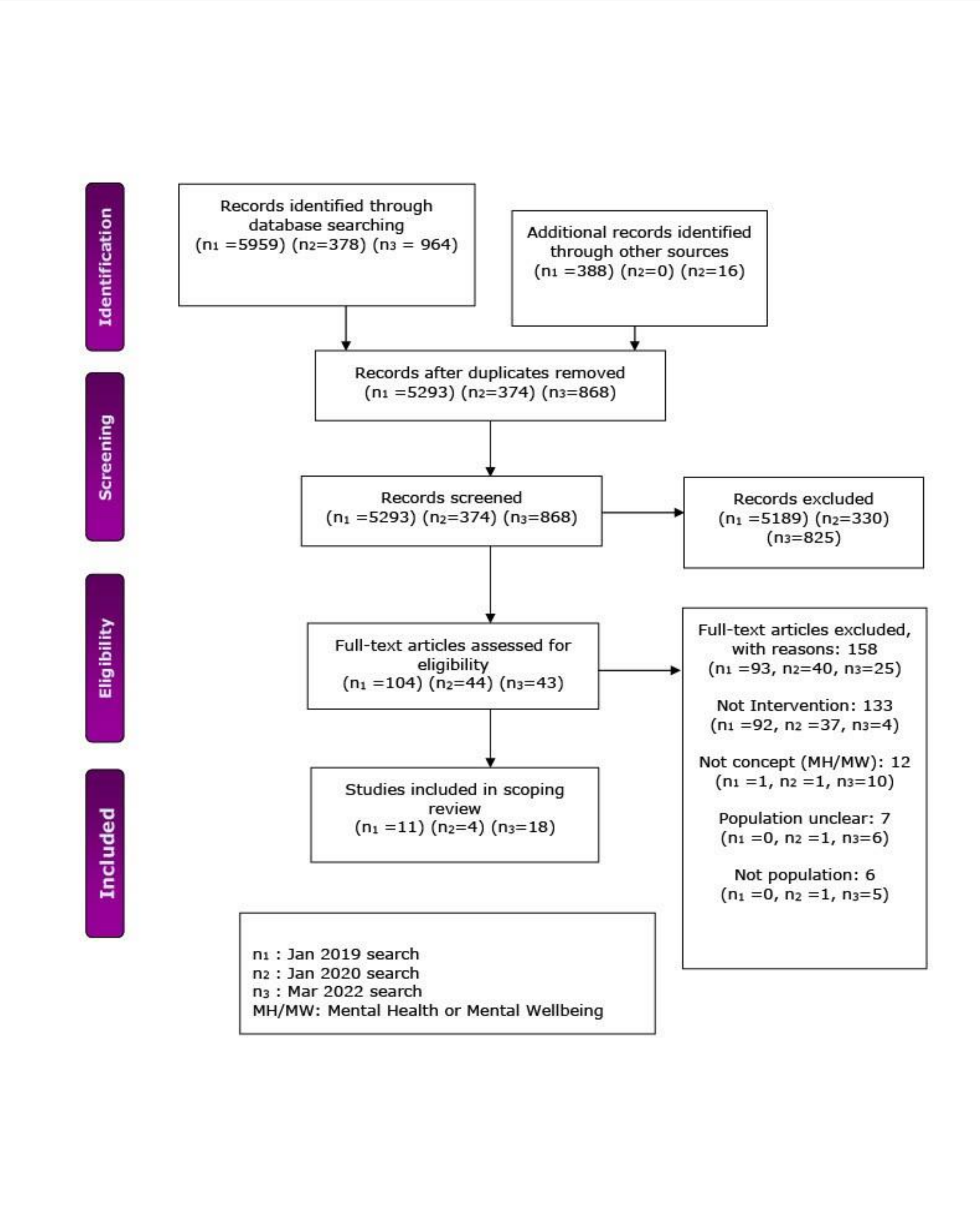

Figure 10. PRISMA Flowchart.

Table 3 is the list of included sources of evidence. To enhance readability, the reference number for each source will be referred to in the results and discussion sections.

The included studies represented over 4000 engineering students from ten countries (Table 4).

Table 3. List of Included Sources.

No.	Database	Author, Year	Title
1	Engineering Village	Abiade & Moliski. 2020.	Work-in Progress: Identity and transitions laboratory: Utilizing acceptance and commitment therapy framework to support engineering student success
2	CINAHL	Altun. 2008.	Effect of a health promotion course on health promoting behaviours of university students
3	Engineering Village	Aree et al. 2020.	An approach for mental preparation for first-year college students: A case study of engineering students
4	Engineering Village	Berger, Lampe & Caruccio. 2015.	Just-in-time support: An evidence-based academic-student affairs partnership to enable engineering student success
5	Internet Search	D'Entremont et al. 2019.	Student Mental Wellbeing Interventions with a Second-Year Engineering Cohort
6	ERIC	Eren-Sisman, Cigdemoglu & Geban. 2018.	The effect of peer-led team learning on undergraduate engineering students' conceptual understanding, state anxiety, and social anxiety
7	Internet Search	Estrada & Dalton. 2019.	Impact of Student Mindfulness Facets on Engineering Education Outcomes: An Initial Exploration
8	Engineering Village	Grasty et al. 2021.	Benefits of Utilizing Counseling Services Among Doctoral Women of Color in STEM
9	Internet Search	Huerta et al. 2021.	Inner engineering: Evaluating the utility of mindfulness training to cultivate intrapersonal and interpersonal competencies among first-year engineering students
10	Engineering Village	Johnson-Glauch, Cooper & Harding. 2020.	Goal setting as a means of improved mental health outcomes for materials and mechanical engineering students
11	Cochrane	Joshi & Kiran. 2020.	Gauging the effectiveness of music and yoga for reducing stress among engineering students: An investigation based on Galvanic Skin Response
12	CINAHL	Joshi et al. 2017a.	An Experimental Analysis to Monitor and Manage Stress Among Engineering Students Using Galvanic Stress Response Meter
13	CINAHL	Joshi et al. 2017b.	Stress monitoring through non-invasive instrumental analysis of skin conductivity
14	CINAHL	Joshi et al. 2016	Stress management through regulation of blood pressure among college students
15	ERIC	Khan et al. 2018.	Measuring the Impact of a Weeklong Fall Break on Stress Physiology in First Year Engineering Students (Same intervention as 27)
16	Internet Search	Lal et al. 2019.	Effect of Dispositional Mindfulness on Perceived Stress Scores of Engineering Students: An Empirical Study

17	Engineering Village	Maxson & Tomasko. 2020.	Supporting the Mental Health and Wellness of Chemical Engineering Students at the Department and College Levels
18	ERIC	Mazumder. 2012.	Improvement of Confidence and Motivation Using Online Metacognition Tool
19	Internet Search	Miller et al. 2021.	WIP: Supporting Student Mental Health: Understanding the Use of Biometrics Analysis in an Engineering Design Project to Promote Wellness
20	ERIC	Miller & Jensen. 2022.	Introduction of Mindfulness in an Online Engineering Core Course During the COVID-19 Pandemic
21	Epistemonikos	Miller et al. 2022.	Development and Implementation of a Biometrics Device Design Project in an Introductory BME Course to Support Student Wellness.
22	Engineering Village	Moran & Benson. 2016.	Effects of an intensive mathematics course on freshmen engineering students' mathematics anxiety perceptions
23	Engineering Village	Nolte, Huff & McComb. 2022.	No time for that? An investigation of mindfulness and stress in first-year engineering design
24	Engineering Village	Paniagua et al. 2019.	Study of Binqui. An application for smartphones based on the problems without data methodology to reduce stress levels and improve academic performance of chemical engineering students
25	Internet Search	Paul et al. 2021.	Impact of integrating mental wellness and personal learning reflections into first-year undergraduate engineering courses.
26	Linked from updated paper	Paul et al. 2020.	The "Engineers have feelings" Project: Integrating Mental Wellness and Lifelong Learning Skills in First-Year Undergraduate Engineering Courses
27	ERIC	Poole, Khan & Agnew. 2017.	One Week, Many Ripples: Measuring the Impacts of the Fall Reading Week on Student Stress (same intervention as 15)
28	SCOPUS	Rodríguez-Jiménez et al. 2022.	Embodied Learning for Well-Being, Self-Awareness, and Stress Regulation: A Randomized Trial with Engineering Students Using a Mixed-Method Approach
29	Engineering Village	Su. 2016.	The effects of students' motivation, cognitive load and learning anxiety in gamification software engineering education: a structural equation modeling study
30	Engineering Village	Tragodara. 2021.	Virtual tutoring from the comprehensive training model to Engineering students during the COVID-19 pandemic
31	Web of Science	Vitasari et al. 2011.	A pilot study of pre-post anxiety treatment to improve academic performance for engineering students
32	Web of Science	Walton et al. 2015.	Two brief interventions to mitigate a 'chilly climate' transform women's experience, relationships, and achievement in engineering
33	Engineering Village	Yanik et al. 2016.	Sources of anxiety among engineering students: Assessment and mitigation

Table 4. Country of Publication.

Country	Source Reference	Total Number from Country
Canada	5,15,25-27,32	6
India	11-14, 16	5
Malaysia	31	1
Mexico	22	1
Peru	30	1
Spain	24,28	2
Taiwan	29	1
Thailand	3	1
Turkey	2	1
USA	1,4,6-10,17-21, 23,33	14
Total		**33**

Six sources related to three studies (15 and 27, 25 and 26, and 20 and 21). Sample sizes ranged from one to 809 participants. The majority (22 sources, 67%) of included evidence focused on undergraduate students rather than postgraduate students, with 10 studies on first year students. Not all sources stated the level of academic study, however. Engineering subdisciplines were reported in some sources. While the protocol of this scoping review had planned to map participant groups as per UK HESA categories, the lack of use of the HESA categories by international study authors did not enable this grouping to be conducted.

The characteristics of included sources of evidence is presented in Appendix 3 and provides a broad overview of the aims of the study, a short description of the target population, the study design, outcome measures, results and conclusions.

2.6.2 Types of Mental Health and Wellbeing Research

Table 5 shows the types of mental health and wellbeing study designs conducted varied across sources. The majority of studies were in the form of a pilot (n=18), and there was only one RCT (Randomised Controlled Trial) but seven other experimental study designs. Most studies were conducted in the last five years (n=18).

Table 5. Types of Study design in Included Sources.

Study Design	Source Reference	N=
Case Study	8, 18	2
Case Study/Pilot	3	1
Experimental	6, 11-14, 16, 17, 24, 28	8
Pilot	1, 4, 5, 7, 9, 10, 15,19-23, 25,26, 27 29-31, 33	18 (15 and 27 same intervention)
Quasi-experimental non-equivalent pilot	2	1
RCT	32	1
Total		32

2.6.3 Mental Health and Wellbeing Interventions for Engineering Students

Interventions to support good mental wellbeing in engineering students were reported across all included sources of evidence. The included sources were categorised into psychological (n =14), physiological (n =5), and educational (n=15) interventions.

Psychological interventions included mindfulness training (n=7), enhanced counselling support (n=2) and listening to music (n=2). Physiological interventions included specific breathing exercises (n=5) and body awareness exercises (n=1). Educational interventions related to mental health and wellbeing awareness (n=8), changes to teaching approaches (n =11), and changes to curriculum timetabling (n=1).

Table 6 describes the interventions and outcome measures used to evaluate the interventions. While many of the studies developed their own surveys to measure outcomes, some made use of existing outcome measures.

Table 6. Interventions and Outcome Measures Used.

No.	Author	Intervention	Category	Outcome Measures
1	Abiade & Moliski, 2020.	6-week programme (Identity and Transitions Lab) including information on Acceptance and Commitment Therapy, imposter syndrome, stress management, and identifying signs of a mental or emotional disorder.	Educational	Written feedback, follow-up survey, grades and retention. Cohort 2 anonymous feedback, 3 end of program assessments and follow up survey.
2	Altun, 2008	15-week course which included 30 hours of classroom lectures, group discussions and demonstrations – included definition and purpose of health promotion, concepts of health promotion, disease, lifestyle, stress management.	Educational	Exercise of Self-care agency scale and Health Promotion Lifestyle Profile II Scale
3	Aree et al. 2020	3-hour mindfulness training course	Psychological	Survey
4	Berger, Lampe, & Caruccio 2015	New partnership fully contextualised to engineering and located within the engineering school providing academic and pastoral support. This was different from the standard centralised services	Psychological	Data from handwritten notes at staff meetings where student situations discussed, student demographics (gender, academic major) and academic outcomes- progress towards graduation
5	d'Entremont et al, 2019	1 information session, 1 reflection exercises based on a video about stress, 1 workshop on stress and stress reduction methods, deployed consecutively over a term.	Educational	4 surveys (including MSLQ, Academic Buoyancy) analysis of reflection responses, pre-post intervention surveys

6	Eren-Sisman, Cigdemoglu, & Geban 2018	Introduction of Peer Led Team Learning. control group: instructed using traditional college instruction experimental group: instructed using the PLTL model.	Educational	General Chemistry Concept Test, State Trait Anxiety Inventory, Social Anxiety Questionnaire for Adults
7	Estrada & Dalton 2019	4-week mindfulness-based stress reduction intervention	Psychological	Survey - Five Facet Mindfulness Questionnaire (FFMQ) and ABET Outcomes
8	Grasty et al. 2021	Impact of Counselling services	Psychological	Interview data
9	Huerta et al. 2021	4-session mindfulness-based programme	Psychological	Survey and Interview data
10	Johnson-Glauch et al. 2020	Pilot mental health action plan assignment	Psychological	Pre and post surveys including a 17-item validated self-efficacy instrument, content analysis of the action plans and of the free text areas on the survey
11	Joshi & Kiran 2020	Experimental group underwent yogic breathing and listening to religious and flute music. The Control group did not.	Physiological Psychological	Skin conductivity
12	Joshi, Kiran & Sah 2017a	Experimental group listened to hymns, the Control group did not.	Psychological	Skin conductivity
13	Joshi Kiran & Sah 2017b	Experimental group underwent yogic breathing, the Control group did not.	Physiological	Skin conductivity
14	Joshi et al. 2016	Experimental group carried out deep breathing	Physiological	Blood pressure

15	Khan et al, 2018	A weeklong break during 1st semester, intervention group and control group (Same intervention as 27)	Educational	DHEA levels in saliva measuring cortisol
16	Lal et al, 2019	Meditation	Psychological	Perceived Stress scale [PSS] and Mindfulness Attention Awareness Scale [MAAS] was administered on both the groups of students.
17	Maxson & Tomasko 2020	Introduction of a Wellness Committee with a number of activities aiming to improve mental wellbeing	Educational	Questionnaires and academic performance
18	Mazumder 2012	Metacognition-based software Lecture Tools (http://www.lecturetools,com) providing interactive environment for the students.	Educational	Engagement and feedback
19	Miller & Jensen 2020	16 mindfulness sessions after online lessons	Psychological	Course evaluation
20	Miller et al. 2021	A design exercise for students focusing on the measurement of physiological changes through mindfulness. (same intervention as 21)	Educational	Surveys
21	Miller et al. 2022	Introduction of a biosensor project with experiments to reduce stress. (same intervention as 20)	Educational	Pre post survey and feedback
22	Moran & Benson 2016	Four-week maths course designed to standardise maths knowledge. Students met 5 x per week for 2 hours duration to review basic maths	Educational	Items from the Mathematics Anxiety Rating Scale 30 and other items not relating to the paper - pre and post.

		knowledge. 3 weekly tests and a final test end of week 4.		
23	Nolte, Huff, & McComb, 2022	First-year engineering design students completed three 30-minute experimental sessions during an engineering design course, where their stress and mindfulness during three principal stages of the design process were investigated. Each session consisted of a short video followed by a 10-minute design task.	Educational, psychological	Pre and post surveys including Toronto Mindfulness Scale, Short Stress State Questionnaire, modified NASA-RTLC, and author developed stress questions
24	Paniagua et al. 2019	Use of gamification software for teaching. Group A: elements of gamification were incorporated into the teaching Group B: control group no gamification	Educational	Hamilton Anxiety Scale and academic performance
25	Paul et al. 2020	A mental health promotion programme integrated into the 1st year engineering curriculum. (same intervention as 26)	Educational	Analysis of feedback
26	Paul et al. 2021	A mental health promotion programme integrated into the 1st year engineering curriculum.	Educational	End of year survey with additional wellness and identity validated scales
27	Poole, Khan, & Agnew 2017	A weeklong break during 1st semester with survey before and after and text message during. (Same intervention as 15)	Educational	Survey (Perceived Stress Scale) and Focus Groups, and DHEA levels in saliva

28	Rodríguez-Jiménez et al., 2022	A body awareness program based on Dance Movement Therapy Experimental. Group attended 10 sessions of 90 minutes twice a week.	Physiological	Satisfaction with Life Scale, Perceived Stress Scale, the TECA (Cognitive and Affective Empathy Test), WHO-5, Body Awareness Questionnaire (BAG) Scale Body Connection, Heart Rate Viability. Saliva cortisol, D2 test (selective attention and mind concentration), RP 30 - problem solving cognitive abilities, reflective diary
29	Su, 2016	Introduction of gamification software	Educational	Gamification Learning Scale, Learning Motivation Scale, Cognitive Load Scale, Learning Anxiety Scale, Academic Performance Scale
30	Tragodara 2021	Online personal tutoring during Covid including positive psychology sessions, flow sessions	Psychological	Interview data and questionnaires, attendance monitoring
31	Vitasari et al. 2011	6 sessions of treatment each for 2 hours to include Breathing exercises, Relaxation, Study skills	Physiological, psychological, educational	Beats per Minute (BPM) and Grade Point Average (GPA). BPM measured using stress sweeper device.
32	Walton et al. 2015	Intervention included social belonging intervention and affirmation training intervention. Control group – cohort 1 study skills and cohorts 2 and 3 outcomes related to attention and effort.	Psychological	Pre-Intervention Survey- belonging/confidence. Post - GPA, diaries, survey
33	Yanik et al. 2016	Periodic vertically integrated discussion groups with faculty mentors and their peers at multiple levels of seniority, introduced to university resources designed to address specific student needs.	Educational	Analysis of journals and discussions

The reported interventions were mapped against the template for intervention description and replication (TIDieR) checklist (Hoffman et al., 2014) to identify the components of interventions reported across the included sources of evidence. The TIDieR checklist was devised by Hoffman et al (2014) in order to support evaluation of interventions in publications. It is a useful tool to provide an overview of key features such as the materials used, who delivered the intervention, were there any changes to the original plan. The intention was to improve reporting of interventions, but it is also useful as a high level overview of the interventions identified in the scoping review. While no critical appraisal was conducted on individual study quality, the TIDieR checklist was used to identify the quality of intervention reporting. Poor reporting of interventions hinders their replicability in practice (McCambridge et al, 2021).

Table 7 maps the interventions to the TIDieR checklist, which comprises 10 criteria that are recorded "X" if the criteria are reported in the article and left blank if it is not reported. The majority of sources reported when and how many interventions were delivered (n=33). Most sources included some of the required criteria. Three studies were published prior to the TIDieR checklist, so the reviewers acknowledge this would not have guided their reporting, however the checklist is a useful tool to evaluate reporting quality and therefore evaluate replicability.

Table 7. Engineering student interventions mapped to the TIDieR checklist (After Hoffman et al, 2014).

No. Author, Year	Materials Used	Procedures & processes used	Who provided	How – Mode of delivery	Where – location of intervention	When & how many, duration etc.	Tailoring– any adaptions	Modified during study	How well planned	How well actual	Score
1. Abiade & Moliski, 2020.	X	X	X	X	X	X	X				7
2. Altun, 2008.		X	X	X	X	X					5
3. Aree et al. 2020.	X	X	X	X	X	X					6
4. Berger, Lampe, & Caruccio, 2015.			X		X	X	X				4
5. d'Entremont et al, 2019.	X	X	X	X	X	X					6
6. Eren-Sisman et al., 2018.		X	X	X	X	X					5
7. Estrada & Dalton. 2019.	X	X	X	X	X	X					6
8. Grasty et al, 2021.		X									1
9. Huerta et al. 2021.	X	X	X	X	X	X					6
10. Johnson-Glauch et al. 2020.	X	X	X	X	X	X					6
11. Joshi & Kiran, 2020.	X	X		X	X	X					5
12. Joshi et al, 2017a.		X		X		X					3
13. Joshi et al. 2017b.		X		X		X					3
14. Joshi et al, 2016.						X					1
15. Khan et al, 2018.						X					1
16. Lal et al, 2019.		X			X						2
17. Maxson & Tomasko, 2020.	X	X	X	X	X	X					6
18. Mazumder, 2012.	X		X		X	X					4
19. Miller and Jensen, 2020.	X	X	X	X	X	X				X	7
20. Miller et al., 2021.	X	X	X	X	X	X				X	7
21. Miller et al., 2022.	X	X	X	X	X	X					6
22. Moran & Benson, 2016.						X					1
23. Nolte, Huff, & McComb, 2022.	X	X	X	X	X	X					6
24. Paniagua et al., 2019.	X		X		X	X					4
25. Paul et al., 2020.	X	X	X	X	X	X					6
26. Paul et al., 2021.						X					1
27. Poole, Khan, and Agnew, 2017.						X					1
28. Rodríguez-Jiménez et al. 2022.	X	X	X	X	X	X					6
29. Su, 2016.	X	X	X	X	X	X					6
30. Tragodara, 2021.		X	X	X	X	X					5
31. Vitasari et al., 2011.						X					1
32. Walton et al., 2015.					X	X					2
33. Yanik et al., 2016.		X		X		X					3
Total - n	17	23	20	21	23	31	2	0	0	2	
Total - %	52%	70%	67%	64%	70%	94%	1%	0%	0%	1%	

2.6.4 Outcome Measures

Heterogeneity was noted across outcome measures reported in the included sources of evidence. The tools adopted included physiological measurements (11, 12, 13, 14, 15, 27, 31), and self-administered surveys (1-3, 5-7, 9,10, 16, 25-30 18, 20-24, 25-30, 32).

Academic performance was measured through grades (1, 18, 24), Grade Point Average (GPA) (1, 18, 24), graduation and dropout rates (4) and ABET (American Board of Engineering and Technology) outcomes (7). ABET outcomes are the accreditation educational criteria for engineering programmes in the USA (ABET, 2022). Physiological measurements were made through Galvanic Skin Response (skin conductivity), (11, 13, 14), Breaths Per Minute (31), blood pressure (12), and cortisol measurements through dehydroepiandrosterone (DHEA) levels in saliva (15).

Qualitative methods were also used in the research projects. This included analysis of student feedback, student reflection or journals, and interviews and discussions (Table 8).

Table 8. Types of Qualitative Measure.

Qualitative Measure	Source
Written feedback/course evaluation	1, 10, 19
Survey comments	3, 5, 20
Analysis of reflection responses	5
Interview transcript	8, 30
Feedback	17, 21, 25, 26
Reflective diary, diaries, journals	28, 32, 33
Discussions	33

2.6.5 Reported Outcomes

The main outcomes reported from the included sources of evidence related to academic achievement, stress, and anxiety, with a range of outcome measures used across studies (Table, Table 7). Study outcomes focussed on reduced stress (5, 7, 16, 24, 25, 27, 28), improved academic achievement (1, 3, 4, 6, 18, 25, 29, 31, 32), reduced anxiety (3, 5, 6, 9, 24, 29, 33), improved communication (18, 33), improved motivation (18, 29), participant acceptability of mindfulness interventions (19, 21, 23, 26) and improved physiological markers (11-15, 27).

Table 9 outlines the results and author conclusions from the included sources. Of particular note are the interventions using mindfulness training (3,7,9,19,23). For the six mindfulness training interventions five studies reported positive impacts of mindfulness training on students' mental wellbeing and one (23) reported that while stress was not reduced, participants reported benefitting from the training. Source 7 reported statistically significant improvements to trait mindfulness following the intervention. All sources recommended further research into mindfulness training with engineering students.

Table 9. Result and Conclusions of Included Sources.

No. Author, Year	Results	Conclusions
1.Abiade & Moliski, 2020	Improvement in GPA, other results ongoing	Positive responses and improved GPA indicate the programme is helpful, authors will continue to monitor both cohorts.
2. Altun, 2008	Statistically significant improvement in health responsibility and health promoting behaviours on both scales. ESCA increase statistically significant suggesting increased self-care abilities.	Course was beneficial to students as it helped improve self-care behaviour. Health promotion courses should be more widely used. Recommended that this type of course becomes a part of curriculum.
3. Aree et al. 2020	Improvement in knowledge, and decrease in anxiety and depression	Stress management through medication/mindfulness could reduce anxiety in engineering students.
4. Berger, Lampe & Caruccio, 2015	Outcomes achieved by students in different Cohorts were "similar or improved". Physical location and training in engineering issues key to providing support. Merging support benefited students in terms of success rates (graduation). Women better served by the new model in particular African American women.	Bringing student support services into a School of Engineering can improve achievement rates and may benefit women and women of colour in particular most.
5. d'Entremont et al. 2019	8/18 respondents felt wellness interventions had a positive effect on their student experience, 4/8 indicated interventions provided tools to deal with stress. 8/18 felt interventions were not helpful. Anecdotally, faculty and staff saw a decrease in number of visits from students in emotional distress.	Good preliminary evidence that the intervention helped to dampen the effects that entering the program has on wellbeing.
6.Eren-Sisman, Cigdemoglu, & Geban, 2018	PLTL approach had significant effect on performance (not as much as was expected) but STAI was significantly improved in the PLTL group. Social anxiety was not affected and remained high in both groups.	Model may be helpful in improving learning and alleviating state anxiety. It was not as effective in reducing social anxiety when compared to traditional college instruction.

7. Estrada & Dalton, 2019	Significantly increased engineering students' trait mindfulness, engagement in mindfulness outside of sessions and intellectual curiosity and exploration but not perceived stress	Supports the feasibility of further mindfulness-based intervention for engineering students.
8. Grasty et al. 2021	Engineering student continued studies and felt counselling contributed to this. The benefit of feeling heard was noted and counselling helped to set boundaries and improve interpersonal skills	Counselling proved effective for this student.
9. Huerta et al. 2021	Improvements in confidence and reduced anxiety.	Mindfulness training can support self-efficacy and improve aspects of mental wellbeing.
10. Johnson-Glauch et al. 2020	No statistically significant difference in self-efficacy overall. Those with large gains had scored low initially.	Result suggests that these types of assignments may preferentially benefit students with low self-efficacy.
11. Joshi & Kiran, 2020	Experimental group reported reduction in mean value in Galvanic Skin Response (GSR) from deep yogic breathing, listened to religious hymns and listening to flute music.	Listening to flute music emerged from these three drills as the most effective stimulus for stress management.
12. Joshi et al. 2017a,	Statistically significant improvement in skin conductivity post session for both the control and the experimental group. Results reflected yogic breathing had a significant effect on skin conductivity.	Deep breathing techniques can reduce skin conductivity and in turn stress levels of engineering students. Basic yogic breathing could be included in core curriculum to reduce and manage stress among engineering students.
13. Joshi et al. 2017b	Statistically significant increase in GSR for the control group after 300 seconds ($p<0.01$), whereas significant reduction ($p<0.01$) in GSR after listening to hymns in the experimental group.	Listening to hymns could provide a strategy to manage stress in educational institutions for student with high levels of self-reported stress
14. Joshi et al. 2016	Deep breathing technique had a statistically significant reduction on systolic and diastolic blood pressure in engineering students with high academic stress.	Deep breathing techniques could be beneficial in improving students learning and efficiency.

15. Khan, 2018	Students without a break had marginally higher cortisol and DHEA levels. Engineering students that did not have a break (control group) had slightly greater output of cortisol to DHEA than those that experienced time away from school (experimental group).	A break may be helpful in reducing stress, but the sample size was small, and more research needed
16. Lal et al. 2019	Significant decreases in stress perception level among those students who are practicing meditations and high level of stress perception level among those who are not practicing any techniques to cope with stress respectively.	Meditation showed promise in reducing stress among college students.
17. Maxson & Tomasko, 2020	Improved MH and MW awareness, improved pastoral skills, improved perception	Publication is a work in progress, but the overall intervention has been received positively
18. Mazumder, 2012	Interaction positively contributed to students paying more attention. Increased interactions resulted in higher exam scores. Communication apprehension reduced. Use of interactive technology followed by group discussions and class assignments greatly enhanced students' comprehension of scientific facts and their ability to explain them.	Interactive software in modules may help with motivation and communication apprehension. Increased interactions improved their level of understanding of the subject matter, which resulted in higher exam scores. It is possible that clarification and further understanding of any questions could have resulted from the group discussion and not necessarily from the use of technology.
19. Miller et al. 2021	20 students that participated self-reported improved relaxation as a benefit.	Mindfulness training embedded in a design project may benefit students' wellbeing.
20. Miller & Jensen, 2020	Positive responses to the addition of mindfulness activities.	Introduction of wellness activities may promote cultures of student wellness.
21. Miller et al. 2022	Students noted collecting their own biometric data was convincing of the effectiveness of wellness practices. Students noted the project applied	Integration of wellness into the core curriculum can normalize the use of these resources in engineering departments and

	engineering principles while also providing students with valuable life skills. At the end of the, 88% of students voted to continue meditating daily at the start of class.	equip students with stress management tools for their careers.
22. Moran & Benson, 2016	Math anxiety increased after the 4-week course. Females reported higher anxiety than males. Gender, type of high school and students' origin increased math anxiety for both math test and math activities. Math test anxiety was higher than math activities showing most of the stress is related to the tests. Math anxiety increase was significant for males and females but effects > for females post course ($p<0.05$). Outcomes achieved across 3 cohorts were similar or improved	Fast-paced maths courses could increase anxiety levels and lead to maths avoidance and negative affective reactions performing maths activities. This may be more problematic for women engineering students. Significant increase in maths anxiety measurements from before to after an intensive course particularly for maths test anxiety. Females also experienced higher levels of maths test anxiety but not maths activities anxiety. Educators should therefore be aware of designing maths courses acknowledging the stress related to maths tests.
23. Nolte et al. 2022	Mindfulness-based video increased students decentering overall, but effect is small. Written feedback: five students would do this type of activity again in the future or would like to incorporate more mindfulness into their lives. Results indicate experiencing a mindfulness-based video did not noticeably impact perceived sources of stress during design tasks. Students' top perceived source of stress was time limitation. Overall, mindfulness-based body scan video increased students' decentering. However, students' total TMS scores and curiosity were not affected.	Increase in students' state mindfulness was not found to have an observable impact on students' stress experience. Students were receptive to completing a mindfulness-based activity in-class and perceived multiple benefits. While students currently utilise many mechanisms for coping with task-induced stress, teaching engineering students' mindfulness is still a promising avenue for helping students manage the stress of engineering and design.
24. Paniagua, 2019	Using the app improved comfort and stress levels significantly. Academic results also showed improvement.	Reduction in perceived stress and improvement of academic performance showed the introduction of the PWD model app was beneficial to the course.

25. Paul et al. 2021	Stress was a significant predictor of overall GPA after first year. Negative relationship between stress and overall GPA was buffered by resilience but enhanced by student engagement (i.e., resilient students seemed to manage stress better). Students also prioritize academics first and social life second, physical activity comes third, while mental health was mentioned least, it is also a factor to consider for responses from social wellness.	Personal reflection in the curriculum provided several benefits.
26. Paul et al. 2020	Students preferred shorter sessions, but there was acknowledgement this wasn't their top priority.	Study highlighted some benefits to incorporating concepts of student wellness and lifelong learning into the engineering curriculum. Further results will be reviewed in Paul 2021. (Ref Source25 above)
27. Poole, 2017	Students with fall break demonstrated lower ratio of cortisol to DHEA after the break suggesting students with a break had less stress on their return to class (p=0.052).	Break may be beneficial from stress hormones data, but these results are limited due to small sample size and no significant statistical effect.
28. Rodríguez-Jiménez et al. 2022	Results showed improvements in stress levels, well-being, and life satisfaction, along with increase in the levels of self-awareness and self-knowledge	Dedicating time and resources to interventions can help students to increase their level of awareness and health and generate healthier educational environments.
29. Su, 2016	Software had significant positive effect on learning motivation, academic achievement and decreased cognitive load. Decreased cognitive load associated with decreased learning anxiety. Decreased learning anxiety associated with strong learning motivation.	Improvements to motivation cognitive load and learning anxiety were statistically significant and may be useful in course enhancement.
30. Tragodara, 2021	Main demand of students related to the academic subject time management and study techniques. Main reason students requested counseling was anxiety, followed by demotivation.	Virtual tutoring supported the wellbeing of the students

31. Vitasari et al, 2011	Breath per minute significantly reduced post intervention, Grade Point Average improved but not statistically significant. Anxiety reduced significantly ($p<0.05$).	Intervention was effective in reducing anxiety levels - but 6 sessions was not enough to significantly improve academic performance. Subjects improved GPA as compared to pretreatment.
32. Walton et al, 2015	Both interventions raised women's engineering grade-point-average (GPA) eliminating gender differences. Both led women to view daily adversities as more manageable and improved women's academic attitudes. The 2 interventions had divergent effects on women's social experiences. Gender differences and intervention effects were concentrated in male-dominated majors (~20% women).	Results highlight how social marginalization contributes to gender inequality in quantitative fields and 2 potential remedies. Social-belonging intervention helped women integrate into engineering. Affirmation-training helped women develop external resources, deepening their identification with their gender group.
33. Yanik, 2016	Identified 3 themes: anxiety related to time management (procrastination and effect on work, having a balanced life with studies and other roles), anxiety related to success and completion of their degree (lack of confidence in academic ability, deficits in academic preparation) and anxiety related to life post-graduation (concerns about finding a job, uncertainty on ability for employer). Other sources in isolated cases included accumulation of debt, loneliness, and inability to take full advantage of opportunities available through the college experience. Group discussions had greatest perceived value, with time management practices, completion strategies and what comes after graduation of most benefit.	Reflection had a positive effect on students' understandings of the courses and possible remedies for commonly occurring anxieties. Activities were easily implemented and fostered both self-awareness among individuals and cohesion among the larger group.

2.7 Discussion

This scoping review aimed to map the evidence on mental wellbeing in engineering students and specifically identify the types of study designs, mental wellbeing interventions and outcomes in relation to this population.

2.7.1 Types of Study Design Reported

The review identified mainly quantitative studies, with some studies adopting a mixed method approach. One study (8) was fully qualitative. There is a need for qualitative studies to explore engineering students' lived experience in higher education and their experience of strategies to maintain their mental health and wellbeing.

From the quantitative study designs reported, the majority were positioned lower on the evidence hierarchy (Physiopedia, 2021) with mainly pilot studies, and only one RCT. To enable researchers to identify effective interventions by conducting prospective quantitative systematic reviews and meta-analysis, there is a need for more high-quality, adequately powered, robust studies (such as RCT) to be conducted so results can be pooled for analysis.

According to the Medical Research Council (MRC, 2008), robust research studies following a complex intervention approach are needed; they can help establish feasibility, acceptability, fidelity and finally effectiveness of these interventions. With the updated literature searches it was noted there has been an increase in interest in the topic of mental health and wellbeing of engineering students and that with this increase there may be an increase in quality as the research area is explored more fully.

2.7.2 Mental Health and Wellbeing Interventions

There were 33 interventions that were considered to have met the inclusion criteria for this review. There is a growing body of evidence in this area with 13 of the studies conducted in the last two years and the remaining studies more spread out over time. This demonstrates the increasing awareness of this topic within engineering education. Most studies were conducted in North America or Asia, with only one study conducted in Europe. Whilst student mental health and wellbeing is regarded as important within the higher education setting (De Pury and Dicks, 2020), this review has identified a research gap in engineering student mental health and wellbeing interventions in UK settings as no studies were identified for this review. This reflects findings in a recent review of UK higher education students (Worsley et al., 2020). There may be interventions being delivered in UK settings, but these are not easily identified despite a comprehensive search of published and unpublished literature. There is an urgent need for focused research in this area, including co-production work to identify and create interventions to support good mental health and wellbeing. As most included sources focused on undergraduate students there is also a need to explore suitable interventions for postgraduate engineering students.

The main interventions reported in this review involved training and the use of relaxation methods. More recently, research on mindfulness interventions for engineering students has begun to emerge, (3, 7, 9, 16, 19-21, 23), with encouraging results (Nolte et al., 2022).

In terms of reporting, none of the sources fully adhered to the TIDieR guidelines (Hoffmann et al., 2014), with key items missing that limit the uptake and replication of interventions in practice. From the findings of this review, future research to investigate wellbeing interventions for engineering students should ensure authors adhere to transparent reporting using tools such as the TIDieR guidance and other reporting guidance available from the Equator Network (Equator, 2022).

From the interventions reported in this review there was similarity to mental health and wellbeing interventions that are used in general higher education student populations such as introducing mindfulness and health promotion (Hassed et al., 2009), coaching, (Larcus et al., 2016) and breathing exercises (Cho et al., 2016) although specific engineering mental health and wellbeing interventions should also be considered to address issues that are more common to engineering students such as mathematics anxiety (Vitasari et al. 2010) and delayed help-seeking (Deziel, 2013).

2.7.3 Outcomes Reported

The outcomes mapped in this review present evidence for mental health and wellbeing interventions to improve a range of factors, some of which are also similar to general student population wellbeing interventions outcomes such as academic achievement, reduced stress and anxiety, improved motivation, attitude, physical activity, spirituality health awareness, confidence and communication (Universities UK, 2015, Baik et al., 2016, Worsley et al., 2020). Due to the variety of interventions and heterogeneity between outcomes and outcome measures reported, recommendations for subsequent systematic reviews of effectiveness cannot be made at this time. Future research should focus on development of a core outcome set to be used across studies of interventions in this area to enable future systematic reviews.

2.7.4 Limitations

Only sources of evidence in English were included. This may have excluded some sources of evidence and may have impacted on the results. However, some sources included in this review were from non-English speaking countries. There was a deviation from the a priori protocol as it was anticipated to map participant groups as per UK HESA categories, but the international evidence mapped by this review did not use this categorisation. The search and screening phases were updated due to delays as a result of the global pandemic. This review included pre-Covid literature. With the pandemic impact there has rightly been greater recognition of mental health and wellbeing issues within students and more availability of evidence in this area. This is demonstrated through the increase in publications in the past two years (13 of the 33 sources included).

2.8 Conclusions and Recommendations

Engineering students enter a challenging and competitive sector in higher education and are potentially at risk of poor mental health and or mental wellbeing and less likely to seek help when experiencing poor mental health or wellbeing. It is important to raise awareness of and proactively support good mental health and wellbeing for engineering students. To map the literature on this topic, a scoping review was conducted using JBI scoping review methodology (Peters et al. 2020). Ten databases were searched for this review. Searches were conducted in January 2019 and updated in January 2020, and March 2022. Two authors independently screened all titles and abstracts, full text sources and extracted data.

The scoping review identified and mapped various sources of evidence for interventions on mental health and wellbeing for engineering students and the intervention components, outcomes and outcome measures utilized in this area. The key interventions focused on introducing positive mental health and wellbeing behaviours. The research designs most frequently used are quasi-experimental, quantitative, and used a variety of outcome measures.

The main results indicated reduced stress and anxiety, and improvement of academic achievement, communication, motivation, physiological responses, attitude, physical activity, spirituality, health awareness and confidence. Searches identified 191 sources of evidence after title screening and 33 sources of evidence were included for final extraction following full-text screening. The included studies represented over 4000 engineering students from 10 countries. Included studies were predominantly pilots, which suggests a lack of robust intervention studies e.g., Randomised Controlled Trials (RCTs) and a lack of longitudinal studies in the existing research base. Studies also varied in approaches to reporting.

Interventions included training, relaxation, technology use, alternative teaching models, support services and a study break with a range of outcome measures used to evaluate intervention effects. Study results indicated reduced stress and anxiety, improved academic achievement, improved communication, motivation, physiological responses, attitude, and increased physical activity, health awareness, and confidence. Mindfulness activities appear to be accepted by and helpful to engineering students. This review mapped interventions to support mental health and wellbeing in engineering students but identified a need for further high-quality robust studies that are transparently reported using reporting guidelines.

2.8.1 Research Recommendations

In accordance with scoping review methodology, (Peters et al, 2020) this review cannot provide recommendations for practice. However, the following recommendations have been identified:

- Robust and transparent reporting of research adhering to reporting guidelines is needed;
- Research is required in higher education settings to identify effective interventions for engineering students using robust experimental study designs;
- Increase of qualitative or mixed-methods study designs are needed to explore the lived experience, impact, and acceptability of interventions to support mental health and wellbeing of engineering students;
- There is a need to establish the effectiveness of interventions via systematic review and meta-analysis.

2.8.2 Recent Interventions

Since the last search and screen activity was undertaken in March 2022 and this thesis was completed, there have been further interventions reported in the intervening time. Systematic scoping review methodology requires two researchers to search, screen, exclude and extract data and therefore this short summary is intended to inform the reader of updates since the completion of the scoping review rather than to provide the same level of scrutiny as it was conducted by the author of this thesis.

One recent intervention was identified, Crone et al (2023), conducted a pilot study which delivered 8 weekly mindfulness training sessions to engineering students with significant improvements in emotional health demonstrated through pre and post survey. Medium effect sizes were reported for Positive Affect (d=0.67), Awareness (d=0.77) Mindfulness (d=0.64) (Crone, 2023). Their results align with other mindfulness related outcomes identified in literature (Medlicott et al, 2021, Worsley, Pennington and Corcoran, 2022). While not a formal intervention, based on their previous work on engineering student helpseeking, Wilson and Goldberg (2023) encourage staff to be proactive and ensure they are familiar with on-campus support and also understanding their role in supporting engineering students. They provide a summary support tool to help engineering staff to feel confident in supporting students. Further to this, Bork and Mondisa (2022) published a scoping review on the mental health of graduate engineering students and also recommended improved reporting standardisation in this area as part of their conclusions.

2.9 Chapter Summary

This chapter comprised a two-part literature review exploring the mental health and wellbeing of engineering students. It is clear that interest in the topic is rapidly increasing and while this is a positive direction there are challenges in relation to reaching an agreement of what is being measured in engineering students and why. There is a risk of pathologising and medicalising the student experience by using measures of illness, rather than viewing it more holistically. Gaps in knowledge around the actual mental health and wellbeing of engineering students were identified but the existing research points towards unmet needs in this population and a growing problem. Crucially, most of the research is being carried out internationally and not in the UK. While there are many aspects of engineering education that will undoubtedly be similar, the UK culture and perspective should not be ignored as a contributing factor to a person's mental health and wellbeing.

A systematic scoping review was carried out with a view to identifying mental health and wellbeing interventions in the global engineering student population. The review highlighted that the small number of interventions identified were useful, however a lack of consistency in selection of outcome measures, would make it difficult to synthesise or generalise findings to the wider engineering student population. Further research was recommended including conducting qualitative research in the subject to address the qualitative research gap that was observed. The next chapter, Methodology (Chapter 3) will describe and provide a rationale for the research design of the thesis, provide information on the research methods, instruments and processes to be used and also explore the strengths and weaknesses of the approaches.

Chapter 3: Methodology

3.1 Overview

The previous chapter provided a review of existing literature, key terms and concepts, and interventions in the subject of mental health and wellbeing in engineering students. This chapter introduces the underlying theoretical and philosophical concepts supporting the research, which aims to answer:

- What is the mental health and wellbeing of engineering students in the UK?
- What are the mental health help-seeking behaviours of engineering students in the UK?
- What are the approaches or strategies to support or facilitate mental wellbeing utilised by engineering students in the UK?

In this chapter, the research philosophies of the work are described and explored, and in turn, the subsequent positioning of axiology and high level research lenses, ontology, epistemology and methodology adopted is discussed in relation to the worldview of the researcher. The research design and methods for the separate phases are detailed along with a discussion of strengths, weaknesses, and ethical considerations.

3.2 Research Philosophy

A research philosophy is a conceptual, heuristic device or lens through which a research question can be posed and explored (Kaushik and Walsh, 2019).

Figure 11 shows the ‘Research Onion’ which is a useful graphic for highlighting the layers of positionality in relation to research. Figure 12 is a “research onion” tailored to this research highlighting the philosophical underpinnings and subsequent methodology and methods.

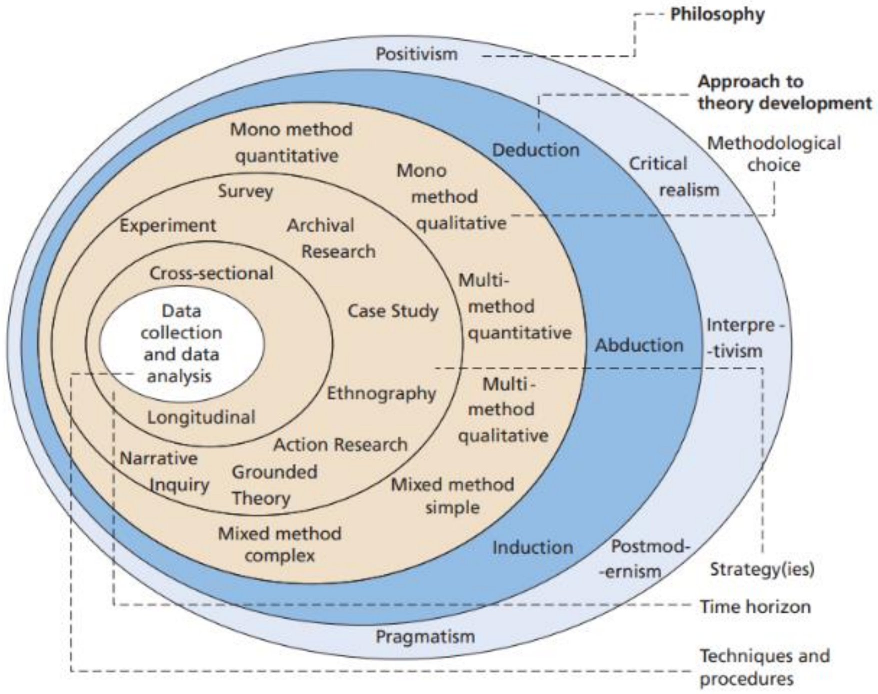

Figure 11. The research onion (Saunders, Lewis, and Thornhill et al., 2019). Used with permission.

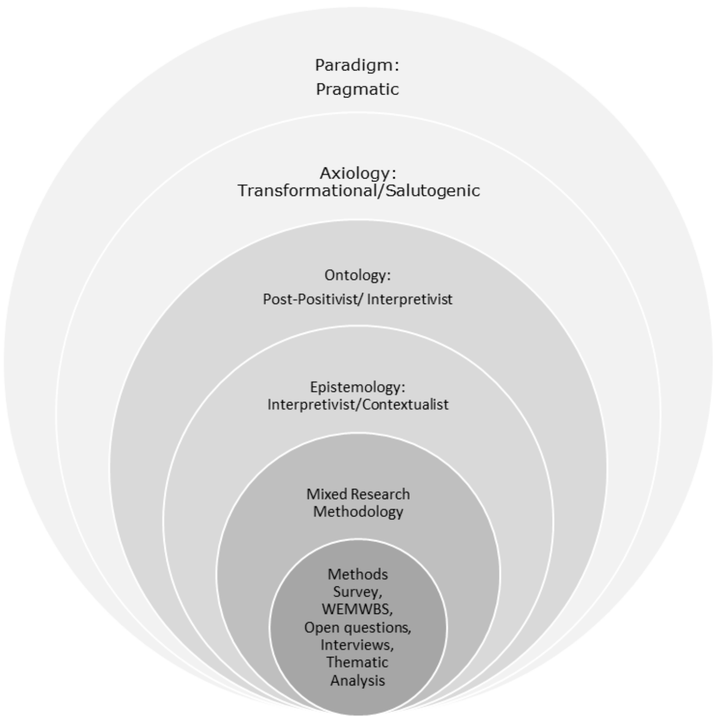

Figure 12. This Research Onion.

3.2.1 Pragmatism

This research project was grounded in an essentially pragmatic philosophy. Pragmatist thinking encourages knowledge and action (Goldkuhl 2012) and allows room for adaptability in research design should it be required. But it is more than a convenient option. There are many varieties of positions on pragmatism as a philosophy (Biddle and Schafft, 2015), but at its core is the idea that a theory or result is only so if it contributes to social progress: "Beliefs, in short, are rules for action" (James, 1898). In the late 1800's the development of pragmatism as a philosophy had begun and was heavily influenced by Peirce, James, and Dewey (Legg and Hookway, 2021). It originated from the belief that the world was inseparable from the agency within it (Legg and Hookway, 2021). Deweyan pragmatism includes an intent to support moral progress (Sorrell, 2013) towards a social good (Biddle and Schafft, 2015).

Given the likelihood of the knowledge contribution from this work having a practical application in terms of development of pastoral support and potentially curriculum reform a "Deweyan" pragmatic approach to the research was preferred. However, it is important not to use pragmatism as simply a convenient way to justify a mixed-method approach. Biddle and Schafft (2015) note that pragmatism is one of the most used philosophical frameworks in research. This is in part due to the flexibility pragmatism affords in relation to seemingly opposing paradigms (Biesta, 2010, Biddle and Schafft, 2015).

The lack of baseline quantitative data and narrowly focussed existing literature supporting the research area supported the adoption of both a pragmatic philosophy and a mixed-method approach. In short, how could a problem be solved if it were not clear how big the problem was or indeed that there was a problem at all? A pragmatic philosophy allowed for the flexibility of choice of methodological approach in answering the research questions. However, it is important to think more deeply about the philosophy of pragmatism (Kelly and Cordeiro, 2020) which may often be regarded as an easy option, rather than simply stating the research philosophy is pragmatism with little explanation.

The emergence of metaparadigms perhaps provides a deeper philosophical root than the initial impression the selection of a pragmatist philosophy makes. Pragmatism, which considers knowledge as a product of person-environment interactions, acknowledges both socially constructed and mind-independent realities (Shan, 2021). Shan (2021) describes three "senses" of philosophical foundations of mixed-method research. These are described as "weak, moderate, and strong", with "weak" being that mixed-method research is possible therefore has been selected, "moderate" being that there is good reason to use mixed-methods, and "strong" being it "justifies a normative thesis that mixed methods research should be encouraged in social science research" (Shan, 2021). This evaluation or grading of strengths of philosophical foundations helps underpin the various paradigms through which

Mixed Methods Research (MMR) can be viewed. Johnson (2016) highlighted the following paradigms in relation to MMR, shown in Table 10 and combined with Shan's evaluations.

Table 10. Overview of Research Paradigms presented by Johnson (2016) and Philosophical Foundations as discussed by Shan (2021).

Research Paradigm	Source	Strength of Philosophical Foundations (Shan, 2021)
Pragmatism	Creswell and Plano Clark, 2011 Morgan, 2014; Teddlie and Tashakkori, 2009; Yardley and Bishop, 2008)	Weak
Transformativism	(Mertens, 2007),	Moderate
Dialecticalism	(Greene, 2007),	Strong

3.2.2 Is it Transformational?

Biddle and Schafft (2015) argue that the selection of a transformative paradigm for pragmatic mixed methods researchers indicate there has not been full engagement with the "implications of pragmatic axiology". The essence of Transformativism is the "pursuit of social justice and furtherance of human rights" (Mertens, 2012). Mertens' definition of a transformative paradigm necessitates a consideration of power at each stage of the research process and involving community members in the initial discussions of the research process (Mertens, 2007). This stance is highly worthy and attractive to the researcher, however at this early stage of inquiry, the more fundamental pragmatic axiology of working towards a social good is more practical. It is likely that further research in this area will move towards transformational research or indeed dialectical pluralism.

3.2.3 Is it Dialectical Pluralism?

Dialectical Pluralism recognises and accepts the legitimacy of all other philosophical positions. Indeed, different philosophical positions are encouraged. The dialectical pluralistic paradigm means looking at the mental wellbeing of a social or occupational group (Mingers, 2003). As engineers have, in some quarters, been considered to be a group distinct from other disciplines, adopting a dialectical pluralistic paradigm is a valid option. The paradigm is flexible in that there is recognition that there cannot an absolute answer, for example there are limits/ranges of wellbeing in Dialectical Pluralism (Johnson, 2016). Reality is seen as multiple and there are multiple ways of conceptualising reality. Knowledge in the social sciences is fallible and contextual and social scientific research is value-laden. According to Johnson

(2016): *"The word "pluralism" refers to the acceptance and expectancy of difference in virtually every realm of inquiry, including reality, and the age-old word "dialectical" refers to the operative process which is both dialectical and dialogical"* (Johnson, 2016. pp.156).

It is anticipated that further research beyond the scope of this thesis will sit within the metaparadigm of both transformative, and of dialectical pluralism. Engaging with multiple stakeholders is key to systemic change, but in order to establish what actually needs changed, we return to the pragmatic fold for the purposes of this work.

3.2.4 Axiology

Axiology is the values with which a researcher is approaching a research question. This research is being viewed through two Axiology-oriented high-level lenses: transformativism and salutogenesis. It is intended that the conclusions and recommendations of this research inform social and educational reform within engineering education, particularly in the UK, but also potentially internationally. It is also the position of the researcher that having a mental illness or poor mental wellbeing should not be a barrier to becoming an engineer, rather the move to a more inclusive body of engineers is a positive step in developing solutions of the future. The intention of the researcher in carrying out this work is to explore mental health and wellbeing in engineering students to support engineering educators, education providers, engineers and engineering students to improve and enhance their mental health and wellbeing. This is with the longer term aim that the engineering profession becomes more attractive for a wider range of people and also that people already in the engineering profession choose to remain and feel supported in maintaining good mental health and wellbeing.

There are a number of ways one might explore mental health and wellbeing in an occupational group. One such way is through a salutogenic theoretical framework. Salutogenesis considers wellness and illness to be a continuum from "dis-ease to health-ease" and has similar characteristics to positive psychology (Joseph and Sagy, 2016).

Originally developed as a stress and coping model (Antonovsky, 1979, Mittelmark, 2016), the model seeks to demonstrate a holistic view of a person's wellness. Central to the salutogenic model is the Sense of Coherence (SOC). This is the critical attribute that helps a person cope with stress (Bauer, 2020). Antonovsky developed a 29-item questionnaire, the Orientation to Life Questionnaire (OLQ) (Bauer et al, 2020) in an effort to measure this attribute. While this research uses an alternative measurement due to the need for general population comparison, it is a feasible option to utilise this measure in future research. It is not the intention of this research to solely focus on or limit to one model, merely to use salutogenesis as a high-level lens.

While engineering students may suffer from mental illness, it is not the primary focus of this research to identify a pathological diagnosis in this occupational group. Rather, any illness may be self-reported and evaluated in context. It is the assertion of the author that engineering education does not in itself cause mental illness. It is, however, likely that engineering education and culture does contribute to poor wellbeing, which in turn can exacerbate an existing illness or predisposition for an illness. By using salutogenesis as a “heuristic device” (Antonovsky, 1996) or overarching theoretical model rather than as a rigid tool, it is possible to begin the journey of exploring mental wellbeing in engineering students.

Adopting a salutogenic lens allows us to accept that engineering students are on a continuum of mental health and wellbeing rather than viewing them through a medical or pathogenic lens and attempting to diagnose or cure an entire occupational group. That is not to say that mental illness is not taken into consideration, more that mental wellbeing is the focus and that this may be at different levels depending on a person’s situation.

At the same time, it is important to acknowledge the different approaches that could have been taken in investigating this area. Approaching the query with a medical or pathogenic mindset for example limited the scope to mental illness or mental disorders, where the overarching intention of this work is to bring about impactful improvements to the mental health *and* wellbeing of engineering students.

Having identified risk factors in the general population, it was not unrealistic to suspect that engineering students are at risk of suffering from mental ill health and poor mental wellbeing and are also less likely to seek assistance than students of other disciplines. Some progress has been made in this regard, in terms of more recent literature researching mental health and wellbeing rather than only mental health problems. Mental health in engineering student studies report using a diverse range of tools to measure similar aspects of mental health or illness. A focus on what could be argued as pathology or illness does not fully encapsulate or investigate the engineering student experience. A pathogenic approach to the project would only really focus on students who had a mental illness and ways to remove or reduce the impacts of that illness.

A salutogenic approach, on the other hand, allows for all engineering students to be included, whether or not there is the presence of an illness, and focuses on ways to improve wellbeing from the perspective of the individual student. That is to say, the aim of the project is to support engineering students to improve their mental health and wellbeing holistically, within the context of their own situation. The salutogenic approach considers all people to be on a continuum between total illness and total health (Antonovsky, 1996, Mittelmark and Bauer, 2016, Vinje, Langeland and Bull, 2017).

Salutogenesis is a lens by which all aspects of engineering students' mental health and wellbeing can be explored, without assuming illness or attempting to "cure" them. A focus on health and wellbeing promotion in this way can potentially optimise all engineering students' mental health and wellbeing.

The salutogenic model (Figure 13) as an orientation or lens is therefore an acceptable and appropriate one to consider the issue of mental health and wellbeing in engineering students. Salutogenesis provides a broad base from which to work without pathologizing the experience of engineering students. The "Salutogenic Question" (Joseph and Sagy, 2016) is an inspiration for this research: the posing of the question, "What are the approaches or strategies to support or facilitate mental wellbeing utilised by engineering students in the UK?" is deliberately wellness focussed, i.e., how can we move engineering students toward the "ease" pole of Antonovsky's ease-disease continuum.

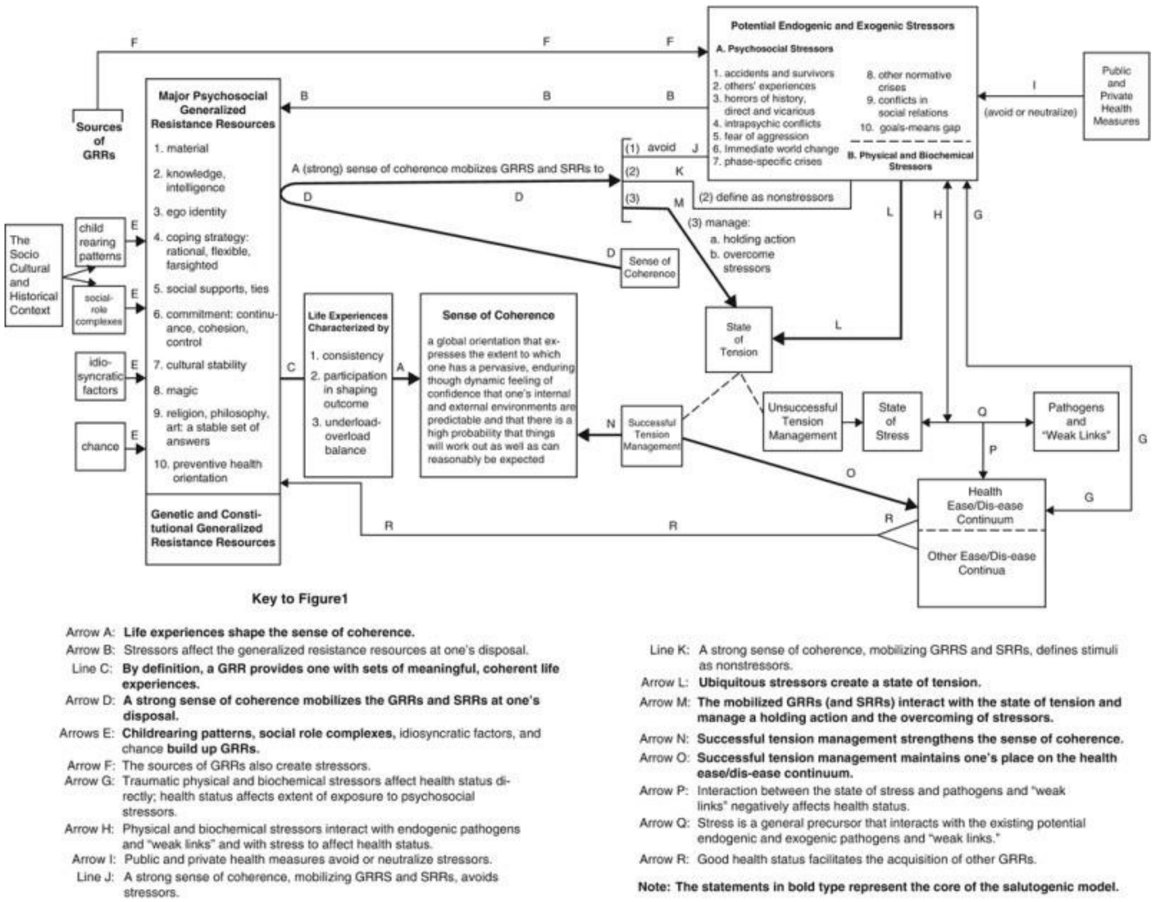

Figure 13. Antonovsky's Salutogenic Model of Health (Vinje, Langeland and Bull, 2017). Used with permission.

3.2.5 Ontology

In order to answer the research questions, it was helpful to adopt notionally different ontological positions during different phases of the research, from the quasi-positivist position of measuring mental health and wellbeing in the engineering student population in the first phase to a more subjectivist-interpretivist ontological position in the second phase. It could be argued that the more quantitative methods used in the first phase are based on subjective information, hence the reference to quasi-positivism. Braun and Clarke (2022) discuss the concept of "Situated interpreted realities" and this is perhaps the crux of the research; identifying patterns in the situated interpreted realities of engineering students.

3.2.6 Epistemology

This work is being developed through a contextualist – interpretivist - pragmatic epistemological framework. This means the acknowledgement that participants are looking at the same events (engineering education) from different perspectives and the author is interpreting the data from the position of researcher (Braun and Clarke, 2022), rather than constructing their own reality or simply reporting someone else's. This is with the intention to inform change in the engineering curriculum and culture.

3.2.7 Positionality of Researcher

In order to develop a research project, it is important to position oneself in the research, to acknowledge world views and biases (Holmes, 2020). The author is a white, Scottish, woman who has taught geology in engineering curricula and supported engineering educators for nearly 20 years in a Scottish university. She is a senior academic in a School of Engineering and leads on student experience and academic quality. Previously a geologist, she has been working in engineering education since 2002, and has a Master's degree in Higher Education, Learning, and Teaching. Her main interests are in the pastoral care of engineering students and has a passion for improving retention of engineering students in the field of engineering. She is mental health first aid and ASIST (applied suicide intervention skills) trained. Researcher positionality is important in locating the researcher in three areas in particular: the subject, the participants, and the research context and process (Holmes, 2020). In terms of the subject the researcher is a novice health sciences researcher with a relatively open mind on models of mental health and wellbeing, but is generally positively focussed i.e., how do we keep well. She recognises the need to maintain and advocate for good mental health and wellbeing in engineering students as she feels this will encourage retention in the engineering discipline. Identifying effective ways that mental health and wellbeing can be enhanced for this group will support and develop a resilient engineering workforce and help address the increasing global demand for engineers. The research participants are engineering students and as a senior academic in a school of engineering the findings of this work will influence key strategic decisions regarding the reform of the curricula. It is understood that the researcher's professional role may have meant some participants feeling less able to be open, and so an additional interviewer (one of the supervisory team) conducted the interviews for participants from the researcher's institution. This approach supported the aim of participants being considered in the same way throughout the interview process.

3.3 Mixed Research Design Methodology

Kelly and Cordeiro (2020, pp 1.) outlined three key principles of pragmatist methodology: *"an emphasis on actionable knowledge, recognition on the interconnectedness of experience, knowing and acting, and inquiry as an experiential process."* This approach supports the research design. A mixed method sequential design was adopted to establish a baseline from which to work, and to explore the engineering student experience. A mixed methods phenomenological approach (QUAN-phen) was initially considered for the study as a quantitative phase followed by description and interpretation of lived experience (Mayoh and Onwuegbuzie 2015) as an appropriate and valid approach. However, it was considered important to attribute equal importance to both research phases.

Convergent parallel design (where quantitative and qualitative data is collected at the same time) was also considered, however this approach works best when there are two researchers on the project, one focussing on each dataset (Petrosyan, 2014). The researcher was to work on both datasets and therefore this was also rejected.

Sequential exploratory design was rejected as a method as the gathering of quantitative data to inform a qualitative phase rather than the other way around was more appropriate for the purposes of this study. An embedded approach was also considered as there would have been a benefit in time-saving, however the risk that a qualitative section might be seen as an add-on rather than a critical part of the research was too high.

Ultimately, a mixed-method sequential explanatory design approach (Creswell, 2014) was selected. This approach allowed a preliminary mapping of the area of inquiry and the findings of the early quantitative stage informed the qualitative phase of the research. Sequential explanatory design allowed for more opportunity for the gathering and generation of knowledge and for the development of potential models or hypotheses.

This took the form of a survey followed by interviews of volunteers from the survey participants. Phase one was primarily quantitative but included optional open text questions.

Phase two of the research documented and explored participants' experiences through semi-structured interviews, and participants were asked to answer direct questions about their mental health and wellbeing and to describe their lived experiences.

3.3.1 Advantages and Limitations of Mixed Method Design Based Research

As with any research design there are limitations. In mixed method research there is a risk of superficiality and that the research is too broad in scope. If there is a primary researcher, then that researcher needs to be proficient in more than one method in order to complete the work. Given that both qualitative and quantitative methods are employed in the research, this may weaken or strengthen research depending on one's point of view. Quantitative research has the advantage of being able to provide numerical data, quick to obtain, less time consuming, researcher independent, and potentially more favourably viewed by decision-makers (Johnson and Onwegbuzie, 2004). However, there is still a risk of confirmation bias (Johnson and Onwegbuzie, 2004).

Qualitative research has the potential to generate rich data and enhance understanding of a phenomena or experience (Tariq and Woodman, 2013) although there is a challenge in terms of generalisability (Johnson and Onwegbuzie, 2004, Tariq and Woodman, 2013)

Essentially MMR has challenges for a solo researcher in that the researcher needs to be competent in both methodologies in order to do the research. There is a risk that the work may not be of sufficient depth, but the advantages are that MMR can provide triangulation to further validate or explain findings.

3.4 Overview of Research Design

The study is a mixed-methods research project, following a sequential – explanatory design model (Ivankova, Cresswell and Stick, 2006). As the area of research was largely unmapped in 2018-19 when the research design was developed, a mixed-methods approach offered the best opportunity for understanding. This allowed the researcher to both measure and explore mental health and wellbeing in engineering students.

The overall mixed method research design is depicted in Fig 14.

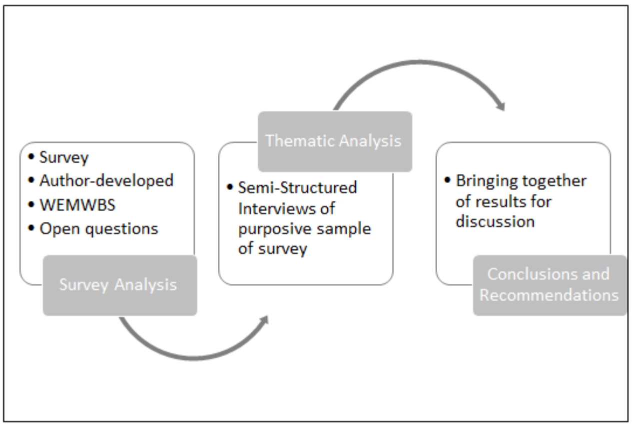

Figure 14. Research Design.

The first phase was a survey of mental health and wellbeing in the engineering student population. Statistical and content analysis were carried out on the data generated from the first phase and the results informed the design of the second phase. The second phase was a series of interviews of participants from the survey. Thematic Framework Analysis was carried out on the transcripts of the interviews.

3.4.1 Strengths and Limitations of the Research Design

Limitations in the analysis of both the quantitative and qualitative results include self-referral of those most likely to come forward. There may be an over representation of female engineering students as noted in recent survey raw data results on mental health in 14 universities including the researcher's own institution (Alterline, 2017).

Given the male: female ratio in UK Schools of Engineering is around 20:1 (HESA, 2020) it is anticipated that in future surveys there may be a similar response in terms of over-representation. This may be addressed in the statistical analysis but also may highlight a further area for exploration. As a result of this, there is a risk of sample bias.

3.5 Methods Phase One: Survey

3.5.1 Overview

An online survey was identified as the optimal method for generating primary quantitative data from the engineering student population. Of key importance was a need to reach engineering students in multiple institutions across the UK. By enabling direct input from the engineering student population it would be possible to use evidence-based and nationally used survey instruments to measure engineering student mental wellbeing directly, something that to has not being carried out before. This chapter includes a description of the survey design, choice of measures within the survey, with some examples of measures that were rejected, and ultimately the justification for the measures selected. Strengths and weaknesses of the methods are described and discussed.

3.5.2 Survey Design

Prior to developing the survey, a review of different mental health measures was carried out for possible inclusion. Examples of available surveys included a scaled version of the General Health Questionnaire (GHQ) (Goldberg and Hillier, 1979) which is a screening test for symptoms of mental ill health. It is described as being widely used in similar studies to the one proposed and it can be used in short or longer forms (Jackson, 2007). It has been used to study general populations (Scottish Health Survey, 2021, NHS DIGITAL, 2021) and is therefore a potential for the research as comparators will be readily available.

Meta-analyses of the GHQ (12) have indicated that it is essentially too blunt an instrument and recommend researchers looking for differentiation in mental health and wellbeing results to look at the longer versions or use alternative instruments, for example the GHQ (28) (Gnambs and Staufehbiel 2018). As there was existing population data from the GHQ (12) it was a potential tool for the study.

The Warwick Edinburgh Mental Wellbeing Scale is a 14-item survey that can be completed online or on paper comprising a series of positive statements with 5 response categories (Warwick Medical School, 2022). The responses are then summed to provide a single score which can range from 0-70, with higher scores indicating good mental wellbeing. The WEMWBS has been validated for use across a number of populations including young adult, higher education students, and the general population (Tennant et al, 2007, Stewart-Brown et al 2009, Warwick Medical School, 2022). Its performance has since been validated several times by different researchers and has been used to evaluate the mental health and wellbeing of the general population in the UK (Tennant et al, 2007, Clarke et al, 2011, Bianco, 2012). As an example of its use Bartram et al (2011) utilised the WEMWBS when looking at population mental health in the veterinary profession. While it is not intended as an indicator for mental disorder, a 44.5 or lower result indicates depression (Bianco, 2012).

The GHQ-12 and the WEMWBS-14 have both been completed by participants from the UK population, in line with the dual factor model. The results of both questionnaires were published in 2015 in the Scottish Mental Health Survey (Wilson et al. 2015). These results may prove a useful comparator in later analysis. Potentially, mean scores for the engineering student population could be generated and compared with the general population.

A list of mental health and wellbeing measures used in the engineering population can be found in the literature review (Table 6).

3.5.3 The Case for the Warwick Edinburgh Mental Wellbeing Scale

While the questions on both tools have similar phrasing, the WEMWBS and the GHQ measure different phenomena, i.e., mental health (GHQ (12)) and mental wellbeing (WEMWBS-14). In the results of the Scottish Mental Health Survey, it was highlighted that deprivation was found to be a predictor for poor mental wellbeing (low WEMWBS) but not for mental disorders (score of 4+ on GHQ (12)). However, results from use of the Zagazig Depression Scale (Ibrahim, Kelly and Glazebrook, 2013) in a study of engineering students from six UK universities indicated those from a poor socio-economic background were more likely to report depressive symptoms. This assertion is further supported in the Scottish Mental Health report (2022).

The WEMWBS has been validated for the general population and can be incorporated into a larger survey question set, allowing a great deal of flexibility. While the WEMWBS is 14 items long and there is a short form SWEMWBS which has 7 items, the full WEMWBS is more sensitive to gender differences (Ng et al, 2017) and given the aforementioned gender imbalance in the engineering student population the full WEMWBS was the preferred option.

The WEMWBS mean for the Scottish population is 50, with the mean for men at 50.3 and women at 49.7. Wellbeing is noted to be higher in lower age groups, lower in age groups 45-54 and peaks in the age group 65-74. Participants considered to be in the lowest 20% in terms of deprivation (Scottish Government, 2020) scored lower at 47.2. Participants considered to be in the highest 20% of Scottish Index of Multiple Deprivation (SIMD) i.e., the least deprived in the population had a 51.8 mean (Wilson et al 2015). Results are displayed in Table 11.

Universities in Scotland have been tasked with a number of targets (Scottish Funding Council, 2020) relating to the student population: improving gender balance in subjects with severe gender imbalance e.g., engineering and nursing and improving access for applicants from areas of multiple deprivation (SIMD 20, SIMD 40). Wilson et al (2015) reported students in full-time education had 50.6 mean WEMWBS score, which is surprising given the number of sources in the literature review are suggesting this would be lower. It is possible that there is some confirmation bias in smaller studies.

Table 11. Mean WEMWBS-14 in Scotland (Wilson et al 2015).

Scottish Population Mean	Men	Women	FT Student	MD20 *	MD80*	16-24	45-54
50	50.3	49.7	50.6	47.2	51.8	50.1	48.9

* MD20 and MD80 refer to the Scottish Index of Multiple Deprivation, with MD20 referring to participants considered to be in the lowest 20% in terms of deprivation Scotland (Scottish Government, 2020).

Population results for GHQ 12 in relation to presence of possible psychiatric disorder (score of 4 or more) was 15% in the Scottish population, 13% in men, 18% in women and 21% for men between the ages of 25- 34. It was 18% for those in full-time higher education. (Wilson et al 2015).

Ultimately, the Warwick Edinburgh Mental Wellbeing Scale was selected as the primary measurement tool, with author developed self-report questions for any mental health issues, rather than inclusion of the GHQ 12. This was primarily a budgetary constraint as the research was for doctoral study with no funding, but following discussions with the supervisory team it was decided that optional self-disclosure rather than measurement was actually preferred as it resonated with the salutogenic theory i.e., focussing on wellbeing rather than attempting to identify illness.

3.5.4 Strengths and Limitations of Surveys

A survey is a research tool that enable a researcher to evaluate a large number of people in a population of interest (Jones, Baxter and Khanduja, 2013). One of the aims of surveying a large number of people in a population is to produce results that may be able to be generalisable across the whole of the population of interest (Weisberg, 2008), in this case, engineering students. Online or internet surveys are questionnaires that are delivered on the internet to participants who complete the questions on their own (Vehovar, Manfreda, and Koren, 2008). There are key advantages to data collection via online survey, not least because it is a good option economically (Nayak and Narayan, 2019) as there are numerous options for hosting surveys. Some survey hosting services also offer data analysis tools to support research, for example JISC online surveys. These tools can support the novice researcher to begin the process of analysing the data they have collected through the survey. It should be noted that these tools may only be useful if the research questions have been designed in such a way that the responses are able to be managed by the tools.

Online surveys carry some risks, including the ability of the participant to lie should they wish to, or present themselves in a different light. There is also the risk of selection bias, where those with a particular interest in a topic are more likely to respond or are more systematically likely to respond and lead to measurement error (Wilson, 2015). As the survey does not offer any remuneration it is likely that participants will be intrinsically motivated to complete it, whether it be through interest in the topic itself, or in supporting research generally (Saleh and Bista, 2017).

Crucially, while a survey may be able to indicate the mental health and wellbeing of the engineering student population, it is less able to evaluate at depth (Choy, 2014) the contributing factors to the state of mental health and wellbeing. By including open text questions it was anticipated that additional depth through narrative from respondents would be achieved (Wijngaards, Burger and van Exel, 2019). Combining the survey questions with a qualitative interview phase will provide a range of rich data sets to answer the research questions.

Response rates for online surveys can also be a significant challenge (Nayak and Narayan, 2019) and a survey response rate may indicate non-generalisable results (Wu, Zhao and Fils-Aime, 2022). Additionally, Non-response (Sturgis, 2015) is also an issue, where the people you want to hear from are not interested in completing the survey, skewing the results. Therefore every effort should be made to encourage a good response rate. These efforts are described in Section 3.5.6.

Despite the weaknesses of online surveys as a research tool, they are an effective way to gather data from across the UK and therefore an appropriate method for the purposes of this research.

3.5.5 Designing and Developing the Survey

The electronic survey was developed, informed by the results and conclusions of existing publications and the scoping review. A survey provides a convenient method of collecting information from a sample of a population (Ponto, 2015). Linton, Dieppe and Medina-Lara (2015) collated information on 99 self-report tools that assessed wellness or wellbeing. These tools included those primarily aimed at establishing risk of mental disorders and the paper itself provided a comprehensive overview of the landscape of available self-report tools that would be potentially useful for this research. Ultimately, a series of demographic questions were combined with the Warwick Edinburgh Wellbeing Scale and self-report questions on mental health issues.

The survey for this phase of the research was designed to establish the mental wellbeing of engineering students in the UK, and to identify mental health problems, help-seeking behaviours, and wellbeing activities. The researcher developed a series of demographic questions to collect data on the stage, discipline, age, and gender of the student.

The development of the survey was informed by existing literature.

Approval was given by Warwick University to use the Warwick Edinburgh Mental Wellbeing Scale - WEMWBS-14 (Tennant et al 2007, Warwick Medical School, 2022) embedded in the survey (JISC Online Surveys).

A pilot of the survey was carried out with 2 recent engineering graduates independent to the study who provided feedback resulting in minor adjustments to the flow of questions and correction of one of the “Select all that apply” questions. Following successful approval (SRRG Ref: SHS 18-14, Appendix 4) by the School Research Review Group (SRRG) of the School of Health Sciences, Robert Gordon University, the survey was released through JISC Online Surveys, the university’s approved and GDPR compliant survey tool.

The final survey can be found in Appendix 5.

3.5.6 Distribution and Promotion of Survey

An invitation to share the survey was sent to the 162 institutions delivering engineering degrees in the UK. The email was also sent to PSRBs, and societies that support engineering students undertaking a Further or Higher Education degree in the UK. Twenty-seven institutions including eight PSRBs responded agreeing to disseminate an invitation to the survey with hyperlink included via email to their students/members.

Support from the Royal Academy of Engineering, The Engineering Professors’ Council and the Engineering Education Research Network was requested and provided to promote the survey. These institutions have active links with engineering students and the additional promotion through websites and networks was sought in order to encourage participation from students.

The research project was also highlighted on the Push website, a resource for students and outreach groups. The Engineering Professor’s Council hosted a guest blog (Tait, 2019) on their website to promote the survey (Appendix 6). Two news articles were published, one in a local newspaper (Appendix 7) and one in The Engineer, a monthly magazine and website based in the UK (Appendix 8). The story was picked up by other news outlets, for example Grampian Chamber of Commerce (Appendix 9) and a recruitment website (Appendix 10). Finally, a radio interview was broadcast about the survey and research project on Original 106 FM. The positive response and support from different areas of the engineering discipline highlighted the need and welcome for the research by the engineering community. Data collection for the survey was carried out from 29th November 2019 to 20th January 2020. A reminder was sent twice, two weeks apart, to encourage responses.

3.5.7 Analysis of Results

A variety of data was collected through the survey. All data was extracted from the JISC survey website and stored on the University's secure drive. The data was analysed after cleaning, through descriptive and inferential statistical analysis including the Kolmogorov–Smirnov Test for normality (Mishra et al, 2019a), the Student T-Test (Mishra et al, 2019b) for statistical significance, Cohen's d (Lakens, 2013, Dey and Mulekar, 2018) to examine effect size, and The Warwick Edinburgh Mental Wellbeing Scale User Guide (Warwick Medical School, 2021b). Tests were calculated using Social Science Statistics Calculators (Stangroom, 2023) and Microsoft Excel. Comparison of Warwick Edinburgh Mental Wellbeing Scale scores would be carried out using available national data for the UK and for university students in the UK if available. Conceptual summative content analysis (Hsieh and Shannon, 2005) was carried out on the open text questions.

3.6 Methods Phase Two: Semi-Structured Interviews

3.6.1 Overview

This section outlines the interview design, participant recruitment, selection, interview process, data management, and analysis including justification for the choice of method adopted. Phase 2 aimed to explore the experiences of engineering students in higher education, relating to mental health and wellbeing. A semi-structured interview guide was developed and piloted prior to recruitment of participants. Changes following the pilot related to flow of questions and gentler lead-in to mental health questions. Interviews were carried out online via Teams and Zoom, and by telephone dependent on participant preference.

Participants from the researcher's institution were interviewed by one of the researcher's supervisors for the comfort of the participants and to reduce the likelihood of the participant and researcher knowing one another. Further information on interview design can be found in 3.6.2. A grant was awarded by the Energy Institute to fund the secure GDP compliant external transcription of interview audio. Interviews were transcribed using intelligent verbatim transcription which is essentially a cleaned up transcript to exclude sounds such as sighs or "um's", (McMullin, 2021), prior to analysis. Data description, and content and framework analysis were applied to the data (Nowell et al, 2017, Gale et al, 2013, Ritchie et al 2014, Braun and Clarke, 2022). More information about Framework Analysis can be found in Section 3.6.4.

3.6.2 Interview Design

The aim of Phase Two was to explore mental health and wellbeing, help-seeking behaviours and wellbeing-seeking behaviours, but the structure and actual questions were not agreed until the survey responses had been reviewed. Following discussion with the supervisory team, a semi-structured interview approach was agreed as it was considered to be the most appropriate approach in providing the opportunity for collection of both comparable qualitative data and also for open ended questions which may uncover unanticipated information (QUALRES, 2018).

Early mock interviews (n=4) using questions designed during an internal staff training workshop in qualitative interviewing and thematic analysis were conducted. Feedback from these mock interviews and from conducting unstructured telephone interviews with engineering graduates (n=7) informed design considerations along with guidance from Qualitative Research Practice: A Guide for Social Science Students and Researchers (Ritchie et al, 2014) and from Creswell, 2014. Alternative approaches were considered, e.g., potentially the inclusion of vignette cards to support participants should talking about their own mental health become distressing (Edwards and Holland, 2013). Vignette cards, where a scenario is described, and some questions asked may have provided a useful approach and their use was considered as there was a concern that engineering students may find it difficult to discuss mental health and wellbeing directly. However early pilot interviews with engineering students suggested this would not be an issue and so vignettes were not included in the research design.

The interview guide covered some demographic queries (subject, year of study), attitudes to mental health and wellbeing, exploration of the students' mental health and wellbeing, ways to keep well, and their experience of being an engineering student in relation to mental health and wellbeing. There were four sections of the interview:

- Demographic information;
- The course they are studying;
- Their mental health and wellbeing;
- The engineering profession and mental health and wellbeing.

Interview participants also had the opportunity to ask questions or comment if they felt the interview had not covered something they wished to convey.

Finally, the interview was piloted with a final year engineering student. Following feedback from the student relating to structure and flow, the interview guide was updated and approved by the School of Health Sciences Research Ethics Committee. A copy of the interview guide is in Appendix 11. Invitations were sent to volunteers from the survey in phase one along with an information sheet explaining the reasons for the interviews. Invited participants were required to provide consent to be interviewed and training on informed consent was completed by the primary researcher.

3.6.3 Strengths and Limitations of Semi Structured Interviews

A semi-structured interview is a common research instrument, particularly in the social sciences (Ruslin et al, 2022). It sits between the structured and the unstructured interview (Jennings, 2005) in that it combines structured and unstructured questions (Wilson, 2014). The semi-structured method supports the researcher in quantifying elements of the transcript if desired and also provides an early framework from which to begin a thematic analysis. A major strength of an interview approach is that participants respond in their own words and describe their experiences. While quantitative data is very helpful, perceptions of mental health and wellbeing can't be explored as richly as in an interview.

All research instruments have strengths and weaknesses, and interviews are no different. Interviews are time consuming and if carried out in person can impact the participant group if only those who are able to attend are interviewed. E-interview, or use of the internet to carry out interviews is an option that may be more convenient for participants (Hanna, 2012) and post-COVID-19 is now common practice (Sah, Singh and Sah, 2020, Oliffe et al, 2021).

Between the end of the survey (20th January 2020) and the start of the interviews (16th June 2020) the COVID-19 pandemic led to the UK-wide lockdown which persisted for several months (23rd March-29th May 2020). The rapid normalisation of web-based videoconferencing (Oliffe et al, 2021) led to shifting planned interviews from a blend of in-person and telephone interviews to primarily video-conferencing based interviews using Microsoft Teams (St. George's, 2023), and Zoom (Archibald et al, 2019) with some on the telephone at the participants' request. While the lockdown and pandemic clearly impacted on student experience and was discussed in some of the interviews, the participants were asked to consider questions more generally and try not to focus entirely on their perceived impact from the pandemic. Anecdotally, the researcher felt that the move to videoconferencing may have enhanced the interview experience for her and the participants as it added an ability to visually connect in the interview.

Another drawback of interviews is that they rely on the participants view or recollection (Green and Thorogood, 2014) which is by nature subjective and not generalisable. Participants themselves may also be impacted by the interview topic and sharing personal experiences. In order to mitigate for potential distress of the participant, supporting materials and signposting was made available and also the researcher had been trained in mental health first aid. Additionally, and time was allocated between interviews to allow the interviewer to debrief with researchers and for recovery if the interview was found to be challenging. Mitigation is further discussed in Section 3.7.2.

3.6.4 Data Analysis

A pragmatic approach to analysis of the interview data was taken, in the form of an inductive Framework Analysis. *"Framework analysis is most commonly used for the thematic analysis of semi structured interview transcripts."* (Gale et al. 2013 pp.2). The initial intention was to carry out reflexive thematic analysis, supported by NVivo, on the qualitative dataset.

Thematic analysis involves identifying patterns in qualitative data (Braun and Clarke, 2006). It is informed by interpretivism and was the initial primary analysis choice for the researcher. However, over time, and with the publication of Thematic Analysis by Braun and Clarke (2022) the reflexive thematic analysis approach has evolved away from a straightforward tool for analysis (arguably it was never straightforward, rather misinterpreted and misused by researchers (Braun and Clarke, 2022)) to something very reflexive, positioning the researcher heavily within the dataset. The purpose of this research was to primarily give voice to the participants and, while interpretation and drawing out of themes is necessary, there were key areas already identified that provided an existing shape to the dataset. After discussion with the supervisory team, it was decided to adjust the method of analysis to Framework Analysis which more appropriately supports this aim.

What is Framework Analysis?

Framework Analysis is a structured method of analysing qualitative data through a sequence of coding, indexing and charting. The following steps are recommended (Ritchie and Spencer 1994, Srivastava and Thomson, 2009, Ritchie et al 2014, Braun and Clarke, 2022).

1. Familiarization;
2. Constructing the initial framework;
3. Indexing;
4. Reviewing Data Extracts;

5. Data Summary and Display;
6. Abstraction and Interpretation.

Framework analysis is flexible and well suited to data generated from semi-structured interviews as there is already the beginnings of a framework in the form of the questions in the interview guide. The Framework approach was initially rejected as there appeared to be little room for emergent data to be captured. It was also asserted that Framework Analysis is recommended for experienced researchers so was not initially considered appropriate. However, Ritchie et al (2014) published a guide which allowed for unanticipated themes to be reflexively incorporated into a framework, and the part-time programme allowed for a greater period of time for the researcher to become more confident in analysis techniques. Given the interviews were semi-structured and the questions had been informed by the analysis of the survey data there were specific areas of interest for the research. Moving to an inductive Framework Analysis meant that these key areas were covered but also new areas were able to be brought forward for discussion.

Strengths and Weaknesses of Framework Analysis

Gale et al (2013) describes many benefits and attractive features of Framework analysis but also outlines some drawbacks to be aware of. One particularly relevant drawback of Framework Analysis in this context is the potential to treat qualitative data quantitatively (Gale et al, 2013). This is largely due to the way data is captured in the framework. In this research, this has been mitigated by the researcher engaging in training and working with supervisors to ensure analysis remains qualitative.

Additionally, the researcher has used the guiding work of Ritchie et al (2014) to ensure a robust analysis process. As with other qualitative analysis methods, Framework Analysis is time-consuming (Gale et al, 2013) and it is important that researchers have training. Fortunately, during the initial approach of reflexive thematic analysis the researcher had become comfortable with coding, thinking reflexively, and interpretation. Gale et al recommends an experienced qualitative researcher to lead Framework Analysis, an assertion that Hackett and Strickland (2018) agree with. However, with support from the researcher's supervisory team it was agreed to proceed with Framework Analysis as the preferred method.

3.7 Ethical Considerations

An application was made to the School Research Review Group (SRRG) of the School of Health Sciences, Robert Gordon University following the PhD transfer process. The application included information sheets, consent forms, data collection protocols and forms, recruitment materials, research tools, interview guides, and letters of support from Professional and Statutory Regulatory Bodies (PSRBs). As the researcher comes from a non-healthcare academic background, she attended training courses offered by NHS Scotland including “Good Research Practice for Health Care Research” and “Informed Consent” to support the research and ensure work was ethical and robust.

Informed consent was obtained for both phases of the research. Informed consent is a term that means that participants in the research have been given enough appropriate information about the research project (UKRI, 2023), for example, what is planned for the data that is collected, information about the project, what happens to data after the research is concluded. This is in order for participants to make an informed choice about whether or not they wish to participate. For the survey, and information sheet accompanied the email invitation and the first page of the online survey repeated this information for convenience. In order to recruit for Phase Two, survey participants were invited to leave a contact email but were able to complete the survey without divulging contact information.

Quantitative and qualitative data were collated from the survey through JISC Online Survey tools for Phase One of the research. Data required secure storage, including password protection, which was provided by Robert Gordon University in a secure Research Drive. UK data protection laws were adhered to along with institution requirements.

3.7.2 Phase Two

As with all research it is important to consider the ethical implications for data collection. The interview method is not exempt from this and for the purposes of this research there are a number of ethical considerations. It may be that having a conversation about mental health results in further thoughts about mental health and has the potential to be distressing for some participants. To mitigate this, the information sheet included guidance about selecting a comfortable space for the telephone interview and as it was anticipated that the majority of interviews were to be carried out by phone, signposting to appropriate sources of support was included in an information sheet which was issued to participants prior to their interview.

While the primary researcher is ASIST certificated (Applied Suicide Intervention Skills Trained) and is trained in mental health first aid, the information sheet included contact details of support that could be accessed and also the researcher’s principal supervisor in case a participant felt distressed or wished to talk with someone else following the interview. It was anticipated that students from the researcher’s own university would prefer an independent interviewer as the researcher may have had direct teaching contact. This would avoid risk of coercion or bias relating to the researcher being a senior academic in their School. Fear of judgement and reprisal has been reported in the engineering student population relating to discussing mental health and wellbeing (Sandhu, Arora, and Brasch 2021, Wright, 2021, Sanchez-Pena, 2021, Conceicao, 2022, Jensen, 2023, Wright et al, 2023). With that in mind, one of the supervisory team from another School in the university conducted the interviews of participants from the researcher's institution. Finally, but crucially, the final questions focussed on positive health and wellbeing behaviours.

3.7.3 Data Management

Data from Phase One and Two was stored on a secure drive of the university in compliance with institution guidelines. The JISC online survey tools include assigning of a unique number and the contact details of any participant who left contact details were removed prior to analysis. For Phase Two, participants were allocated a unique identifying number before recordings were anonymised. Interviews were then independently and intelligently transcribed by an outsourced transcription service approved by the university. Transcription was funded by the Energy Institute in support of mental health and wellbeing in engineers. Transcriptions were received via a secure link and stored on the secure research drive before uploading to NVivo for analysis. The NVivo file was also stored on the secure research drive. During analysis, anonymised data was transferred to Excel for tabulation and to develop the themed frameworks for presentation in the thesis. This file was also stored on the university secure drive.

3.8 Phase Integration

Once the findings for both phases had been presented, they were combined to form an integrated discussion in line with the methodology. Juxtaposed results are presented in table form accompanied by narrative discussion. This is with a view to beginning to draw the work to a close, highlighting overall findings and gaps and considering limitations of the research as a whole.

3.9 Chapter Summary

This chapter introduced and discussed the research philosophy and rationale for the mixed methodology research design. It explored the grounding of pragmatism and the salutogenic lens through which the researcher is viewing this work. The overarching research design was described, with high level information about each phase including rationale for the selected method and an appraisal of the strengths and weaknesses of the research instruments and approaches. Ethical considerations were explored and an overview of mitigations put in place. Finally a description of how the two phases would be integrated was provided. In the next two chapters Phase One and Phase Two are described, with each method and process articulated in detail prior to the presentation of findings.

Chapter 4: Phase One

4.1 Overview

This chapter reports on Phase One of the research which was to explore the research questions by a web-based survey. A description of the participant characteristics is provided and the results of the survey are presented and discussed. Following this there is a discussion of the results including limitations of the work. Finally recommendations for Phase Two are outlined.

4.2 Introduction to Phase One

The purpose of phase one was to establish a measure of the mental health and wellbeing of engineering students in the UK, and to identify mental health problems, help-seeking behaviours, and wellbeing activities. The researcher developed a series of demographic questions to collect data on the stage, discipline, age, and gender of the student. The methods are described in detail in the previous chapter (3.5). Data collection for the survey was carried out from 29th November 2019 to 20th January 2020. A reminder was sent by email twice two weeks apart to encourage responses.

The data was collected via the JISC online survey tool. Data from the survey was extracted as a Microsoft excel spreadsheet and stored on a GDPR secure University research drive for cleaning and arranging for analysis. Following the data cleaning, information on engineering sub-discipline, age, gender, year of course, type of course, health and wellbeing scores and related activities were analysed. Descriptive analysis of results was conducted, and for the WEMWBS-14 data, inferential analysis was undertaken to determine the mean scores of participants and to compare these to the general population scores, the general student population, between genders, disciplines, and stages. Effect size was calculated using Cohen's d (Lakens, 2013, Dey and Mulekar, 2018). Responses to open questions were categorised and summarised, and a content analysis of open text responses to mental health conditions and wellbeing behaviours was conducted. The survey results informed the inclusion and exclusion criteria for participant recruitment in the qualitative interviewing phase and supported the development of lines of questioning for the topic guide. There were 417 respondents to the survey. The estimated sample size based on universities agreeing to take part was 32,955 engineering students. From this estimated sample size the response rate of 1.3% was calculated. The estimated sample size was calculated by extracting population data from HESA on the relevant universities (HESA, 2023). While this response rate is very low, it is unlikely all engineering students were contacted by the university gatekeeper and it is also perhaps unsurprising that there is a low response rate given the reported low rates of helpseeking in this population.

4.2 Description of Participant Characteristics

Participant characteristics and related PSRB information can be found in Tables 12 and 13.

Table 12 Participant Characteristics.

Characteristic	**Male**	**Female**	**Non Binary/Prefer not to say**	**All**
Gender	273	137	7	417
Mean age and range	22 (16-71)	21 (16-34)	20 (18-23)	22 (16-71)
Mean Age Standard Dev.	5.35	3.13	1.69	5.34
Fulltime	260	134	8	402
Part time	3	3		6
Other (Graduate Apprentice, Online)	9			9
Engineering Discipline				
General Engineering	28	17		45
Civil Engineering	30	20		50
Mechanical Engineering	104	38	1	143
Aeronautical Engineering	7	4		11
Electrical & Electronic Engineering	63	16	6	85
Production Engineering	2	4		6
Chemical Engineering	6	8		14
Other Engineering	32	30	1	63
Type of Award				
HNC/HND	11	4		15
BSc	5	1		6
BEng	104	42	6	152
MEng	121	66	2	189
MSc	10	8		18
MSc/MRes/PhD/EngD/Other	21	9		30
Academic Stage				
1st Year College	15	2		17
2nd Year College	3	2		5
3rd Year College	1			1
1st Year UG University	52	31	3	86
2nd Year UG University	47	20	1	68
3rd Year UG University	55	25	3	83
4th Year UG University	56	22		78
5th Year UG University	17	15	1	33
1st Year Postgraduate	13	8		21
2nd Year Postgraduate	2	4		6
Pre-Transfer PhD/Eng D	3	2		5
Post Transfer PhD/EngD	3	1		4
Other	5	5		10

Table 13 Professional Body Accreditation.

Professional Body Accreditation	Male	Female	Non Binary/Prefer not to say	All
No	12	8	1	21
Don't know	74	44	2	120
CIHT (Chartered Institution of Highways and Transportation)		1		1
Energy Institute	2	2		4
IOM3 (Institute of Materials, Minerals and Mining)		2		2
Institute of Water		1		1
IChemE (Institution of Chemical Engineers)	4	5		9
ICE(Institution of Civil Engineers)	24	15		39
IET (Institution of Engineering and Technology)	53	16	4	73
Institution of Engineering Designers		1		1
IMEchE (Institution of Mechanical Engineers)	93	37	1	131
InstRE (Institution of Structural Engineers)	4	1		5
RAeS Royal Aeronautical Society	3	2		5
(RINA) Royal Institution of Naval Architects	1	1		2

Most students were full-time (96.6%, n=403), undergraduate (85%, n=354) engineering students. Table 12 shows the respondents' course types according to the Higher Education Statistics Agency (HESA) codes for engineering subjects (HESA, 2021). The Professional Body accrediting the respondents' courses varied but most students (31.6%, n=131) were registered on courses accredited by the Institution of Mechanical Engineers (IMechE) (Table 13). Figure 15 shows the age of the respondents by self-described gender. The majority of respondents were in the age 18-25 range.

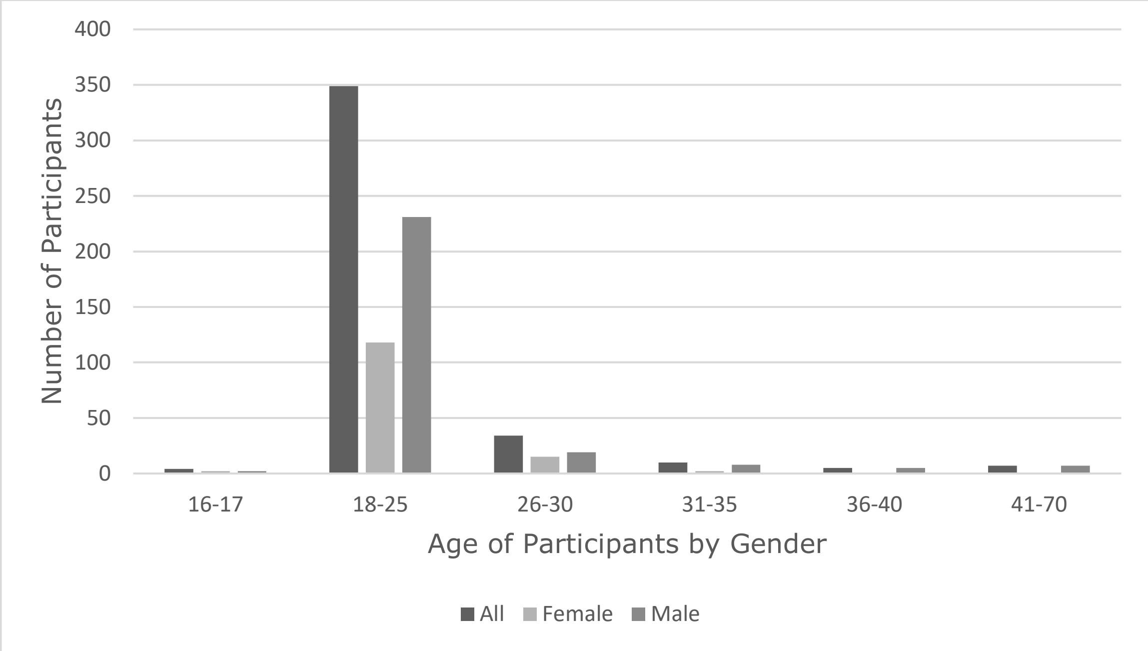

Figure 15. Age Range of Survey Respondents by Gender.

4.3 The Mental Wellbeing of Engineering Students in the UK

Of the 417 respondents, 414 students (135 female, 271 male, 6 non-binary and 2 prefer not to say) completed the WEMWBS (Figure 20). The spread of overall WEMWBS results shows a left skew towards poorer mental wellbeing using the guides set out by Warwick Medical School (Warwick, 2021). The WEMWBS Scores were tested for normality of distribution (Awati, 2022) using the Kolmogorov-Smirnov test (Mishra, Pandey and Singh et al, 2019). Results of this test showed a non-significant difference from normal distribution (D=0.5, p=0.24). The Kolmogorov -Smirnov tests intended for large sample sizes (>50 and therefore appropriate for the data set). As the difference was indicated to be non-significant, the scores were treated as normally distributed and Student-T tests (Mishra, Singh and Pandey, 2019) were performed.

The range of wellbeing scores was 20-69 (male 21-69, female 20-64, and non-binary 25-39). The overall mean WEMWBS score for all 414 respondents was 41.3 (SD 9.3). This mean is within the accepted thresholds for possible clinical depression (41-44) (Warwick, 2021).

Nearly half - 48.8% - (n=202) meeting the threshold for probable depression (<41). The recommended threshold for high mental wellbeing is 60. Of the 414 respondents, 3.62% (5 women, 10 men) scored 60 or above. Figure 16 depicts the results from the survey with establised thresholds overlain (Warwick, 2021). Blue denotes the range for probable depression, grey denotes the range for possible depression and green denotes the range for high mental wellbeing. Current literature doesn't offer a definition for the range between 44-59 but the national mean scores all fall into this category.

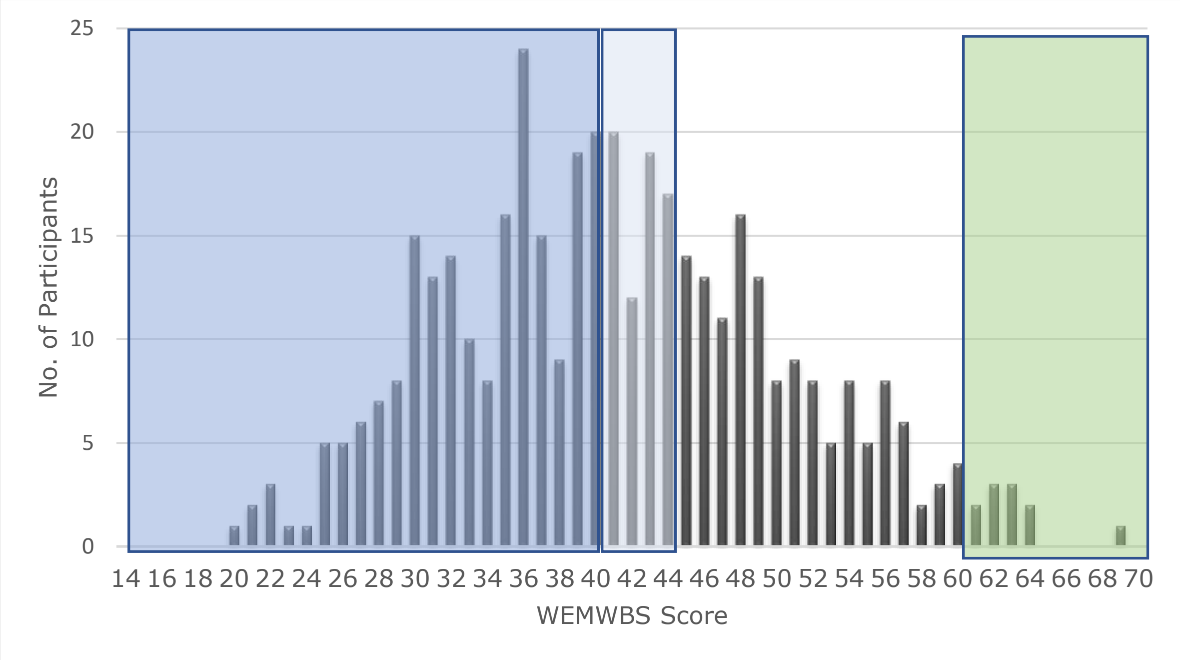

Figure 16. Engineering Students' WEMWBS Scores.

4.3.1 Comparison of WEMWBS Scores by Gender

Female respondents reported statistically significantly (*p* < .024, CI 95% [0.24, 4.08]) poorer mental wellbeing (39.97, SD 9.68) than their male counterparts (42.14, SD 9.08) in a two-tailed test (Glen, 2023). However, the Cohen's d between the two means was calculated to be 0.23 which indicates a small effect size.

The number of non-binary students in the sample was small (6) and so inferential statistics were not carried out. However, it should be noted that non-binary students reported extremely poor wellbeing and would warrant further investigation with greater numbers.

Figure 17 shows the range of WEMWBS results split into male and female.

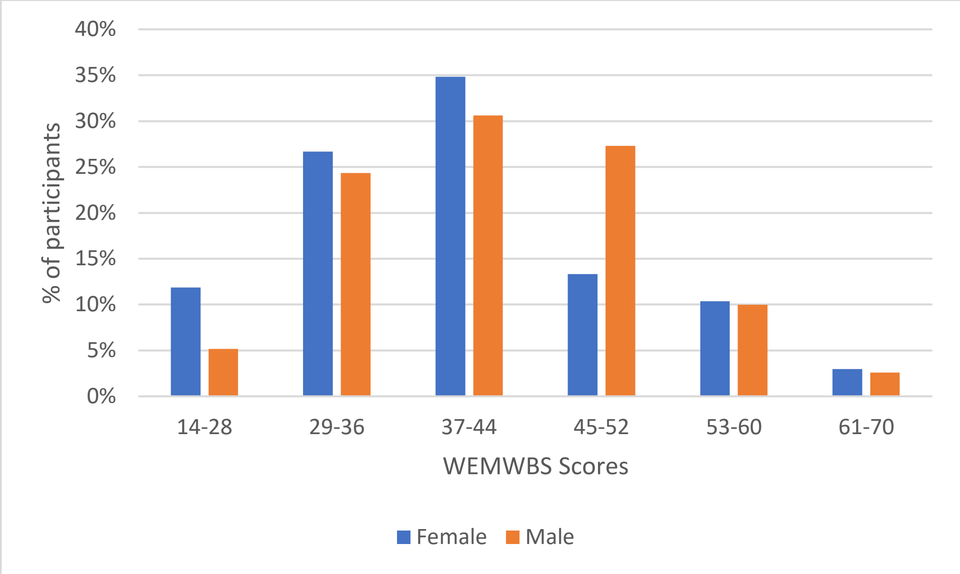

Figure 17. Male and Female Engineering Students' Wellbeing Scores.

4.3.2 Engineering Students Compared to the UK General Population

Mental Health and Wellbeing are measured at a national level in the UK general population for each home country. This means that there is no recent overall UK population norm available for WEMWBS and therefore it was not possible to compare the survey scores directly to the UK population as a whole. Instead, the data was compared against available national data from Scotland (Scottish Government Health Survey, 2020), England, (Health Survey England, 2016) and Wales (National Survey for Wales, 2019). There was no WEMWBS data available for Northern Ireland at the time of data analysis for this project.

For Scotland, the national general population mean was 49.8 (Scottish Health Survey, 2019). Most respondents (98%, n=406) in the Phase One survey were aged between 16-25, and the national WEBWMS mean in Scotland for the same age group scored 49.3 (Scottish Health Survey, 2019). The difference between the engineering student respondents and the overall population were tested for statistical significance using an unpaired T-test (Bobbitt, 2021) and for effect size by calculating Cohen's *d*. Both the overall population mean, and the population mean for the age range 16-24 (England and Wales) and 16-25 (Scotland) were tested and the results presented in Tables 15-17.

More recently there was an additional National Health Survey in 2020, however this data has not been utilised for comparison because of the potential for the Covid-19 lockdown to be a confounding factor, given the data from the engineering student survey was gathered in 2019 pre-pandemic. However, for information, the national mean for ages 16-44 in August-September 2020 was 51.9 (Scottish Health Survey, 2020). This shows an even greater difference between the general population and engineering students. Due to lack of supporting data in the Scottish Health Survey (2020) i.e., mean, number of responses, standard deviation, it was not possible to carry out statistical significance tests using the 2020 National Health Survey Data.

In England, the national mean for the general population aged 16-24 in 2016 was 51 for women and 52.4 for men (Health Survey England, 2016). Both figures were statistically significantly higher than the engineering student population in this study with p-values <0.001 and a Cohen's *d* of 1.08. In Wales, the national mean for WEMWBS is 50.6 for people aged 16-24 (National Survey for Wales, 2019). Again, both figures were statistically significantly higher than the engineering student population in this study with p-values <0.001 and a Cohen's *d* of 0.86. Table 14 presents the information for the three home nations.

Table 14. WEMWBS Scores for Scotland, England, and Wales Combined.

Source of WEMWBS Mean Score	**Mean**	**N**	**S.D**	**C.I. (95%)**
Scottish Population (All data)	49.8	4,251	9.1	49.53, 50.07
Wales Population (All data)	51.35	9,755	9.43	51.16, 51.53
England Population 2015(All data)	51.6	7,048	10.07	51.37, 51.83
Scotland, Wales, and England Population Pooled	51.12	21,054	9.54	50.99, 51.24
Engineering Student Survey (All data)	41.28	414	9.31	40.38, 42.17
Scottish Population (Age 16-25)	49.3	532	9.3	48.51, 50.09
Engineering Student Survey (Age 16-25)	41.27	406	9.33	40.36, 42.18
Wales Population (Age 16-24)	50.61	587	9.65	49.83, 51.39
England Population (Age 16-24)	50.9	620	8.47	50.23, 51.56
Engineering Student Survey (Age 16-24)	41.28	346	9.4	40.29, 42.27

*For Tables 14-16 all comparisons are statistically significant with two tailed *p* values at <0.001.

Table 15. National Comparison – Scotland.

Source of WEMWBS Mean Score	Scottish Population (All data)	Engineering Student Survey (All data)	Scottish Population (Age 16-25)	Engineering Student Survey (Age 16-25)
Mean	49.8	41.28	49.3	41.27
N	4251	414	532	406
SD	9.1	9.31	9.3	9.33
Difference between means (CI 95%)	[7.5996, 9.4404]		[6.8256, 9.2344]	
Cohen's *d*	0.93		0.86	

Table 16. National Comparison – Wales.

Source of WEMWBS Mean Score	Wales Population (All data)	Engineering Student Survey (All data)	Wales Population (Age 16-24)	Engineering Student Survey (Age 16-24)
Mean	51.35	41.28	50.61	41.28
N	9755	414	587	346
SD	9.43	9.31	9.65	9.4
Difference between means (CI 95%)	[9.1429,10.9971]		[8.0586, 10.6014]	
Cohen's *d*	1.08		0.98	

Table 17. National Comparison - England.

Source of WEMWBS Mean Score	England Population 2015 (All data)	Engineering Student Survey (All data)	England Population (Age 16-24)	Engineering Student Survey (Age 16-24)
Mean	51.6	41.28	50.9	41.28
N	7048	414	620	346
SD	10.07	9.31	8.47	9.4
Difference between means (CI 95%)	[9.3258, 11.3142]		[8.4593, 10.7807]	
Cohen's *d*	1.07		1.08	

*SD = Standard Deviation

CI = Confidence Interval

4.3.3 Engineering Mental Wellbeing Compared to the Student Population

An additional literature search was carried out to identify comparable data relating to student mental wellbeing. Two main sources were identified for comparison purposes Davoren et al (2013) and Alterline Being Well, Doing Well (2019). Davoren et al (2013) carried out a survey of students in their university based in Ireland and reported WEMWBS data. These students were primarily UG students from several disciplines including engineering. The sample size was 2044 and this enabled a comparison with the current survey data using the same methods as with the comparison with national data. Engineering students in the current survey reported statistically significantly poorer mental wellbeing than that of the Davoren et al respondents. It should be noted that the Davoren study is now several years old, and it is likely that factors may have changed in the intervening years. The data from Davoren and the Engineering Student Survey are presented in Table 18.

Table 18. Comparison of Engineering Students and General Student Population.

	Engineering Student Survey WEMWBS	**Davoren et al (2013) WEMWBS**	**Cohen's *d***	
Male	42.14 (SD* 9.084)	50.2 (SD 8.4)	0.92	p>0.001
Female	39.98 (SD 9.679)	49.3 (SD 8.4)	1.03	p>0.001

*SD = Standard Deviation

Alterline

Being Well, Doing Well (Alterline, 2019) was a report based on a large survey of university students across the UK. There were 12,731 respondents from 14 universities, with primarily undergraduate students responding. As the WEMWBS data from the Alterline survey was reported in percentages rather than as mean scores it was not possible to carry out the same inferential analysis as with the national general population data. The data was requested but there was no response. It was possible however to reconfigure the survey data to compare responses by calculating the percentages of responses for each question. Table 17 presents the data extracted from the Alterline 2019 survey and the results of the current survey.

Comparing the individual Likert WEMWBS statements with the data from the results from the engineering student survey shows some differences in scoring. In four of the WEMWBS statements (highlighted in Table 19), the Engineering Student Survey showed a lower percentage of respondents selecting “Often” or “All of the Time”.

Table 19. Comparison of Data Between Engineering Students and Student Respondents from the Alterline Survey 2019.

WEMWBS Statement	Data Source	Rarely/None of the Time (%)	Some of the time (%)	Often/All of the time (%)
I've been feeling optimistic about the future	Engineering Student Survey	23.6	39.2	37.2
	Alterline	22	39	39
I've been feeling useful	Engineering Student	34.8	38.4	26.8
	Alterline	27	39	34
I've been feeling relaxed	Engineering Student Survey	62.2	23.1	14.7
	Alterline	31	38	24
I've been feeling interested in other people	Engineering Student Survey	25.5	35.8	38.7
	Alterline	19	35	45
I've had energy to spare	Engineering Student Survey	51.3	28.4	20.3
	Alterline	49	31	21
I've been dealing with problems well	Engineering Student Survey	34.1	38.7	27.2
	Alterline	26	40	35
I've been thinking clearly	Engineering Student Survey	29.4	38.8	31.8
	Alterline	24	39	37
I've been feeling good about myself	Engineering Student Survey	42	33.5	24.6
	Alterline	34	36	30
I've been feeling close to other people	Engineering Student Survey	35.6	32.2	32.2
	Alterline	25	35	41
I've been feeling confident	Engineering Student Survey	39	37.8	23.1
	Alterline	33	37	31
I've been able to make up my own mind about things	Engineering Student Survey	19.5	27.6	52.8
	Alterline	16	30	54

I've been feeling loved	Engineering Student Survey	25.6	30.1	44.4
	Alterline	18	31	51
I've been interested in new things	Engineering Student Survey	27.7	30.8	41.6
	Alterline	24	32	45
I've been feeling cheerful	Engineering Student Survey	36	38.5	25.4
	Alterline	18	40	38

One statement, *I've been feeling relaxed*, showed both data sets having negative responses, however the Engineering Student Survey responses showed a much higher percentage of negative responses (62.2%) compared with the Alterline responses (31%).

4.3.4 Comparison of WEMWBS Mean Scores by Academic Stage and Gender

At academic stage level the mean scores of respondents showed that apart from Stage 3, female students reported poorer mental wellbeing than their male counterparts. This was particularly noticeable in years or Stages 2 and 4, Student T-Tests (Mishra et al, 2019b) between male and female students, at each stage were calculated (Table 20).

No statistically significant differences were found between male and female WEMWBS mean scores at any stage at $p<.05$. (Stage 1: $P= .081$, Stage 2: $P=.053$, Stage 3: $P = .311$, Stage 4 $P = .094$, Stage 5: $P =.895$, Postgraduate: $P = 0.349$)). Respondents who selected non-binary as their gender were not included in this comparison due to small sample size (n=6).

Table 20. WEMWBS Mean by Stage and Gender.

Stage	**1st**		**2nd**		**3rd**		**4th**		**5th**	
Mean * significant difference to 1st year.	43.7		39.5*		39.6*		40*		40.6	
Gender	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
Mean	45.5	41.8	41	36.2	39	40.7	41	37	41	40.6
n (345)	51	30	47	18	55	25	56	22	17	15

The mean WEMWBS scores for all stages represented in the survey data are all below the notional threshold for possible depression with 3 stages (2nd, 3rd, and 4th) meeting the threshold for probable depression (<41). The difference in WEMWBS means between stage 1 and stages 2, 3, and 4 were found to be statistically significant (*P*= .006, .005 and .012 respectively). However, a statistically significant difference was not found between stages 1 and 5.(*P*=.117). This means that students in Stages 2, 3, and 4 had significantly poorer mental wellbeing than students in Stage 1.

4.3.5 Sub disciplinary Differences in Mental Wellbeing

Electrical and Electronic engineering students reported the poorest mental wellbeing in the survey, with Aeronautical students reporting the best mental wellbeing with the highest mean at 46.27. All scores were below the UK national population norms. Table 21 shows the WEMWBS means by discipline as outlined by HESA category. It should be noted that some subdisciplines represented in the data are small samples and further data is required before any meaningful conclusions can be drawn.

Table 21. WEMWBS Means by Subdiscipline.

Subdiscipline	WEMWBS Mean	Standard Deviation	N Respondents
Aeronautical	46.27	11.37	11
Architectural	42.67	13.47	6
Chemical	41.14	9.16	14
Civil	43.51	9.14	51
Electrical and Electronic	40.14	8.86	88
General	40.75	7.78	44
Mechanical	40.94	9.4	143
Motorsport	44.5	11.03	4
Other	40.69	9.55	45
Production	42.5	12.76	8
All Disciplines	41.28	9.31	414
Scottish Mean (2019)	49.8	9.1	4251

While the sample sizes for some of the disciplines were small, it was possible to carry out basic statistical analysis to compare the disciplines with each other. A Two-Tailed test for statistical significance was carried out to show the p-values of compared subdisciplines.

There was a statistically significant difference between the means of both Aeronautical and Civil Engineering and Electrical and Electronic Engineering at $p<0.05$:

- p=.039 and Cohen's d = 0.6 (medium effect size) between Aeronautical and Electrical and Electronic
- p=.034, Cohen's d = 0.37 (small effect size) between Civil and Electrical and Electronic).

There was no statistically significant difference between any other subdiscipline mean or between a subdiscipline mean and the total mean of the engineering student survey results.

For the subdisciplines with larger sample sizes, a comparison of wellbeing means by gender was carried out. In the Electronic and Electrical discipline, the WEMWBS mean for female students was statistically significantly lower than the mean for male students (p =.037). In the Mechanical subdiscipline there was no statistically significant difference between male and female student mean scores.

4.4 The Mental Health of Engineering Students in the UK

Respondents were asked if they had ever been diagnosed with or treated for a mental health condition. Of the 417 who answered this question, 69% (n=286) did not report a mental health condition, 28% (n=118) stated they had and 3% (n=13) selected "prefer not to say". Female respondents reported having been treated or diagnosed for a mental health condition in greater numbers than male respondents (40.7% (55 of 135 female respondents) versus 22.14% (60 of 271 male respondents) respectively). Figure 18 shows the breakdown of results for self-reported mental health conditions of the respondents. A comparison of the mean WEMWBS scores with self-reported mental health condition showed that there was a statistically significant (p<.00001) lower wellbeing score of those who reported having been diagnosed or treated for a mental health problem, compared to those who did not. The effect size of this difference was calculated to be d=0.52 which is considered to be a moderate effect size.

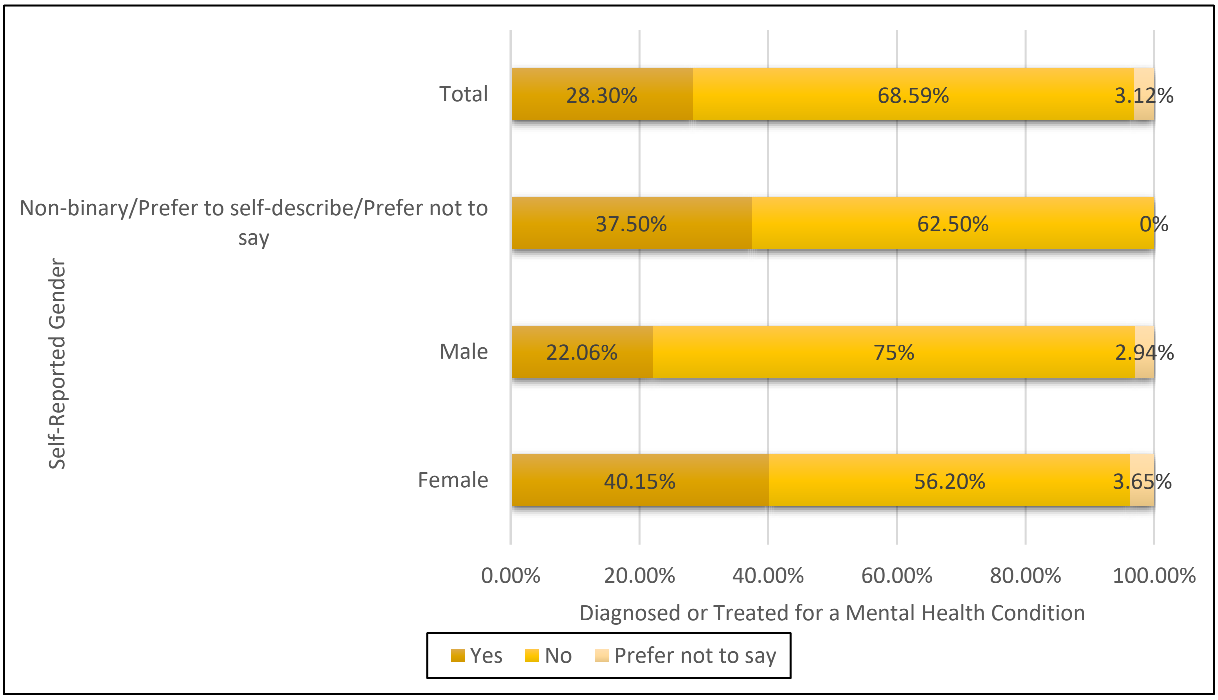

Figure 18. Self-Reported Mental Health Condition by Gender.

When comparing the different engineering disciplines, the sample sizes for some are small and so proportions are more exaggerated. However, there is a difference between the reports of diagnosis and or treatment between the Electrical and Electronic discipline (34.09%, 30 of 88) and the Mechanical discipline (26.9%, 39 of 145). This adds to and is supportive of the lower mental health data reported for students of Electrical and Electronic engineering (Deziel, 2013). Figure 19 shows the breakdown of self-reported mental health problem by discipline.

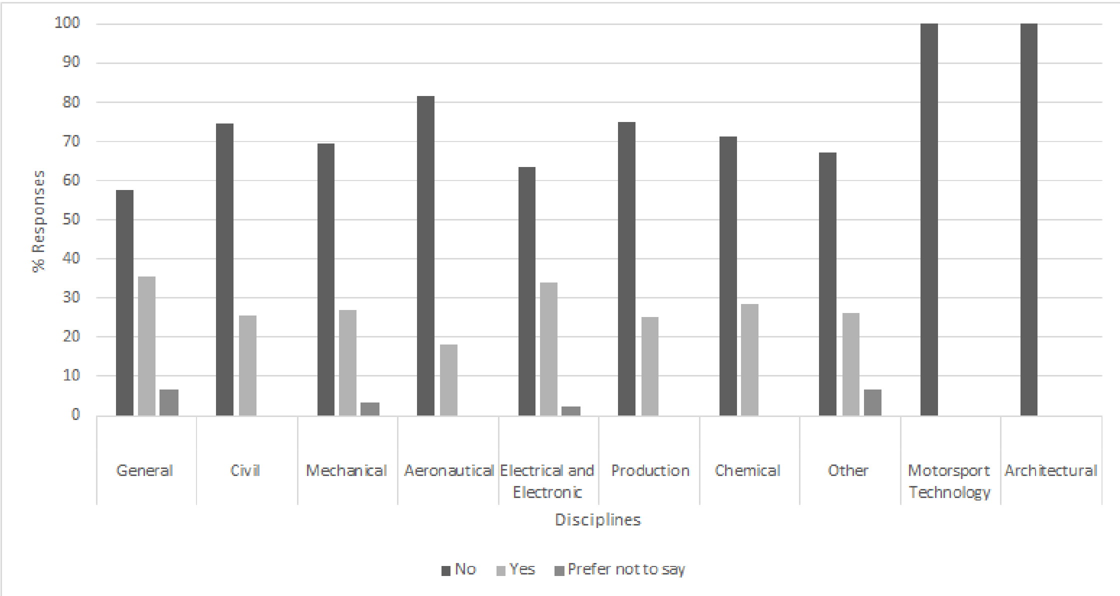

Figure 19. Self-Reported Mental Health Condition by Discipline.

Respondents were asked to share details of their mental health condition. Of the 118 that reported having a mental health condition, depression was the most common (70.34%) anxiety (66.95%) and both depression and anxiety (34.75%). Table 22 shows the breakdown of self-reported mental health problems.

Table 22. Self-reported Mental Health Problems.

MH Condition	No. of Respondents	% of those reporting a MH Condition (n=118)	% of all Respondents (n=417)
Depression	83	70.34%	19.90%
Anxiety Disorder	79	66.95%	18.94%
Anxiety and Depression	41	34.75%	9.83%
Multiple (more than 3 conditions)	17	14.41%	4.07%
ADHD (Attention Deficit Hyperactivity Disorder)	6	5.08%	1.44%

OCD (Obsessive Compulsive Disorder)	5	4.24%	1.20%
Bipolar Disorder	4	3.39%	0.96%
Eating Disorder	4	3.39%	0.96%
ASD (Autism Spectrum Disorder)	2	1.69%	0.48%
BPD (Borderline Personality Disorder)	2	1.69%	0.48%
PTSD (Post-traumatic Stress Disorder)	2	1.69%	0.48%
Prefer not to say	5	5.08%	1.20%

For 1st year university engineering students 19% (4 of 21) were diagnosed or treated for the first time during their first year of study with the remaining 17 having entered university with a pre-existing mental health condition, having completed this survey 5 months into their studies. Table 23 shows the number of respondents by stage and when they were first diagnosed or treated.

In the later stages of study, 14.7% (10 of 68) of 2nd year engineering students, 18.1% (15 of 83) of 3rd year students, 14.1% (11) of the 78 4th year students and 21.2% (7) of the 33 5th year students were treated or diagnosed during their time at university. Just under half of the 118 respondents (49.15%) reported having been diagnosed or treated in the 24 months before the survey.

Table 23. Self-reported time since diagnosis.

How long ago were you first diagnosed/treated?	0-3 months	4-6 months	7-12 months	13-24 months	2-5 years	> 5 years	Total
1st year College	0	0	1	0	1	3	5
2nd year College	0	0	1	1	1	1	4
1st year UG	1	3	4	3	8	2	21
2nd year UG	1	2	6	1	6	2	18
3rd year UG	0	5	3	7	9	6	30
4th year UG	3	1	2	5	5	4	20
5th year UG	1	0	3	1	2	2	9
1st year PG	1	0	0	1	0	1	3
2nd year PG	0	0	0	0	3	0	3
Pre-Transfer PhD/EngD	0	0	0	0	2	0	2
Other	0	0	0	1	1	1	3
Total	**7**	**11**	**20**	**20**	**38**	**22**	**118**

In relation to mental health management, 36.44% (n=43) respondents felt they managed their condition well or very well, but 27% (n=32) felt their condition was poorly or very poorly managed with the remaining 36.44% (n=43) unsure.

Figure 20 shows a comparison of the respondents WEMWBS scores and their self-reported Mental Health. It is not possible to infer causality, but regardless of whether there was a mental health problem reported or not, 64% (75 of n= 118) of those who had been diagnosed or treated for a mental health problem and 41% (115 of n=283) of those who had not, scored in the lowest WEMWBS range, indicating probable depression. Of those who scored in the highest range, there were no respondents who had reported being diagnosed or treated for a mental health problem.

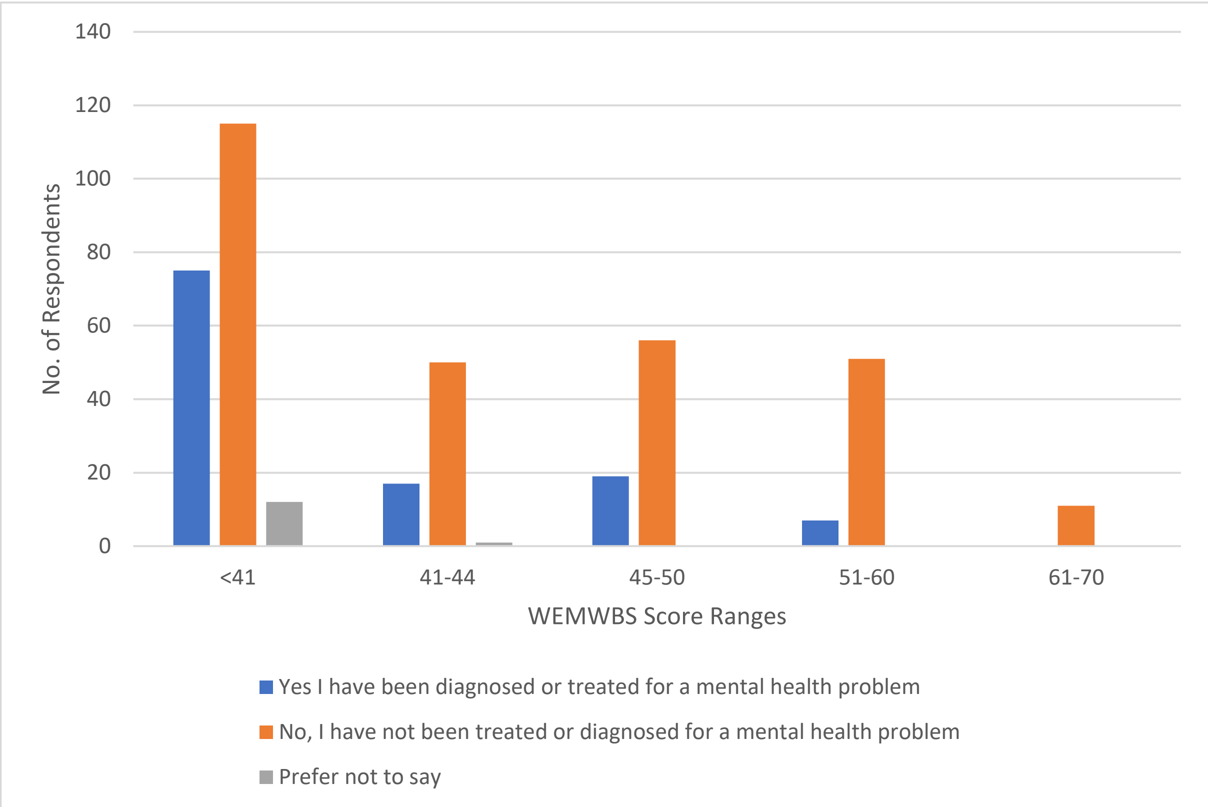

Figure 20. Comparison of Warwick Edinburgh Mental Wellbeing Scores with Self-Reported Mental Health Problem.

4.5 Student Views on Reaching out to Engineering Staff

Of respondents who reported a mental health condition, 10% (n=12) had shared this information with a lecturer. 76.2% (n=90) had shared with a friend, 75% (n=88) had spoken with their parents or guardian, 17% (n=20) reported they had shared their mental health condition to a personal tutor, and 10% (n=12) reported sharing this information with a course administrator. A small proportion, 6.78% (n=8) had not shared their mental health condition with anyone. Over half of respondents (53.2%, n=222) stated they would not talk to a member of engineering staff if they were feeling low or mentally unwell with a quarter (24.7%, 103) stating they would. The remaining 22% (n=91) selected “unsure”.

Of the 118 respondents reporting having a mental health condition, 28% (n=33) would reach out to a member of staff in their School of Engineering if they were feeling low, 29% (n=34) were not sure, and 43% (n=51) would not. Of the 286 students who did not report having a mental health condition, 23% (n=66) said they would reach out to a member of staff in their School of Engineering if they were feeling low, 19% (n=54) were not sure, and 58% (n=163) would not. In the open question asking the reason for their answer 252 respondents provided comments with 84 comments relating to who they would prefer to reach out to.

Figure 20 shows the frequency count of open text comments naming someone they would prefer to reach out to with friends or family being the most popular choice. There were several respondents (n=23) who said they would rather deal with it themselves or that they were not comfortable to speak to anyone at all.

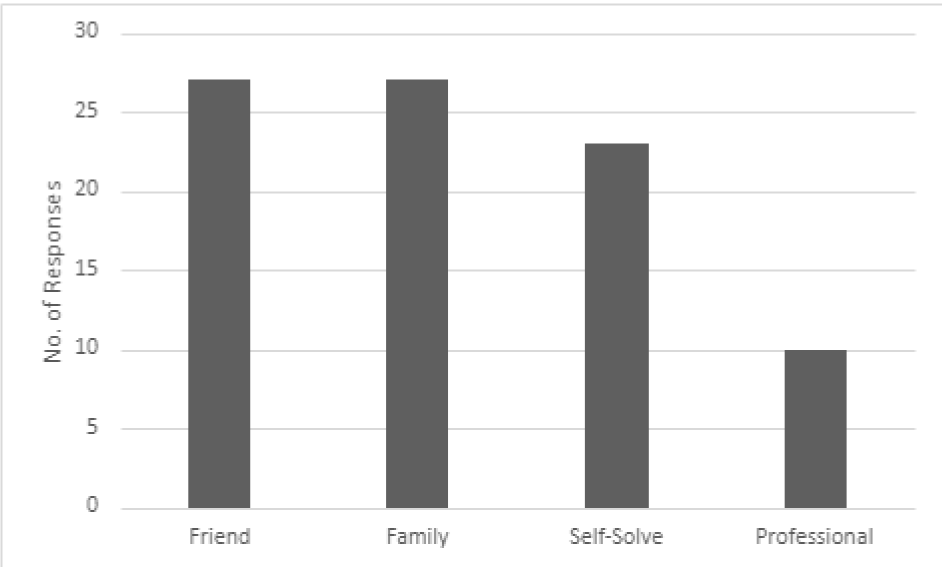

Figure 21. Respondents Preferred Person to Speak to about feeling mentally low.

Respondents were asked to explain their reasons for or against talking to a member of engineering staff with 263 responses recorded for this free-text question. While over half (58%, n=163) would not seek help from a lecturer there were positive behaviours reported around help seeking in reaching out to friends and family with 15.6% of respondents (n=41 of 263) preferring to speak with friends or family rather than engineering staff. Figure 21 shows the number of responses against reasons described in the open text question.

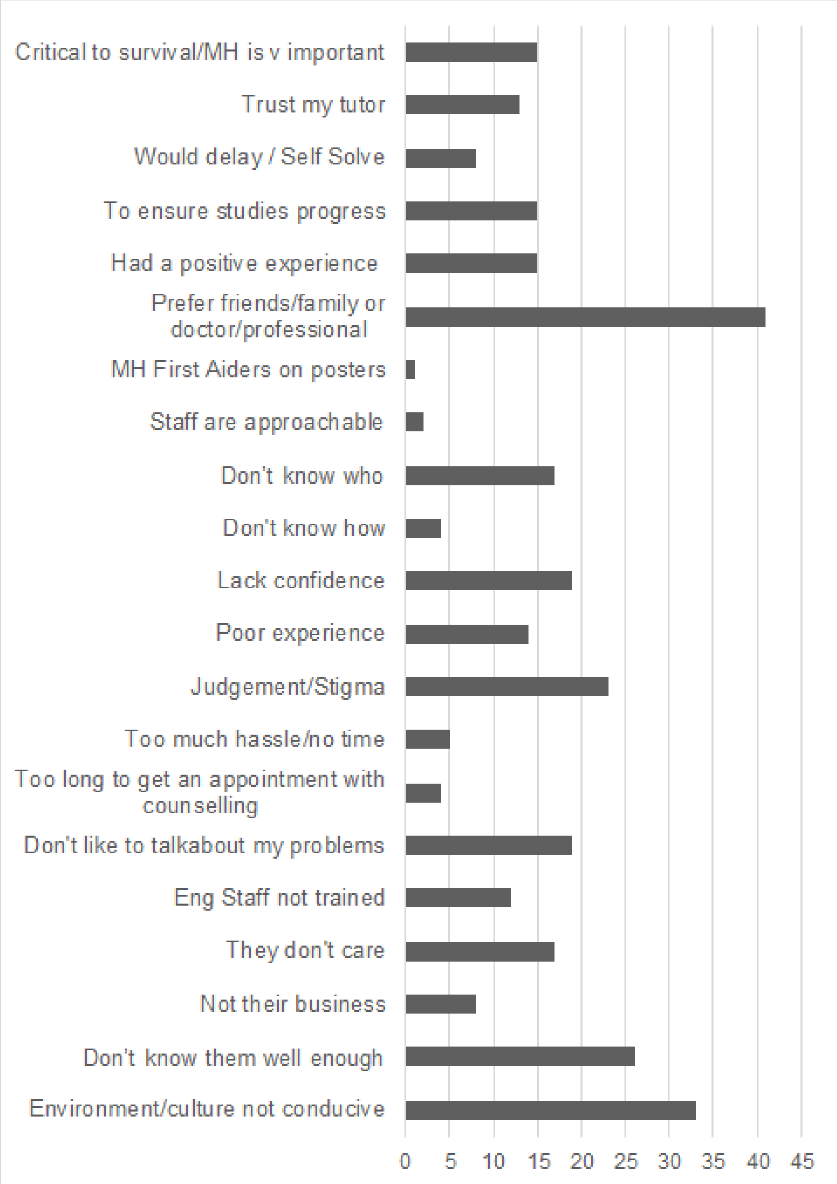

Figure 22. Reasons for and against helpseeking from the university/staff.

A small number of respondents 1.5% (n=4) reported not feeling able to say what they wanted to say, or not knowing how to start that kind of conversation, and 6.5% (n=17) did not know who they were supposed to ask for help. Some respondents 7.2% (n=19) reported not wanting to talk about their own problems or bother staff with their issues. One responded explained others need is greater: "*I wouldn't talk to anyone if I was because I wouldn't want to cause any issues or for people to spend their time on me instead of people who need it more.*"

4.5.1 Experiences of Helpseeking

Respondents who had previously disclosed to academic staff regarding their mental health (n=14) commented on poor experiences. One participant commented: *"We were told at the* *beginning of 1st year that if we have a problem to 'man up' and deal with it"* in relation to mental wellbeing, setting the tone that this was something not to be discussed.

Others reported similar negative interactions had put them off reaching out for help:

"Because I don't feel staff care very much. I was upfront last year when they emailed threatening to start de-registration process and told them I was struggling, and a lecturer basically said okay but I don't believe you so doesn't put much trust in staff."

Conversely, 14 participants found they had had positive experiences in relation to both their personal tutor experiences: *"I have a very good personal tutor who has already given me his time to have a conversation over such issues"*, and staff support in general:

"You can see staff have your best interests at heart and would readily offer advice to help".

But while there were positive experiences there was a recognition that this is not always the case: *"A very supportive department and supervisor. So I was lucky."*

4.5.2 Lack of Trust

Participants commented about lack of familiarity with engineering staff and the feeling that engineering staff were not approachable or the culture was not welcoming. Others simply stated that engineering staff did not or would not care.

"I think if anything I would have approached friends or family first before uni staff members, plus there just isn't much of the members around that I could feel comfortable having personal conversation with (since we're encouraged to be "professional" students and all), and these topics would just seem out of place if brought up and probably will get redirected anyway."

Fear of repercussion was also raised with one participant stating they would be concerned about information on their mental state being made known to employers. Judgement and stigma were major concerns for 8.7% (n=23) of respondents. *"I don't feel close the members of staff at my Uni. Since mental illness can be misunderstood and I've been judged for it before I would rather not talk to them about it."* However, 5.7% (n=15) felt that it was important to have issues raised to ensure they progressed with their studies and 5.7% (n=15) stated they had had a positive experience and would do this again.

Trust appeared to be a factor in whether or not the respondents would reach out to an engineering staff member. There were 13 individual comments about feeling able to speak to personal tutors or supervisor because respondents trusted them. *"Depends on the trust I have to said person, or if I believe I can deal with the situation myself."* Self-solving or not causing problems for others was mentioned in 23 comments related to help-seeking. Not appearing weak was mentioned: "*I prefer to deal with my own mental health problems myself, in the past if I've been upset or whatnot it's usually alone time that helps me to get back to the straight and narrow*," and *"I would like to think I would [ask for help], but I can imagine that I would likely just try and deal with it myself*."

4.5.3 Culture of Stigma

Comments provided by participants described a culture of silence and stigma when it came to mental health and wellbeing support in engineering departments: "*They wouldn't understand. They might think I'm weak or would think lesser of me as a person."*

Reluctance to talk about problems was also reported with participants not feeling comfortable with people they don't know well, or fear of being judged *"I feel it is risky to talk about your mental health condition, because a lot of people tend to judge you only on your condition".*

Lack of time was also raised as a concern (n=9) both from the point of view of the student: *"I've tried contacting the well-being department and they're overbooked and I believe there are people who struggle more than me and they should get help before me because I manage so far"* and from the point of view of the staff: *"it seems like not many of the engineering tutors would have time for something like that/have helpful advice."*

4.5.4 Normalisation of Stress

Some comments indicated a normalisation of stress, with one in particular saying: "*We were told at the beginning of 1st year that if we have a problem to 'man up' and deal with it."* Another comment related to feeling like everyone else was managing with the stress: *"Also feels stupid to breakdown to someone within the school when every other student is going through same thing and coping".* One respondent suggested that given engineering is all about solving problems perhaps more could be done to support mental health within a department: "*unfortunately engineering types aren't considered to be the people most open with their emotions. But think of the intelligent conversations we could be having as part of the wider science department about mental health among students (and staff), our department is all about intelligent solutions and should be doing more to lift the stigma."*

4.6 Engineering students' views on keeping mentally well

Respondents were asked how important they felt looking after their mental wellbeing was and why. Of 414 respondents for the question, the majority of students felt this was important

(79%, n=327) with 41% of the 327 (n=170) reporting it as "absolutely essential". However, just over a third (34%) of 417 respondents reported either rarely or not looking after their mental wellbeing at all in the previous 2 weeks, with 7.4% (n=156) reporting sometimes doing something to look after their mental wellbeing and 28.5% (n=119) reported often looking after their mental wellbeing or looking after it most of the time (Figure 23). Interestingly, 142 respondents seldom or did not do anything in the previous two weeks to support their mental wellbeing while at the same time considering looking after their mental wellbeing to be important or absolutely essential.

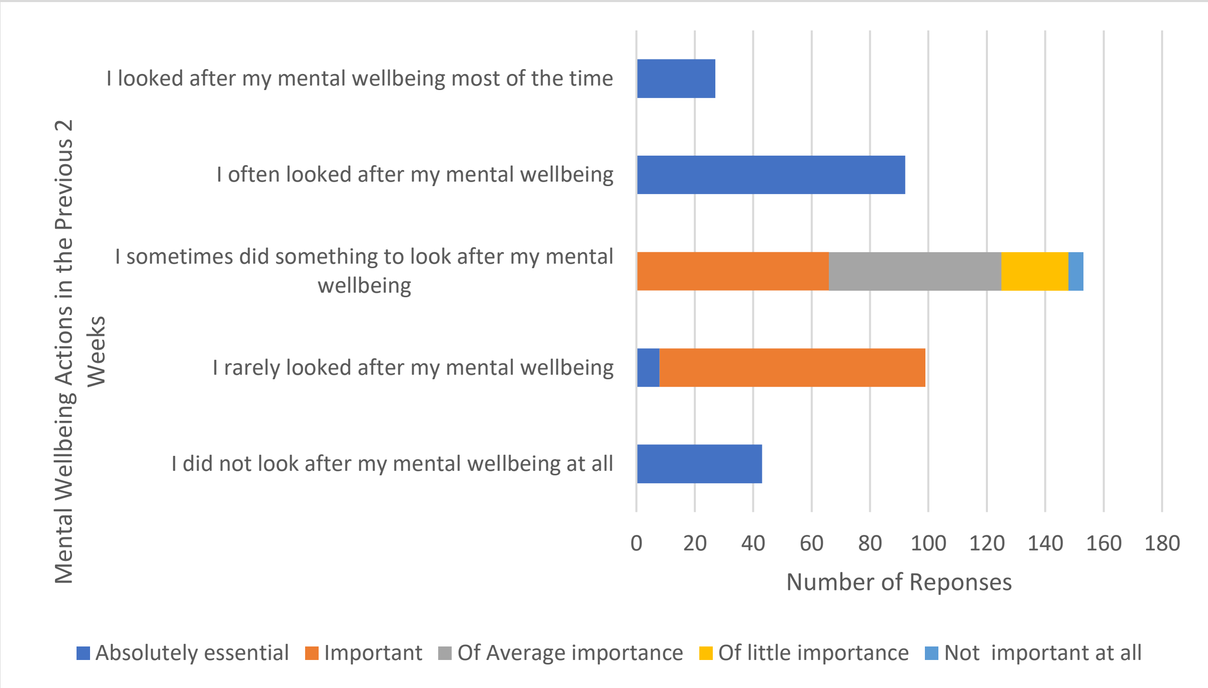

Figure 23. Attitudes and Actions Related to Mental Self-Care.

Additionally, there were 222 free text individual comments for this section relating to the importance of self-care. These were tabulated and categorised into higher level codes to support description (Figure 24). Some open text comments were coded to more than one category where appropriate. Some comments (n=63) linked poor mental wellbeing with poor performance or productivity in their studies. Many (n=188) considered mental health and wellbeing to be important). Linking mental health and wellbeing and ability to function was mentioned by 66 respondents. A small number of respondents (n=3) disclosed a friend had died by suicide with a further two commenting that they considered not looking after mental wellbeing to be potentially fatal. Another participant considered looking after their mental wellbeing to being critical to their survival. Some respondents' comments (n=29) related to work/study being more of a priority and others (n=23) noting that other things are important. There were 11 respondents who felt self-care was unimportant or less important. Comparisons were made to the importance of maintaining physical health (n=16). Lack of time was raised by 18 respondents as a reason for not seeking help for issues relating to mental health and wellbeing.

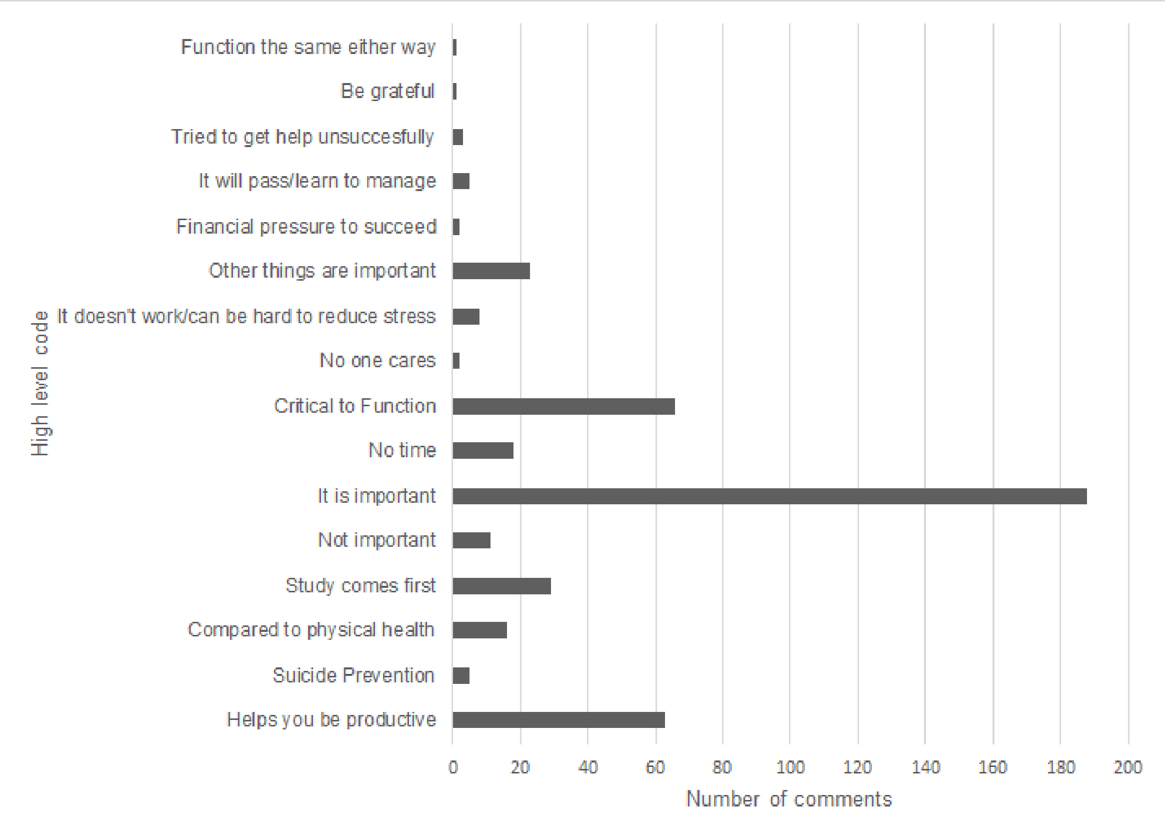

Figure 24. Responses to "Why is it important (or not) to look after your mental health and wellbeing?

4.6.1 Activities in the Previous Two Weeks

Respondents were asked to reflect on their activities and behaviours from a list over the previous two weeks. Table 24 details the responses. As the questions were all optional there is a slight variation in total responses between questions. The responses are given in percentages.

The questions related broadly to four themes: physical health and activity, entertainment, creativity, and connection. Over half (56.4%, n=233 of 412) reported exercising alone sometimes or more often in the previous two weeks, with 46.7% (n=192 of 411) reporting exercising with others.

There were mixed responses relating to eating habits with nearly 40% (165) reported often eating unhealthily but 44.6% (n=185) reported often eating healthily. Over half of respondents (59.27%, 243) reported sleeping very little either sometimes or more frequently, and 8.8%

(n=36) smoked or vaped and 27.7% (n=115) drank alcohol often or all the time. Worryingly, 14.3% (n=59) of respondents reported self-harming in the previous two weeks, with 1.46% (n=6) reported to have self-harmed frequently.

Most engineering students (77.78%, n=322) listened to music often or all the time with smaller proportions watching television or films and playing computer games. Most students did not appear to have a creative outlet (from the selection offered) with very few reporting writing or playing music, or making art. In terms of connection, over half (51.94%, n=214) had often spoken with friends or family in the previous 2 weeks, and 5.94% (n=12) students reported often or frequently meditating.

Table 24. Activities in Previous Two Weeks.

Activity (No. of Responses)/ % Frequency	Often or All the Time	Sometimes	Rarely or Never
Physical Health			
I exercise alone - 412	29.85%	26.70%	43.45%
I exercise with others - 411	26.76%	19.95%	53.28%
I eat healthy food - 413	44.55%	38.98%	16.46%
I eat unhealthy food - 411	40.15%	39.42%	20.44%
I sleep a lot - 412	36.17%	33.98%	29.85%
I sleep very little - 410	29.27%	30.00%	40.73%
I smoke/vape - 405	8.89%	7.65%	83.46%
I drink alcohol - 412	27.91%	31.80%	40.29%
I take non prescribed drugs - 412	4.85%	9.71%	85.44%
I self-harm - 410	1.46%	5.12%	93.41%
Entertainment			
I play computer games alone - 413	21.55%	17.92%	60.53%
I play computer games with others - 412	14.08%	18.20%	67.72%
I play board games - 410	3.17%	20.24%	76.59%
I read - 408	21.32%	30.15%	48.53%
I listen to music - 414	77.78%	15.94%	6.28%
I watch tv/films - 414	58.70%	29.71%	11.59%
Creativity			
I play music - 411	15.82%	12.90%	71.29%
I write music - 410	4.15%	4.15%	91.71%
I write - 408	10.05%	12.50%	77.45%
I make Art - 412	6.31%	10.44%	83.25%
Mindfulness/Connection			
I meditate - 411	5.84%	11.92%	82.24%
I talk with friends or family - 412	51.94%	32.28%	15.78%
I talk to a counsellor - 411	3.65%	6.08%	90.27%
I go to a place of religious worship - 410	6.34%	5.61%	88.05%

Respondents were also asked to report how often they had looked after their mental wellbeing in the previous two weeks. Figure 24 shows the spread of the 414 responses. There is a slight skew in the responses with 34.3% (n=142) respondents saying they either rarely or did not look after their mental wellbeing in the previous 2 weeks, and 28.7% (n=119) saying they either often looked after their wellbeing or looked after it most of the time. Female respondents reported slightly more self-care in the previous 2 weeks than male students (Figure 25).

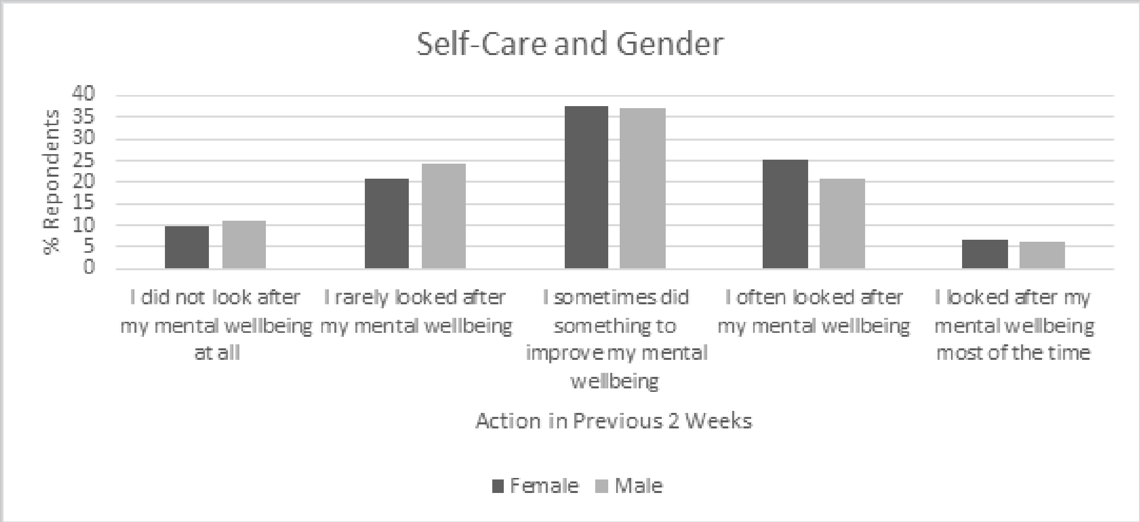

Figure 25. Comparison of Gender and Action Related to Self-Care.

Comparing these responses with the WEMWBS mean score for respondents demonstrated those who reported looking after their mental wellbeing "not at all", "rarely" fell below the threshold for probable depression. The WEMWBS mean score for respondent "sometimes" looking after their mental wellbeing fell below the threshold for possible depression (Figure 26). The mean score for respondents saying they looked after their mental wellbeing most of the time (50.48) is comparable to the national population norms of adults in Scotland.

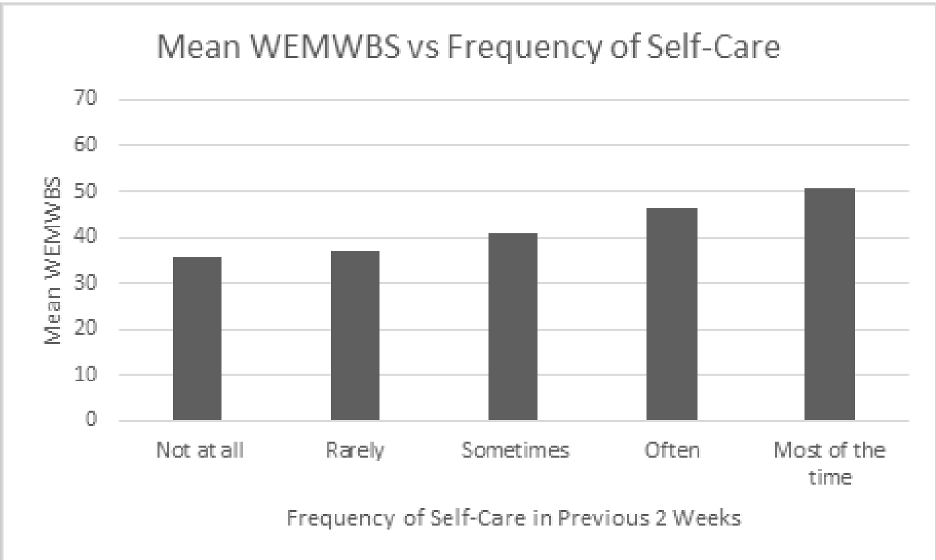

Figure 26. Mean WEMWBS Score vs Frequency of Self-Care.

Of the 43 respondents who reported rarely or not looking after their mental wellbeing in the previous two weeks, there were reports of activities that may be viewed as supporting mental wellbeing. For example, 60.47% (n=26) of the 43 respondents reported exercising alone and

51.16% (n=22) of the 43 reported exercising with others at least sometimes during the previous 2 weeks.

4.6.2 Advice to New Engineering Students

As a final question, respondents were asked to share advice to new engineering students and 76.74% (n=320) of the 417 respondents provided comments (Figure 27).

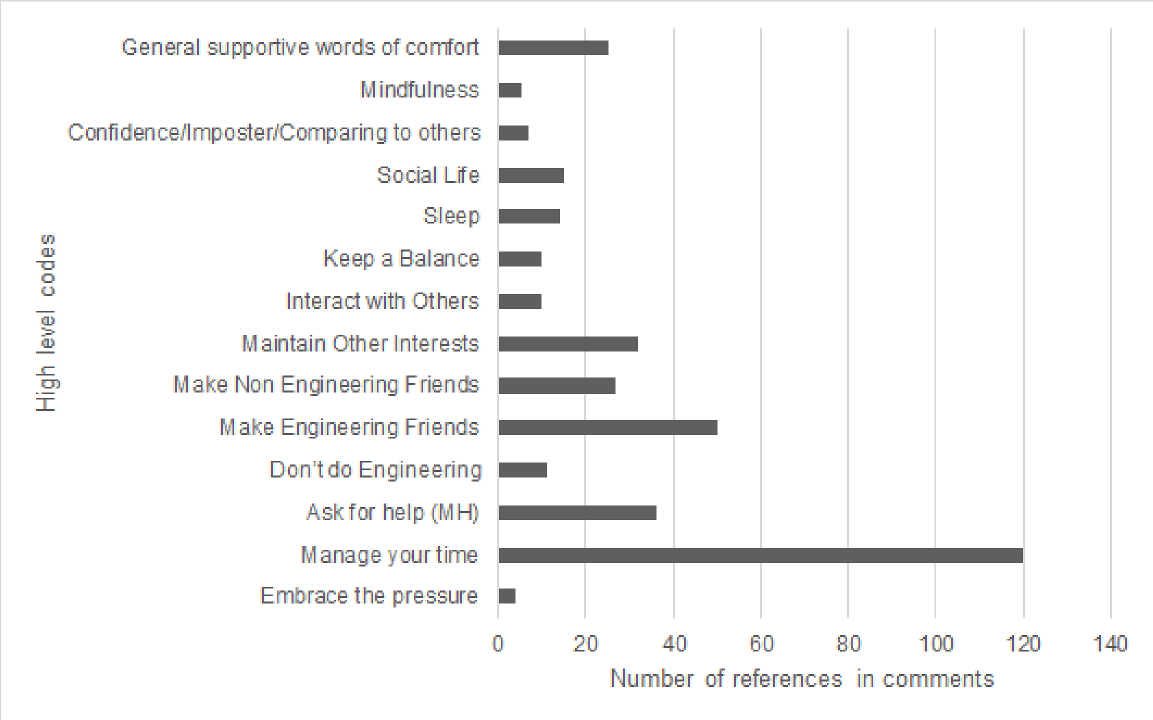

Figure 27. Advice to New Engineering Students.

Many (19% n=120) comments related to time management, organisation, and keeping on top of deadlines. A selection of representative quotes from the data are as follows:

- *To keep on top of the workload and if you all fall behind, don't beat yourself up and just leave that work until you have a moment instead of getting so stressed;*
- *Stay on top Of your work. As it's a quick snowball of stress;*
- *Keep on top of your workload from the start, do a little bit every day so you don't fall behind and get stressed;*
- *Do work when it's given to you, consolidate learning immediately: it's too much to cram at the last minute and you WILL burn out;*

Making friends was the next most common advice with 12% (77 comments, 50 of which advising making friends with people studying engineering, as they would share a common understanding, and 27 comments recommending making friends with others outside the subject).

- *Have a person you trust who you like to listen to, and who listens and hears you and never belittles or tells you 'just brush it off' kind of stuff when you talk about your mental health*;
- *Find societies and clubs to make friends in, engineering really doesn't support socialising with others so there's little opportunity to find people you'll trust to look after you;*
- *Also, be honest with your peers about how you're feeling, as it's very likely they're feeling the same;*

Taking time for yourself and maintaining a routine (13%, n=67) was the third most common suggestion with suggestions to get enough sleep: "*Getting enough sleep is very important + also giving yourself some time off"*, to socialise: "*socialise frequently(societies/clubs can allow you to do this), give yourself downtime to relax, spend some time being creative".* and exercise: "*make sure to have plenty of breaks to avoid burn out and to balance your lifestyle with exercise and socialising."*.

Mindfulness or meditative activities were mentioned once both indirectly: "*Set yourself some time to think about yourself and no one else. Like 15 mins before bed of actively thinking about you as an entity. Not about work or learning. Just your body and mind",* and directly: *"Engineering is very stressful. Meditations helped me get out of the stress and focus on my studies. I'd recommend meditating. But every person is different."*

Asking for help appeared less frequently in the comments, (7%, n=36) with different suggestions on who to approach: "*If you are feeling down and it's having significant impact on your daily life, talk to someone (a GP, personal tutor, parents/guardians etc.) because that can take a lot of weight away from your shoulders",* and when: "*Reflect on yourself, see why you may not be interacting with others or why you may not want to. Think about how you were when you are younger compared to how you are now. Do you have habits and are antisocial or anxious and over think everything? Speak to someone, doesn't have to be close to you! If they seem worried, then get professional advice. I couldn't see how bad things were until the people closest to me told me to seek help. The best thing I did was listen to them".*

4.7 Discussion

The online survey was conducted to identify the mental health and wellbeing in the UK engineering student population, to identify help-seeking behaviours and explore their habits and activities in relation to mental health and wellbeing.

The research questions were:

1. What is the mental health and wellbeing of engineering students in the UK?
2. What are the mental health help-seeking behaviours of engineering students in the UK?
3. What are the approaches to mental wellbeing utilised by engineering students in the UK?

In addition, respondents were asked to share advice for new students on what they felt supported their mental wellbeing.

4.7.1 The Respondents

The respondents were primarily full-time undergraduate students from a range of engineering disciplines, the largest number being mechanical engineering students. There is an over representation of female engineering students (32.85 %, n=137) compared to UK national data (20.4% n=37,965, HESA, 2023).

4.7.2 The Mental Health and Wellbeing of Engineering Students in the UK

The results of this Mental health and wellbeing survey identified UK engineering students have statistically poorer mental wellbeing than the general Scottish and English populations, and also in comparison to UK general student populations and an institution in Ireland.

The comparison with data from Alterline (2019) and other institutions supports the suggestion that Engineering students experience poorer mental wellbeing than the general Higher Education population in the UK. It was also found that students on Electronic and Electrical courses appeared to be experiencing poorer mental wellbeing than the other engineering disciplines which supports Deziel's (2013) findings.

Female engineering students reported poorer mental wellbeing than their male counterparts and there was also an over-representation of female engineering students in the data. As it has been reported in existing literature, (Deziel, 2013) female engineering students report poorer mental wellbeing than their male peers, a comparison was carried out to establish if the current survey data supported this. As reported earlier, a comparison of male and female means in the survey showed a statistically significant difference at subject level.

4.7.3 Mental Health Issues

Of the 417 respondents, 118 (28%) reported having been diagnosed or treated for a mental health condition in the past, with higher reports coming from female respondents. In Scotland, the estimated proportion of people experiencing a mental health problem is approximately 1 in 6 (Health Scotland, 2021) whereas in England it is estimated to be 1 in 4 (NHS England, 2021). As there is a risk of over representation of people with poor mental wellbeing by self-selection for the survey it is not prudent to draw any meaningful conclusion other than reports of mental health problems appear to be similar to UK population norms being between 20 and 33%. Comparing the WEMWBS mean scores with responses relating to mental health conditions it is perhaps unsurprising to see that those who have been diagnosed or treated for a mental health condition had lower mental wellbeing. This finding supports Cruwys and Gunaseelan's (2016) assertion that identifying as having depression is a predictor for lower wellbeing. It is possible that additional support would improve wellbeing outcomes for engineering students with existing mental health conditions.

Depression was the most commonly reported condition, with anxiety second. Other reported conditions were few and far below accepted population norms, for example ADHD (Sayal et al, 2018) norms are between 2-5%. This could be a result of the self-report approach of the survey. Published literature measuring mental illness in engineering students reports higher prevalence of PTSD symptoms in engineering students (Danowitz and Beddoes, 2018) at 18.2% of the study participants.

Given that 13% of the respondents selected "prefer not to say" when asked about mental health problems, and that the open text answers contained many comments about lack of trust and indicating stigma, it is possible this question under-represents the extent of mental health issues in the group of respondents. Unfortunately, with over-representation from female respondents and the low response rate, it is not possible to claim generalisable findings. If the results are indicative of the wider engineering student population, it is possible that engineering students in the UK experience mental health problems in similar proportions to the general population and in some cases potentially experience fewer mental health problems or illnesses overall.

Lastly, from the responses on time since diagnosis many of the students were first diagnosed or treated during their engineering studies. There may be an opportunity to highlight additional support to engineering students who are experiencing mental health problems particularly in first year when students are often away from home for the first time.

4.7.4 Engineering Students' Mental Health Help-Seeking

Help-seeking behaviour reported was largely through friends and family, with a reluctance to approach engineering staff for support. A number of reasons were put forward for this reluctance including poor past experiences, lack of trust, and stigma. There was a clear preference for self-solving i.e., dealing with the problem without speaking to anyone and an indication that the academic engineering culture was felt to be inhospitable in terms of feeling able to reach out. Others felt it was not the engineering staff's role to support mental wellbeing and that this was something best left to "a professional."

Some respondents reported having had poor experiences when approaching engineering staff in relation to mental wellbeing, preventing them from considering that again. There are opportunities here to amplify existing support mechanisms within institutions, provide mental health first aid training to engineering staff and to develop a more inclusive culture in Schools of Engineering where students feel able to ask for help when they need it. Those who responded positively to asking for help from engineering staff said they had had positive experiences from supportive staff members, whereas others who had tried in the past were put off doing so because of a negative experience.

There is a clear need for improved signposting and awareness of the types of help available in Schools of Engineering and their respective universities. From the open text questions, a few respondents alluded to student counselling not being particularly desirable as they were not "one to talk about feelings." This points to a misconception about what counselling involves.

There is an opportunity to create better understanding of the benefits of counselling and the counselling process, particularly as counsellors work with students to help them become self-sufficient (NHS, 2020) and that engineering students in the main do have a preference of self-solving their problems.

4.7.5 Engineering Students' Approaches to Mental Wellbeing

The findings suggest that the respondents felt that looking after mental wellbeing was important, but this was not clearly reflected in their reported actions to support mental wellbeing in the previous two weeks, with around a third (34%, 142) of the 414 respondents stating they rarely did anything to support their mental wellbeing. Interestingly 43 respondents said they did nothing at all to support their mental wellbeing, but some did report taking part in exercise and socialising with friends. It is possible that some of the respondents did not consider exercise as a specific mental wellbeing activity. It could also be seen that the WEMWBS mean score of those who looked after their wellbeing "Most of the time" was better than those who reported not doing so and was similar to general population norms.

In the open text questions, there were indications that respondents felt often that Engineering is particularly hard and that the culture of engineering is to not be open about mental health or wellbeing problems. This should be explored in phase two of the study.

4.8 Limitations

It is important to note there are several limitations related to the survey and results. With regards to recruitment, much effort went into raising awareness of the survey, through radio interviews, networking with gatekeepers, support from PSRBs and industry publications. Despite these efforts and despite there being widespread agreement of the importance of the research from Engineering schools, it was hoped that there would be a higher number of respondents. The lower than anticipated response rate impacted the depth to which some of the analysis could be carried out, for example, comparisons between different engineering disciplines and generalisation of the results. All stages and main engineering disciplines were represented in the data, but in some cases, for example Motorsport, in very small numbers.

Another limitation was in the selection of which Stage a respondent was in. In Scotland, for MEng students, this is most often a 5-year course, with BEng being 4 years. However, there does exist a fast-track route which could mean an MEng student in 4^{th} year was actually in their final year. Similarly, in England and Wales, an engineering MEng will be 4 years' duration with BEng 3 years. It would have been prudent to ask the respondent in which country their course was. While this may not impact significantly on the data it is not possible to identify if a student was in their "final" year just by looking at the Stage number. Additional work in this area would be needed to study the impact of Stage or Level on Engineering student wellbeing.

Ethnicity was not explored in the survey, and there is potential for future research into the experiences of people from diverse backgrounds in engineering education, particularly as emerging literature indicates there may be even poorer mental health and wellbeing from non-white engineering students (Bork and Mondisa, 2022).

While a pilot was carried out on the draft survey, some of the questions could have been better presented on reflection. For example, there was a question relating to habits and behaviours asking if the respondent had taken non prescribed drugs in the previous 2 weeks. This was intended to explore recreational drug usage but could also relate to over-the-counter pharmacy medication for a minor ailment. This was not identified at pilot stage and as such, the question was not highly informative.

The survey was voluntary with no compensation or incentive due to the research forming a doctoral thesis with no funding attached. Therefore, the responses came from people motivated to complete it for intrinsic reasons over financial reward. This potentially could mean that there is an over representation of people with a particular interest in mental health and wellbeing in the results. There was an over representation of women at 32.8%. The UK Higher Education Statistics Agency records show the current percentage of women in Engineering courses is 19.74% (HESA, 2022). As discussed in the methods section (3.5) considerable effort was exerted to raise awareness of the survey including press, PSRB support, and university gatekeeper support.

4.9 Recommendations for Phase Two

The first phase of this research established a mean Warwick Edinburgh Mental Wellbeing Score for engineering students in the UK that fell significantly below population norms. Remaining questions highlighted areas for further exploration and discussion in phase two.

Phase two explores the experiences of a purposive sample of the respondents from the survey, through a semi-structured interview. The sample included representation from each Stage, and a sample of different disciplines.

Findings from phase one informed the design of the interview guide including the need to explore and discuss:

- the ways participants are being taught and assessed, and their views on their experiences;
- wellbeing activities and their views on what works;
- attitudes to mental health and wellbeing and engineering culture;
- perceptions of engineering industry in terms of supporting mental health and wellbeing.

4.10 Chapter Summary

This chapter presented phase one of the research study which was quantitative in nature with additional open text questions. An online survey was developed, piloted and shared with the engineering student community in the UK and the results presented and discussed. Mental wellbeing in engineering students from this study were significantly poorer than general population norms and, in comparison with other relevant datasets, indicated poorer wellbeing than students in other disciplines. Mental health problems were reported by 28.3% of the respondents which is slightly higher than national population norms.

Attitudes to help-seeking indicated a culture of stigma, a lack of trust, and time concerns prevented earlier help-seeking. There was also a strong preference to self-solve within the responses. It was noted that it was possible some students may not recognise activities that promote wellbeing, for example exercise. Limitations of the survey were reported and recommendations for phase two were made.

Chapter 5: Phase Two Findings

5.1 Overview

This chapter reports on Phase Two of the research which was to explore the research questions by semi-structured interview. Thematic Framework Analysis was selected as the most appropriate tool to analyse the data and was described in section 3.6.4. Quality was ensured by utilising a peer reviewed analysis process (Ritchie et al, 2014), Rigour was ensured by consideration of the four-dimension criteria of Credibility (through peer debriefing), Transferability (through thick description), Dependability (through supervisor review) and Confirmability (through triangulation with literature) (Lincoln and Guba, 1986, 2004.) A description of the analysis process that was followed is provided using the recommended stages of Framework Thematic Analysis (Ritchie et al. 2014) and data summaries are presented by theme. This is followed by interpretation and development of themes. After this, the abstraction stage is presented with the development of high level constructs and a proposed framework for supporting mental health and wellbeing in engineering students.

5.2 Introduction

Participants who completed the Engineering Student Survey in Phase One were invited to participate in the interviews at the end of the survey by providing their contact details. See Table 26 for a breakdown of the participant characteristics. Of the 417 survey participants, 104 participants volunteered to be interviewed. Purposive sampling was undertaken to cover each year of study, engineering subdisciplines (mechanical, electrical etc) where possible and representation of gender resulting in 28 participants initially agreeing to be interviewed. One participant withdrew from the interview stage for personal reasons unrelated to the research.

Interviews were conducted between the 15th and 30th of June 2020, primarily via videoconferencing with a small number by telephone as requested by the participant. Interviews with students from the primary researchers' host institution were carried out by one of the supervisory team to ensure comfort for the students. This was to provide a clear delineation for the students and the primary researcher as she is a senior member of the School of Engineering. All participants consented to the primary researcher analysing the data. Verbal audio recorded consent was given by each participant prior to each interview.

The following sections are set out in line with presentation recommendations for Framework Thematic Analysis (Ritchie et al, 2014). Due to the qualitative nature of the data and the analytical approach of framework analysis, presenting the results and discussion together as findings is intended to reduce duplication of information and provide flow and impact for the reader. Table 25 below outlines the framework analysis process. NVivo 12 (Jackson and Bazeley, 2019) was used to develop the framework matrix. The researcher coded the first 8 interviews using the initial framework supported by the semi-structured interview guide. As this was carried out, additional codes were generated. A coding brief was sent to the researcher's principal supervisor for cross-checking. The principal supervisor coded 3 further interviews to ensure the process was robust. The initial framework was reviewed by the research team and indexing was carried out. Charting of the data then followed which is presented in the findings section in Chapter 5 along with the Abstraction and Interpretation stage.

Table 25. Framework Analysis Process (after Ritchie et al. 2014).

Stage in Process	**Description**
Data familiarisation	Reading the transcripts, taking notes of observations
Constructing an initial thematic framework	Combination of a priori and emergent concepts (Ritchie and Spencer, 1994) Major themes and Components. Revised Framework coding
Indexing and Sorting	Linking remaining data to codes and reviewing data extracts
Charting, Data Summary and Display	Summarising the matrix data
Abstraction and Interpretation	The discussion section, developing categories, mapping linkage.

5.2 Stage One – Data Familiarisation

The semi-structured interviews were carried out by the researcher and, for the purposes of confidentiality for the participants at the researcher's institution, one of the supervisory team. The rationale for the alternative interviewer was because at that point the researcher was a senior member of staff in the School of Engineering with student facing contact.

Following interviews carried out by the researcher (n=22) field notes were made which could be revisited during analysis. The alternative interviewer did not make field notes.

Once the interviews (n=27) were transcribed, the researcher identified ring fenced time to allow immersion in the data. Transcripts were read several times and a reflective diary of the journey kept (Turner, 2020) to support analysis.

5.2.1 Participants

The 27 participants varied from college to postgraduate research and were from different subdisciplines detailed in Table 25. There were 8 female and 19 male participants (29.6% female, meaning they were slightly over-represented in the data). Participants had travelled various distances to go to their university from coming from the same town as their university to travelling 270 miles.

There were 17 participants who had never been diagnosed or treated for a mental health condition, meaning an over representation of those who had (37%). The interview participants were mainly undergraduate engineering students either on a Bachelor or Integrated Masters programme. Typically, students experienced a lecture-based course delivery with some practical classes to varying degrees. This is typical of engineering courses in the UK at the time of writing although it should be noted that there has been an increase in the number of project-based engineering institutions (NMITE, Dyson Institute). Overall experiences were positive, but some participants reported feeling that some lecturers gave the appearance of not wanting to be there, from a general lack of quality in course materials, to not answering questions. Table 26 outlines the characteristics of the interview participants.

Table 26. Characteristics of Participants.

Characteristic	**Information** (n)
Gender (Self-Described)	Male (19) Female (8)
Age range	18-71
Stages Represented	1st yr. UG (4) 2nd year UG (4) 3rd year UG (6) 4th year UG (7) 5th year UG (1) MSc (3) NC (1) 1PhD Post transfer (1)
Disciplines Represented	Mechanical- 9 Electronic and Electrical - 7 Other- 11
Courses represented	NC, BEng, MEng, MSc, PhD
Universities Represented	(11)
Mental Health Condition Reported?	Yes (10) No (17)
WEMWBS	Mean: 40.55 SD 9.68 Range 22-64

5.3 Stage Two – Constructing an Initial Thematic Framework

The next step in Framework Analysis is the development of an initial framework. This typically involves coding a small number of transcripts and developing a coding index (Hackett and Strickland, 2018). As the semi-structured interview was designed to generate data on particular topics, the initial framework included these as topic headers or clusters. Table 26 shows this process from left to right. In Chapter 3 the high-level overview of the interview guide themes was presented. These were: demographic information, the course being studied, participants' mental health and wellbeing, and mental health and wellbeing of the engineering profession. Coding was carried out using NVivo, by the researcher and a sample of three transcripts were coded by the supervisor to test initial codes. Subsequently, 41 further codes were added. The researcher then coded the transcripts again against the additional codes. A transcript was tested by a second supervisor for completeness of coding, with no further additions recommended. Table 27 presents the evolution of theme development.

Table 27. Evolution of Early Themes.

Initial Topic Clusters	**Identified Additional Topic Clusters**	**Initial Themes**
Choosing Engineering	Asking for help	Engineering Identity – "We have to make it work all the time"
Views on their Course (1st-4th year)	Accepting Help	Keeping Up = Missing Out "When I'm not busy I start to feel bad"
Views on Teaching	Current MHW	Keeping Well "I'm still riding my bike, bye."
Views on Assessment	Discipline Differences	Impact of Workload
Experiences of Engineering Staff	Experience of Assessment	Impact of Engineering Staff Interaction
Experiences of University Counselling/Support	Help From Staff	
Suggestions for Engineering Schools	Impact of Workload	Impact of Covid
Being an Engineering Student	Views on Gender	Ways Forward for Engineering Educators
Impact of Covid	About their course	
Helping Peers	Extracurricular	
Keeping Well	Coping	
Managing Time	Women in engineering	
Perceptions of Industry		

5.4 Stage Three - Indexing and Sorting

Once coding was complete, the qualitative data was indexed and sorted which is a way of arranging the qualitative data into a manageable format for interrogation (Ritchie et al, 2014) and forms part of the framework analysis method. Indexing and sorting was carried out using both NVivo and Excel for the ease of visualisation for the researcher. Data extracts were reviewed to ensure coherence with the initial themes. A selection of screenshots from the indexing and sorting processed are presented here, selected to show the gradual clustering of topics (Figures 28-30).

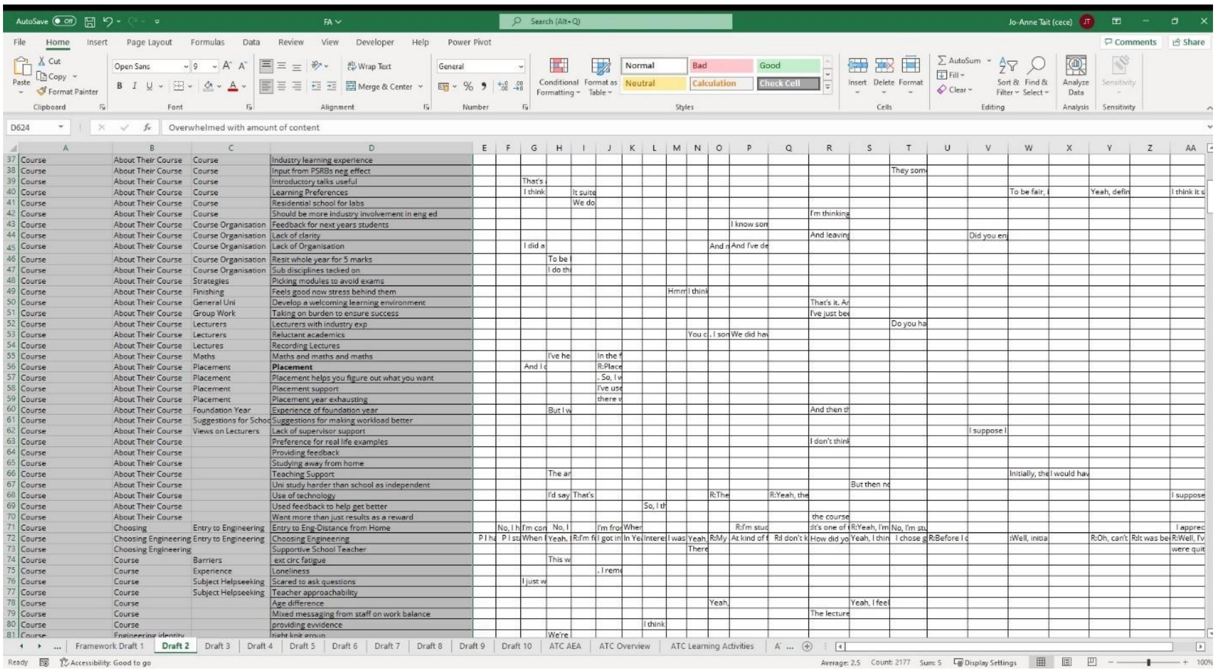

Figure 28. Screenshot of Version 2.

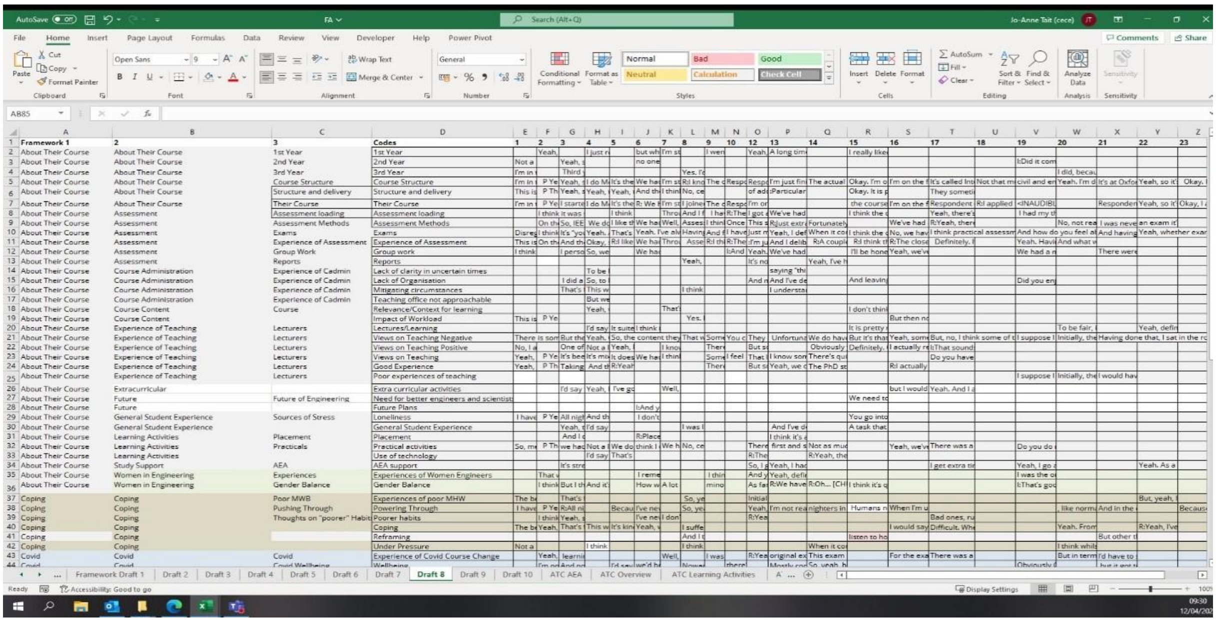

Figure 29. Screenshot of Version 8.

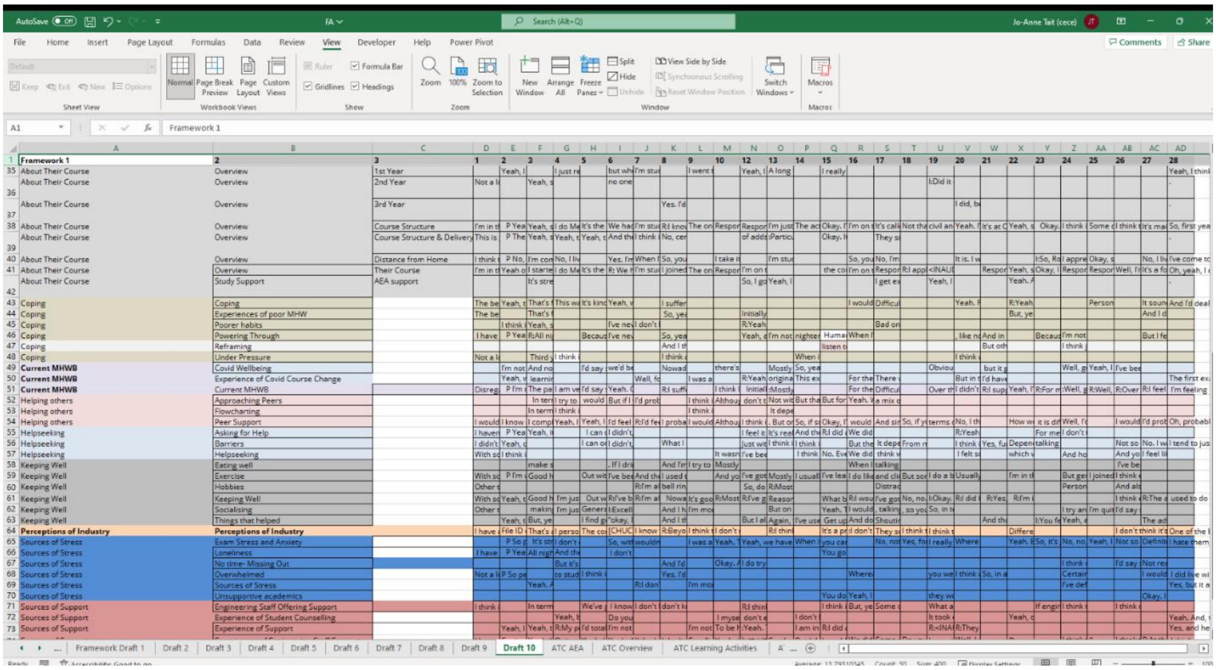

Figure 30. Screenshot of Version 10.

5.5 Stage 4 Charting, Data Summary, and Display

The qualitative data has been summarised using the following framework structure (Table 28).

Table 28. Framework Matrix.

Themes	Subthemes
The Engineering Education Experience	Participant Description
	Course Structure/Content
	Learning Activities
	Experience of Teaching
	Assessment
	Study Support
	Course Administration
	Experiences of Women Engineers
	General Student Experience
	Covid changes
Engineering Identity	Choosing Engineering
	Views on Engineering
	Engineering Habits and Culture
	Engineering views on MHWB
	Perceptions of Industry
Mental Health and Wellbeing (MHWB)	Current MHWB

	Sources of Stress
	Coping
	Helpseeking
	Helping Others
	Sources of Support
	Keeping Well
	Time Management
Suggestions for Institutions	Visibility
	Curriculum Enhancement
	Training

5.6 Data Summaries by Theme

The identified themes of The Engineering Education Experience, Engineering Identity, Mental Health and Wellbeing, and Suggestions for Institutions are summarised in Tables 29-32 below. Text in square brackets has been inserted by the author for clarification.

The Engineering Education Experience Theme focuses on participants' experiences in engineering courses, ranging from college to postgraduate study. The theme encompasses course structure, learning activities, teaching experiences, assessment methods, study support, course administration, gender balance, extracurricular activities, and the impact of the COVID-19 pandemic on their experiences. The theme also includes the experiences of women engineers and the impact of online course changes. The matrix summary can be found in Table 29.

Table 29. The Engineering Education Experience Theme Framework Matrix Summary.

Subthemes	Example Codes	Description
Participant Description	Discipline, Year, About their Course	The participants vary from college to postgraduate research and undertake different subdisciplines. Participant description can be found in 5.2.1.
Course Structure/ Content	Content, Structure, Delivery, Experience of Teaching	The general content of courses was appropriate and acceptable to the participants. Participants described their courses and general experiences.

Learning Activities	Placement, Practicals, Technology	The majority of learning activities described were lectures, labs, and projects. There were differing opinions on lectures, but majority felt labs and projects were useful if set at the appropriate level.
Experience of Teaching		Descriptions of different teaching experiences including lectures, tutorials, activities etc. Positive experiences included passionate lecturers, clear direction, good quality course material. Poor experiences included feeling afraid to ask questions, feeling like the lecturer did not care,
Assessment	Loading, methods, exams, experience of assessments	Participants had mixed opinions assessment i.e., exams or reports etc but most reported feeling there were too many overall, and there was a lot of pressure. Some felt that this meant in order to keep up they had to lower their standards – giving rise to feelings of failure. Exams were present in the courses of all participants. Some participants expressed that closed book exams were inauthentic and led to surface learning. Some participants were not stressed by closed book exams while others felt very stressed and preferred other forms of assessment.
Study Support	AEA, experience of staff support	Six participants discussed alternative assessment arrangements, which largely focussed on examination support. Of these, four specifically mentioned dyslexia as the main issue for requiring alternative arrangements. Extra time for exams and support for report writing, mitigation for spelling, handwriting and grammar, organisation and also rest breaks were reported. Participants were appreciative of the support they received. Participants not referencing Study Support discussed informal academic support.
Course Administration	Clarity, organisation, mitigating circumstances	Course Administration was raised as a poor experience by some participants. The three key topics within this was the lack of clarity, lack of academic course organisation, and the experience of applying for mitigating circumstances/exam deferrals.
Experiences of Women Engineers	Gender balance, experiences of women	Some participants discussed their experiences of being a woman in an engineering course. The visibility of women in class due to the small number of them was an issue for some. One participant mentioned her perception that the teachers on her course thought that girls needed more help than boys. This made her feel like she was helpless and also felt a need to prove people wrong. There were some positive experiences.
General Student Experience	Extracurricular, General	This area captures general student experiences to help with context. This included extracurricular activity where described home life/working/socialising.
Covid changes	Experience of Course changes	Descriptions of university activities and assessments that were moved online due to the pandemic. Some struggled with the new format, some found it harder to study, and some found the move and assessments ok.

The Engineering Identity theme includes the perceptions of engineering students, the practical application of engineering, and their views on the engineering discipline itself. Some participants felt that there was a focus on rote learning and a misunderstanding of engineering, with unrealistic expectations and perfectionism. They also noted pressure, perfectionism, and unrealistic expectations in the engineering culture.
Perceptions of the industry were also included. The matrix summary can be found in Table 30.

Table 30. Engineering Identity Theme Framework Matrix Summary.

Subthemes	Example Codes	Description
Choosing Engineering	Entry to Eng. Supportive teacher	Less than half had engineers in the family, some referred to supportive teachers or being curious about engineering as a child. Some were actively encouraged by parents. There was a perception that the practical application aspect of engineering i.e., solving problems was very attractive.
Views on Engineering	Need for better engineers, different to other subjects	While engineering identity was not explicitly explored it was clear that there were assumptions and thoughts about being an engineer/engineering student . Some participants felt there was a focus on learning by rote rather than understanding. Some felt that engineering as a subject was misunderstood, and the amount of maths was not appreciated. Some mentioned the difference noted by non-engineering students in terms of how much attendance was required. Perfectionism was mentioned in terms of the engineering subject making people into perfectionists which is hard to deal with because nothing is perfect.
Engineering Habits and Culture	Pressure, perfectionism, unrealistic expectations, engineering culture, perceptions of being an engineer.	Participants described continuous pressure, and some referenced higher student contact time led to higher study hours. Confidence also appeared to be an issue. *My friend did a funny drawing the other day, it was like the Dunning-Kruger effect, the graph, like "we are here," and he pointed at the lowest point possible on the graph, confidence here. Like, okay, this is how recent graduates of engineering feel, brilliant".*
Engineering views on MHWB	Views on MHWB, stigma, difficult to recognise	Participants indicated how engineering courses did not cover or speak about mental health, and some indicated that while it might not seem relevant it was perhaps a good idea to start. *"Not to stereotype, but engineers aren't the best about talking about it. I think engineering as a whole, there's a lot of stress and there's a lot of people who just don't go and get help, don't talk about it."*
Perceptions of Industry	Performative, sexist, old school, man up.	Few participants felt able to voice an opinion but those that did answer had opposing perceptions from perceptions of engineering industries being "old school" to being open and receptive.

The Mental Health and Wellbeing Theme included descriptions of various mental health and wellbeing issues experienced by engineering students, including exam stress, coping with coping mechanisms, and seeking help. The Matrix summary can be found in Table 31.

Table 31. Mental Health and Wellbeing Theme Framework Matrix Summary.

Subthemes	Example Codes	Description
Current MHWB	Covid wellbeing, Current MHWB	Participants were asked how they were feeling generally - it had been 4 months since they completed the survey. Some participants had felt ok with others reporting feeling a bit down or worse. The interviews were carried out during the first lockdown and so this is referred to in some responses. Some participants reported that lockdown actually helped them reset mentally whereas others struggled to study.
Sources of Stress	Exam Stress No time- Missing Out, Overwhelmed, Sources of Stress	Participants struggled to find time for things they enjoy, such as going to the gym and keeping fit and active, due to the pressure on students to study all day. Many felt that they found exams very stressful: others found that exams were not particularly stressful but that they were more of a memory test than allowing them to demonstrate knowledge. Participant 5 described just getting on with things like exams: ". Participants mentioned feeling overwhelmed and seeing others feeling the same. Participant 1 " You do see some people when you start a new semester, that you were mates with just drop out because they can't take it and you can visibly see some people get overwhelmed.
Coping	Coping, poor MHW, Powering Through, Reframing, Under Pressure	Participants were asked about things they would do when under pressure, how they would cope. This was separated from how they kept well. Participants gave a variety of responses from trying to push through their problems, to ignoring them entirely until crisis, to isolating themselves. One or two mentioned alcohol use for a short time but that this hadn't helped so they had stopped. All night study happened earlier in studies, but they appeared to move away from it. feeling a bit overwhelmed. Participant 27 mentions the "crying toilets" where engineering student go to break down. "It's kind of a running joke in the university, but I'm not going to lie, me and my friends have all used them a couple of times."
Helpseeking	Stress and Anxiety, Loneliness, No time- Missing Out,	Participants discussed their own feelings on helpseeking and sometimes considered how other engineering students might feel. Some stated they had not sought help even though they acknowledged they needed it (1, 2,14) Some felt it was not talked about (10,14,15). Example: Participant 14: " I think engineering as a whole, there's a lot of stress and there's a lot of people who just don't go and get help, don't talk about it." Participant 2 " There was a time I felt really down, around the time I was thinking about dropping out, and I stayed in a lot, I didn't really communicate with anyone, I didn't let my friends in

Helping Others	Approaching Peers, Flowcharting, Peer Support	Of the 25 who were asked the question (Participant 21 was not asked and Participant 25 connection cut out 23 participants felt comfortable to support peers through a mental health or wellbeing issue. Participants 23, and 28 both felt they would struggle to feel comfortable but would feel sympathetic. Participants 15 and P24 mentioned it might depend on how well they knew the person and participant 13 has been in situations before through a social activity and is keen to get training to better help. This indicates that the engineering students in the interviews had the desire and general confidence to provide peer support informally.

The Suggestions theme captured areas for enhancement suggested by participants. This included increased visibility of help provision, increased support and training for staff, and improved content delivery. The Suggestions Matrix summary can be found in Table 32.

Table 32. Suggestions Framework Theme Matrix Summary.

Subthemes	**Example Codes**	**Description**	**Summary**
Suggestions for Institutions	Visibility	Mental health promotion, Need for training and awareness, tailored approach	Participants suggested increased visibility of where help is provided. Staff including professional and support staff should be more open and supportive and equipped with signposting information.
	Curriculum Enhancement	Organisation, load spreading	Suggestions ranged from ensuring content is delivered in right order and spreading content and assessments better to treating students more respectfully. A comprehensive list will be provided in the findings.
	Training	Need for training and awareness	Participants suggested that mental health and wellbeing training should be given to staff and key people particularly those who are in regular contact with students.

5.7 Stage 5a Interpretation

In the Interpretation phase the themes are discussed and explored in turn.

5.7.1 Theme One: The Engineering Education Experience

Subthemes and example codes are presented visually in Table 33 and descriptions are integrated into the supportive narrative.

Table 33. The Engineering Education Experience Framework Matrix Summary.

Subthemes	Example Codes
Participant Description	Discipline, Year, About their Course
Course Structure/ Content	Content, Structure, Delivery, Experience of Teaching
Learning Activities	Placement, Practicals, Technology
Experience of Teaching	Lecturers, Tutorials, Academic support
Assessment	Loading, methods, exams, experience of assessments
Study Support	AEA, experience of staff support
Course Administration	Clarity, organisation, mitigating circumstances
Experiences of Women Engineers	Gender balance, experiences of women
General Student Experience	Extracurricular, General
Covid changes	Experience of Course changes

Course Structure/Content

"I don't want to do it now; I want to do it in year two when it is relevant."

Overall, it appeared that the general content of courses was appropriate and acceptable to the participants. Participants described their courses and general experiences with the key dimensions being:

- Relevance to Engineering;
- Importance of good quality course materials;
- Structure.

Relevance to Engineering

Relevance was very important to participants in terms of what was or was not discussed in the classroom. *"we're in engineering, this is not a political debate, I want to just learn the course and go home and study. I don't really want to know about other stuff."* Context and application were considered important for making lessons more interesting, as it helps to explain why each topic is important and why it is interesting.

Importance of good quality course materials

Attention to detail in preparation of course materials was seen as important and participants described they felt disappointment and undervalued when presented with materials with errors or old information. Some were more accepting that errors happen, particularly for new courses, but participants also reported feedback to staff was not acted upon, leading to a feeling that they were not the lecturer's priority.

"You don't really feel valued at all there, because you have work, even notes, that you can tell has just been cut and stuck together over the last ten years or something like that, and nobody has been bothered to go through and make it consistent."

Structure

A limited variety of course structures were described with participants mainly describing courses with a common core structure with specialism only in later years. Others mentioned several types of module delivery including "long thin" approaches which sometimes worked well for them but there was a risk of having two semesters with a poor lecturer.

Duration of lectures were described as boring and not conducive to good learning. Some found the lecture heavy, but the passive learning approach supported their learning and others found it less helpful, relying on lecture recordings and practical sessions to underpin knowledge. The point at which content was delivered was an issue for some, where material was delivered too early or too late in the programme resulting in frustration and feeling inadequate for not being able to keep up.

Learning Activities

"It's good to have the lab sessions and the practical work because I find it really reinforces the theory, makes the theory a lot more easy to understand if you've got an application. Yeah, it's been good, I've enjoyed it, and learned a lot."

Participants were asked about the different activities they undertook as part of their course. The majority of learning activities described were lectures, labs, and projects. There were differing opinions on lectures, but majority felt labs and projects were useful if set at the appropriate level. Key dimensions were:

- Value of practical classes for supporting theory;
- Behaviours of lecturers;
- Group work;
- Tutorials.

Value of practical classes for supporting theory

Participants valued practical classes to support theory and apply knowledge, but they meant increased class time which added pressure. One participant noted:

"They just made life absolutely hell because you were in uni 9-5 almost every day in first year".

There was variation in experience in terms of number of practicals on a course. Some saw an increase in practical sessions with each stage whereas others noted a decrease. The following writing up of labs was very time-consuming adding further burden which was not accounted for by lecturers.

Behaviours of lecturers

Behaviours perceived as good by the participants were thorough clear explanations, a mix of academic and industry experienced lecturers, provision of recordings of lectures, and supporting lecture notes.

Group Work

Group work was less valued by participants but there were mixed experiences. This is largely due to the experience of students where others are not engaging as expected, either doing too little or taking over and not listening. One participant described their group work experience where they felt left to do the bulk of the work.

"And if you get a group of four of those [coasting students]*, then it's just miserable, I've just been completely on my own, just took all the work on myself ended up doing about 60% of it myself first year, I think I did all the work completely independent."*

However, there were descriptions of positive group work where the group had worked well together and found the experience useful.

Tutorials

The activities described by participants appeared to be standard/traditional approaches to teaching and learning in the UK engineering education system. Participants described a heavy load of activities crammed into the week and that some activities may not have been accurately evaluated in terms of hours of effort required to achieve tasks or goals i.e., a lab report that has been described as an hour job taking 4 or 5 hours in reality. The heavy loads described by the participants echo similar reports on engineering courses internationally [Gerrard et al, 2017, Jensen, 2023] and points to the challenge of ensuring engineers are ready for employment while not overwhelming them and causing student attrition or causing graduates to choose a different career [Wright, 2022].

Experience of Teaching

"I remember sitting in chemical engineering last year and the lecturer being like "so, you'll do this assignment in AutoCAD," and that being the end of it. And at the end I spoke to him and went "we haven't ever used AutoCAD."

Participants described their thoughts on the teaching on their course and their experiences were usually mixed with the occasional great or poor experience. Key dimensions were:

- Maths experience can put students off
- Lab/Workshop banter isn't always helpful
- Lecturers expecting too much or knowledge not yet learned
- Showing passion

Maths experience can put students off

Maths was raised as an area where students can lose confidence and feel they are perhaps not suited for engineering. Industry experienced lecturers were valued by some whereas others were less concerned with this and prioritised good teaching above time in industry.

Lab/Workshop banter isn't always helpful

Lab or workshop banter can form part of a sense of exclusion for some engineering students, particularly those who are underrepresented (Lee et al, 2020). In particular, some of the female participants reported feeling singled out for extra help in labs making them feel less competent. Some participants felt that lecturers who talked about things other than engineering in lectures were wasting time whereas others felt it was good to hear about things beyond the subject. However, relevance and context are key.

Lecturers expecting too much, or knowledge not yet learned

Lecturers who appeared to expect too much of their students caused stress and anxiety to students, and also poorer academic performance. Going through the motions was also a source of frustration:

> *"I had one this semester who basically didn't really teach us, just kind of went through tutorials with us and then expected us to be able to do that times ten the difficulty."*

Some participants felt that lecturers often appeared to dislike teaching, and also would not record their lecturers, causing issues with revision. Lack of clarity in academic expectation also caused frustration.

Showing passion

Participants valued lecturers who ensure students are up to speed and also make themselves approachable. They didn't want to cause lecturer's bother by approaching them so knowing this was welcomed was helpful. However, some felt that support from lecturers was unhelpful or perpetuated the stress culture with one participant saying:

"it kind of feels like if we do say we're really struggling or really stressed, they're just kind of like "well, you have to get on with it. We've all been there before." And I'm sure they have."

It was evident that lecturers showing passion for the subject, being organised, showing relevance, and understanding the student journey in terms of what they already know is key to being valued by the students.

Assessment

"You can visibly see some people get overwhelmed."

Participants had varied opinions on the types of assessment they had experienced i.e., exams or reports but most reported feeling there were too many overall, and there was a lot of pressure. Some felt that this meant in order to keep up they had to lower their standards – giving rise to feelings of failure. Exams were present in the courses of all participants. Some participants expressed that closed book exams were inauthentic and led to surface learning. Some participants were not stressed by closed book exams while others felt incredibly stressed and preferred other forms of assessment. The key dimensions were:

- Frequency and volume of assessment;
- Impact of assessment;
- Impact of closed book exam;
- Meeting expectations;
- General feeling of overwhelming workload;
- Authentic assessment.

Frequency and volume of assessment

Many participants reported feeling there were too many assessments, and there was a lot of pressure. Some felt that this meant in order to keep up they had to lower their standards – giving rise to feelings of failure. Exams were present in the courses of all interview participants apart from one who was working towards a PhD. While there was variation in assessment regimes described by participants, it was clear that there was routinely a heavy workload and stressful assessments adding to a sense of the participants being overwhelmed with work regularly throughout their course.

“because there was a first test every weekend, we felt a bit rushed because as soon as we finished one and the week would go by so fast, we had to do another one."

Clashing deadlines were also discussed by participants, causing knock on effects to other assessments. Some participants felt that while their course was assessment heavy, the spacing was enough for them to feel they could manage it and were therefore content overall.

Impact of Assessment

Challenges in balancing appropriate and authentic assessment with volume of assessment and items being assessed appears to be resulting in different problems i.e., too much assessment- loses value, adds stress but reducing assessments to single points of failure also adds stress. Students are overwhelmed either way.

Impact of Closed Book Exams

Some participants did not feel they experienced excess stress when being assessed by closed book exams while others felt incredibly stressed and preferred other forms of assessment. Participants described a number of impacts of excess stress including migraines, exacerbated symptoms, tearfulness, worry. The weighting of exams where they essentially become a single point of failure causing stress.

[Blanking in exams] "But if it's something that I'm really not sure of, even no matter how much I revise it, I always seem to go in and completely blank out."

For students who find closed book exams intimidating and stressful there is a negative impact on wellbeing when they are used as the main form of assessment. Excess stress leads to lower academic performance (Pascoe et al, 2020), and it is possible that students who perform badly in that assessment setting lose confidence in themselves as engineers (Eisenberg et al, 2009, Pascoe et al, 2020). The worry of the high weighting or single point of failure is that there is a real risk that external events will impact performance, poor sleep for example. While Universities in the UK will have a process for impact on performance, this is usually for sudden illness or injury and not lack of rest.

Meeting Expectations

Academic expectations were clearly important to the participants. Differing expectations for related items such as lab reports caused confusion and wasted time rather than allowing the student to focus on the engineering problem at hand.

General Feeling of Overwhelming Workload

Participants described an exam heavy intense learning schedule with assessments that cause stress and anxiety through unexpected difficulty, underestimated expectation of effort required to complete, or through sheer volume.

"I did a ten-credit [module] and it took countless hours. Probably two times the hours on the syllabus. It was a difficult, difficult module, just because of the lab scripts, the lab reports we had to do."

Overall, most but not all participants found closed book exams excessively stressful, and no participant thought that closed-book exams actually assessed anything more than memory. Some assessments may not be accurately checked for hours of effort required. Lack of clarity in assessment briefs adds pressure.

Authentic Assessment

Many questioned the value of the closed book exam, and also articulated the impact exams had on excess stress and anxiety. Some students felt they performed better in exams over coursework and that a weighting towards exams meant that there was less workload for them during the year. However, they did also note that there was a tendency to surface learn for exams and that most of what they learned was forgotten straight after the exam. It was also noted that there was no incentive to learn subjects from the ground up because there would always be those who got better marks from question spotting and learning by rote.

"It doesn't really assess you on your creativity or ingenuity when it comes to engineering, it's just your ability to store information, which when it comes to engineering, you're never going to need to have it in your head. A couple of days after, you don't remember any of it, so what was the point?"

"I wipe it from my head pretty much as soon as I leave. Yeah. That's one of my worries about these exams, they're testing your memory and then it's gone. How useful is that as an assessment, I'm not quite sure."

"The closed book exams for engineering, for me I think that would be really hard because there's so much to memorise or learn, and for closed book exams it's pretty much memorising. Whereas in actual engineering you wouldn't have to memorise everything. You'd need to have basic understanding, but you wouldn't need to fully memorise…Yeah, it's definitely really stressful. At first, you have to find the time to memorise everything, but after the exams it's like you don't even remember most of it anyway, so what was the point?"

"I've always felt more confident in subjects with more coursework and not just 100% exam, because I feel like the coursework is actually testing what I know, whereas an exam is just testing what I can regurgitate in a couple of hours."

Study Support

"Once I got extra time, it wasn't too bad, actually. But, yeah, it's still a lot of pressure, and a lot of pressure on just one day."

Participants were appreciative of the support they received. Participants not referencing Study Support discussed informal academic support. Participants discussed their experiences of study support which ranged from academic support to accommodations for people with different study or assessment needs. The main focus was on alternative assessment arrangements. Dyslexia was the main reason for requiring alternative arrangements. Extra time was given for exams and report writing, mitigation for spelling, handwriting and grammar, organisation and also rest breaks were mentioned. Participants were appreciative of the support they received particularly not having to see other students before an exam, and also regular check ins from university support. While the accommodations helped it was still felt that exams cause a lot of pressure.

Participants did not report receiving academic support for mental health issues, which suggests either there is still stigma relating to asking for or receiving help in relation to studies or there is a gap in the offer from universities in relation to study support. It may be the case that the support needs for mental health and wellbeing in relation to academic support are considered to be more nebulous than, for example support for dyslexia. Consideration might be given to how institutions might offer support on issues with concentration or motivation when experiencing poor mental health and wellbeing.

Course Administration

"So, I felt there were people just pushing me on, "oh, I can't see us changing it, but I think it will be this," and it was incredible. And it was only five marks, I'd failed by five marks."

Course Administration was raised as a poor experience by some participants. When participants were asked to talk about their courses some described poor experiences of academic administration and its impact on their student experience and general wellbeing. Of particular note was the inability of staff to provide an answer without the decision having gone through the proper processes of the university – which, while understandable, led to increased anxiety and dissatisfaction and limited the ability of the participants to plan their next moves, causing further stress and frustration. Course organisation caused stress too, with students receiving results accidentally on exam days, academic staff not making changes based on feedback resulting in continued deadline clashes. This leads students to feel undervalued and again causes unnecessary stress.

"Most of the time it's just like "well, why are you complaining? It's not that bad. You just need to crack on with it." So, I feel like it's not really viewed as important or that big of an issue."

Experiences of Women Engineering Students

“The year above us...had the same number of girls as it did guys called Ben."

While it was not the primary focus of the research, there was an opportunity to explore the experiences of women on engineering courses. Literature about female engineering students’ experiences point to there being additional risk in terms of higher stress, lower wellbeing, lower confidence (Deziel et al, 2013, Pozniak, 2017, Negi et al., 2019, Jensen and Cross, 2021) and therefore relevant to the research. Some of the participants discussed their experiences of being a woman in an engineering course. Participants reported the perception that the teachers on their courses thought that girls needed more help than boys. This made them feel like they were helpless and also felt a need to prove people wrong. Key dimensions of this topic were:

- Feeling “less than” male engineering students;
- Group work can be problematic;
- Hypervisibility;
- Positive experiences.

Feeling “less than” male engineering students

Feeling less capable than male engineering students was mentioned by some participants and this can be a driver to succeed or leave the subject.

“It’s been something that’s always happened, even in college my lecturers at the start always thought like I was less, I didn’t know what was going on as much as the boys. But obviously, you have to prove them wrong.”

Group work can be problematic

“I always feel better if I have another female in the group to help back me up on things, because I feel especially in third year, two of my first semester projects where men would talk over me, they’d put their hand up in front of my face if they didn't want to listen to what I had to say, they would just write off really quickly what I was actually having an input in. And basically, it was like “you’re a girl, you shouldn't have input to this, you should know this.”

Hypervisibility

“I walked into my electrical lecture and the first thing he said, it’s great to see so many females first years. And I was like, “yup that’s great.” Yeah, [awkward] that’s what it is. For me personally, I don’t really like it [extra attention] because I think they feel like I’m helpless.”

“Yeah, there’s usually a few girls per group, or one or two. I don't really mind it because obviously I worked in motorsports so it doesn't even really register anymore, like this is my life now, I’m fine. CHUCKLES"

There were positive experiences also in the data:

“I’m very happy to have never experienced any sort of issues of “oh, you are a woman, what are you doing here?” I’m quite happy about that, yeah.”

“So, when I came to university, I could never imagine being that sort of engineer that goes on an oil rig, on an oil platform, but then I’ve seen three women who have done that, and that opened my horizons a lot, I realised I could do that as well. Then I decided not to because it seems like a crazy job to me.”

The overall impression was of a negatively skewed mixed experience of being an engineering student from the women in the participant group, and that cohort dynamics in terms of gender balance contribute to some of the stigma related to mental health and wellbeing helpseeking.

General Student Experience

“A task that might be interesting, by the time you actually get through it, you just want to get the thing finished and handed in.”

Some participants observed others feeling overwhelmed or that they found balancing life and studying challenging:

“I found that to be able to maintain this level, the general university things that you would partake in such as going out on the weekday, or at least being able to take part in more

societies and extracurricular things became very difficult in my third year because to really stay on top of everything I was given, I had to do enormous amounts of work.”

”Some of them forget that people do work as well as go to uni, and they almost don't understand why you’re struggling.”

Two participants described highly active extracurricular activity:

“I’ve gone out to schools, I help out with events, and I really love that job. Through it, I think I’ve discovered I want to be a teacher after I leave uni, because I’ve really developed a passion for helping and teaching".

Few participants described an active extracurricular schedule but one who did noted struggling to manage tasks. They recognised when they were feeling overwhelmed but felt staff were supportive.

“I also study Spanish alongside it because I was meant to be going to Spain next year but that’s been put on hold. I do two hours of professional talking practice every Wednesday since first year to help improve my Spanish language. Yes, I was dragged into both REP positions, but they said they’d rather have someone that was dragged into it than someone who was being a bit too keen. Yeah, I struggle balancing multiple tasks at the best of times, which is what I’ve managed. But when I’m struggling with stuff outside of the course like emotionally as well, it amplifies those difficulties I face and I find it a lot harder. However, I’ve received very good support and understanding from academic staff in relation to coursework extensions and that stuff. But I’ve got a good rapport. I’m the chairperson for the staff-student panel, so I’ve got a good rapport with all of them which is really helpful.”

COVID-19 Changes

“Staff made the exams disproportionally hard and there were errors also, both of which made the experience very stressful. What ended up happening was they put in questions that no one could do. And it was incredibly stressful.”

The COVID-19 pandemic in 2020 forced universities to move their teaching and assessment online overnight. As the interviews were carried out in May and June 2020 some of the participants described their experiences. While the interview guide did not ask questions related to the pandemic experience, the following summary is provided to provide some further context. Some participants discussed university activities and assessments that were moved online due to the pandemic. Some struggled with the new format, some found it harder to study, and some found the move and assessments did not cause any problems.

Key dimensions of the summaries include:

- Lack of structure/need for structure;
- Change of assessment method;
- Impacts on mental wellbeing.

Lack of structure/need for structure.

The lack of structure was a key part of engineering students struggling to study during the lockdown, and establishing or re-establishing routines supported their progress and feelings of mental wellbeing.

"It was very difficult for me there to get back in to find new strategies and keep working. So, yeah, there was definitely a period of low mood because I was struggling to get my work done. I think that's a good way to put it, a bit of a rut. obviously in more normal times, it would be making sure that I spend enough time with my friends and get to see people, do new things. Obviously during COVID things are a little bit less... learning to work around my SPLD [Specific Learning Difficulty] *in an environment where I can move around, I can go to different places, and so I had coping strategies for that. And now when lockdown happened, I was confined to just working in my house, my study room or whatever."*

"Definitely having a routine, that's something that I really need, and I think at the start of lockdown that's what I found really hard was the lack of routine. Certainly, when we were doing online learning, I'd try to have quite a structured day like get up at a certain time and study for a certain time, have a break and then come back. Having that daily structure, I found really helpful."

Change of assessment method (closed to open online, or negatively marked multiple choice) caused problems for some. Some participants felt very rushed and that the lecturers had made the exams disproportionally hard to mitigate for the open book approach.

One participant reported that the COVID-19 national lockdown actually supported their mental wellbeing due to not having so many commitments.

“Over the last few months, I think I’ve been probably the best I’ve been for quite a while. And I think probably a lot of people are the opposite, but I’ve never had so much time on my hands to just look after myself. I’ve been feeling quite good, I’ve been doing a lot of cooking, I’ve been exercising quite a lot. Get a lot of time for stuff I actually enjoy doing, which maybe I’ve not taken the time out to do it before. So, it’s been quite a good reset, I’d say. I’d say so because I think you don't really get time to turn off.”

Theme 1: Summary

Overall, the Engineering Education Experience described by participants is high in workload, assessment points, and continual pressure. Lecturers when viewed positively, engage with students, are passionate about their subject, and clear about the aims of the teaching and assessment. Where viewed negatively, lecturers are passive, do not show interest in their teaching, and are often vague about academic expectations. Positive aspects of the engineering education experience are where there are opportunities to put theory to practice, fairness of assessment, and trust in the engineering staff to be supportive. Major stress is mainly from assessment and continual workload.

5.7.2 Theme 2: Engineering Identity

The interview participants came from a variety of backgrounds, some with supportive family who were engineers or familiar with engineering, and some who were not. The researcher got a sense of “this is how engineers are” in some of the conversations, which also included stereotypes of people unable and unwilling to articulate feelings, to appear weak, and a celebration of stress culture. However, this was less strong than the researcher had anticipated, perhaps indicating a move towards valuing emotional intelligence and the benefits of keeping mentally well. Some participants held views or perceptions of how industry viewed mental health and wellbeing and again this was mixed, with some feeling very positive about the support companies would give and some considering industry to be old fashioned and behind the curve when it came to mental wellbeing of employees. Subthemes and example codes are presented visually in Table 34 and descriptions are integrated into the supportive narrative.

Table 34. Engineering Identity Framework Matrix Summary.

Subthemes	Example Codes
Choosing Engineering	Entry to engineering, Supportive teacher

Views on Engineering	Need for better engineers, different to other subjects
Engineering Habits and Culture	Pressure, perfectionism, unrealistic expectations, engineering culture, perceptions of being an engineer.
Engineering views on MHWB	Views on MHWB, stigma, difficult to recognise
Perceptions of Industry	Performative, sexist, old school, man up.

Choosing Engineering

"We all grow up into it, I don't think anyone just wakes up and thinks, "yeah, engineering."

The participants were asked how they got into engineering or chose to study it. There were a small number of ways in which this happened for them. One was a lifelong interest in how things worked, another was encouragement from engineering family members, and another was encouragement from teachers and school career visits to companies.

Some participants had family members (less than half) who were engineers and who supported their interest, whereas others found they were strong in STEM subjects, and it felt right to pursue engineering.

"Looking back, when I was little, I used to ask for Lego and Lego Technic every single Christmas. Anything that got broken was immediately taken apart and fiddled with. I'm still like that to this day, to tell the truth. And farther back than that, I had an electronics kit that I used to really enjoy playing around with, but that wasn't involved in the consideration, it's just something I remember now."

Others enjoyed technical subjects, discussing engineering with family members. Career prospects were also mentioned by one participant who chose engineering over an arts-based degree.

Views on Engineering

"I suppose one thing, and it's maybe just for me personally and I maybe don't speak for other people that are studying engineering, but I find engineering makes you into a bit of a perfectionist, and I think that sometimes can be quite hard to deal with, because you can't possibly have everything."

While engineering identity was not explicitly explored it was clear that there were assumptions and thoughts about being an engineer/engineering student. There was a focus on learning by rote rather than understanding. Another participant felt that engineering as a subject was misunderstood, and the amount of maths required was not appreciated. Others mentioned the difference noted by non-engineering students in terms of how much attendance was required. Perfectionism was noted by one participant in that the engineering subject made them into a bit of a perfectionist which is hard to deal with because nothing is perfect. Participants highlighted sub disciplinary differences and highlights his value of real engineers teaching.

"Not to point fingers but as a mechanical student, I've noticed the electrical courses were always a bit more, had an old school demeanour about them. It was always there, not just to the mechanical students, there were a couple people there who would make you feel like an absolute idiot. Obviously, the curriculum is valid but when I was there (previous University) a lot of the people I had teaching me weren't engineers. I know there's an overlap, but we had a physicist teaching us CAD [Computer Aided Design] *, people from the maths school teaching us maths and that. I think in my time there I only had one lecturer who was a chartered engineer."*

Participants described a culture of not asking questions for fear of looking stupid, which leads to not asking for mental health and wellbeing help for fear of looking weak.

There were comparisons of differences in engineering to other subjects and then comparisons of different subtypes of engineer.

"We're almost quite a tight-knit group, us medical engineers, but I do think we branch out really well with the mechanicals. I don't feel like there's any divide between the mechanicals and the medicals. It's sometimes more difficult with the other types of engineer, like the civil engineers or the architectural engineers, just because we don't share any classes with them, so it's harder to get to know them in a social setting."

One felt that creativity was stifled due to using previous year as exemplar to ensure passing the course rather than being adventurous:

"I didn't have very much confidence in myself or my own abilities at the time, which kind of limited what creatively I was able to do. I'd sort of look at last year and go "well, that didn't

fail, so if I make it something like that then it's probably going to be fine." Which is not the most creative way of doing things and it's not really how to build a really good race car."

Others were inspired by the applicability of engineering:

"we can use this thing for that," the practical applications of it. And that's more or less what engineering is."

[Engineering is] *"mainly focused on just construction and everything to do with other than people, in a sense. Although it's built for people, it's not focused on the people."*

Negative perfectionism was described by some participants, and they could feel like they could never achieve perfection and then feel bad about it.

"I suppose one thing, and it's maybe just for me personally and I maybe don't speak for other people that are studying engineering, but I find engineering makes you into a bit of a perfectionist, and I think that sometimes can be quite hard to deal with, because you can't possibly have everything."

"I've definitely found myself getting burned out because obviously you want everything to be at the highest possible standard, but it physically isn't possible, there's only so many hours in the day, and I've found that I'm handing in work that I know is probably good but is maybe not perfect and I come away feeling a bit of a failure. Even though that's totally unreasonable and illogical, but that's just me personally."

[Engineering students] *"struggle with the social side of things, because it can be quite a lot of time just spent studying on your own or maybe with a small group of friends, sometimes socialising isn't really a big part of studying. I suppose that can be quite hard for mental health as well."*

Engineering Habits and Culture

"This is a thing that engineers don't really do [experiment]; it has to work all of the time, and it has to work repeatedly, this is what engineers do. But physicists or geologists maybe come with ideas and engineers are like "no, we have to make it work all of the time."

One participant felt that there was stress for all types of students to be studying all the time, whereas other participants referenced the higher student contact time which led to higher study hours. Confidence also appeared to be an issue with one participant saying:

"My friend did a funny drawing the other day, it was like the Dunning-Kruger effect, the graph, like "we are here," and he pointed at the lowest point possible on the graph, confidence here. Like, okay, this is how recent graduates of engineering feel, brilliant".

"I've noticed this more among the male students, is that there's a pride and people don't want to look stupid."

"I think there is quite a bit of focus indirectly on that, and you just need to know, and I think there's also the sort of "need to know it but you don't need to understand it."

"But it's almost like there's no time for anything else, I've got to study, but then I feel like I beat myself up because I don't study all day. I found it difficult to find time for things I enjoyed like going to the gym and keeping fit and active. I think anyone who studies engineering has to be a slightly strange creature. A creature of the subject."

[There is a] *"very poor work mentality, The lecturers I think sort of support this as well, sort of joking at the beginning of "oh-ho, you're going to have to pull some weekends, do some overtime." And all this. You think "you've contradicted yourself." This should be quite a simple subject, but then you're saying you're not going to have any life. So, which is it? Humans need to have a kind of praise and lift through doing things, otherwise it's just year blocks at a time, or longer, without having anything, you just hold out for the entirety of it."*

"It's difficult because I think I can say this as an engineering student that other students aren't necessarily very personable either. Like as a group, engineers aren't the most emotionally intelligent people. I've noticed this in myself, and having friends that do other things, I have friends that are doing like medicine courses and things, like "oh, okay, this is how to understand feelings, I will learn from you."

"Yeah, like if you just hang out with engineers all the time, then emotional growth is maybe a bit more limited perhaps. It's quite like black and white thinking. It's quite nice to hide behind like if you do a maths question like "yeah, it's right, tick." Whereas it's not really how the world works. It's only once you go to work and escape it that you realise "okay, I have to look after this other part of my intelligence as well."

"I think looking at the confidence of an engineer in their own ability and then relating that to creativity, and maybe saying something like "make the weirdest design that you think will work," and then it doesn't matter if it doesn't work, because you've tried. This is a thing that engineers don't really do; it has to work all of the time, and it has to work repeatedly, this is what engineers do. But physicists or geologists maybe come with ideas and engineers are like "no, we have to make it work all of the time."

Interviewer: Well, you know, it would be good if aeroplanes would work all the time.

Participant : Yeah, we like it when they do that."

Engineering Views on Mental Health and Wellbeing

"Not to stereotype, but engineers aren't the best about talking about it. I think engineering as a whole, there's a lot of stress and there's a lot of people who just don't go and get help, don't talk about it."

Participants indicated how engineering courses did not cover or speak about mental health, and some indicated that while it might not seem relevant it was perhaps a good idea to start.

"I think engineering is a course that is going to be susceptible to those issues. It's a bit of a running joke even though it's not funny, people on the course make jokes about their mental wellbeing saying how aww I'm so depressed, these kinds of coping mechanisms. And a lot of the time I think they're just trying to be funny, but I think a part of it is like venting. I think a lot of people will feel affected by it and it's a bit of a running joke which says a lot about the course workload wise."

Engineering subject is behind other subjects on wellbeing.

"But I think there is also a problem with the attitude, and in some ways, in my opinion at least, it's a few steps behind the progress that maybe other teaching programs have in terms of supporting student wellbeing and creating a good environment. And I think probably a lot of that has to do with the high percentage of men."

"I've heard about people who had some mental health issues who studied engineering, but they weren't talking about it, and the people who were able to talk with other people about their mental health issues tended to study the humanities subjects, so business management, or… I think generally people in engineering are not that open in this."

“A heterosexual white male engineering student engaging with wellbeing, they thought I was a unicorn or something.”

“If you look at mental health statistics of men, problematic attitudes, it all combines very nicely to make engineering...”
Interviewer: “A perfect storm.”
”Yes.”

“I think the course is quite a lonely course. You go into the lecture halls, sit there, listen to the lecturer talk for two hours, and then everyone just leaves. So, it’s not even that you try and chat to people.”

“But, yeah, it’s not a main part of engineering, so you wouldn't expect it to be addressed in it, really.”

“In those days if you couldn’t cope, tough, that was it. Man up, or whatever the expression used to be, whatever the correct expression of the day was. But now, seeing the allowances made, I’m not giving away anything in the way of a person’s name, but one of the people on the course, we’re talking postgrad, has diagnosed ADHD. To see the allowances made and the adjustments made for dyslexia, for other not only physical disabilities, there weren’t any of those but all the whole mental side of things, whereas just in the past it was just if you can’t learn and can’t keep up that’s really rather tough.”

“I do a lot of work, I can work twelve hours straight, I can work more than that, just because one needs to sleep. But I believe it does not affect me much, but before, it used to affect me lots. So, mental health issues are really not addressed and really not thinking of in engineering that much. mental health. That’s only on this side of the world.”

Engineering is more intense than other subjects.

"I did live with two history students last year and they had four hours of lectures a week and we had twenty-two. Not saying there’s anything wrong with history, just as an

engineering student it's a bit more hands-on and intense, definitely. In terms of the exams and the workload, it seems very intense."

Perceptions of Engineering Industry

"I don't know if they would have spoken to anybody at their work placements if they were struggling. I think when you go in, you're a student trying to prove yourself to the industry and the bosses, and you don't really want to be asking for help because you want to show what you can give them. You want to impress them."

Participants were asked about how they felt engineering industry viewed mental health and wellbeing. Few participants felt able to answer this question and those that did answer had opposing perceptions from perceptions of engineering industries being "old school" to them being open and receptive and making efforts to support mental health and wellbeing. Some participants had worked in engineering before studying, others had some experience through placements or internships, and others had no experience in this area.

There was repetition of the concept of men/boys being unable to articulate their feelings within the dataset:

"I think it's not a really important factor in engineering because it's mostly boys that are doing it and boys don't like to talk about their feelings and even if they are feeling down, they usually don't reach out. And I feel it's so hard to deal with detect who's not feeling well about themselves because everyone's used to covering it up. So, I think it's a bit pushed aside because they think, if they can't detect them then it must be fine."

"[CHUCKLES] Well, it's difficult because it's quite stereotypically a male environment. Stereotypically, men are not very good at talking about feelings ever, so if they're confronted with a crying girl sat at their desk, they'll pretend it's not there.

"Especially engineers, they're more individual, they kind of hide, keep to themselves a lot more."

"And I've heard about people who had some mental health issues who studied engineering, but they weren't talking about it, and the people who were able to talk with other people about their mental health issues tended to study the humanities subjects, so business management, or… I think generally people in engineering are not that open in this."

“I think a lot of old school companies, especially drilling, oil and gas it’s very much there’s no work life balance, it’s all work. I’ve heard stories that if you weren’t still in the office after home time, then you were just not taking your job seriously.”

“I don't think there’s much in the engineering profession because it’s mainly focused on just construction and everything to do with other than people, in a sense. Although it’s built for people, it’s not focused on the people.”

The concept of stigma was not explicitly explored in the interviews but was apparent to the researcher in the discussions on perceptions of mental health and wellbeing in engineering industries. Phrases like “Old School Generation” or “Get On With It” came up but also there were reports of companies who did provide a more open culture and active support. This was viewed positively, but some felt that this openness can be performative rather than the reality.

“So, my Uncle is old school generation, worked on rigs and all that so I think some of them are very, they think it’s weakness and they think just be a man. The old school industry- not everyone but the old school industry is very tight upper lip, be a man.”

“Yeah, I’d say in my department, the strict engineering department, it was very much not so… it was less… how do I put this? I would have said it’s more traditional Bosch or corporate. But it was very much more reserved, it was less open. I wouldn't have talked about how I was doing personally. It was very formal.”

“I think it’s still one of those things that’s still very much swept under the rug and people don’t talk about it until it gets too late, and don’t talk about it enough. It’s hard to tell because I’ve worked for one engineering company but that doesn't really give much of an impression of the industry as a whole. But you sort of get the impression that the bigger older engineering companies, Rolls Royce or whatever, don’t really view it as something to be concerned about or focus on particularly at all.”

“I don't think it’s viewed much at all, to be honest. My experience is there’s a lot of pressure, almost all the time, constant pressure. It gets mentioned, but when it comes down to it, they much prefer to see the work and to get things done. It’s almost a bit ignored, I’d say. Very rarely have I heard of somebody… like the culture in a workshop, you’re not going to hear

somebody talking about their mental health or anything. People have the mentality of "get on with it."

Theme 2: Summary

The idea of engineering identity and culture was explored in theme 2. Participants were drawn to engineering through early interest in how things worked, and or encouragement from family or teachers. Practical application was most of interest, but career/employment was also mentioned as a driver. Participants discussed ways of thinking and ways of solving problems that while are not unique, are perhaps distinct from other disciplines and there were discussions on perfectionism, need for routine, need for things to work all the time, and fear of failure. There appeared to be an issue with stigma generally, more specifically personal stigma – participants understood that helpseeking is a good thing but expressed reticence at doing it themselves. Understandably participants who had positive help seeking experiences felt more confident to seek help again if they needed to.

5.7.3 Theme 3: Mental Health and Wellbeing

Subthemes and example codes are presented visually in Table 35 and descriptions are integrated into the supportive narrative. Interview participants were asked to consider their current mental wellbeing. The interviews were carried out during the first UK lockdown of the Covid-19 pandemic and so some discuss this as part of the narrative. Most participants considered themselves to be feeling generally well, lockdown notwithstanding, and that the lockdown had given them space to study and rest without the usual obligations. Some felt that they were not able to adjust well to studying from home where their usual routines were not possible. Sources of stress largely tied back to curriculum demands and pressure. Participants had different ways of coping when under pressure, some of which might be less helpful.

Table 35. Mental Health and Wellbeing Framework Matrix Summary.

Subthemes	**Example Codes**
Current MHWB	Covid wellbeing, Current MHWB
Sources of Stress	Exam Stress, No time, Missing Out, Overwhelmed, Sources of Stress
Coping	Coping, poor MHW, Powering Through, Reframing, Under Pressure
Helpseeking	Stress and Anxiety, Loneliness, No time- Missing Out
Helping Others	Approaching Peers, Flowcharting, Peer Support
Sources of Support	Support, GP Counselling, Friends and Family

Keeping Well	Eating well, Exercise, Hobbies, Socialising, Things that helped
Time Management	Managing Time, Planning Ahead, taking breaks

Current Mental Wellbeing

“Obviously COVID is a terrible thing that happened, but it actually was quite nice to just take a break from everything else that was going on around me.”

Participants were asked how they were feeling generally given they had filled in the survey a few months previously. The interviews were carried out during the first lockdown and so this is referred to in some responses. Some participants reported that lockdown actually helped them reset mentally whereas others struggled to study. There were a mix of reports with some finding that being in lockdown provided them with a reprieve, able to study without having to make excuses about not keeping up with social activities Others found the move to online learning difficult due to having established working routines that involved being on campus, making it difficult to concentrate.

“The past few months have been pretty stressful, I would say. I would say for me it’s been most difficult because I’ve been learning to work around my SPLD in an environment where I can move around, I can go to different places, and so I had coping strategies for that. And now when lockdown happened, I was confined to just working in my house, my study room or whatever, so it was very difficult for me there to get back in to find new strategies and keep working. So, yeah, there was definitely a period of low mood because I was struggling to get my work done. I think that’s a good way to put it, a bit of a rut.”

Participants who had finished their assessments reported feeling more relaxed.

“It’s a mix. On one hand, I’m quite happy to have finished the work that I had to, then there’s obviously the stress of not being with my family and having to study for exams. But that stress is now a bit behind me, so I’m mostly happy.”

However, others have struggled, and considered but ultimately rejected helpseeking:

There have been moments in the last three months where ordinarily I’d have thought maybe I should go to the doctor, but that's not really an option at the moment. But I have managed. My mental health is definitely a lot more well managed than it was, say, at the start of my first year."

I'm not going to lie, it's been a bit hard, but I feel like it's been like that for everyone. And I've had my down days where I didn't even want to get out of bed, and I felt really down. Especially during the whole when our exams were due. I didn't have any energy to do any of them.

Sources of Stress

"You were just so behind that it felt you were buried."

Participants struggled to find time for things they enjoy, such as going to the gym and keeping fit and active, due to the pressure on students to study all day. Many felt that they found exams incredibly stressful while others found that exams were not particularly stressful but that they were more of a memory test than allowing them to demonstrate knowledge. Some simply felt it was a necessary thing they just had to get on with. Participants mentioned feeling overwhelmed and seeing others feeling the same.

"You do see some people when you start a new semester, that you were mates with just drop out because they can't take it and you can visibly see some people get overwhelmed."

Participants described various sources of stress related to their course. Key sources identified in the data were:

- Exam stress
- Assessment schedule intensity
- Workload
- Lack of clarity

Exam Stress

Exam stress was mentioned the most as a source of excessive stress. While one participant felt that exam anxiety supported them to prepare better, and another considered it just part of being a student, other participants felt that exams (closed book mainly but some forms of online exam also) caused significant stress and worry:

"But if it's something that I'm really not sure of, even no matter how much I revise it, I always seem to go in and completely blank out."

The lack of inclusivity in the choice of closed book exams as an assessment tool was also raised as a concern:

“It’s stressful, I suppose. Yeah. And I wouldn't say that’s particularly healthy for people, and I think it puts a lot of stress on people to have the right answer and not do things in their own way and think about things in a way that works for them. I think that’s particularly relevant for students with an SPLD [specific learning difficulty] or something like that, at least in my personal experience, that they need to be given the space and allowed to think about things in their own way or helped to do that. I think a lot of that doesn't really happen.“

"I hate exams, I had a horrible time with exams last year, I was like “I'm not doing this again.”

Assessment Schedule Intensity

The intensity of assessment diet was another source of stress, even among those who did not find exams in themselves overly stressful. Assessments scheduled close to each other caused anxiety:

“I’ve found there have been a lot of deadlines happening in a very short period of time, so it’s kind of like a juggling act to try and keep all these five assignments going and then handing them in on time. And meanwhile studying for exams and things. So, it can be quite a lot of pressure and a lot of stress. I’ve definitely found myself getting burned out because obviously you want everything to be at the highest possible standard, but it physically isn't possible, there’s only so many hours in the day, and I’ve found that I’m handing in work that I know is probably good but is maybe not perfect and I come away feeling a bit of a failure.”

Workload

Participants also described a low-mid level continuous pressure from the workload and that pressure can lead to a feeling of being unable to do one’s best, losing academic self-efficacy.

“I’m trying to combine continued study preparation for next year, self-interest, gardening, shopping, you name it, all of those things, to try and achieve some kind of balance, and yet it feels a bit like those circus acts where you see the wooden rods with the plates on top and the person spinning all the plates, and I’m trying to let not too many plates hit the deck.”

“So, even though I did lots of work throughout the year, I always felt like it ended up being a massive climax where I’d be cramming loads of stuff the day and the night before and hoping for the best. I’d often go to the library in the weekend as well. And I found that to be able to maintain this level, the general university things that you would partake in such as going out on the weekday, or at least being able to take part in more societies and extracurricular things became very difficult in my third year because to really stay on top of everything I was given, I had to do enormous amounts of work. And I think it meant I’d often cancel on things, cancel on friends."

Other participants felt particular stages were more stressful than others with 2nd and 3rd year transitions being particularly challenging:

“I’d say what I said the start of third year was maybe the worst, just because you’re working with people. I think it would depend, if you’re more susceptible to stress and that you’ve got pre-existing mental health or other extenuating circumstances, I think that could make it harder.”

“I feel like that (calming exercises) definitely helped in the middle of exams and stuff, if I was ever feeling a bit panicked, then I would try and calm myself down and then I could concentrate again on continuing the exam. But I feel like that kind of took care of that problem, so the new problem was when you’ve got X number of deadlines, X number of exams approaching, all of these lectures and stuff, and you’re just generally feeling a bit run down, but it’s not a single moment of stress.”

Lack of Clarity

Course administration lack of clarity also appeared as a source of stress. In this instance course administration relates to requesting extensions or assessment deferrals due to an extenuating circumstance, or lack of clarity on assessment briefs.

“And it didn't help that at the end of second year when I think I had six exams, and my sister was also doing her A Levels at the same time, our grandma died in Northern Ireland and had a whole bunch of faff around… I ended up talking to my department to say “look, what happens if I miss an exam?” and they were like “well, you’ll have to submit a form and we’ll consider it.” And I was like “well, I can tell you exactly what the situation will be, what

happens?" And it ended up making the whole situation more stressful, so I had to take exams at the end of August as well."

"Confusion from different lecturers, exam pressure: "If two or three lecturers are teaching the same module, you can ask the three lecturers and get a different answer from all three of them, which is quite stressful because some of the time you don't know what's entirely being asked of you because you're being told different things from different people. It can just put you on edge."

Coping

"I try to avoid everything as possible; I'm not going to lie. I just shut everything out and I just try to get rid of all my responsibilities, I just pretend they're not there. Even though it's going to come back and bite me.".

Participants were asked about things they would do when under pressure, how they would cope. This was separated from how they kept well to draw out behaviours that may appear when under stress and Keeping Well activities have been reduced due to workload or stress. Participants gave a variety of responses from trying to push through their problems, to ignoring them entirely until crisis, to isolating themselves. One or two mentioned alcohol use for a brief time but that this hadn't helped so they had stopped. All night study happened earlier in studies, but they appeared to move away from it. Feeling a bit overwhelmed.

Key dimensions of the discussions were:

- Powering through
- Giving up exercising/socialising/hobbies
- Masking
- Crying toilets

Powering Through

A portion of the respondents referred to powering through, going all in etc. While the students weren't leaving things til the last minute the quantity of deadlines meant that there were times where assessment crush just meant either just getting on with it or failing.

Giving Up exercising/socialising/hobbies

Throughout the data there were descriptions of participants routinely giving up on social or exercise activities to study. While some level of prioritisation might be expected during a degree course, a balance needs to be set to avoid students burning out and becoming fatigued.

“Yeah, when I’m stressed, I sleep more. Which makes me more stressed because there’s less time. Yeah, definitely when I’m sleeping a lot, I think something’s not quite right here, and I pick up on that. But I worked really hard in the first three years of my degree because I knew fourth year was weighted 50% and I knew fourth years who had had a really bad time, so I kind of front-loaded my degree as much as I could so that this year I could be like “well, this is happening. I’m still riding my bike, bye.”

Masking

Some participants described masking their emotions or feelings when feeling low or stressed and there were observations from participants on how common this is in engineers. This may be in part due to the high number of men on engineering courses (Imasogie, Oyatogun and Taiwo, 2018, Martin, 2021, Bosworth, 2022, Engineers Canada, 2021, Catalyst, 2022, HESA, 2023) but also it could be in part due to the engineering culture of silence and celebration of stress of the department (Jensen, 2021) making it more likely that an engineering student will set aside their feelings in order to fit in:

"It’s difficult because, for me, I’m someone who completely covers it. I don't let anyone know."

"no one would be able to tell I was the most unhappiest person in public, laugh and joke and all that shit but obviously not inside. It’s putting on a mask, isn't it?"

“Well, for me, even if I’m having problems, I wouldn't demonstrate to everyone. No one would actually see that I’m actually having problems, I’d try to cover it up somehow, try to act normal. That’s a very common thing amongst engineers, I’ve seen that, I’ve done it myself, I’ll be honest.”

Crying Toilets

“there are certain toilets which you can go to which are the crying toilets, and that’s just wherever we go whenever we’re feeling a bit overwhelmed. It’s kind of a running joke in the university, but I’m not going to lie, me and my friends have all used them a couple of times.”

Helpseeking

"I shouldn’t have not told people. I think the lecturers would have accommodated it if they had saw how bad it was."

Participants discussed their own feelings on helpseeking and sometimes considered how other engineering students might feel. Some stated they had not sought help even though they acknowledged they needed it. Some felt it was not talked about and there wasn’t a culture that supported this.

"I think engineering as a whole, there’s a lot of stress and there’s a lot of people who just don't go and get help, don't talk about it."

“There was a time I felt really down, around the time I was thinking about dropping out, and I stayed in a lot, I didn’t really communicate with anyone, I didn’t let my friends in.”

In current literature it is common to see references to delayed or no helpseeking in relation to engineering student mental health and wellbeing. Publications have reported some key barriers to helpseeking and some of these barriers are referred to in the interview data. As a high-level overview, the participants generally did not wish to seek help themselves but would be happy to help others.

“There was a time I felt really down, around the time I was thinking about dropping out, and I stayed in a lot, I didn’t really communicate with anyone, I didn’t let my friends in. Even when I went to lectures I would just sit there not speaking and just go back to my room. But I just had to get over it and once I’d done that, I actually realised how bad that was for me personally because I’m not the type of person to open up to anyone either. Even though there was a lot of support, I was still not the type of person to reach out or open up to anyone. I’m an only child, and growing up, I was only around boys. So, I’ve kind of adapted their mentality and just the fact that they don’t open up, they don’t talk about their feelings, I’m a lot like that as well.”

“I had lost I think five family members in the space of about six months, so I had a really rough summer that year. And I was my fault completely, I didn't apply for extenuating circumstances for the exam, but I’d applied for so many extenuating circumstances that I reached a point where I wanted to pretend it didn't happen, wanted to pretend it didn't exist.”

"No. Everything was just kind of "chin up, you'll be fine."

"I was going to (go back), but I didn't have time to book the appointment, because this fourth year had so many deadlines and the dissertation and stuff. So, I didn't really want to take the time to do it. "

Helping Others

"You'd probably get that from an engineer, them asking "okay, is this guy my friend, or someone I don't talk to?" You get different flowcharts and everything."

A few participants felt comfortable to support peers through a mental health or wellbeing issue. Some felt they would struggle to feel comfortable but would feel sympathetic. Others mentioned it might depend on how well they knew the person and there was some appetite to get training to better help others. This indicates that a portion of engineering students had the desire and general confidence to provide peer support informally but may benefit from training.

"*I think a lot of people would maybe find it awkward but having had experience growing up with mental health and family members with it, my first instinct would be I want to help them because I'd understand. And I think saying things like that to people when they're suffering falling on deaf ears but do generally understand how all-consuming it is, so I'd be happy if people reached out to me. And I would check up on them, so I'd try and get them to get help and I wouldn't just leave."*

While participants appeared less inclined to seek help for themselves, they showed much more comfort in supporting others both directly and indirectly. This is potentially showing a moving of the culture of silence or reduction of stigma in relation to mental health and wellbeing and possibly a sign that in time engineering students may begin to feel comfortable about seeking help for themselves.

"It depends how close I was with them. I wouldn't want to feel like "this person has noticed I'm acting weird therefore everyone must have noticed." I wouldn't want to make them feel like that. But if I was friends with them, close enough with them, which is probably more of a function of how I am as a person than anything else, then I would approach them and ask them if they were okay, what's going on and whatever, and take it from there, really."

Some participants felt they would be able to approach someone directly if they were concerned, where others would consider their relationship to someone before deciding on a course of action. One participant hinted at a potential stereotypical way an engineering student might approach helping another person.

Sources of Support

"I found it was actually really beneficial, so I did go back two or three more times until eventually I went one last time, I kind of said "I am feeling a lot better in and of myself."

Sources of support discussed included friends, family, student counselling, GP support, Headspace. Some participants had a fairly positive view of university support, but others had poor experiences. Central services i.e., Disability and Dyslexia services were viewed positively. Key dimensions of this section: some participants aware of available support and have experienced good support enabling them to persist. Some felt the administrative staff were not sympathetic or helpful whereas others felt there was good support available even if they didn't themselves feel they needed to use it. Those who felt there was good support mentioned posters they had seen in their Schools/Departments and that lecturers regularly mentioned being available to chat. There were differences in how the participants viewed support from lecturers, with some saying it was good that engineering staff were available to discuss mental health and wellbeing and others suggesting this was not their job, there was a problem with power balance, or again fear of judgement.

One participant described hearing that another engineering student had the phone number of their personal tutor and found this supportive.

"I know that one of my friends who's in a different tutor group, he still has his academic's phone number in his phone because he was like "you can phone me at any time. If you're on a train and you're coming back from somewhere and you're not having a good time, you can just phone me, it's fine."

This is slightly concerning as staff should also maintain boundaries of their own and this type of availability may not be possible for other staff leading to mixed experiences for students and potential of overburden for some staff.

More broad support was also mentioned i.e., university wide support which was positively regarded.

“I had some issues in my fourth year with my thesis where I got into anxiety, and the university supported me quite well.”

Mobile App Headspace was mentioned by one participant as a useful tool but other than that apps were not mentioned. Another participant described their experiences in getting support from their personal tutor where the tutor was able to listen and make them feel comfortable but then did not follow through with practical support they would expect from a personal tutor (support with the course administration process for absence to see a dying loved one).

Consistency of experience was described by some participants who noted that if you had your personal tutor as a lecturer in a small class, they were often more approachable than if your personal tutor was not. This may lead to inconsistent support across a cohort.

Keeping Well

“I think time management is a big part of it. If you leave a lot to the last minute, and you've got everything coming at you, whereas if you can kind of stagger your workloads or stagger the amount of assessments you’ve got, things are more manageable in smaller chunks than a big pile.”

Some participants indicated that physical activity helped them keep well, but that study meant that there was a reduction in activity, due to lack of time to focus on themselves. Some participants mentioned eating well, socialising, and a variety of hobbies. Time management and taking regular breaks was also important for keeping well. Things that worked for participants were: Routine, taking time for themselves, break away from screens, time management, listening to death metal, planned treats, headspace app, meditation, screaming, ACT therapy, reframing, breathing exercises. Participants described the activities they engaged in to keep mentally well. It was anticipated that the data generated from this question would align and perhaps expand on the information given in phase one.

Key dimensions of the data were: exercise, either with others or individually, listening to music. Eating well. Bell ringing, glee club, kayaking, engineers without borders. Some mention social activities and hanging out with friends outside of engineering. For the most part activities related to them personally, i.e., exercise, socialising but there was also mention of some volunteering (engineers without borders) or caring for an animal. This type of activity or community engagement has been linked with improvements in mental wellbeing (Tabassum, Mohan and Smith, 2016) and supporting eudaemonic happiness (Son and Wilson, 2012). Time management was again raised as something people actively do to ensure they have time to stay well.

Finding time to pursue these activities was noted as a challenge, particularly during the week.

"Yeah, when I'm stressed, I sleep more. Which makes me more stressed because there's less time. Yeah, definitely when I'm sleeping a lot, I think something's not quite right here, and I pick up on that. But I worked really hard in the first three years of my degree because I knew fourth year was weighted 50% and I knew fourth years who had had a really bad time, so I kind of front-loaded my degree as much as I could so that this year I could be like "well, this is happening. I'm still riding my bike, bye."

Routine was seen as important also with a participant describing how working gave them a routine and supported their wellbeing.

"So, that was the way I recovered, that was my way out." "I felt that I could handle it. I had a good routine, I knew I was capable of working hard, I was stable."

Mindfulness or yoga was also described as helpful activity. Positive thinking also was discussed, and going for walk was mentioned frequently as a way to clear one's head and feel better.

Time Management

"I'd schedule it into what I'd class as my frees, so that is how I would cope with the stress, at least I can get it done if it's on a checklist and I can tick it off. I like to make schedules…So, if there was something I knew I needed to do, I'd schedule that in."

Time management was discussed in most interviews. Responses varied from those who felt they managed their time well and those who found this particularly challenging. Most participants mentioned workload or hours required for study was a lot and some participants said they often sacrificed other interests often to keep up. In the survey, time management appeared to be a useful mitigator for stress in that those who viewed their time management skills positively appeared to have better mental wellbeing. Key dimensions were developing and sticking to routines, maintaining hobbies and exercise (or not), working to deadlines as a useful motivator.

"I just look at the deadlines and I think right, I've got a week to do it, I need to do it, it doesn't matter how I feel, I'll be fine in the future, so I've got to get this done now. Although I think I gravitated away from them [all-nighters] *as the program went on. But, yeah, I think the worst thing was just all-nighters, really."*

Those who felt they managed time well described habits such as developing routines and building in rest breaks. Some of the routines described may be difficult to stick to over prolonged periods of time and there may be a potential for illness or an unexpected event to derail this. Some described all or nothing approaches to study, which over short period might be temporarily helpful but again over prolonged time this could lead to burnout and poor mental wellbeing.

"I'm not good at managing my time in the sense of spreading it. So, I'll just go all in. All or nothing. So, I'll just spend 10 hour days just studying and this is a bit stupid, but part of what happened to me when I got run down was just forgetting to do simple things like eating, looking after myself, exercising, getting very stressed."

"Because I try to keep three weeks ahead of the modules, and when the exams do start or we get issued with the exams, they're normally issued about two or three weeks into that set part of the module, I just continually work through them as they come across. I've never been one for leaving things until the last minute. I need a bit of flexibility."

Theme 3: Summary

This theme looked at mental health and wellbeing in engineering students. Stressors were identified in the data relating to curricular activities, in particular overwhelming workload, exam/assessment stress, and lack of clarity on expectations. Coping strategies were overworking/powering through and dropping social activities. Strategies for keeping well included rest breaks, eating well, exercise, socialising and hobbies. Participants noted having to reduce or remove these strategies at stressful times in the academic year. Sources of support were friends, family and support services although these were used least, those that did use support services like counselling found they were very helpful.

5.7.4 Theme 4: Suggestions for Institutions

As part of the semi-structured interview, participants were asked if they had any suggestions for improvements in relation to mental health and wellbeing support in their School of Engineering. Table 36 is the matrix summary for this theme.

Table 36. Suggestions Framework Matrix Summary.

Subthemes	Example Codes
Suggestions for Institutions	Visibility
	Curriculum Enhancement
	Training

The key dimensions of the discussions related to:

- Visibility;
- Curriculum Enhancement;
- Training;

Visibility

"I wouldn't really know who to go and speak to if I wanted to… I think when I went to defer, I had to contact the union, and they put me through to a counsellor who had to sign me off, and that was fine, they did that, that was grand. But I don't feel there would be anyone at the engineering level. Well, actually, they wanted me to go and speak to a personal tutor, but I don't know who my personal tutor is because no one's told me and my original one left."

Participants felt that there was a lack of visibility in terms of what was available to them in term of mental health and wellbeing support. A dedicated mental health and wellbeing advisor was suggested, and this has been beneficial in the "centralised support" intervention but may be too costly for universities in the UK – would this be needed in all schools rather than only engineering. Staff including professional and support staff should be more open and supportive and equipped with signposting information and a more open environment in the School office was also suggested, pointing to an overall unwelcome feeling.

“I’d say sometimes the teaching office just being more friendly and open. I know that’s silly, but just feeling like you can speak to people is a huge part of wanting to speak to them.”

Curriculum Enhancement

"Currently they treat everybody like they know everything from start to finish, and kind of like they’re not struggling with it."

Some participants proposed changes to curriculum and staff enhancements, particularly around course organisation and ensuring topics are covered in the right order at the right level, and also increased in complexity perhaps more steadily than it is perceived to be:

“*one configuration involved mechanical analysis that you don’t learn until third year and I think a lot of the lecturers thought we knew it already and they didn’t realise until later on, these people don’t know this.”*

There were suggestions to move to more coursework and fewer exams, but there were also suggestions that there was already too much in the assessment schedule. This perpetuates existing arguments in engineering education around assessment. The advantages and disadvantages of exams versus coursework have long been a source of discussion and is an argument not likely to be solved any time soon. However, pace, frequency, academic difficulty, pressure, and risk of collusion/personation all need to be considered in deciding on an assessment plan. Mentoring from people closer to the students’ learning journey was also suggested, either by peers/buddies or by PhD students.

Ensuring the order of topics is correct, more flexibility with assessment submission, and timely study skills support were raised as key areas for enhancement.

Training

“I don't really feel like I could turn to the teaching office if I had an issue. I feel like they’re sometimes a little bit…I don't feel like they’re very understanding at times, that at times you have issues going on outside of uni.”

Participants suggested that mental health and wellbeing training should be given to staff and key people particularly those who are in regular contact with students. Students should be able to have open communication with staff and they should all have some awareness of mental health and wellbeing problems. Training the people who deal with students every day to recognise where there are issues would be beneficial. This is especially important in engineering, as many people don't ask for help when they first need it. A dedicated engineering counsellor was suggested also, which may be of benefit, if there is room in the budget.

"Otherwise, you're just being handed this thing and you've got no idea what it is or what to do with it." Maybe the uni could be clearer who to talk to or have someone specially assigned for everyone, rather than just giving it as another job to a lecturer who has already got other jobs to do."

Finally, mental health and wellbeing support should include understanding what students are dealing with outside of the university setting.

5.8 Stage 5B Abstraction

The previous stage described the findings of the framework analysis and developed three key themes and one suggestions category. This stage of the analysis explores more deeply the overarching constructs that contribute to mental health and wellbeing in engineering students.

5.8.1 High Level Constructs

Once data summaries were produced, the high-level constructs of "The Curriculum," "The Student," and "The Culture" were developed. Time was spent considering the distinct aspects of the data summaries looking to categorise into higher level constructs. The three high level constructs were teased out from the summaries as aspects that different stakeholders might influence. This is in line with the pragmatic and salutogenic nature of the research – we have answers and so what is the next course of action. The stakeholders are: Academic institutions, Engineering Students, Engineering Industry. All three stakeholders can influence and can be influenced by to a greater or lesser extent the constructs of The Curriculum, The Student, and the Culture (Figure 30).

The Curriculum

The Curriculum is largely set by the academic institution, influenced by market demands and professional regulatory bodies, and to a lesser extent, student feedback. The curriculum reflects and sometimes perpetuates the Culture and impacts on the Student.

The Student

The Students' ability or inability to thrive is largely influenced by the curriculum and the culture. The Student has the most potential to drive lasting Curricular and Culture change and yet is at risk of driving cultural reproduction.

The Culture

The Culture of engineering as a concept is currently one of stress celebration, of silence, of stigma. The Culture is influenced by the Curriculum and itself and can be perpetuated by the Student.

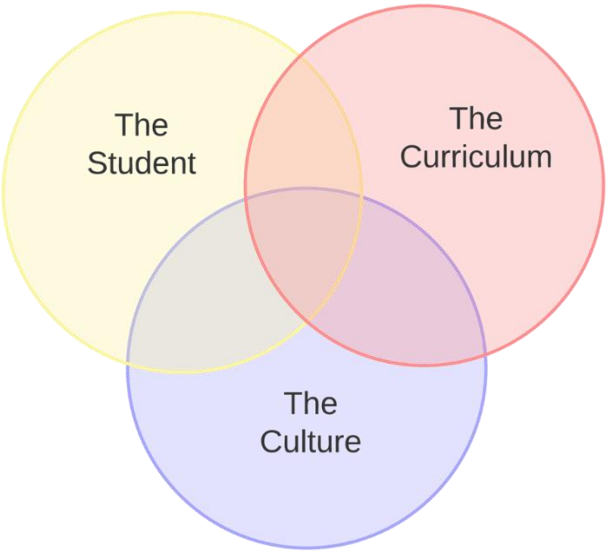

Figure 31. Diagram of the High-Level Constructs.

5.8.2 Proposed Framework: S.O.S – S.O.R.T

It was the hope of the researcher to develop a tentative framework to support the improvement of mental health and wellbeing in engineering students. Any model would need to appeal to both engineering students and staff. The following is a description of the development of this model. Summaries were further reviewed and assigned concepts with the intention of building a relatively simple model to support enhancement of engineering student mental wellbeing. These concepts were arranged into S.O.S (deficits, or factors contributing to poor mental wellbeing) and S.O.R.T. (strengths, or factors contributing to good mental wellbeing). Table 37 shows the Framework Matrix with the related assigned high-level concepts.

Table 37. Framework Matrix with High Level Concepts.

Themes	Subthemes	Concepts
Curriculum	Participant Description	-
	Course Structure/Content	Overwhelm
	Learning Activities	Stigma, Trust
	Experience of Teaching	Stigma, Trust
	Assessment	Overwhelm
	Study Support	inefficacy/Self Efficacy
	Course Administration	Overwhelm/Stigma
	Experiences of Women Engineers	inefficacy/Self Efficacy
	General Student Experience	All
	Covid changes	Overwhelm/Self-efficacy
Engineering Identity	Choosing Engineering	inefficacy/Self Efficacy
	Views on Engineering	inefficacy/Self Efficacy
	Engineering Habits and Culture	inefficacy/Self Efficacy
	Engineering views on MHWB	Stigma
	Perceptions of Industry	Stigma
Mental Health and Wellbeing (MHWB)	Current MHWB	inefficacy/Self Efficacy/Stigma
	Sources of Stress	Overwhelm
	Coping	inefficacy/Self Efficacy
	Helpseeking	Stigma
	Helping Others	Stigma
	Sources of Support	Self-Efficacy Organisation/Routine
	Keeping Well	Organisation/Routine
	Time Management	Overwhelm/Organisation
Suggestions for Institutions	Visibility	Stigma/Trust
	Curriculum Enhancement	Self-Efficacy/Organisation/Routine
	Training	Stigma/Trust

In summary, the qualitative data has been reviewed with the following high-level constructs in mind: The Student, The Curriculum, and the Culture, with the supporting concepts relating to poor or good mental wellbeing. Figure 31 depicts an initial proposed framework in a similar style to the salutogenic continuum. Future research evaluating and developing the framework would be required before recommendations for its use could be made.

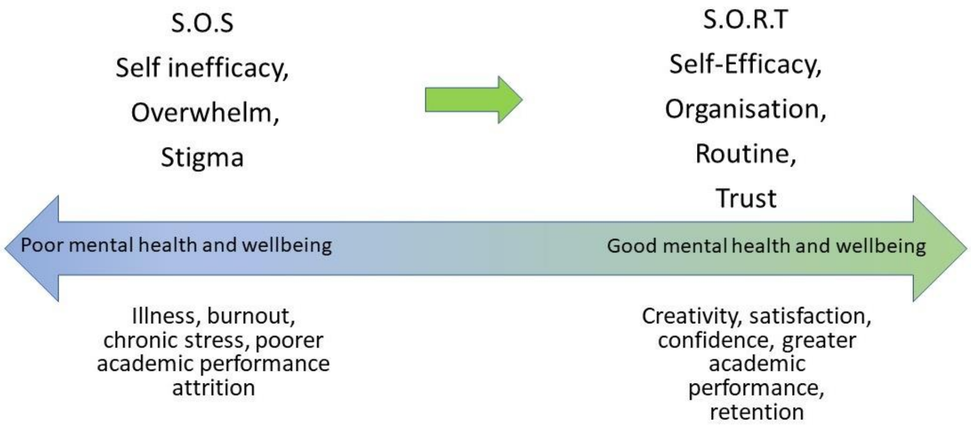

Figure 32. The S.O.S - S.O.R.T Continuum.

5.8.3 S.O.S

S.O.S. is the acronym describing overarching concepts contributing to poor mental health and wellbeing in engineering students. It has been developed to support understanding for engineering educators and stakeholders.

Self-Inefficacy

Self-Inefficacy or negative self-efficacy is a concept that describes a person's perception of their inability to cope with adverse situations (Bandura, 1987). It is described by Tacke (2022) as a feeling of lack of capacity to produce a desired effect and can contribute to burnout (Schaufeli and Salanova, 2007). A survey of the tech workforce reported 33% of workers at high risk of burnout felt inefficient at their job (BurnoutIndex, 2022). Burnout can lead to poor mental health and can be associated to mental illnesses such as anxiety and depression (Koutsimani, Montgomery, and Georganta, 2019). Students who described poor time-management, low confidence, lack of belief in themselves academically, particularly in relation to exams, were describing self-inefficacy.

Overwhelm

Participants described a crowded curriculum, over assessment, excessive activity, and lack of clarity in processes and expectations. Some described problematic cultures from celebration or normalisation of continuous stress to sexism. Other narrative included a lack of clarity in processes, uncertain futures, confusing briefs, unknown expectations, and overwhelming volume of course content.

Stigma

Participants described experiencing unsupportive environments, a culture of silence or not feeling welcome to be open about mental health and wellbeing, untrained staff, feeling inadequate in themselves, feeling afraid to appear weak, wanting to impress employers, and fear of judgement. Reducing stigma is critical to improving mental health and wellbeing for engineering students.

5.8.4 S.O.R.T

As this research is embedded with a salutogenic focus, the data was also analysed for wellbeing promoting factors. S.O.R.T. is the acronym describing overarching concepts contributing to good mental health and wellbeing in engineering students. As with S.O.S., it has been developed to support understanding for engineering educators and stakeholders.

Self-Efficacy

Coping self-efficacy is the perceived ability to cope effectively with life challenges. Some participants demonstrated self-efficacy, expressing their belief in their ability to deal with the challenges an engineering course presents. Strategies for success included excellent time management and maintaining social links and personal activities.

Organisation

Time management in particular allowed participants to plan and maintain study schedules and activities that support mental wellbeing. Ensuring work was done on time and not worrying about perfection were ways to keep a balance, although this was sometimes difficult to maintain.

Routine

While the main wellbeing activity appeared to be exercise in various forms, the ability to maintain a routine that included wellbeing activity was not always apparent. Those who stuck to a routine that included their own interests appeared to have a higher sense of general wellbeing and control. Therefore, setting and maintaining a routine may have beneficial impact on mental health and wellbeing.

Trust

Developing a community or culture of trust in engineering schools and departments will be critical to supporting good mental health and wellbeing. Those who felt they had good mental health and wellbeing also felt that they were able to talk with at least one member of engineering staff about how they were feeling and that they had a good network of support in place.

5.9 Chapter Summary

This chapter reported on phase two of the doctoral research. Semi-structured interviews were carried out with a subset of volunteers from the respondents of the survey in phase one. The transcripts were analysed using framework thematic analysis and the themes of The Engineering Education Experience, Engineering Identity, Mental Health and Wellbeing, and Suggestions for Institutions were identified. The frameworks were then analysed for higher level themes which were developed to be The Curriculum, The Student, and The Culture. Further to this a proposal for a framework to support good mental health and wellbeing in engineering students was put forward with a salutogenic underpinning. The next chapter will integrate phase one and two findings for discussion and begin to draw the research to conclusions and recommendations.

Chapter 6: Integrative Discussion

6.1 Chapter Overview

The previous two chapters presented the findings and discussions for each phase of the sequential explanatory research design. This chapter will now integrate results and discussion from both phases into a unified discussion that revisits the research aims and questions and begins to draw conclusions from the research. This includes bringing findings together and presenting them side-by side.

6.2 Introduction

There are several ways that integration of mixed methods can be achieved (Fetters, Curry, and Creswell, 2013, Guetterman, Fetters, and Creswell, 2015). The following paragraphs describe how results and findings from this work have been integrated. This research was developed and implemented as a sequential explanatory mixed-method design. This means that the findings of phase one (quantitative) informed the data collection of the phase two (qualitative) (Ivankova, Creswell, and Stick, 2006).

The two phases of the research were integrated through ‘connection’ and ‘building’ (Fetters, Curry, and Creswell, 2013). Participants of the survey were purposively sampled for the interview phase and the results of the survey informed the development of interview questions.

The research has been further integrated at the ‘interpretation and reporting level’ (Fetters, Curry, and Creswell, 2013) through the joint display and discussion that follows in this section.

To support the reader, the following visual guide has been developed incorporating guidance from Ivankova, Creswell, and Stick (2006) with the purpose of providing an overview of each phase, the linking points, the procedures, and the resultant ‘product’ (Ivankova, Creswell, and Stick, 2006). This is outlined in Table 38.

Table 38. Visual Model for Mixed-Method Design Procedure.

Phase	Procedure	Product
Systematic Scoping Review	JBI methodology, development of systematic review protocol, execution of review	Scoping review protocol Peer reviewed published scoping review
Phase One: Quantitative Data Collection	Web-based survey for engineering students (*n* = 417)	Numerical and open text data
Quantitative data analysis	Data cleaning and screening Descriptive statistical analysis WEMWBS scoring analysis. Content analysis	Descriptive statistics WEMWBS Scores Presentation of content analysis
Connecting phases one and two	Purposive sampling for stage/subdiscipline. (*n* = 27) Developing semi-structured interview guide Piloting guide	Cases (*n* = 27) Interview guide Supporting information document for participants
Phase two: Qualitative data collection	Individual recorded video-conferencing and telephone interviews with 27 participants.	Audio and video files. (n=27)
Qualitative data analysis	Coding and framework thematic analysis supported by NVivo. Theme development Abstraction and interpretation	Transcriptions (*n* = 27) Images of analysis process Framework matrices Data summaries Theme description Abstraction and visual models
Integration of phases	Juxtaposition of results and findings against research questions to identify patterns of association Interpretation and discussion of combined findings	Discussion Limitations Conclusions and recommendations for future work

6.2 Juxtaposition of Findings: Mental Health and Wellbeing

An electronic survey was developed and carried out in November 2019-January 2020. The survey included the Warwick Edinburgh Mental Wellbeing Scale and an option to self-report any mental illness. The results of the survey in Phase One indicated that the mental health of engineering students in the UK was similar to the mental health of the general UK population, but mental wellbeing of engineering students was statistically significantly poorer than the mental wellbeing of both the general UK population and the general student UK population. Some gender differences were also noted with female students reporting poorer mental wellbeing than the male students. Mental Health and Wellbeing was also explored in Phase Two which included some discussion of the COVID-19 lockdown. Table 39 brings the two phases together and provides a short summary answering the research question.

It should be acknowledged that that many respondents disclosing a mental health condition had been diagnosed and or treated for it for the first time during their studies, The implication of this is that students may be processing and coping with new medications or treatment plans and poor mental health at the same time as learning complex engineering learning material and coping with a heavily loaded study schedule. This should be considered when supporting students in poor mental health.

6.2.1 Mental Wellbeing

The Warwick Edinburgh Mental Wellbeing Scale score for engineering students who participated in the survey was 41.3, which is within the accepted threshold for possible clinical depression. Only 3.62% of respondents scored for high mental wellbeing (60-70). Compared to general UK populations of Scotland, England, and Wales where data was available, engineering students have statistically significantly poorer mental wellbeing. Compared to the UK student population the engineering UK student population appeared to have poorer elements of mental wellbeing in relation to feeling useful, dealing with problems well, feeling close to people and feeling cheerful, but it was not possible to compare directly with data due to the presentation style of publication results. Stages 2-4 had significantly worse mental wellbeing than Stage 1 and female students reported poorer mental wellbeing than male students.

Aeronautical students reported the highest mental wellbeing at 46. Electronic and Electrical students reported the lowest mental wellbeing at 40 and there was a statistically significant difference was noted with female electronic and electrical students reporting poorer mental wellbeing than their counterparts.

Table 39. Juxtaposition of Results for Research Question 1.

Research Questions	Phase One	Phase Two	Summary
What is the mental wellbeing of engineering students in the UK	Mean WEMWBS Score 41.3. 3.62% High MWB. Aeronautical students report highest mean at 46. Electronic and Electrical students scored lowest at 40. Female students reported poorer MWB than male students ($p>0.024$).	A mix of reports from participants, some who found the previous couple of months stressful and others who felt not having to make excuses not to go out helpful for their studies. Routines were hard to reinvent during COVID-19 lockdown and studying for many was harder.	Significantly poorer than general population and elements of MWB poorer than general student population ($p<0.001$). Large effect size between engineering students and general population. Interviews highlighted areas of concern like loss of routine, and in relation to covid some found being in lockdown a relief. Both quantitative and qualitative findings indicate a mental wellbeing problem.
What is the mental health of engineering students in the UK	28% diagnosed or treated for a mental health condition. 19.9% Depression, 18.94% Anxiety	Not covered	Prevalence of mental health problems appeared to be similar to the general UK population, but there was over representation of women in the data, and risk of response bias.
How long has it been since diagnosis?	Just under half of the 118 respondents (49.15%) reported having been diagnosed or treated in the 24 months before the survey.	Not covered	Results indicate many respondents dealing with a diagnosis and/or being treated for mental health problems for the first time while also being at university. This indicates and area where support may be beneficial.

6.2.2 Mental Health Problems

Participants were asked to self-report any mental health problem and 28% reported having been diagnosed or treated for a mental health condition with 9.9% of participants experiencing depression, 18.94% experiencing anxiety disorder, and 9.83% experiencing both depression and anxiety disorder. Of these participants 36.44% felt they managed their condition well or very well, and 27% felt they managed their condition poorly or very poorly. These results are similar to those of Danowitz and Beddoes (2022). Participants indicated when they were first diagnosed or treated for a mental health condition and the responses indicated that many respondents reporting a mental health condition had been diagnosed and or treated for it for the first time during their studies, with 15 3rd year undergraduates and 11 4th year undergraduates reporting having been diagnosed or treated for a mental health condition within 2 years of study.

6.3 Juxtaposition of Findings: Helpseeking

To answer this question, both phases were utilised more fully (Table 40). The survey indicated that mental health helpseeking behaviours were similar to the behaviours identified in international literature on engineering students in that there were low rates of help-seeking, resistance to help-seeking, issues of stigma, and lack of trust (Jensen and Cross, 2021, Wright et al, 2021, Bork and Mondisa, 2022). Over half of respondents (53.2%, n=222) stated they would not talk to a member of engineering staff if they were feeling low or mentally unwell with a quarter (24.7%, n=103)) stating they would with the remaining 91 (21.82%) stating they were unsure if they would talk to a member of engineering staff. Respondents to the survey said they would prefer to seek help from friends or family rather than engineering staff and would prefer to deal with their own problems with only 10 respondents saying they would seek professional help. Participants stated they would prefer to disclose to a partner or family member before a member of university staff and would go to a GP over a university support resource. The interview analysis highlighted a general lack of trust in academic staff, and also that students had often experienced poor support from universities in the past, discouraging them from thinking about approaching university staff for support and guidance. Examples of good pastoral care were also reported but these were in the minority from the sample and were placed in context of being unusual experiences for the culture. Participants generally felt that mental health and wellbeing was overlooked in their engineering schools of departments, and those who discussed the engineering profession largely felt that this was reflective of engineering culture generally. This perception may in part be contributing to the culture of silence and lack or delay of helpseeking engineering students.

Table 40. Juxtaposition of Findings: Helpseeking.

Research Questions	Phase One	Phase Two	Summary
What are the mental health help-seeking behaviours of engineering students in the UK?	53% would not seek help from engineering staff, 24.7% would seek help, remainder unsure. 43% participants who reported a mental health condition would not seek help from engineering staff. 58% of participants who reported not having a mental health condition would not seek help from engineering staff.	Preference to seek help from friends or family and would prefer to deal with their own problems. Some were confident that personal tutors/other eng staff would help but many did not, either reporting staff members being incapable, unsympathetic, judgemental or believing this to be the case. Concerns about being judged/reduced grades/not getting jobs were concerns about seeking help. If they seek help it is usually because they have failed or need an extension or they are now very ill/at crisis. Some acknowledged they should have spoken up earlier.	Both Phase One and Two indicate lack of trust in engineering staff overall. Some participants had found good personal support. Delayed helpseeking was evident from open text survey questions and interviews.
Who do they seek help from	Friends (32%) or family (32%) Self-Solve (27%) professional (12%)	Participants mentioned supportive personal tutors, GP, and partner as people they would go to for help. Student counselling was also mentioned as an option and generally positive experiences, but some felt it was only for people who really needed it, and others' needs would be greater than theirs. Waiting times were mentioned as unhelpful.	Interview findings supported survey findings.
What are their experiences of help seeking	Open text responses included mixed experiences from poor to good. Poor experiences put respondents off trying again.	Participants had mixed experiences of helpseeking, with some regretting not having sought help sooner and others experiencing judgement or observing others being judged and then put off seeking help themselves.	Interview findings supported survey findings.

6.4 Juxtaposition of Findings: Mental Health and Wellbeing Strategies

Participants were asked in both the surveys and the interviews what they did to keep well. The question was indicated to mean mental wellbeing. Not all participants answered all questions. Some participants indicated that physical activity helped them keep well, but that study meant that there was a reduction in activity, due to lack of time to focus on themselves. Most engineering students (77.78%, *n* = 322) listened to music often or all the time with smaller proportions watching television or films and playing computer games. Over half (56.4%, 233 of 412) reported exercising alone sometimes or more often in the previous two weeks, with 46.7% (192 of 411) reporting exercising with others. In terms of connection, over half (51.94%, n=214) had often spoken with friends or family in the previous 2 weeks, and 5.94% (*n*=12) students reported often or frequently meditating. Time management was also considered important for keeping well. This adds to findings by Adams and Blair (2019) where time management was reported to be strongly associated with better academic performance. Table 41 displays the joint findings for mental health and wellbeing strategies used by engineering students.

6.4.1 Not recognising symptoms /not recognising activities – lack of self-awareness

From the survey there were unusual results with very low reports of doing anything to support their wellbeing. However, when asked to identify activities generally, there were a great deal of activities being undertaken that would be considered as supportive to wellbeing i.e., exercise, socialising, music etc. This may indicate a lack of awareness of the benefits of hobbies and exercise on mental health and wellbeing. The scoping review (section 2.4) identified self-care and self-awareness interventions that may support better mental health and wellbeing (Altun, 2008, Huerta et al, 2021). However, it is also important to acknowledge that as mental health and wellbeing deteriorates in a person there can also be an associated reduction in insight; medically termed ‘anosognosia’ (Mograbi and Morris, 2018), as to the impact poor mental health and wellbeing may be having. This lack of insight may lead to students not recognising the need for help and therefore not help-seeking, perpetuating a vicious cycle.

Table 41. Juxtaposition of findings: Mental Health and Wellbeing Strategies.

Research Questions	Phase One	Phase Two	Summary
Types of wellbeing activity	(77.78%, n= 322) listened to music often or all the time with smaller proportions watching television or films and playing computer games. 56.4%, 233 of 412) reported exercised alone in the previous two weeks, with 46.7% (192 of 411) exercised with others. 51.94%, n=214) had often spoken with friends or family in the previous 2 weeks. 5.94% (n=12) students reported often or frequently meditating.	Exercise, socialising, music etc. Rock climbing stood out to the researcher as an activity that appeared to be associated with good mental wellbeing.	Participants described a variety of activities including video/audio consumption and exercise.
Perceptions of wellbeing activity	Participants who reported spending time on their mental health and wellbeing also scored higher in the WEMWBS.	Participants felt their activities did support better mental wellbeing, but many mentioned having to stop engaging due to having no time.	Some participants did not appear to link looking after mental wellbeing to the activities they reported engaging in.
Keeping Well	79% felt this was important, but 34% reported either not looking after their mental wellbeing in the previous 2 weeks.	Volunteering, community engagement etc beneficial to some. Time management was again raised as something people actively do to ensure they have time to stay well.	Some participants knew what kept them well and either were or were not successful in maintaining these activities. Participants considered keeping well important but didn't or couldn't do these activities.
Coping	Reaching out to friends, family, or dealing with problems on their own. Not likely to ask for help from engineering staff unless had positive experience.	Powering through, Giving up exercising/socialising/hobbies, Masking, Crying toilets	When coping rather than maintaining wellness, there is tendency to power through and try to cope on own.

There was a clear desire for some students to self-solve wherever possible, with “dealing with things myself” being the third most selected choice when asked who they would seek help from.

Anecdotal evidence from personal communications with a student counsellor was that this preference aligned with a counselling approach that they found to be positively impactful for engineering students – that of Gestalt psychology (BACP, 2023). Paradoxically, in contrast to the engineering approach of reductionism to solve a problem, Gestalt psychology is based on holism (Stevens, 2023), i.e., something being more than a sum of parts. Given that engineering problem-solving and process improvement is largely reductionist as an activity i.e., breaking problems down to smaller parts, it is surprising that some engineering students respond well to a Gestalt psychological approach in counselling therapy. More research into this area would be helpful as there is an increasing move to project and team-based learning within the engineering curriculum which may support collegiality and increase opportunities for peer support.

Mindfulness was not an activity that was mentioned often in the interviews but through the systematic scoping review that was updated after the data generating phase it appears that guided mindfulness activities may be positively impactful for engineering students.

Comparing these responses with the WEMWBS mean score for respondents demonstrated those who reported looking after their mental wellbeing often or most of the time had an overall WEBWMS mean score that fell above the threshold for possible depression indicating that their activities may be supporting their mental wellbeing.

6.5 Feeding Forward

Survey participants were asked if they had any comments for future engineering students. Interview participants were asked if they had any suggestions for Schools or Departments of Engineering. Comments for students mainly focussed on time management, rest, and getting help, and suggestions for Schools or Departments focussed on visibility of help, curriculum enhancements, and Mental Health training for staff. Table 42 presents juxtaposed findings.

6.5.1 Visibility

More visibility and more advertising of existing services. This should be a straightforward and inexpensive enhancement to deliver. Expectations should be managed however if there are significant waiting times, or particular opening times to consider. Students should be able to talk openly with supervisors. Academic supervisors should have information to hand and be able to signpost. Academic supervisors may not be the best people to approach with a mental health problem and there are issues of boundaries. There is also a culture of stigma evidenced from the interviews, the survey data, and supported by published literature (Jensen and Cross, 2021, Sanchez-Pena, et al., 2021, Hargis et al., 2021, Bork and Mondisa, 2022, Jensen, 2023). Teaching office should be friendly and open. Mental Health training may be useful for all engineering staff – while there is a cost associated with this there is the benefit of reducing stigma generally (Morgan, Ross, and Reavely, 2018, Edgar and Connaughton, 2021). Assign a dedicated mental health professional in the engineering department was also a suggestion.

Table 42. Juxtapositions of Findings for Suggestions and Comments .

Research Questions	Survey Findings	Interview Findings	Summary
Do you have any comments or suggestions for Engineering schools?	Not covered explicitly but issues with stigma and heavy workloads appeared in open text questions. Reducing these would likely support mental wellbeing.	More visibility of services available Open culture Better course organisation with topics in the right order Better spread of assessment Clear expectations Mental Health training for staff	Visibility Curriculum Enhancement Training
Do you have any comments for new engineering students?	Key topics from the advice comments were around time management and organisation, finding similar minded people to connect with, asking for help, and taking time for yourself.	Not covered explicitly but time management was important to participants in terms of keeping well.	Time management Social connection Asking for help

6.5.2 Curriculum Enhancements

There were a number of curriculum enhancements suggested in the interviews including course organisation, scheduling improvements and clearer expectation setting. All participants indicated an overwhelming amount of study is required to pass their course. It is possible there may be a difference between actual expectation of engineering staff and perceived workload of students (Gerrard et al, 2017, Yangdon et al, 2021, Jensen, 2023). However, the fact remains that the engineering curriculum is perceived to be overfull (Dodd and Stonyer, 2003, Wolff, et al, 2019, Korsten, Wolff, and Booysen, 2021, de Jager and McClell Pott, 2022) and students are often overwhelmed and stressed by the amount of work they are doing. There is a balance to be struck between the efficiency but stress of closed book examination and the continual workload and resulting stress of continuous assessment. Other suggestions were:

- Implementing a coherent assessment schedule would relieve the pressure and allow students time to do their best instead of just doing enough;
- Taking a more active role with the students;
- Providing more clarity on who does what i.e., employability, placements, counselling;
- Developing a systematic way of identifying what is happening with a student for a consistent supportive experience;
- Developing supportive learning environments;
- Organising larger group activities at the start of each year, more informal social activity;
- Increasing reward feeling throughout year;
- Extra tutoring/catch up support for people returning after an illness.

There is a wealth of university level education research to support enhancements in these areas from journals such as the European Journal for Engineering Education, the Engineering Education Research Network and the American Society for Engineering Education. It is beyond the scope of this thesis to explore this further however it is a recommendation of the research to develop evidence-based interventions and enhancements in this area.

6.5.3 Training

Participants suggested MH training for engineering staff. While it is the author's opinion that Mental Health first aid training is helpful for everyone, there should be an understanding that it is not a qualification as such. Someone who has undergone training will have some knowledge and ability to listen and support or signpost but is not a trained counsellor.

Some universities are beginning to ask personal tutors to undertake more pastoral activities including mental health and wellbeing support – and this is a risk to all concerned, from patchy support from some personal tutors being less willing or able, to overburdening of staff who are considered by students to be more approachable.

Participants also suggested laboratory staff and others with closer contact to students should have training, which is a reasonable suggestion as they may be more likely to spot if something is troubling a student. However, the same risk applies in terms of overburdening staff. The true aim of mental health training should be to support the person undergoing the training to feel more confident about mental health and wellbeing discussions and to encourage stigma reduction and so this should be made clear to anyone approving or implementing training for staff. Tailored support was also suggested, possibly even with a specific counsellor for engineering who would be able to tailor support around exam stress and other key areas. Positive results from the intervention by Berger, Lampe, and Caruccio (2015) would indicate that contextualised support might be beneficial.

6.6 From S.O.S to S.O.R.T

The findings of Phase Two culminated in the shaping of a proposed framework to support mental health and wellbeing in engineering students (Chapter 5, Figure 35). This section aims to draw together the findings of both research phases and existing evidence in literature to underpin each item of the framework.

6.6.1 From Self-Inefficacy to Self-Efficacy

Supporting engineering students to develop their self-efficacy will be key to their success in and beyond the classroom (Hsieh. 2012, Aleta, 2016). Enabling engineering students to gain an understanding of themselves and enhance their active coping skills may contribute positively to overall mental health and wellbeing. Activities in the classroom (Mazumder, 2012, Moran and Benson, 2016, Su, 2016, Eren-Sisman, Cigdemoglu, and Geban, 2018, Paniagua et al., 2019, Johnson-Glauch et al, 2020, Miller and Jensen, 2020, Miller et al, 2021, Miller et al, 2022 , Rodríguez-Jiménez et al., 2022, Nolte, Huff, and McComb, 2022) may support students to develop both "coping" self-efficacy and academic self-efficacy, culminating in a rounded and resilient engineering graduate.

6.6.2 Overwhelm to Organisation and Routine

From the open text responses in Phase One, there was a strong sense of students feeling frequently overwhelmed with workload and assessments. This was also evident in the findings in Phase Two where interview participants felt that routine and keeping organised were key to supporting mental health and wellbeing. A more manageable workload, including actual regular breaks in study where one does not feel like one is falling behind, and training in time management and prioritisation would support better results and perhaps retain those who may otherwise drop out and support better mental health and wellbeing (Gelles, 2020, Aeon, Faber, and Panaccio, 2021). One possible enhancement would be to develop a time management toolkit to support engineering students as while they recognise the need for organisation and time management they do not always have the necessary skills to implement a strategy (Twehues, 2013, Adams and Blair, 2019).

6.6.3 Stigma to Trust

In both Phases of the research participants reported feeling distrustful of academic staff, although some felt at a local level i.e., a personal tutor, they were able to be open about how they were feeling. A general sense of stigma and that the engineering academic environment was not generally welcoming was clear from these findings and also is evidenced in literature on this topic. Reducing stigma has been shown to increase trust, and this should be a clear aim of any engineering school or department. Developing a culture of wellbeing (Berger, Lampe and Caruccio, 2015, Walton et al., 2015, Yanik et al., 2016, Maxon and Tomasko, 2020, Grasty et al, 2021, Tragodara, 2021) will help reduce stigma and build trust in an engineering school. This could be achieved by embedding activities within the general curriculum (Joshi et al 2016, Aree et al 2020, Joshi, Kiran and Sah, 2017a, 2017b, Estrada and Dalton, 2019, Lal et al, 2019, d'Entremont et al, 2019, Abiade and Moliski, 2020, Huerta et al, 2021, Paul et al, 2021).

6.6.4 Summary

While it is not within the scope of the thesis to develop a model or framework for mental health and wellbeing enhancement for engineering students, further research or enhancement activity may be carried out as a result of this work. The S.O.S-S.O.R.T framework is merely the beginning of a conceptual model design process (Brady et al, 2020) to visually support potentially key aspects and protective factors in supporting engineering student mental health and wellbeing.

6.7 Implications for Engineering Education Enhancement

The findings from this study indicate there is room for improvement in terms of engineering student mental health and wellbeing. Students' states of mind impact positively or negatively on academic achievement and so it is important for engineering educators to be cognisant of this and to consider ways to mediate, and to enhance the curriculum to support better outcomes both academically and personally. As research evolves in this space, it is hoped there will be an evidence-base from which to develop effective interventions and ultimately effective preventions against poor mental health and wellbeing in engineering students.

Key areas for improvement are

- Review the heavy workload of students. Many students noted frequently having to give up social events, exercise, and general self-care/wellbeing activities to keep up with the workload. While this might be expected from time to time during degree study, the regularity and frequency of doing this may be leading to poor mental wellbeing and selfcare generally.

- The benefits of practical sessions may be outweighed by the additional workload this appeared to generate for some.
- Positive experiences included lecturers providing context, explaining things well, and being clear about what was needed. Less positive experiences included being provided with poor course materials, being expected to know things before they had been taught, and not being approachable for help, both academically and pastorally.
- All who discussed closed book exams expressed an opinion felt that they were an ineffective way to assess their knowledge and understanding and led to surface learning and strategic studying. This was regardless of whether or not they found closed book exams stressful.

6.8 Limitations

6.8.1 Reflexivity

The researcher has been working on this project since Autumn 2017 and over the duration of the project has developed and evolved from having next to no research experience, to being “research ready”. This is not to say the researcher is now experienced, as she is still a novice, however she has learned how to approach, design, implement and evaluate a research project using a range of research methods and recognising the different research philosophies that frame a research project. Originally the researcher had aimed to essentially diagnose engineering students and identify solutions, but over the project has developed a salutogenic philosophy, one of health and wellbeing promotion, rather than illness mitigation or cure. This evolution has allowed the researcher to focus areas that are within the control of the engineering discipline – i.e. the culture and the curriculum and supporting the student as an individual. While there has been an increase in the research abilities of the researcher, there are still a number of limitations which should be acknowledged. Firstly, this research was conducted as a part-time PhD research project, with the researcher working full time in academia, and with a young family at home. This means that the research was often worked in in fits and starts, before, during, and after the COVID-19 pandemic, and therefore slower than anticipated. As the research has been carried out over a longer period of time, in some areas has, while it has not been superseded, has been "caught up” by more experienced researchers publishing emerging results during the course of the research period. In phase one, the survey did not request information on race or ethnicity as it focussed purely on the lens of engineering education itself. Further research should consider this aspect of the engineering student experience to include differences in experience and produce more meaningful and inclusive data, particularly as literature points to poorer experiences of engineering from non-white backgrounds. The researcher made use of basic statistical analysis techniques and followed analysis protocol for the WEMWBS section, but there may have been more sophisticated or elegant ways to establish the results.

Phase one also had the following limitations – challenges with recruitment despite widespread efforts to promote the survey and liaison with university gatekeepers, selection bias and over-representation of women, and challenges with data cleaning/management, presentation due to sub optimal question design. This meant that analysis took longer to carry out than anticipated.

The COVID-19 pandemic impacted phase two, particularly the method of conducting the interview phase, although it could be argued that the move to videoconferencing potentially improved the interview quality through a more face-to-face approach instead of phone interview. The impact of COVID-19 on the research was reasonably limited, as phase one of data collection was completed before the UK lockdown, and it was possible and feasible to move phase two onto videoconferencing. Indeed, this may have been an enhancement to the original study plan as it allowed face to face interaction and access to physical cues for the interviewer. However, there was a delay in securing participants as the original plan was to run interviews prior to student examinations. During the first UK national lockdown the author was balancing the competing demands of home schooling while, converting an on-campus School of Engineering to an online one and also managing academic and professional staff in challenging circumstances, This resulted in interviews being carried out during the students' vacation. As the interviews were carried out during June 2020, it was agreed with the supervisory team to not exclude discussions on how lockdown had impacted the participant's wellbeing but as it was not the focus of the interviews, participants were asked to consider the questions more generally. Following transcription, the data was analysed with the fact it was gathered during lockdown in mind.

The researcher was new to interviewing and it is possible that other researchers may have been able to draw out further data or probe areas more efficiently. However, a small number of the interviews were carried out by one of the supervisory team (the researcher's own institution as the participants would likely have been taught by the researcher), and the interview guide was piloted prior to use and also was scrutinised by the supervisory team and the ethics committee.

The researcher was unable to perform the thematic analysis until 2022, two years later, due to significant time constraints. This gap may have impacted how the data was analysed as further literature research had been undertaken in the meantime. Finally, only studies published in English were reviewed as part of this research due to budgetary constraints, however, a wide range of international papers were included in the literature review.

6.9 Chapter Summary

This chapter integrated the findings from the separate research phases to address the original research questions. Engineering students in the UK have poorer mental wellbeing than the general UK student population and much poorer mental wellbeing than the general UK population. Engineering students are far less likely to seek help for a mental health problem, citing issues of trust and stigma as primary concerns. Engineering students are aware of activities that are good for them but did not readily associate this with good mental wellbeing. Engineering students in the research undertook a wide variety of activities that support mental wellbeing but highlighted they were not able to do as much of these activities as they would like due to high workload of their courses.

Good time management appeared to be an indicator of a student's mental wellbeing along with general self-efficacy and maintaining a routine. Participants who trusted engineering staff reported being more likely to ask for help relating to mental health and wellbeing. The next chapter provides the reader with conclusions and recommendations for future research and practice.

The study shows that engineering students in the UK suffered poorer mental health and wellbeing than the age scaled general population, in particular female students and electronic and electrical students. While the WEMWBS results were very low in comparison to the UK general population, the interviews indicated general positivity and participants did not appear to be in an unusually low mood. Potentially the perception is that this is normal – the baseline is lower, or that they don't align with the health-focussed language in the survey.

Chapter 7: Conclusions and Recommendations

7.1 Overview

This study provided both quantitative and qualitative data to help in answering the research questions and a variety of analysis methods were adopted to probe the results.

The research aims were to:

- Establish the mental health and wellbeing of engineering students and compare it with the general population and student population to identify if there is an unmet need in relation to mental health support.
- Identify key health-seeking behaviours of engineering students in order for institutions to be able to make strategic decisions around teaching approaches, pastoral support, and curriculum design in relation to students of engineering.

The purpose of the research questions was to establish a baseline for the mental health and wellbeing of engineering students in the UK, and to identify their key help-seeking behaviours and health and wellbeing preferences with a view to supporting engineering schools and departments to promote better mental health and wellbeing. The research was carried out with a salutogenic lens, in that while mental illness was noted and discussed as part of the mental health continuum the focus was on mental health and wellbeing and keeping well.

A pragmatic mixed-methodological approach was used to explore the research questions, with a sequential explanatory research design. The findings of the survey and interview phases were presented and discussed separately, and the integrative discussion chapter brought both research phases together to present juxtaposed results and discussion of the research questions.

An author-developed survey was designed and disseminated across the engineering student population in the UK which included the Warwick Edinburgh Mental Wellbeing Scale, and semi-structured interviews of volunteers from the survey were carried out following data analysis of the survey results. Interview transcripts were analysed by framework thematic analysis. A model for supporting the enhancement of mental health and wellbeing in engineering students was proposed.

The recommendations have been split into distinct parts for clarity: recommendations for further research, for professional and regulatory bodies, for academic institutions, for staff, and for students.

7.2 Phase One

The results of the phase one indicated that the mental health of engineering students in the UK was slightly worse i.e., presence of a mental illness, than the general population. The mental wellbeing of engineering students was reported to be statistically significantly worse and low help-seeking rates were reported. An unmet need in relation to mental health and wellbeing support was inferred.

The participating engineering students demonstrated some common traits which result in lower rates of help-seeking and delayed help-seeking. Trust was a major factor in whether or not they would seek help and experiences of help-seeking ranged from positive to extremely negative.

Approaching mental health and wellbeing with an engineering process driven approach may increase help-seeking and earlier reporting. This is supported by recent internal service development projects within the institution. Supporting students to recognise and accept sensations of poor mental health and wellbeing will also help towards improved help-seeking. Understanding the process of counselling and the evidence base for wellbeing activities will also improve uptake of self-care in engineering students.

Despite this being an especially important area of research, and while there is an increase of interest and literature, there is still more work to be done. Specifically, there is a lack of robust qualitative research on mental health and wellbeing in engineering students, and also in quantitative research. The measures used in published literature are still too varied to be synthesised, and still focus on illness rather than wellness in the main.

7.3 Phase Two

The second phase of the research resulted in the identification of key constructs influencing mental health and wellbeing in engineering students. These are: The Curriculum, The Student, and The Culture. All three influence each other positively or negatively and to greater or lesser extents.

As part of the framework analysis, a high-level model was proposed to enable the enhancement of mental health and wellbeing in engineering students. The S.O.S. - S.O.R.T continuum, inspired by the Salutogenic continuum supports a simple visual cue for academic institutions to develop impactful interventions and effect meaningful cultural and curricular change for the engineering students of tomorrow.

7.4 Recommendations for Further Research

As with many projects of this type this work answered some research questions but also generated others. The following is a list of recommendations designed to pave a way forward for future research syntheses and to further explore the topic of mental health and wellbeing in engineering students.

Broaden Types of Research Study

From the comprehensive scoping review it was reported that there was a lack of qualitative research studies which has led to a knowledge gap in this area. Given the openness of the interview participants it is possible that participative research may be a useful research approach to explore experiences of engineering students.

Priority Topics for Research

From the literature and supported by this research, *self-efficacy* appears to be a predictive and protective factor in engineering student mental health and wellbeing. Therefore, further research to support self-efficacy would be beneficial.

Time management also appeared to support mental health and wellbeing and interventions to support time-management and organisational skills would add to the evidence base.

Research on *mindfulness* interventions in engineering students is increasing and given the early encouraging results this should continue, if possible, with multi-institutional, multi-national collaboration.

Evaluation of the S.O.S- S.O.RT continuum framework possibly through pilot studies.

Develop a set of core outcome measures

Future research should focus on increased use of robust standardised measures in order to maximise the opportunities for data synthesis. There should be evaluation and discipline wide agreement of intervention outcome measures and consistency of reporting, and potentially develop a core outcome set.

International collaboration

International research on engineering student mental health and wellbeing should be carried out as where it was possible to compare results directly there was considerable heterogeneity.

Agree consistent terminology relating to mental health and wellbeing

One of the issues in reviewing the literature was the different terminologies used relating to mental health and wellbeing, which can lead to confusion and hinders literature identification. Agreeing consistent terminology and definitions would support further research.

7.5 Recommendations for Professional and Regulatory Bodies

As has been described in this thesis, PSRB's, particularly in the UK, have a strong influence over the engineering degree curriculum in terms of content and assessment. PSRB's also have influence over engineering professionals after graduation. Therefore, they are well positioned to support cultural and curricular change, and as a result, the engineering student.

The Curriculum

One way of encouraging engineers to look after their mental wellbeing in the UK is to support metacognition activities more explicitly through the UKSPEC's section D, to include development of intrapersonal skills. Placing an importance on this at the heart of what it is to be a professional engineer will feed through to AHEP and Approval of Qualifications and Apprenticeships (AQAH) requirements and may be a way to support institutions in working towards building a supportive environment for engineering personal development.

The Student

PSRBs often have student chapters or student engagement activities. These networks and activities are an opportunity to promote a more open and supportive culture in the engineering profession.

The Culture

Asking Higher Education Institutions about engineering student mental health and wellbeing as part of accreditation documentation and panel discussions would support the normalisation of a more open culture in relation to supporting engineering mental health and wellbeing.

7.6 Recommendations for Institutions

Institutions should work collaboratively with staff and students to identify barriers to their help-seeking within the institution and co-produce support systems that dismantle or at least reduce these barriers. Recommendations have been split into the high-level themes of the Curriculum, The Student, and The Culture.

The Curriculum

- Engage with Engineering Council/PSRBS/National Engineering bodies to evolve and enhance requirements around mental health and wellbeing in the UKSpec and AHEP to support retention and career longevity;

The Student

- Support staff and students by providing clear pathways and signposting to existing support. Institutions should work collaboratively with schools or departments of Engineering to develop clear, manageable processes and procedures to support good mental health and wellbeing.

The Culture

- Consider implementing recommended interventions from literature as they increase and develop in quality and effect;

- Develop and implement a debriefing network for those who are supporting mental health and wellbeing.

7.7 Recommendations for Staff in Engineering Schools and Departments

It was an intended outcome of this research that there would be recommendations that would support staff in departments or schools of engineering in terms of encouraging good mental health and wellbeing in engineering students. These recommendations arise from identifying aspects that are likely to be in the department's or school's control.

The Curriculum

- Ensure courses are well organised and follow a sensible progression of topics and academic difficulty;
- Develop a clear and manageable assessment plan;
- Develop transparent and inclusive assessment briefs showing the relevance and value of the work;
- Develop inclusive assessment alternatives where appropriate;
- Ensure tasks have been tested for hours of effort required.

The Student

- Develop ways to support students' time-management and organisational skills;
- Work with central student support departments to facilitate easier help-seeking routes for engineering students;
- Highlight existing processes and pathways or develop new ones – advertise these everywhere;
- Support students who have been off to catch up;
- Work with the institution to develop a "worst case scenario" handbook.

The Culture

- Consider ways in which a culture of trust within engineering Schools or departments can be built;
- Recognise and acknowledge diverse cultures and backgrounds of the engineering student cohort;
- Develop a debriefing network for those supporting the mental health and wellbeing of engineering students;
- Facilitate more social opportunities for students and staff to be together;
- Remember staff are not counsellors but also be more aware of our students and be better equipped to listen.

7.8 Recommendations for Students

It is vital to acknowledge that engineering students are not simply passive receivers of support and knowledge. Engineering students themselves hold the power to support curriculum development, themselves, and also drive a positive cultural shift within the engineering profession. Staff, institutions, PSRB's and researchers can go a long way to enhance the student experience and improve mental health and wellbeing, but it is the engineering students who are integral to any success in this area. As such, the following recommendations are suggested and again separated into the concepts of the Curriculum, the Student, and the Culture.

The Curriculum

- Provide constructive feedback about your course and the support you receive;
- Participate in discussions about course development and enhancements;
- Learn how to manage time and organise yourself. Most universities have resources available to help you do this from day one;

- Remember no one knows everything.

The Student

You should consider their mental health and wellbeing as part of your study planning where possible, to ensure sufficient rest breaks and time for interests.

- Make time to learn about what makes you feel well and confident;
- Learn what causes you distress and work with others to develop active coping habits to reduce anxiety and stress;
- Find out where to go for help if you need it, before you need it;
- Use the resources available – they are there for student use.

The Culture

- Be open to helping others, you won't be the only one feeling stress but that doesn't mean it is ok;
- Feel confident that you belong in engineering. The future of engineering relies on there being lots of diverse types of people in the profession.

7.9 Chapter Summary

This concluding chapter highlighted the conclusions and recommendations of the research. The research study aimed to provide a unique insight into a population that had been overlooked in mental wellbeing studies and were potentially at increased risk of poor mental health and wellbeing. A literature review including a systematic scoping review was carried out and a research project designed and executed to answer the research questions:

- What is the mental health and wellbeing of engineering students in the UK?
- What are the mental health and wellbeing help-seeking behaviours of engineering students in the UK?
- What are the approaches or strategies to support or facilitate mental health and wellbeing utilised by engineering students in the UK?

These questions were answered using established research methods valid for the population of interest. Findings were discussed and brought together to form combined findings for triangulation and comparison. A proposed framework was developed with a view to supporting further research in this area. Finally, recommendations were put forward for researchers, professional bodies, higher education institutions, staff, and students. Given the shortage of engineers in the UK, it is important to continue to evaluate and support the mental wellbeing of engineering students because, increasingly, more is expected of engineers. They need to be more mentally agile and more able to drive change and innovation than ever before.

For that they need to have skills that are now being explored in university engineering education: resilience, empathy, active listening, self-preservation, conflict resolution and, essentially, self-efficacy.

This study contributed evidence that engineering students in the UK have statistically significantly lower mental wellbeing than the general population and the student population and crucially are less likely to ask for help in relation to their mental health and wellbeing. Overfull curricula, heavy assessment, and stigma are key factors contributing to a culture of stress and silence. Curricular and cultural enhancements along with supporting self-efficacy and time management will go some way to improving engineering student mental health and wellbeing.

References

ABET. 2022. Criteria for Accrediting Engineering Programs. Available from:

Criteria for Accrediting Engineering Programs, 2021 – 2022 | ABET

ABIADE, J. and MOLISKI, J. 2020. Work-in Progress: Identity and transitions laboratory: Utilizing acceptance and commitment therapy framework to support engineering student success. 2020 ASEE Virtual Annual Conference. Available from: https://peer.asee.org/work-in-progress-identity-and-transitions-laboratory-utilizing-acceptance-and-commitment-therapy-framework-to-support-engineering-student-success

ADAMS, R., and BLAIR, E., 2019. Impact of Time Management Behaviors on Undergraduate Engineering Students' Performance. SAGE Open. 9. 215824401882450. 10.1177/2158244018824506.

ADDINGTON, J., GOLDSTEIN, B.I., WANG, J.L. et al. 2018. Youth at-risk for serious mental illness: methods of the PROCAN study. BMC Psychiatry 18, 219 (2018). https://doi.org/10.1186/s12888-018-1801-0

AEON, B., FABER, A., and PANACCIO, A. 2021. Does time management work? A meta-analysis. PLoS One. 2021 Jan 11;16(1):e0245066. doi: 10.1371/journal.pone.0245066. PMID: 33428644; PMCID: PMC7799745.

AKHTAR, S., TABASUM, H., YOUSANAF, S., HUSSAIN, A. et al. 2021. Mental Health Status of post graduate medical and engineering students in Pakistan. European Academic Research, Vol IX.I Issue 2. May 2021.

AL-HASHIMI, B.M. 2023. Comment: Engineering's Skills Gap Demands a Radical Solution. The Engineer. [online] Available from: The Engineer - Comment: Engineering's skills gap demands a radical solution

ALETA, B.T. 2016. Engineering Self-Efficacy Contributing to the Academic Performance of AMAIUB Engineering Students: A Qualitative Investigation. Journal of Education and Practice, 7, 53-61.

ALLEN, J. et al. 2014 Social Determinants of Mental Health, *International Review of Psychiatry*, 26:4, 392-407, [online]. Available from: https://www-tandfonline.com.ezproxy.rgu.ac.uk/doi/full/10.3109/09540261.2014.928270?scroll=topandneedAccess=true [Accessed 10 April 2019].

ALTERLINE, 2017. Union Futures 2: Being Well, doing well [online]. Available from: http://alterline.co.uk/student-mental-health/ [Accessed 5 April 2018].

ALTUN I., 2008. Effect of a health promotion course on health promoting behaviors of university students. Turkey*. Eastern Mediterranean Health Journal*, 2008; 14(4): 880-887.

Effect of a health promotion course on health promoting behaviors

ANDREWS, J. and CLARK, R., 2017. Trailing or Failing? A Hidden Mental Health Issue: The Changing Futures Project. *American Society for Engineering Education.* [online].

Available from: https://research.aston.ac.uk/portal/en/researchoutput/trailing-or-failing-a-hidden-mental-health-issue-the-changing-futures-project(4fb93385-dfc5-457c-bab1-49f7b3d9fecc).html [Accessed 2 April 2019].

ANTONOVSKY, A., 1979. Health, Stress, and Coping. Jossey-Bass Inc., San Francisco.

ANTONOVSKY, A., 1996. The Salutogenic Model as a Theory to Guide Health Promotion. Health Promotion International, 11, 11-18.

APA (American Psychological Association). 2022. Stress won't go away? Maybe you are suffering from chronic stress. Stress

ARCHIBALD, M. M., AMBAGTSHEER, R. C., CASEY, M. G., and LAWLESS, M. 2019. Using Zoom Videoconferencing for Qualitative Data Collection: Perceptions and Experiences of Researchers and Participants. *International Journal of Qualitative Methods*, *18*. https://doi.org/10.1177/1609406919874596

AREE, P., et al., 2020. An approach for mental preparation for first-year college students: A case study of engineering students. 2020 5th International STEM Education Conference (iSTEM-Ed), 2020, pp. 161-164, doi: 10.1109/iSTEM-Ed50324.2020.9332797.

ARKSEY, H., and O'MALLEY, L. 2005. Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology*. 8:1, 19-32, DOI: 10.1080/1364557032000119616

ARUNKUMAR, G., 2015. Effectiveness of taichi exercises on stress among college students at selected colleges, Salem. Masters thesis, Sri Gokulam College of Nursing, Salem.

ASGHAR, M., MINICHIELLO, A., and IQBAL, A. 2022. Perceived Factors Contributing to the Subjective Wellbeing of Undergraduate Engineering Students: An Exploratory Study. Int. J. Environ. Res. Public Health 2022, 19, 16284. https://doi.org/10.3390/ijerph192316284

ASGHAR, M. and MINICHIELLO, A., 2023. Two sides to every psyche: Implications of positive psychology for “mental health” research in engineering education. J Eng Educ, 112: 12-17. https://doi.org/10.1002/jee.20493

ATHANASIOU, R. (1968). Technique without Mystique: a Study of Authoritarianism in Engineering Students. *Educational and Psychological Measurement*, *28*(4), 1181–1188. https://doi.org/10.1177/001316446802800419

ATWELL, C. 2022 Electronics and Electrical Engineering Jobs on the Decline. Electronic Design. Available from: Electronics and Electrical Engineering Jobs on the Decline—Can They Be Saved? | Electronic Design

AWATI, R., 2022. What is Normal Distribution? WhatIs.com Data Analytics and AI. [online] Available from: https://www.techtarget.com/whatis/definition/normal-distribution

BAIK, C. et al., 2016. A Framework for Promoting Student Mental Wellbeing in Universities. MCSHE-Student-Wellbeing-Framework_FINAL.pdf (unimelb.edu.au)

BAIQ, Y. PERMATA, S., SITI, U. and CIPTASARI, P. 2020. The Role of Self-Efficacy and Optimism on Academic Stress Towards Industrial Engineering Students at Universitas Ahmad Dahlan, Yogyakarta

BALAJI, N. K., et al., 2019. Perceived stress, anxiety, and coping states in medical and engineering students during examinations. *Industrial psychiatry journal*, *28*(1), 86–97. https://doi.org/10.4103/ipj.ipj_70_18

BALDWIN, D., SINCLAIR, J., and SIMONS, G., 2021. What is mental wellbeing? BJPsych Open. 2021 Jun 18;7(Suppl 1):S236. doi: 10.1192/bjo.2021.631. PMCID: PMC8771997.

BAN, N., et al., 2022. Identifying common perceived stressors and stress-relief strategies among undergraduate engineering students, Proceedings of the ASEE annual conference exposition. Available from: https://peer.asee.org/identifying-common-perceived-stressors-andstress-relief-strategies-among-undergraduate-engineering-students.pdf

BANKS, D. 2016. Engineering Authoritarianism. Cyborgology. Online. Available from Engineering Authoritarianism - Cyborgology (thesocietypages.org)

BARTRAM, D. J. et al., 2011. Validation of the Warwick–Edinburgh Mental Well-being Scale (WEMWBS) as an overall indicator of population mental health and well-being in the UK veterinary profession. *The Veterinary Journal* 187(3), 397-398.

BAUER, G. F. et al., 2020. Future directions for the concept of salutogenesis: a position article. Health promotion international, 35(2), 187–195. https://doi.org/10.1093/heapro/daz057

BCAP (British Association for Counselling and Psychotherapy), 2023. What is Gestalt Therapy? [online] Available from: What is Gestalt therapy? | Types of therapy (bacp.co.uk)

BEDDOES, K., and DANOWITZ, A. 2022. In Their Own Words: How Aspects of Engineering Education Undermine Students' Mental Health. (21) (PDF) In Their Own Words: How Aspects of Engineering Education Undermine Students' Mental Health (researchgate.net)

BEHERE, S.P., YADAV, R., and BEHERE, P.B., 2011. A Comparative Study of Stress Among Students of Medicine, Engineering, and Nursing. *Indian Journal of Psychological Medicine.* [online]. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3271488/

BELL, S. 2022. The National, 2022. Scottish Students Waiting Months for Counselling amid Mental Health Crisis [Accessed 02 May 2024] Available from: Scottish students waiting months for counselling amid mental health 'crisis' | The National

BELLINGER, D. B., DECARO, M. S., and RALSTON, P. A. 2015. Mindfulness, anxiety, and high-stakes mathematics performance in the laboratory and classroom. *Consciousness and cognition*, *37*, 123–132. https://doi.org/10.1016/j.concog.2015.09.001

BENZ, C., BULL, T., MITTELMARK, M. et al., 2014. Culture in salutogenesis: The scholarship of Aaron Antonovsky. Global health promotion. 21. 10.1177/1757975914528550.

BERGER, E.J., LAMPE, L., and CARUCCIO, J.I., 2015. Just-in-time support: An evidence-based academic-student affairs partnership to enable engineering student success. American Journal of Engineering Education (AJEE). 2015; 122. ASEE PEER - Just-in-Time Support: An Evidence-Based Academic-Student Affairs Partnership to Enable Engineering Student Success

BERGMAN, A. and OGUNSHAKIN, N., 2022. Shortage of Engineers is Threatening Climate Action. Euractiv. Available from: Shortage of engineers is threatening climate action – EURACTIV.com

BEST, P., MANKTELOW, R., and TAYLOR, B. J. 2016. Social Work and Social Media: Online Help-Seeking and the Mental Well-Being of Adolescent Males. British Journal of Social Work, 46(1), 257-276. https://doi.org/10.1093/bjsw/bcu130

BEUKEMA, L., TULLIUS, J.M., KOREVAAR, L., and HOFSTRA, J. et al. 2022. Promoting Mental Health Help-Seeking Behaviors by Mental Health Literacy Interventions in Secondary Education? Needs and Perspectives of Adolescents and Educational Professionals. Int J Environ Res Public Health. 2022 Sep 20;19(19):11889. Doi: 10.3390/ijerph191911889

BIANCO, D., 2012. Performance of the Warwick-Edinburgh Mental Well-Being Scale (WEMWBS) as a screening tool for depression in UK and Italy. [online]. Available from: https://warwick.ac.uk/fac/sci/med/research/platform/wemwbs/using/howto/donatella_bianco-thesis.pdf

BIDDLE, C., and SCHAFFT, K. A., 2015. Axiology and Anomaly in the Practice of Mixed Methods Work: Pragmatism, Valuation, and the Transformative Paradigm. Journal of Mixed Methods Research, 9(4), 320–334. https://doi.org/10.1177/1558689814533157

BIESTA, G., 2010. Pragmatism and the philosophical foundations of mixed methods research1. SAGE Publications, Inc., https://doi.org/10.4135/9781506335193

BOBBITT, Z, 2021. Paired vs Unpaired t-test: What's the Difference?? Statology. [online] Available from: https://www.statology.org/paired-vs-unpaired-t-test/

BOLTON, D., and GILLETT, G., 2019. The Biopsychosocial Model of Health and Disease: New Philosophical and Scientific Developments [Internet]. Cham (CH): Palgrave Pivot; 2019. Chapter 4, Biopsychosocial Conditions of Health and Disease. 2019 Mar 29. Available from: https://www.ncbi.nlm.nih.gov/books/NBK552028/ doi: 10.1007/978-3-030-11899-0_4

BONSAKSEN, T. et al., 2022. Students' Mental Health, Well-Being, and Loneliness during the COVID-19 Pandemic: A Cross-National Study. Healthcare (Basel). 2022 May 27;10(6):996. doi: 10.3390/healthcare10060996. PMID: 35742047; PMCID: PMC9222513.

BORK, S. J., and MONDISA, J.-L., 2022. Engineering graduate students' mental health: A scoping literature review. Journal of Engineering Education, 111(3), 665– 702. https://doi.org/10.1002/jee.20465

BORRELL-CARRIO, F. SUCHMAN, A. and EPSTEIN, R., 2004. The Biopsychosocial Model 25 Years Later: Principles, Practice, and Scientific Inquiry. *Annals of Family Medicine.* 2:576-582; 10.1370/afm.245 [online]. Available from: http://www.annfammed.org/content/2/6/576

BOSWORTH, K., 2022. More Women in Engineering Now Than Ever Before. More Women in Engineering Now Than Ever Before - MDPI Blog

BRADY, S.S., BRUBAKER, L., FOK, C.S., GAHAGAN, S. et al. 2020. Development of Conceptual Models to Guide Public Health Research, Practice, and Policy: Synthesizing Traditional and Contemporary Paradigms. Health Promot Pract. 2020 Jul;21(4):510-524. doi: 10.1177/1524839919890869. Epub 2020 Jan 7. PMID: 31910039; PMCID: PMC7869957.

BRAUN, V., and CLARKE, V., 2006. Using thematic analysis in psychology, Qualitative Research in Psychology, *Qualitative Research in Psychology. Volume 3.* [online]. Available from: https://www.tandfonline.com/doi/abs/10.1191/1478088706qp063oa

BRAUN, V., and CLARKE, V., 2022. *Thematic Analysis: a practical guide.* Los Angeles: SAGE.

BROGLIA, E., MILLINGS, A., and BARKHAM, M., 2021. Student mental health profiles and barriers to help seeking: When and why students seek help for a mental health concern. *Couns Psychother Res.*, 21, 816–826. https://doi.org/10.1002/capr.12462

BROTHERTON, H.B., and ORR, M.K. Overcoming Perfectionism: My Journey with the Binary Mindset. 2021 ASEE Annual Conference. Available from: https://peer.asee.org/37553

BROWN, P., 2016.The invisible problem? : Improving students' mental health. Higher Education Policy Institute.

BROWNING, M.H.E.M. et al., 2021. Psychological impacts from COVID-19 among university students: Risk factors across seven states in the United States. PLoS ONE 16(1): e0245327. https://doi.org/10.1371/journal.pone.0245327

BUDZYNSKI, B. 2022. 6 common barriers men face when seeking mental health support. [online] Available from: 6 Barriers Men Face When Seeking Mental Health Support | Ro

BULLEIT, W., SCHMIDT, J., ALVI, I., NELSON, E., and RODRIGUEZ, N.T..2014. Philosophy of Engineering: What It Is and Why It Matters. Journal of Professional Issues in Engineering Education and Practice. 141. 02514003. 10.1061/(ASCE)EI.1943-5541.0000205.

CAMERON, R., 2009. A sequential mixed model research design: Design, analytical and display issues, International Journal of Multiple Research Approaches, 3:2, 140-152, DOI: 10.5172/mra.3.2.140

CAMH (Centre for Addiction and Mental Health)., 2022. Stress. (Stress | CAMH

CAMPBELL, F. et al., 2022. Factors that influence mental health of university and college students in the UK: a systematic review. *BMC Public Health* **22**, 1778 (2022). https://doi.org/10.1186/s12889-022-13943-x

CAMPBELL, F., TRICCO, A.C., MUNN, Z. et al. 2023. Mapping reviews, scoping reviews, and evidence and gap maps (EGMs): the same but different— the "Big Picture" review family. *Syst Rev* **12**, 45 (2023). https://doi.org/10.1186/s13643-023-02178-5

CAMPBELL, K. et al., 2021. Reflexive Thematic Analysis for Applied Qualitative Health Research. Qualitative Report. 26. 2011-2028. 10.46743/2160-3715/2021.5010.

CARR, E. et al., 2022. Trajectories of mental health among UK university staff and postgraduate students during the pandemic. Occupational and Environmental Medicine 2022;79:514-520.

CARROLL, T. K., KRAMER, A., and DRINGENBERG, E., 2019. Intelligence and Smartness in Engineering: Gatekeepers to Diversity and Inclusion Paper presented at 2019 CoNECD - The Collaborative Network for Engineering and Computing Diversity , Crystal City, Virginia. https://strategy.asee.org/31773

CATALYST, 2022. Quick Take: Women in Science, Technology, Engineering, and Mathematics (STEM). https://www.catalyst.org/knowledge/women-science-technology-engineering-and-mathematics-stem

CECH, E., RUBINEAU, B., SILBEY, S., and SERON, C. 2011. Professional Role Confidence and Gendered Persistence in Engineering. American Sociological Review, 76(5), 641–666. https://doi.org/10.1177/0003122411420815

CHEUNG, K., et al., 2020. Depression , anxiety and stress in different subgroups of first-year university students from 4 year cohort data. Journal of Affective Disorders. Vol. 274. https://doi.org/10.1016/j.jad.2020.05.041

CHIDERA, U., 2022. Top 10 Hardest Undergraduate Degrees To Study in the World. Top 10 Hardest undergraduate Degrees to Study in the World (afterschoolafrica.com)

CHO, H. et al., 2016. The Effectiveness of Daily Mindful Breathing Practices on Test Anxiety of Students. *Public Library of Science*. 11(10): DOI: 10.1371/journal.pone.0164822 doi: 10.1371/journal.pone.0164822

CHOWDHURY, U. et al., 2022. Depression and stress regarding future career among university students during COVID-19 pandemic. PLoS One. 2022 Apr 12;17(4):e0266686. doi: 10.1371/journal.pone.0266686. PMID: 35413076; PMCID: PMC9004757.

CHOY, L.T. 2014. The Strengths and Weaknesses of Research Methodology: Comparison and Complimentary between Qualitative and Quantitative Approaches. IOSR Journal of Humanities and Social Science (OSR-JHSS) Volume 19, Issue 4. Ver. .III (Apr 2014), PP 99-104. E:ISSN:2279-0837

CHRON, 2021. What Maths Do You Need to Be an Engineer? What Maths Do You Need to Be an Engineer? (chron.com)

CHUE, K., YEO, A., NIE, Y. et al., 2023. Modifying the PERMA profiler to assess student well-being. Current Psychology. 1-12. 10.1007/s12144-023-04550-z.

CIOCA, L.-I., and BRATU, M.L. 2021. Sustainable Education in the Context of COVID-19: Study of the Social Perception and Well-Being of Students at the Faculty of Engineering in Sibiu, Romania. *Sustainability* **2021**, *13*, 12805. https://doi.org/10.3390/su132212805

CLARKE, A. et al., 2011. Warwick-Edinburgh Mental Well-being Scale (WEMWBS): Validated for teenage school students in England and Scotland. A mixed methods assessment. *BMC Public Health.* [online].

Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-11-487

CODAGNONE, C., BOGLIACINO, F., GÓMEZ C., et al., 2020. Assessing concerns for the economic consequence of the COVID-19 response and mental health problems associated with economic vulnerability and negative economic shock in Italy, Spain, and the United Kingdom. PLoS ONE 15(10): e0240876. https://doi.org/10.1371/journal.pone.0240876

COGGINS, T., COOKE, A., STANSFIELD, J., et al., 2011. Mental Well-being Impact Assessment A Toolkit for Well-being, Members of the National MWIA Collaborative (England).

COLEY, B., and JENNINGS, M., 2019. "The Price of Persistence: Investigating the Impact of Pursuing Engineering on Undergraduate Student Mental Health," *2019 IEEE Frontiers in*

Education Conference (FIE), Covington, KY, USA, 2019, pp. 1-5, doi: 10.1109/FIE43999.2019.9028426.

CONCEIÇÃO, V., ROTHES, I., and GUSMÃO, R. 2022. The association between stigmatizing attitudes towards depression and help seeking attitudes in college students. PLoS ONE 17(2): e0263622. https://doi.org/10.1371/journal.pone.0263622

COOK, W. 2017. Are all Experienced Engineers Rude and New Engineers Obnoxious. Cook Health Alliance. Online. Available from: https://cookhealthalliance.com/2017/03/are-all-experienced-engineers-rude-and-new-engineers-obnoxious

COSGROVE, K. 2021. The Gatekeeping You Don't Know You're Doing. Guest Blog. Stormforge. [online] Available from: The Gatekeeping You Don't Know You're Doing | StormForge

CRESWELL, J., 2014, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches 4th Ed. Sage Publications Inc. ISBN 9781452226101

CRONE, W. C., KESEBIR, P., HAYS, B., and MIRGAIN, S. A., et al. 2023. Cultivating well-being in engineering graduate students through mindfulness training. *PloS one*, *18*(3), e0281994. https://doi.org/10.1371/journal.pone.0281994

CROPLEY, D., 2015. Promoting Creativity and Innovation in Engineering Education. Psychology of Aesthetics, Creativity, and the Arts. 9. 10.1037/aca0000008

CRUWYS, T., and GUNASEELAN, S. 2016. "Depression is who I am": Mental illness identity, stigma and wellbeing. *Journal of affective disorders*, *189*, 36–42. https://doi.org/10.1016/j.jad.2015.09.012

DANOWITZ, A., and BEDDOES, K., 2018. Characterizing Mental Health and Wellness in Students Across Engineering Disciplines. *2018 Collaborative Network for Engineering and Computing Diversity. American Society for Engineering Education.* [online]. Available from:

https://peer.asee.org/characterizing-mental-health-and-wellness-in-students-across-engineering-disciplines

DANOWITZ, A., and BEDDOES, K., 2022. Mental Health in Engineering Education: Identifying Population and Intersectional Variation." in IEEE Transactions on Education, vol. 65, no. 3, pp. 257-266, Aug. 2022.

DANOWITZ, A., and BEDDOES, K., 2023. Engineering Students' Mental Health – Research Brief for Engineering Deans. Research in Sociology of Engineering. Available from: Engineering Students Less Likely to Seek Mental Health Help Than Their Cohorts, Research Shows - (calpoly.edu)

DAS, S., KLEINKE, D., and PISTRUI, D., 2020. Reimagining Engineering Education: Does Industry 4.0 Need Education 4.0?. *ASEE Virtual Annual Conference Proceedings.* DOI: 10.18260/1-2-35136. Available from: Mental Health in Engineering Education: Identifying Population and Intersectional Variation | IEEE Journals and Magazine | IEEE Xplore (rgu.ac.uk)

DAVOREN, M.P. et al., 2013. Positive mental health and well-being among a third level student population. *PloS one*, *8*(8), e74921. https://doi.org/10.1371/journal.pone.0074921

DE JAGER, M. and McCLELL POTT, R.W. 2022. Graduates′ views on the curriculum and the transition to the world of work: skills, knowledge, and generic engineering competencies. 2022 IEEE IFEES World Engineering Education Forum - Global Engineering Deans Council, WEEF-GEDC 2022 - Conference Proceedings. https://doi-org.ezproxy.rgu.ac.uk/10.1109/WEEF-GEDC54384.2022.9996244

DE PURY, J., and DICKS, A., 2020. Step Change: Mentally Healthy Universities. Universities UK. https://www.universitiesuk.ac.uk/policy-and-analysis/Pages/Student-and-staff-health-and-wellbeing.aspx

DEASY, C. et al., 2015. Psychological distress and lifestyle of students: implications for health promotion. *Health Promotion International*. 30(1): 77–87. https://doi.org/10.1093/heapro/dau086

DELPHIS, 2019. The Biopsychosocial Model of Mental Health. Mental Health. Online. Available from: The Biopsychosocial Model of Mental Health – Delphis Learning

DEPARTMENT OF HEALTH, 2010. Confident Communities, Brighter Futures: a framework for developing well-being. HM Government. UK. https://webarchive.nationalarchives.gov.uk/20130123201555/http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_114774

DE PILLIS, E., and DE PILLIS, L. 2008. Are engineering schools masculine and authoritarian? The mission statements say yes. Journal of Diversity in Higher Education, 1(1), 33–44. https://doi.org/10.1037/1938-8926.1.1.33

D'ENTREMONT, A. et al., 2019. Student Mental Wellbeing Interventions with a Second-Year Engineering Cohort. 2019: Proceedings of the Canadian Engineering Education Association (CEEA-ACEG) Conference June 8 - 12 Ottawa Ontario. DOI: https://doi.org/10.24908/pceea.vi0.13686

DEY, R., and MULEKAR, M.S. 2018. Effect Size as a Measure of Difference Between Two Populations. In: Alhajj, R., Rokne, J. (eds) Encyclopedia of Social Network Analysis and Mining. Springer, New York, NY. https://doi.org/10.1007/978-1-4939-7131-2_110195

DEZIEL, M. et al., 2013. Analyzing the Mental Health of Engineering Students Using Classification and Regression. *The International Educational Data Mining Society*, 6th International Conference on Educational Data Mining, 228-231 . [online]. Available from: http://www.educationaldatamining.org/EDM2013/papers/rn_paper_34.pdf

DIAS, P. 2019. Philosophy for Engineering: Practice, Context, Ethics, Models, Failure

(SpringerBriefs in Applied Sciences and Technology) Springer. Springer; 1st ed. 2019 edition

DICTUREL, T. 2019. The Problem of Unrealistic Expectations: Really, Did You Think That Was Possible? Online. Available from: The Problem of Unrealistic Expectations: Really, Did You Think That Was Possible? | HackerNoon

DODD, D., and STONYER, H., 2003. Integrating Design into an Alternative Engineering Curriculum. 14th Annual AAEE Conference, Melbourne, Australia. Available from: Integrating Design into an Alternative Engineering Curriculum

DONALDSON SI, VAN ZYL LE, and DONALDSON SI. 2022. PERMA+4: A Framework for Work-Related Wellbeing, Performance and Positive Organizational Psychology 2.0. Front Psychol. 2022 Jan 24;12:817244. doi: 10.3389/fpsyg.2021.817244. PMID: 35140667; PMCID: PMC8819083.

DONELLY, M., 2018. Shortage of Engineers Could Restrict Global Growth. [Internet] 2018 [online]. Available from: https://www.fircroft.com/blogs/shortage-of-engineers-could-restrict-global-growth-88829181061

EBERT, D.D., MORTIER, P., KAEHLKE, F., and BRUFFAERTS, R., et al. 2019. WHO World Mental Health-International College Student Initiative collaborators. Barriers of mental health treatment utilization among first-year college students: First cross-national results from the WHO World Mental Health International College Student Initiative. Int J Methods Psychiatr Res. 2019 Jun;28(2):e1782. doi: 10.1002/mpr.1782

EDGAR, S., and CONNAUGHTON, J., 2021. Using Mental Health First Aid Training to Improve the Mental Health Literacy of Physiotherapy Students. Physiother Can. 2021 Spring;73(2):188-193. doi: 10.3138/ptc-2019-0036. PMID: 34456431; PMCID: PMC8370725.

EDUCATION POLICY INSTITUTE, 2018. Prevalence of Mental Health Issues within the Student-Aged Population. Prevalence of mental health issues within the student-aged population - Education Policy Institute (epi.org.uk)

EDWARD, N., and MIDDLETON, J.C.R., 2001. Occupational Socialisation - A New Model of the Engineer's Formation. *International Conference on Engineering Education*. Oslo, Norway. [online]. Available from: https://www.researchgate.net/publication/229047463_Occupational_Socialisation--a_New_Model_of_the_Engineer's_Formation [Accessed 1 April 2019].

EDWARDS, R., and HOLLAND, J., 2013. *What is Qualitative Interviewing?* "What is?" Research Methods Series. London. Bloomsbury.

EISENBERG, D. et al., 2009. Stigma and Help Seeking for Mental Health Among College Students. *Medical Care Research and Review.* Volume 66 No. 5. 2009 SAGE Publications 10.1177/1077558709335173 http://mcr.sagepub.comhosted athttp://online.sagepub.com

EISENBERG, D., GOLBERSTEIN, E., and GOLLUST, S. E., 2007. Help-seeking and access to mental health care in a university student population. *Medical Care*, *45*(7), 594-601. [online]. Available from: https://www.researchgate.net/publication/6266227_Help-Seeking_and_Access_to_Mental_Health_Care_in_a_University_Student_Population [Accessed 2 April 2018].

ENGEL, G.L., 1977. The Need for a New Medical Model: A Challenge for biomedicine. Science, 196 (4286), 129-136. [online]. Available from: https://science.sciencemag.org/content/196/4286/129/tab-pdf [Accessed 10 April].

ENGINEERING COUNCIL. 2012. Status of Engineers [online] Available from: Engineering Council (engc.org.uk)

ENGINEERING COUNCIL. 2020. Accreditation of Higher Education Programmes (AHEP). 4th Edition. Engineering Council. [online] Available from: ahep-fourth-edition.pdf (engc.org.uk)

ENGINEERING UK, 2020. Educational pathways into engineering. engineering-uk-report-2020.pdf

ENGINEERING X, 2020. Global Engineering Capability Review. On behalf of the Royal Academy of Engineering and Lloyds Register. https://www.raeng.org.uk/publications/reports/global-engineering-capability-review

ENGINEERS CANADA, 2021. Canadian engineers for tomorrow: Trends in engineering enrolment and degrees awarded 2016-2020.Canadian Engineers for Tomorrow | Engineers Canada

EQUATOR, 2022. What is a Reporting Guideline? Available at: https://www.equator-network.org/about-us/what-is-a-reporting-guideline/

EREN-SISMAN E., CIGDEMOGLU, C., and GEBAN, Ö., 2018. The Effect of Peer-Led Team Learning on Undergraduate Engineering Students' Conceptual Understanding, State Anxiety, and Social Anxiety. Chemistry Education Research and Practice.19: 694-710. (9) (1) The Effect of Peer-Led Team Learning on Undergraduate Engineering Students' Conceptual Understanding, State Anxiety, and Social Anxiety | Request PDF (researchgate.net)

ESTRADA, T., and DALTON, E., 2019. Impact of Student Mindfulness Facets on Engineering Education Outcomes: An Initial Exploration. 10.18260/1-2--32934. Available from: (19) Impact of Student Mindfulness Facets on Engineering Education Outcomes: An Initial Exploration | Request PDF (researchgate.net)

EQUAL ENGINEERS, 2019. Masculinity in Engineering. Available from EqualEngineers-Masculinity-Report_Final.pdf

FELMAN, A., 2020. What is mental health? *Medical News Today.* Mental health: Definition, common disorders, early signs, and more (medicalnewstoday.com)

FESMIRE, S., 2003. John Dewey and Moral Imagination: Pragmatism in Ethics. Available from (20) (PDF) John Dewey and Moral Imagination: Pragmatism in Ethics [brief sample] (researchgate.net)

FETTERS, M.D., CURRY, L.A. and CRESWELL, J.W., 2013. Achieving Integration in Mixed Methods Designs—Principles and Practices. Health Serv Res, 48: 2134-2156. https://doi.org/10.1111/1475-6773.12117

FIRST DISCOVERERS., 2019. The Dual Factor Model. Online. Available from: dual factor model - First Discoverers

FLAIG, J., 2022. Pandemic Pushes Already Stressed Engineers to Breaking Point. Professional Engineering Magazine, 2022. Issues 6. Available from: FEATURE: Pandemic pushes already stressed engineers to breaking point (imeche.org)

FLEMING L., ENGERMAN, K., and WILLIAMS, D., 2006. Why Students Leave Engineering: The Unexpected Bond. *ASEE (American Society for Engineering Education Conference)* DOI 10.18260/1-2—375.

FLORMAN, S.C., 1994. The Existential Pleasures of Engineering. 2nd Edition. St, Edmundsbury Press Ltd. England.

FOSTER, C., and SPENCER, L., 2003. Are undergraduate engineering students at greater risk for heart disease than other undergraduate students? *Journal of Engineering Education*, **92**(1), 73– 77. https://doi.org/10.1002/j.2168-9830.2003.tb00740.x

FREENEY, C. 2018. Title of Engineer Must be Protected. [online] Available from: Title of 'Engineer' must be protected | LinkedIn

FRIES, C.J., 2020. Healing Health Care: From Sick Care Towards Salutogenic Healing Systems. *Soc Theory Health* **18**, 16–32 (2020). https://doi.org/10.1057/s41285-019-00103-2

GADDIS, S.M., RAMIREZ, D., and HERNANDEZ, E.L., 2018. Contextualizing public stigma: Endorsed mental health treatment stigma on college and university campuses. Soc. Sci. Med., 197 (2018), pp. 183-191. https://doi.org/10.1016/j.socscimed.2017.11.029

GALDAS, P., CHEATER, F. and MARSHALL, P., 2005. Men and Help-Seeking Behaviour: Literature Review. *Journal of Advance Nursing.* [online]. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2648.2004.03331.x [Accessed 2 April].

GALE, N.K. et al., 2013. Using the framework method for the analysis of qualitative data in multi-disciplinary health research. BMC Med Res Methodol 13, 117 (2013). https://doi.org/10.1186/1471-2288-13-117

Ganguly, S., Kulkarni, M., and Gupta, M. 2017. A Self-Efficacy Intervention for Poorly Performing Students. Indian Journal of Psychology and Education, 7 (2), 63-66.. Indian Journal of Psychology and Education.

GEGA, L., 2020. Is there a difference between wellbeing and mental health? [online] Is there a difference between wellbeing and mental health? (futurelearn.com)

GELLES, L.A. et al., 2020. Compassionate Flexibility and Self-Discipline: Student Adaptation to Emergency Remote Teaching in an Integrated Engineering Energy Course during COVID-19. *Educ. Sci.* **2020**, *10*, 304. https://doi.org/10.3390/educsci10110304

GERRARD, D., NEWFIELD, K., ASLI, N., and VARIAWA, C., 2017. Are Students Overworked? Understanding the Workload Expectations and Realities of First-Year Engineering. 10.18260/1-2--27612.

GLEN, S., 2023. "Two Tailed Test: Definition, Examples". StatisticsHowTo.com: Elementary Statistics for the rest of us! [ONLIN] Available From: https://www.statisticshowto.com/two-tailed-test/

GNAMBS, T., and STAUFENBIEL, T., 2018. The structure of the General Health Questionnaire (GHQ-12): two meta-analytic factor analyses *Health Psychology Review* [online]. Available from: https://doi.org/10.1080/17437199.2018.1426484 [Accessed 4 April 2018].

GOH, M. et al., 2007. Chinese Students Attitudes towards Seeking Professional Psychological Help. *International Journal for the Advancement of Counselling.* 29:187-202.

GOLDBERG, D. P., and HILLIER, V. F., 1979. A scaled version of the General Health Questionnaire. Psychological Medicine, 9(1), 139–145.https://doi.org/10.1017/S0033291700021644

GOLDKUHL, G., 2012. Pragmatism vs interpretivism in qualitative information systems research, *European Journal of Information Systems* (21), 2, 135-146. [online]. Available from: http://dx.doi.org/10.1057/ejis.2011.54 [Accessed 4 April 2018].

GONZÁLEZ-PRIETO, A., PEREZ, J., DIAZ, J. AND LÓPEZ-FERNÁNDEZ, D. 2023. Reliability in software engineering qualitative research through Inter-Coder Agreement, Journal of Systems and Software, Volume 202, 2023, 111707, ISSN 0164-1212, https://doi.org/10.1016/j.jss.2023.111707.

GOVERNMENT OFFICE FOR SCIENCE. 2008. Foresight Mental Capital And Wellbeing Project. Final Project report – Executive summary. The Government Office for Science, London.

GRAHAM, R., 2012. The Royal Academy of Engineering and Massachusetts Institute of Technology Achieving Excellence in Engineering Education: the Ingredients of Successful Change. [online]. Available from: http://www.rhgraham.org/resources/Educational-change-summary-report.pdf [Accessed 29 Aug 2018].

GRASTY, K. et al., 2021. Benefits of Utilizing Counseling Services Among Doctoral Women of Color in STEM. 2021 ASEE Virtual Annual Conference, ASEE 2021 Jul 26, 2021 -Jul 29, 2021

GREEN, J., and THOROUGHGOOD, N., 2014. Qualitative Methods for Health Research. 3rd Edition. SAGE Publications Ltd. London.

HACKETT, A., and STRICKLAND, K., 2018. Using the framework approach to analyse qualitative data: a worked example. Nurse Researcher. doi:10.7748/nr.2018.e1580

HANNA, P. 2012. Using internet technologies (such as Skype) as a research medium: a research note. *Qualitative Research*, *12*(2), 239-242. https://doi.org/10.1177/1468794111426607

HAMACHER, A. 2017. Education models need a 'major shake up' to produce future engineers. Institution of Mechanical Engineers. [online] Available from: Education models need a 'major shake up' to produce future engineers (imeche.org)

HARGIS, L. E. et al., 2021. *Relationship Between Mental Health Distress and Help-Seeking Behaviors Among Engineering Students* Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. https://peer.asee.org/37657

HASSED, C. et al., 2009. Enhancing the health of medical students: outcomes of an integrated mindfulness and lifestyle program. *Advances in Health Sciences Education: Theory and Practice.* 14(3):387-398.

HEALTH SCOTLAND, 2021. Key Facts. Overview of mental health and wellbeing - Mental health and wellbeing - Health topics - Public Health Scotland [Accessed 14 February 2021]

HEALTH SURVEY ENGLAND. 2016. Adult Wellbeing. HSE2016-Adult-wel-bei.pdf (hscic.gov.uk) HSE2016-Adult-wel-bei.pdf (hscic.gov.uk).

HEALTHY MINDS NETWORK, 2022. Healthy Minds National Data Report (AY 2021-2022) https://healthymindsnetwork.]org/wp-content/uploads/2023/03/HMS_national_print-6-1.pdf

HEALTHY MINDS NETWORK, 2021. Healthy Minds National Data Report (Winter Spring Data Report)

https://healthymindsnetwork.org/wp-content/uploads/2022/01/HMS_nationalwinter2021_-update1.5.21.pdf

HEALTHY SHETLAND, 2019. The Dual Factor Model of Mental Health and Wellbeing. [online]. Available from: https://www.healthyshetland.com/site/assets/files/1169/mental-health_continuum.png [Accessed 14 April 2019].

HEIDEGGER, M. 1962. *Being and Time*. Harper & Row, New York, 1962

HESA (HIGHER EDUCATION STATISTICS AGENCY), 2013. JACS Codes. https://www.hesa.ac.uk/support/documentation/jacs/jacs3-principal

HESA (HIGHER EDUCATION STATISTICS AGENCY), 2020. Principal Subject Codes. [online]. Available from: https://www.hesa.ac.uk/support/documentation/jacs/jacs3-principal [Accessed 2 November 2020].

HESA (HIGHER EDUCATION STATISTICS AGENCY), 2023. What do HE Students Study? [online]. Available from: https://www.hesa.ac.uk/data-and-analysis/students/what-study

HOFFMANN, T.C. et al., 2014. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ (British Medical Journal).* 7 (348):1687. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide | The BMJ

HOLMES, A.G.D., 2020. “Researcher Positionality - A Consideration of Its Influence and Place in Qualitative Research - A New Researcher Guide.” Shanlax International Journal of Education, vol. 8, no. 4, 2020, pp. 1-10.

HOLT, M., and POWELL, S., 2017. Healthy Universities: a guiding framework for universities to examine the distinctive health needs of its own student population. Perspectives in Public Health. 137(1): 53-58. DOI: 10.1177/1757913916659095.

HORAK, E., and du TOIT, J. W., 2002. A study of the thinking styles and academic performance of civil engineering students. Journal of the South African Institution of Civil Engineering, 44(3), 18-24.

HSIEH, H.F., and SHANNON, S.E. 2005. Three Approaches to Qualitative Content Analysis. Qualitative Health Research. 2005;15(9):1277-1288. doi:10.1177/1049732305276687

HUDA A. S. 2021. The medical model and its application in mental health. International review of psychiatry (Abingdon, England), 33(5), 463–470. Link

HUERTA, M., 2021. Inner engineering: Evaluating the utility of mindfulness training to cultivate intrapersonal and interpersonal competencies among first-year engineering students. Journal of Engineering Education. 110. 10.1002/jee.20407. Available from: (19) (PDF) Inner engineering: Evaluating the utility of mindfulness training to cultivate intrapersonal and interpersonal competencies among first-year engineering students (researchgate.net)

HUNT, J., and EISENBERG, D., 2010. Mental Health Problems and Help-Seeking Behavior Among College Students. *Journal of Adolescent Health.* [online] Available from: https://www.sciencedirect.com/science/article/pii/S1054139X09003401 [Accessed 1 April 2019].

HUPPERT, F.A., 2009. Psychological Well-being: Evidence Regarding its Causes and Consequences. Applied Psychology: Health and Well-Being, 1: 137-164. https://doi.org/10.1111/j.1758-0854.2009.01008.x

IBRAHIM, A.K., KELLY, S., and GLAZEBROOK, C., 2013. Socioeconomic Status and the Risk of Depression among UK Higher Education Students. [online]. Available from:

https://www.researchgate.net/publication/235629868_Socioeconomic_status_and_the_risk_of_depression_among_UK_higher_education_students [Accessed 25 March 2019].

IAENG (International Association of Engineers)., 2023. Online. Available from: Welcome to IAENG

IET (Institute of Engineering and Technology). 2021. Skills and Demand in Industry Report 2021. [online] Available from: Skills Survey 2021 (theiet.org)

IET (Institute of Engineering and Technology). 2022a. New report led by the IET calls for the government to embed engineering into the current curriculum. [online] Available from: https://www.theiet.org/membership/member-news/member-news-2022/member-news-october-to-december-2022/new-report-led-by-the-iet-calls-for-the-government-to-embed-engineering-into-the-current-curriculum/

IET (Institute of Engineering and Technology). 2022b. Engineering Kids Futures. [online] Available from: engineering-kids-futures.pdf (theiet.org)

IMASOGIE, B.A., OYATOGUN, G.M., and TAIWO, K.A., 2018. Enhancing Gender Balance in Engineering Education and Practice. 2018 World Engineering Education Forum - Global Engineering Deans Council (WEEF-GEDC), Albuquerque, NM, USA, 2018, pp. 1-8, doi: 10.1109/WEEF-GEDC.2018.8629657.

INSTITUTE FOR EMPLOYMENT STUDIES. 2021. Career Deflection: Exploring Diversity, Progression and Retention in Engineering. SNC Lavalin. Atkins. [online] Available from: Career Deflection Report | Careers at SNC-Lavalin, Atkins, Faithful + Gould (snclavalin.com)

INSTITUTION OF MECHANICAL ENGINEERS (IMechE), 2015. The UK and Ireland Engineering Workforce Study. 2015. Workforce survey reveals engineers are dedicated but feel undervalued (imeche.org)

INSTITUTION OF MECHANICAL ENGINEERS (IMechE), 2019. Academic Accreditation Guidelines. https://www.imeche.org/docs/default-source/1-oscar/membership/universities/academic-accreditation-guidelines---sept-2019.pdf?sfvrsn=2

IVANKOVA, N. V., CRESWELL, J. W., and STICK, S. L., 2006. Using Mixed-Methods Sequential Explanatory Design: From Theory to Practice. *Field Methods*, *18*(1), 3–20. https://doi.org/10.1177/1525822X05282260

JACK, J., 2022. Mental Health Stigma in Higher Education. HealthyPlace. Online. Available from:https://www.healthyplace.com/blogs/survivingmentalhealthstigma/2022/2/mental-health-stigma-in-higher-education

JACKSON, C., 2007. *Occupational Medicine*, Volume 57, Issue 1, 1 January 2007, Page 79 [online]. Available from: https://doi.org/10.1093/occmed/kql169 [Accessed 4 April 2018].

JACKSON, K., and BAZELEY, P. 2019. Qualitative Data Analysis with NVivo. (3rd Edition). Sage Publications.

JACKSON, B., SELLERS, R., and PETERSON, C. 2002. Pessimistic explanatory style moderates the effect of stress on physical illness. *Personality and Individual Differences. 32 (2002) 567-573*

JAGACINSKI, C. M., 2013. Women engineering students: Competence perceptions and achievement goals in the freshman engineering course. Sex Roles: A Journal of Research, 69(11-12), 644–657. https://doi.org/10.1007/s11199-013-0325-9

JAMES, W., 1898. Philosophical Conceptions and Practical Results. The University Press. Available from Philosophical conceptions and practical results : James, William, 1842-1910 : Free Download, Borrow, and Streaming : Internet Archive

JENNINGS, G.R. 2005. Social Science Methods Used in Business. Editor(s): Kimberly Kempf-Leonard, Encyclopedia of Social Measurement, Elsevier, 2005,Pages 219-230,
ISBN 9780123693983,

JENSEN, K., 2023. Engineering Students' Perceptions of Stress and Mental Health. BMC On Society.

On Society Engineering Students' Perceptions of Stress and Mental Health (biomedcentral.com)

JENSEN, K., and CROSS, K. J. 2019. Student perceptions of engineering stress culture. Paper presented at the ASEE Annual Conference and Exposition, Tampa, FL. Retrieved from https://peer.asee.org/32418

JENSEN, K.J, and CROSS, K.J., 2021. Engineering stress culture: Relationships among mental health, engineering identity, and sense of inclusion. *Journal of Engineering Education*. 110: 371– 392. https://doi.org/10.1002/jee.20391

JOHNSON-GLAUCH, N., COOPER, L.A., and HARDING, T.S., 2020. Goal-setting as a Means of Improved Mental Health Outcomes for Materials and Mechanical Engineering Students. 2020 ASEE Virtual Annual Conference. DOI 10.18260/1-2--34710.

JOHNSON, R. B., and ONWUEGBUZIE, A. J., 2004. Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher*, *33*(7), 14–26. https://doi.org/10.3102/0013189X033007014

JOHNSON, R. B., 2016. Dialectical Pluralism: A Metaparadigm Whose Time Has Come. *Journal of Mixed Methods Research*, *11*(2), 156–173. https://doi.org/10.1177/1558689815607692

JONES, T. L., BAXTER, M. A., and KHANDUJA, V. 2013. A quick guide to survey research. Annals of the Royal College of Surgeons of England, 95(1), 5–7. https://doi.org/10.1308/003588413X13511609956372

JOSEPH, S., and SAGY, S., 2016. Positive Psychology in the Context of Salutogenesis. 2016 Sep 3. In: Mittelmark MB, Sagy S, Eriksson M, et al., editors. The Handbook of Salutogenesis

[Internet]. Cham (CH): Springer; 2017. Chapter 10. Available from: https://www.ncbi.nlm.nih.gov/books/NBK435833/ doi: 10.1007/978-3-319-04600-6_10

JOSHI, A. et al., 2016. Stress management through regulation of blood pressure among college students. *Work.* 2016;54(3):745-752.

JOSHI, A., KIRAN, R., and SAH, A.N., 2017a. Stress monitoring through non-invasive instrumental analysis of skin conductivity. *Work*. 2017a; 57(2):233-243.

JOSHI, A., KIRAN, R., and SAH, A.N., 2017b. An experimental analysis to monitor and manage stress among engineering students using Galvanic Skin Response meter. *Work*. 2017b; 56: 409–420.

JOSHI, A., and KIRAN, R., 2020. Gauging the effectiveness of music and yoga for reducing stress among engineering students: An investigation based on Galvanic Skin Response. *Work (Reading, Mass.)*, *65*(3), 671–678. https://doi.org/10.3233/WOR-203121

JOUVENT, R., BUNGENER, C., MORAND, P., and MILLET, V. et al. 1999. Distinction trait/état et anxiété an médecine générale. Etude descriptive [Distinction between anxiety state/trait in general practice: a descriptive study]. L'Encephale, 25(1), 44–49.

KAUSHIK, V., and WALSH, C.A., 2019. Pragmatism as a Research Paradigm and Its Implications for Social Work Research. *Social Sciences*. 2019; 8(9):255. https://doi.org/10.3390/socsci8090255

KEARNS, M. et al., 2015. Understanding Help-Seeking Amongst University Students: The Role of Group Identity, Stigma and Exposure to Suicide and Help Seeking. *Frontiers in Psychology.* 6.1462. [online].

Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4586350/

KELLY, L. M., and CORDEIRO, M., 2020. Three principles of pragmatism for research on organizational processes. Methodological Innovations, 13(2). https://doi.org/10.1177/2059799120937242

KEYES C. L. 2005. Mental illness and/or mental health? Investigating axioms of the complete state model of health. *Journal of consulting and clinical psychology*, *73*(3), 539–548. https://doi.org/10.1037/0022-006X.73.3.539

KHALIL, H., et al. 2015. An evidence-based approach to scoping reviews. *Worldviews Evidence Based Nursing* 2015;13(2):118–23.

KHALIL, H., and TRICCO, A. C. 2022. Differentiating between mapping reviews and scoping reviews in the evidence synthesis ecosystem. *Journal of clinical epidemiology*, *149*, 175–182. https://doi.org/10.1016/j.jclinepi.2022.05.012

KHAN, L. 2016. Missed Opportunities: Key Challenges Facing Children's Mental Health. Centre for Mental Health. [online]

Available from: https://www.centreformentalhealth.org.uk/publications/missed-opportunities

KHAN, A., POOLE, H., and BEATON, E., 2018. Measuring the Impact of a Weeklong Fall Break on Stress Physiology in First Year Engineering Students. *Canadian Journal for the Scholarship of Teaching and Learning*. 9: 1-8. ERIC - EJ1192635 - Measuring the Impact of a Weeklong Fall Break on Stress Physiology in First Year Engineering Students, Canadian Journal for the Scholarship of Teaching and Learning, 2018-Sep (ed.gov)

KOCI, J., and DONALDSON, S.I., 2023. Well-Being and Success For University Students: Applying PERMA+4 (1st ed.). Routledge. https://doi.org/10.4324/9781003378365

KORSTEN, N., WOLFF, K., and BOOYSEN, M.J., 2021. Time for mentally healthy engineering students. 2021 World Engineering Education Forum/Global Engineering Deans Council (WEEF/GEDC) 101-109. 10.1109/WEEF/GEDC53299.2021.9657375

KOUTSIMANI, P., MONTGOMERY, A., and GEORGANTA, K., 2019. The Relationship Between Burnout, Depression, And Anxiety: A Systematic Review And Meta-analysis. Front Psychol. 13 March 2019. Sec Organizational Psychology. Vol. 10 – 2019. https://doi.org/10.3389/fpsyg.2019.00284

KOVICH, M.K., SIMPSON V.L., FOLI, K.J., et al., 2023. Application of the PERMA Model of Well-being in Undergraduate Students. Int J Community Wellbeing. 2023;6(1):1-20. doi: 10.1007/s42413-022-00184-4. Epub 2022 Oct 26. PMID: 36320595; PMCID: PMC9607835.

KUHN, T.S., 1970. The Structure of Scientific Revolutions, 2nd Ed. University of Chicago Press, Chicago, 1970)

LAIDLAW, A., MCLELLAN, J., and OZAKINCI, G., 2016. Understanding Undergraduate Student Perceptions of Mental Health, Mental Well-being and Help-seeking Behaviour. Studies in Higher Education, 41:12, 2156-2168, [online]. Available from: https://www.tandfonline.com/doi/full/10.1080/03075079.2015.1026890 [Accessed 3 April 2019].

LAKENS, D. 2013. Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. Front Psychol. 2013 Nov 26;4:863. doi: 10.3389/fpsyg.2013.00863. PMID: 24324449; PMCID: PMC3840331.

LAL, R. et al., 2019. Effect of Dispositional Mindfulness on Perceived Stress Scores of Engineering Students: An Empirical Study. Indian Journal of Public Health Research and Development. 10. 63. 10.5958/0976-5506.2019.00014.7.

LARCUS, J., GIBBS, T., and HACKMAN, T., 2016. Building Capacities For Change: Wellness Coaching As A Positive Approach To Student Development. *Philosophy of Coaching: International Journal.* 1(1): 43-62. DOI: 10.22316/poc/01.1.05.

LEE, M.J., COLLINS, J.D., HARWOOD, S.A. et al. 2020. “If you aren’t White, Asian or Indian, you aren’t an engineer”: racial microaggressions in STEM education. *IJ STEM Ed* **7**, 48 (2020). https://doi.org/10.1186/s40594-020-00241-4

LEE, Y., LUND, C., and YERRICK, R., 2021. Adding Necessary Rigor to Engineering Pedagogical Change: Instructional Innovation Versus Research-Informed Counter-Resistance. Research and Teaching. Vol. 50. No. 6. 2021.

LEE, M.F., and WAN ADAM, W.M.H., 2016. A Comparison Study of the Methods to Solve the Mental Health Problem Between the Engineering and Non-Engineering Students. *IEEE International Conference on Industrial Engineering and Engineering Management (IEEM).*

[online]. Available from: https://www.researchgate.net/publication/312250104_A_comparison_study_of_methods_to_solve_the_mental_health_problem_between_the_engineering_and_non-engineering_students [Accessed 2 April 2019].

LEGG, C., and HOOKWAY, C., 2021. Pragmatism. The Stanford Encyclopedia of Philosophy (Summer 2021 Edition), Edward N. Zalta (ed.) https://plato.stanford.edu/archives/sum2021/entries/pragmatism

LEVAC, D., COLQUHOUN, H. and O'BRIEN, K.K., 2010. Scoping studies: advancing the methodology. *Implementation Science* 5, 69. https://doi.org/10.1186/1748-5908-5-69

LEWIS, J. and BOLTON, P., 2023. Student mental health in England: Statistics, policy and guidance. Online. CBP-8593.pdf (parliament.uk)Link

LIMONE, P., and TOTO, G.A., 2022. Factors That Predispose Undergraduates to Mental Issues: A Cumulative Literature Review for Future Research Perspectives. Front Public Health. 2022 Feb 16;10:831349. https://doi.org/10.1016/j.jad.2022.03.038

LINCOLN, Y.S., and Guba, EG. 1985. Naturalistic Inquiry. Newbury Park, CA: Sage Publications.

LINCOLN, Y., and GUBA, E. 2004. But Is It Rigorous? Trustworthiness and Authenticity in Naturalistic Evaluation. New Directions for Program Evaluation. 1986. 73 - 84. 10.1002/ev.1427.

LINDSTRÖM, B. 2020. Salutogenesis: an introduction. Online. Available from: Salutogenesis: an introduction | Local Government Association

LINTON, M-J., DIEPPE, P., and MEDINA-LARA, A., 2015. Review of 99 self-report measures for assessing wellbeing in adults: exploring dimensions of well-being and developments over time. BMJ [online].

Available from: https://bmjopen.bmj.com/content/bmjopen/6/7/e010641.full.pdf

LIPSON, S.K., et al 2016. Major Differences: Variations in Undergraduate and Graduate Student Mental Health and Treatment Utilization Across Academic Disciplines. *Journal of College Student Psychotherapy*, 30:1, 23-41, DOI: 10.1080/87568225.2016.1105657

LIPSON, S. K. et al. 2022. Trends in college student mental health and help-seeking by race/ethnicity: Findings from the national healthy minds study, 2013–2021, Journal of Affective Disorders, Volume 306, 2022, pp 138-147.

LITTLE, B. 2018. Passive Coping Strategies. In: Zeigler-Hill, V., Shackelford, T. (eds) Encyclopedia of Personality and Individual Differences. Springer, Cham. https://doi.org/10.1007/978-3-319-28099-8_1867-1

LOVIBOND, P.F. AND LOVIBOND, S.H. 1995. The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour research and therapy*, *33*(3), pp.335-343.

LUCAS, B., HANSON, J., and CLAXTON, G., 2014. Thinking Like an Engineer, Implications for the Education System. *A report for the Royal Academy of Engineering Standing Committee for Education and Training* ISBN: 978-1-909327-08-05 [online]. Available from:

https://www.raeng.org.uk/publications/reports/thinking-like-an-engineer-implications-summary [Accessed 29 March 2018].

LUMINET, O., NIELSON, K.A., and RIDOUT, N. 2021. Having no words for feelings: alexithymia as a fundamental personality dimension at the interface of cognition and emotion, Cognition and Emotion, 35:3, 435-448, DOI: 10.1080/02699931.2021.1916442

LYONS, M., HUEBNER, E. and HILLS, K. 2013., The Dual-Factor Model of Mental Health: A Short-Term Longitudinal Study of School-Related Outcomes', Social Indicators Research, 114(2), pp. 549–565. doi: 10.1007/s11205-012-0161-2.

MACASKILL, A., 2012. The Mental Health of University Students in the United Kingdom. *British Journal of Guidance and Counselling, 41 (4), 426-441.* [online]. Available from: http://shura.shu.ac.uk/6449/ [Accessed 1 April 2019].

MAGAARD, J. L., SEERALAN, T., SCHULZ, H., and BRÜTT, A. L. 2017. Factors associated with help-seeking behaviour among individuals with major depression: A systematic review. PloS one, 12(5), e0176730. https://doi.org/10.1371/journal.pone.0176730

MANDERSCHEID, R. et al., 2010. Peer Reviewed: Evolving Definitions of Mental Illness and Wellness. Preventing chronic disease. 7. A19.

MAPLES, B., 2021. What is it like to study Engineering at University? Study Engineering at University - What You Need To Know | Uni Compare (universitycompare.com)

MARTIN, M., 2021. 19 Ground-Breaking Women in Engineering Statistics. 19 Ground-Breaking Women in Engineering Statistics (thecircularboard.com)

MARIOTTI, A., 2015. The effects of chronic stress on health: new insights into the molecular mechanisms of brain-body communication. Future Sci OA. 2015 Nov 1;1(3):FSO23. doi: 10.4155/fso.15.21. PMID: 28031896; PMCID: PMC5137920.

MARRA, R.M. et al., 2009. Women Engineering Students and Self-Efficacy: A Multi-Year, Multi-Institution Study of Women Engineering Student Self-Efficacy. Journal of Engineering Education, 98: 27-38. https://doi.org/10.1002/j.2168-9830.2009.tb01003.x

MARUTA, T. et al., 2002. Optimism-pessimism assessed in the 1960s and self-reported health status 30 years later. *Mayo Clinic proceedings*, *77*(8), 748–753. https://doi.org/10.4065/77.8.748

MAYOH, J., and ONWUEGBUZIE, A., 2015. Toward a Conceptualization of Mixed Methods Phenomenological Research. *Journal of Mixed Methods Research Vol. 9 (1) 91-107* [online]. Available from: https://journals.sagepub.com/doi/pdf/10.1177/1558689813505358 [Accessed 5 April 2018].

MAXSON, A., and TOMASKO, D.L., 2020. Supporting the mental health and wellness of chemical engineering students at the department and college levels. ASEE Virtual Annual Conference 2020. ASEE PEER - Supporting the Mental Health and Wellness of Chemical Engineering Students at the Department and College Levels

MAYOH, J., and ONWUEGBUZIE, A. J., 2015. Toward a Conceptualization of Mixed Methods Phenomenological Research. *Journal of Mixed Methods Research*, *9*(1), 91–107. https://doi.org/10.1177/1558689813505358

MAZUMDER, Q., 2012. Improvement of Confidence And Motivation Using Online Metacognition Tool. American Journal of Engineering Education (AJEE). 2012; 3. DOI: 10.19030/ajee.v3i1.6889

MCCAMBRIDGE, A., NASSER, A., POONAM, M., STUBBS, P., VERHAGEN, A. 2021. Has Reporting on Physical Therapy Interventions Improved in 2 Decades? An Analysis of 140 Trials Reporting on 225 Interventions Journal of Orthopaedic & Sports Physical Therapy September 30, 2021 Volume51 Issue10 Pages503-509 https://www.jospt.org/doi/10.2519/jospt.2021.10642

McDONALD, R. 2022. Future-proofing engineering education: pedagogical reform for engineering resilience and mastery. In Proceedings of the 8th International Symposium for Engineering Education [4485] University of Strathclyde. https://doi.org/10.17868/strath.00082035

MCLAFFERTY M. et al., 2022.Variations in psychological disorders, suicidality, and help-seeking behaviour among college students from different academic disciplines. PLoS ONE 17(12): e0279618. https://doi.org/10.1371/journal.pone.0279618

MCLEOD, S. 2023. Thomas Kuhn: Paradigm Shift. [online] Available from: Thomas Kuhn: Paradigm Shift (simplypsychology.org)

MCGOWAN, V.C., and BELL, P., 2020. Engineering Education as the Development of Critical Sociotechnical Literacy. Sci Educ (Dordr). 2020;29(4):981-1005. doi: 10.1007/s11191-020-00151-5. Epub 2020 Aug 7. PMID: 32836879; PMCID: PMC7410977.

McGRATH, J., 2006. Variations in the Incidence of Schizophrenia: Data Versus Dogma, *Schizophrenia Bulletin*, Volume 32, Issue 1, 1 January 2006, Pages 195–197, [online] Available from: https://doi.org/10.1093/schbul/sbi052 [Accessed 15 April 2018].

MEDLICOTT, E., PHILLIPS, A., CRANE, C., HINZE, V. et al. 2021. The Mental Health and Wellbeing of University Students: Acceptability, Effectiveness, and Mechanisms of a Mindfulness-Based Course. Int J Environ Res Public Health. 2021 Jun 3;18(11):6023. doi: 10.3390/ijerph18116023. PMID: 34205114; PMCID: PMC8199969.

MERTENS, D., 2012. What Comes First? The Paradigm or the Approach?. Journal of Mixed Methods Research. 6. 255-257. 10.1177/1558689812461574.

METJE, N., FRANK, H.L., and CROFT, P.L., 2007. Can't do Maths—understanding students' maths anxiety*, Teaching Mathematics and its Applications: An International Journal of the IMA*, Volume 26, Issue 2, June 2007, Pages 79–88, https://doiorg.ezproxy.rgu.ac.uk/10.1093/teamat/hrl023

MEDICAL RESEARCH COUNCIL (MRC), 2008. Developing and evaluating complex interventions. Medical Research Council. https://mrc.ukri.org/documents/pdf/complex-interventions-guidance/

MENTAL HEALTH FOUNDATION, 2019. Mental Health Statistics: Economic and Social Costs. [online]. Available from: https://www.mentalhealth.org.uk/statistics/mental-health-statistics-economic-and-social-costs [Accessed 10 April 2019].

MENTAL HEALTH, 2020. What is Mental Health? [online]. Available from: https://www.mentalhealth.gov/basics/what-is-mental-health

METJE, N., FRANK, H.L., and CROFT, P.L., 2007. Can't do maths—understanding students' maths anxiety*, Teaching Mathematics and its Applications: An International Journal of the IMA*, Volume 26, Issue 2, June 2007, Pages 79–88, https://doiorg.ezproxy.rgu.ac.uk/10.1093/teamat/hrl023

MEYER, D., and STREVENS, C. 2022. Is using the term wellbeing with students a mistake? Evaluating a wellbeing intervention in a UK Law School - suggestions for repositioning strategies to address the impact of deficit-discourse, The Law Teacher, 56:1, 54-66, DOI: 10.1080/03069400.2022.2030955

MILLER, I. et al., 2021. WIP: Supporting Student Mental Health: Understanding the Use of Biometrics Analysis in an Engineering Design Project to Promote Wellness. ASEE Virtual Annual Conference, 2021. ASEE PEER - WIP: Supporting Student Mental Health: Understanding the Use of Biometrics Analysis in an Engineering Design Project to Promote Wellness

MILLER, I. et al., 2022. Development and Implementation of a Biometrics Device Design Project in an Introductory BME Course to Support Student Wellness. *Biomedical Engineering Education*, *2*(1), 75–82. https://doi.org/10.1007/s43683-021-00060-1

MILLER, I. and JENSEN. K., 2020. Introduction of Mindfulness in an Online Engineering Core Course During the COVID-19 Pandemic. Advances in Engineering Education. Fall 202 Volume 8, 4. AEE-COVID-19-Jensen.pdf (asee.org)

MILLER, M.E. et al., 2022. *Identifying mental health related help-seeking beliefs in undergraduate engineers*. Retrieved from https://par.nsf.gov/biblio/10338241 *ASEE annual conference exposition* .

MILLS, J., and TREAGUST, D., 2003. Engineering Education, Is Problem-Based or Project-Based Learning the Answer. *Australasian Journal of Engineering Education.* 3: 2. (9) (PDF) Engineering Education, Is Problem-Based or Project-Based Learning the Answer (researchgate.net)

MIND, 2017. What Are Mental Health Problems? [online]. Available from: https://www.mind.org.uk/information-support/types-of-mental-health-problems/mental-health-problems-introduction/#.XKIJQvZFyUk [Accessed 1 April 2019].

MIND, 2022. What is Stress? Online. Available from: What is stress? - Mind

MIND, 2023. What is depression? Online. Available from Depression - Mind

MINGERS, J., 2003. The paucity of multimethod research: A review of the information systems literature. Inf. Syst. J. 13. 233-250. 10.1046/j.1365-2575.2003.00143.x

MISHRA, P., PANDEY, C.M., SINGH, U., and GUPTA, A. et al. 2019a. Descriptive statistics and normality tests for statistical data. Ann Card Anaesth. 2019 Jan-Mar;22(1):67-72. doi: 10.4103/aca.ACA_157_18. PMID: 30648682; PMCID: PMC6350423.

MISHRA, P., SINGH, U., PANDEY, C.M., MISHRA, P., and PANDEY, G. 2019b. Application of student's *t*-test, analysis of variance, and covariance. Ann Card Anaesth. 2019 Oct-Dec;22(4):407-411. doi: 10.4103/aca.ACA_94_19. PMID: 31621677; PMCID: PMC6813708.

MITCHELL, J. 2013. Are mechanical engineers neurotic? Online. Available from: [Are mechanical engineers neurotic? - EngineeringClicks]

MITCHELL C, MCMILLAN B, HAGAN T. 2017. Mental health help-seeking behaviours in young adults. Br J Gen Pract. 2017 Jan;67(654):8-9. doi: 10.3399/bjgp17X688453. PMID: 28034926; PMCID: PMC5198588.

MITTELMARK, M.B., and BAUER, G.F., 2016. The Meanings of Salutogenesis. 2016 Sep 3. In: Mittelmark MB, Sagy S, Eriksson M, et al., editors. The Handbook of Salutogenesis [Internet]. Cham (CH): Springer; 2017. Chapter 2. Available from: https://www.ncbi.nlm.nih.gov/books/NBK435854/ doi: 10.1007/978-3-319-04600-6_2

MITTELMARK, M.B. et al., 2022. *The handbook of salutogenesis*. Cham: Springer International Publishing. Available from The Handbook of Salutogenesis (oapen.org)

MOGRABI, D. C., and MORRIS, R. G. 2018. Anosognosia. *Cortex; a journal devoted to the study of the nervous system and behavior*, *103*, 385–386. https://doi.org/10.1016/j.cortex.2018.04.001

MOHER, D. et al., 2009. PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Medicine. 6(7):e1000097. https://pubmed.ncbi.nlm.nih.gov/19621072/

MOLLER-LEIMKUHLER, A.M., 2002. Barriers to Help-Seeking by Men: A Review of Sociocultural and Clinical Literature with Particular Reference to Depression. *Journal of Affective Disorders* 71. [online]. Available from: https://www.researchgate.net/publication/11218434_Barriers_to_help-seeking_by_men_A_review_of_sociocultural_and_clinical_literature_with_particular_reference_to_depression [Accessed 2 April 2019]

MORAN, G., and BENSON, L., 2016. Effects of an intensive mathematics course on freshmen engineering students' mathematics anxiety perceptions. ASEE Annual Conference and Exposition. Effects of an Intensive Mathematics Course on Freshmen Engineering Students' Mathematics Anxiety Perceptions American Society for Engineering Education (asee.org)

MORGAN A.J., ROSS, A., and REAVLEY, N.J., 2018. Systematic review and meta-analysis of Mental Health First Aid training: Effects on knowledge, stigma, and helping behaviour. PLOS ONE 13(5): e0197102. https://doi.org/10.1371/journal.pone.0197102

MORRIS, S., and EARL, K., 2021. Social Research N. Health Survey for England [Internet]. Healthsurvey.hscic.gov.uk. 2017 [cited 12 March 2021]. Available from: http://healthsurvey.hscic.gov.uk/media/63763/HSE2016-Adult-wel-bei.pdf

MORRISH, L., 2019. Pressure Vessels: The epidemic of poor mental health among higher education staff. HEPI Occasional Paper. https://www.hepi.ac.uk/wp-content/uploads/2019/05/HEPI-Pressure-Vessels-Occasional-Paper-20.pdf

MOSES, J., 2006. Introduction of Philosophy to Engineering. [online] 4: Introduction to Philosophy of Engineering I - YouTube

MOSKVITCH, K. 2017. Title Dreams: Can a protected 'Eng.' Title boost the status of Engineering? Institution of Mechanical Engineers. Blog. [Online] Available from: https://www.imeche.org/news/news-article/title-dreams-can-a-protected-%27eng.%27-title-boost-the-status-of-engineering

MUNN, Z., PETERS, M.D.J., STERN, C. et al. 2018. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol* **18**, 143 (2018). https://doi.org/10.1186/s12874-018-0611-x

MUNN, Z., POLLOCK, D., KHALIL, H., ALEXANDER, L., et al. 2022. What are scoping reviews? Providing a formal definition of scoping reviews as a type of evidence synthesis. JBI evidence synthesis, 20(4), 950–952. https://doi.org/10.11124/JBIES-21-00483

NAPHAN-KINGERY, D., and ELLIOTT, M., 2018. Predicting college women's perceptions of a future in engineering by their experiences of micro-aggressions, identity management, and self-efficacy in college engineering. Journal of Women and Minorities in Science and Engineering. 24. 10.1615/JWomenMinorScienEng.2018020527.

NATIONAL ACADEMY OF ENGINEERING, 2022. Grand Challenges - 14 Grand Challenges for Engineering (engineeringchallenges.org)

NATIONAL INSTITUTE OF MENTAL HEALTH, 2024. Statistics. [Accessed 02 May 2024] Available from: Statistics - National Institute of Mental Health (NIMH) (nih.gov)

NATIONAL RECORDS OF SCOTLAND, 2014. *Census 2011: Release 3F - Detailed characteristics on Health in Scotland*. [online]. Available from: http://www.nrscotland.gov.uk/news/2014/census-release-3f. [Accessed 27 September 2016].

NATIONAL SURVEY FOR WALES, 2019. Warwick-Edinburgh Mental Well-being Scale (WEMWBS) by age group and gender (gov.wales)

NAYAK, M. and NARAYAN, K.A. 2019. Strengths and Weakness of Online Surveys. 24. 31-38. 10.9790/0837-2405053138.

NEGI, A.S., KHANNA, A., and AGGARWAL, R., 2019. Psychological health, stressors and coping mechanism of engineering students. *International Journal of Adolescence and Youth.* 1-10. https://doi.org/10.1080/02673843.2019.1570856

NG, F.L. et al*.*, 2017. Evaluating and establishing national norms for mental wellbeing using the short Warwick–Edinburgh Mental Well-being Scale (SWEMWBS): findings from the Health Survey for England. *Qual Life Res* **26,** 1129–1144 (2017). https://doi.org/10.1007/s11136-016-1454-8

NG, F., TRAUER, T., DODD, S., CALLALY, T., et al. 2007. The validity of the 21-item version of the Depression Anxiety Stress Scales as a routine clinical outcome measure. *Acta neuropsychiatrica*, *19*(5), 304–310. https://doi.org/10.1111/j.1601-5215.2007.00217.x

NATIONAL HEALTH SERVICE (NHS), 2020. What is Counselling. Available from Counselling - NHS (www.nhs.uk)

NHS DIGITAL. 2021. Health Survey for England. Available from: https://digital.nhs.uk/data-and-information/publications/statistical/health-survey-for-england/2021-part-2

NATIONAL UNION OF STUDENTS (NUS) SCOTLAND, 2010. Silently Stressed: A Survey info Student Mental Wellbeing [online]. Available from:

https://www.nus.org.uk/Documents/NUS%20Scotland/Silently%20Stressed%20THINK%20POS%20REPORT%20Final.pdf [Accessed 1 April 2019].

NATIONAL UNION OF STUDENTS (NUS), 2013. Mental Distress Survey. *National Union of Students.* [online] Available from: https://www.nus.org.uk/Global/Campaigns/20130517%20Mental%20Distress%20Survey%20%20Overview.pdf [Accessed 2 April 2019].

NATIONAL UNION OF STUDENTS (NUS), 2020. Over half of students' mental health is worse than before the pandemic. Over half of students' mental health is worse than before the pandemic @ NUS [Accessed 15 Feb 2021]

NHS ENGLAND, 2021. NHS England » Adult and older adult mental health [Accessed 14 February 2022]

NHS ENGLAND, 2023. Mental Health of Children and Young People in England, 2023 – wave 4 follow up to the 2017 survey [Accessed 1 May 2024] Available from: https://digital.nhs.uk/data-and-information/publications/statistical/mental-health-of-children-and-young-people-in-england/2023-wave-4-follow-up

NIGHTLINE ASSOCIATION, 2013. Psychological Distress in the UK Student Population: Prevalence, Timing and Accessing Support. [online].

Available from: https://www.nightline.ac.uk/wp-content/uploads/2014/08/Psychological-distress-prevalence-timings-accessing-support-Aug-2014.pdf [Accessed 1 April 2019].

NOLTE, H., HUFF, J., and MCCOMB, C., 2022. No time for that? An investigation of mindfulness and stress in first-year engineering design. *Design Science, 8*, E9. doi:10.1017/dsj.2022.5

NYAMAPFENE, A., 2018. Poor Public Perceptions of Engineering: It doesn't need to be this way. Poor Public Perceptions of Engineering: It doesn't need to be this way

NYAMAPFENE, A., 2019. Engineering Education: Now is the Time to Change. Engineering education: Now is the time to change | Engineering Learning and Teaching

NOWELL, L. et al., 2017. *Thematic Analysis*. International Journal of Qualitative Methods, 16(1), p.160940691773384. [online]. Available from: http://journals.sagepub.com/doi/pdf/10.1177/1609406917733847 [Accessed 15 April 2018].

O'CONNOR, R. 2021. UK engineering firms struggling to hold on to diverse range of talent, new report reveals. Infrastructure Intelligence. [online] Available from: UK engineering firms struggling to hold onto diverse range of talent, new report reveals | Infrastructure Intelligence (infrastructure-intelligence.com)

OFFICE FOR NATIONAL STATISTICS, 2022. Suicides in England and Wales- Office for National Statistics - 2022 Registrations. [online]. Available from: Suicides in England and Wales - Office for National Statistics (ons.gov.uk)

OFFICE FOR NATIONAL STATISTICS, 2023. Sickness absence in the UK labour market: 2022. Sickness absence in the UK labour market - Office for National Statistics (ons.gov.uk)

OFFICE FOR STUDENTS (OfS), 2019. Access and participation data analysis: Students with reported mental health conditions. www.officeforstudents.org.uk/publications/mentalhealth-are-all-students-being-properly-supported

OFFICE FOR STUDENTS (OfS), 2023. Student outcome and experience measures. [Accessed 01 May 2024]. Available from: https://www.officeforstudents.org.uk/data-and-analysis/student-outcome-and-experience-measures/

ONABULE, A., and BOES, S., 2013. International Students' Likelihood to Seek Counseling While Studying Abroad. *Journal of International Students* [online]. Available from: https://files.eric.ed.gov/fulltext/EJ1056444.pdf [Accessed 1 April 2019].

OPITO. 2019. UKCS WORKFORCE DYNAMICS: The Skills Landscape 2019-2025 [online] available from: UKCS-Workforce-Dynamics-The-Skills-Landscape-2019-2025.pdf (opito.com)

ORYGEN, 2017. Under the radar: The mental health of Australian university students. https://www.orygen.org.au/Policy/Policy-Reports/Under-the-radar/Orygen-Under_the_radar_report?ext=.

OSBORN, T.G., LI, S., SAUNDERS, R. et al.2022. University students' use of mental health services: a systematic review and meta-analysis. Int J Ment Health Syst 16, 57 (2022). https://doi.org/10.1186/s13033-022-00569-0

PANIAGUA, S. et al., 2019. Study of Binqui. An application for smartphones based on the Problems With-out Data methodology to reduce stress levels and improve academic performance of chemical engineering students. *Education for Chemical Engineers.* 27: 61-70. https://www.sciencedirect.com/science/article/abs/pii/S1749772818301155

PAPADIMITRIOU, G., 2017. The "Biopsychosocial Model": 40 years of application in Psychiatry. *Psychiatrike=Psychiatriki*, *28*(2),107–110. https://doi.org/10.22365/jpsych.2017.282.107

PASCOE, M. C., HETRICK, S. E., and PARKER, A. G. (2020). The impact of stress on students in secondary school and higher education. *Int. J. Adolesc. Youth* 25, 104–112. doi: 10.1080/02673843.2019.1596823

PAUL, R. et al., 2020. The "Engineers have feelings" Project: Integrating Mental Wellness and Lifelong Learning Skills in First-Year Undergraduate Engineering Courses 2020: Proceedings of the Canadian Engineering Education Association (CEEA) Conference. DOI: https://doi.org/10.24908/pceea.vi0.14154

PAUL, R. et al., 2021. Impact of integrating mental wellness and personal learning reflections into first-year undergraduate engineering courses.2021. Proceedings of the Canadian Engineering Education Association (CEEA-ACEG) Conference June 20 - 23 PEI DOI: 10.24908/pceea.vi0.14973

PEERS, S., 2015. Statistics on Women in Engineering. Stevenage: The Women's Engineering Society. http://www.wes.org.uk/sites/default/files/2018-01/Women%20in%20Engineering%20Statistics%20-%20January%202018%20-%20created%20by%20Sarah%20Peers_0.pdf

PEERS, S., 2018. *Statistics on Women in Engineering*. [ebook] Stevenage: The Women's Engineering Society, p.2. [online]. Available from: http://www.wes.org.uk/sites/default/files/2018-01/Women%20in%20Engineering%20Statistics%20-%20January%202018%20-%20created%20by%20Sarah%20Peers_0.pdf [Accessed 4 April 2018].

PEIRCE, C.S., 1878. How to Make our Ideas Clear. Popular Science Monthly. 12 (January 1878), 286-302. Available from: Peirce 1878 Make Ideas Clear.pdf (mit.edu)

PETERS, M.D.J. et al., 2015. Guidance for conducting systematic scoping reviews. Int J Evid-based Healthc 2015;13(3):141–6.

PETERS, M.D.J. et al., 2017. Chapter 11: Scoping Reviews. In: Aromataris E, Munn Z (Editors). *Joanna Briggs Institute Reviewer's Manual.* The Joanna Briggs Institute, 2017. [online]. Available from: https://www.researchgate.net/publication/319713049_2017_Guidance_for_the_Conduct_of_JBI_Scoping_Reviews [Accessed 1 April 2019].

PETERS, M.D.J. et al., 2020. Chapter 11: Scoping Reviews (2020 version). In: Aromataris E, Munn Z (Editors). Joanna Briggs Institute Reviewer's Manual, JBI. https://reviewersmanual.joannabriggs.org/

PETERS, M. D. J., GODFREY, C., MCINERNEY, P., KHALIL, H. et al. 2022. Best practice guidance and reporting items for the development of scoping review protocols. *JBI evidence synthesis*, *20*(4), 953–968. https://doi.org/10.11124/JBIES-21-00242

PETERSON, C., SELIGMAN, M. E., and VAILLANT, G. E., 1988. Pessimistic explanatory style is a risk factor for physical illness: a thirty-five-year longitudinal study. *Journal of personality and social psychology*, *55*(1), 23–27. https://doi.org/10.1037//0022-3514.55.1.23

PETERSON, C. and STEEN, T.A., 2016. 'Optimistic Explanatory Style', in C. R. Snyder and others (eds), *The Oxford Handbook of Positive Psychology*, 3rd edn (2021; online edn, Oxford Academic, 7 Mar. 2016), https://doi.org/10.1093/oxfordhb/9780199396511.013.70

PETROSKI, H. 1985. To Engineer is Human. The role of Failure in Successful Design. Random House. New York.

PETROSYAN, Y., 2014. Assessing Research Protocols: Mixed Method Research. Methods Workshop for the Ministry of Health and Long-Term Care. [online]. Available from: http://www.hsprn.ca/uploads/files/[Handout]%20Mixed%20Methods%20Research_YP.pdf [Accessed 1 April 2019].

PEREIRA, S. et al., 2018. University Student Mental Health Survey 2018. *The Insight Network*. https://www.theinsightnetwork.co.uk/uncategorized/university-student-mental-health-survey-2018/

PHILLIPS, T., 2022. Is there a Shortage of Developers? CodeSubmit. Available from: https://codesubmit.io/blog/shortage-of-developers/

PHYSIOPEDIA, 2021. *Grades and Levels of Evidence.* Physiopedia. Grades and Levels of Evidence - Physiopedia (physio-pedia.com)

PIPER, S. 2022. The problem with the 'Perfectionist Engineer' mindset. Online. Available from: (8) The problem with the 'Perfectionist Engineer' mindset | LinkedIn

POLLOCK, M. 2022. How to Practice Stewardship Instead of Gatekeeping. Blog. Engineer Inclusion. [online] Available from: https://engineerinclusion.com/stewarding/

POLANYI, M., 1958. Personal knowledge: Towards a post-critical philosophy. London: Routledge & Kegan Paul.

PONTO, J., 2015. Understanding and Evaluating Survey Research. *Journal of the advanced practitioner in oncology*, *6*(2), 168–171. Understanding and Evaluating Survey Research - PMC (nih.gov)

POOLE, D., 2022. Engineering schools are riddled with issues – reinvention is required Engineering schools need to reinvent themselves| THE Campus Learn, Share, Connect (timeshighereducation.com)

POOLE, H., KHAN, A., and AGNEW, M., 2017. One Week, Many Ripples: Measuring the Impacts of the Fall Reading Week on Student Stress. *Collected Essays on Learning and Teaching*. 164-172. One Week, Many Ripples: Measuring the Impacts of the Fall Reading Week on Student Stress | Collected Essays on Learning and Teaching (uwindsor.ca)

POPPER, K.R. 1983. Popper Selections. Ed by D.W. Miller (Princeton University Press, Princeton, 1983)

POZNIAK, H., 2017. The Great UK Engineering Shortage. *The Telegraph.* https://www.telegraph.co.uk/education/stem-awards/energy/the-great-uk-engineering-shortage/

PRAKASH, A., and BAJPAI, P., 2015. Stress among engineering students: Who are responsible. Advances in psychology research. Stress among engineering students: Who are responsible

PUBLIC HEALTH SCOTLAND, 2024. Child and Adolescent Mental Health Services (CAMHS) waiting times. [Accessed 02 May 2024]

QUALRES, 2018. *RWJF - Qualitative Research Guidelines Project* Semi-structured Interviews [online]. Available from: http://www.qualres.org/HomeSemi-3629.html [Accessed 15 April 2018].

RAENG (Royal Academy of Engineering). 2019. Engineering Skills for the Future: The 2013 Perkins Review Revisited. [online] Available from: https://raeng.org.uk/media/hn4hdep3/perkins_report_jan19_final-web.pdf

RAVIJOLAN, U., 2020. How Engineering Students are Enduring More than a Mental Health Crisis. The Eyeopener. 2020. Available from How engineering students are enduring more than a mental health crisis - The Eyeopener

RAZALI, S.N., RUSIMAN, M.S., GAN, W.S. and ARBIN, N. 2018. The Impact of Time Management on Students. Academic. Journal of Physics: Conference Series. 995, 10.1088/1742-6596/995/1/012042

REMSKAR, M. et al., 2022. Understanding University Student Priorities for Mental Health and Well-being Support: A Mixed-Methods Exploration using the Person-Based Approach. Stress and Health, 38(4), 776-789. https://doi.org/10.1002/smi.3133

RETA, Y., SAMUEL, T., and MEKONNEN, M., 2020. Mental Distress and Associated Factors Among Undergraduate Engineering Students of Hawassa University, Ethiopia. *J Multidiscip Healthc*. 2020;13:99-107 Mental Distress and Associated Factors Among Undergraduate Engineering | JMDH (dovepress.com)

RGU OIL AND GAS INSTITUTE, 2018. UKCS workforce dynamics 2018-2035: shaping the skills of tomorrow. Aberdeen: Robert Gordon University [online]. Available from: http://www.rguoilandgasinstitute.com/wp-content/uploads/2018/05/OPITO-Workforce-Dynamics.pdf

RICE, S., PURCELL, R., and McGORRY, P.D. 2018.Adolescent and Young Adult Male Mental Health: Transforming System Failures Into Proactive Models of Engagement, Journal of Adolescent Health,

Volume 62, Issue 3, Supplement,2018, https://doi.org/10.1016/j.jadohealth.2017.07.024.

RICHARDSON, J., 1977. Engineering Education Today. UNESCO Volume 27. No. 4. Octo-Dec 1977.

RITCHIE, J. and SPENCER, L., 1994. Qualitative Data Analysis for Applied Policy Research. In: Bryman, A. and Burgess, R.G., Eds., Analyzing Qualitative Data, Routledge, Abingdon-on-Thames, 173-194. https://doi.org/10.4324/9780203413081_chapter_9

RITCHIE, J. et al., 2014. Qualitative Research Practice: A Guide for Social Science Students and Researchers. Sage, Thousand Oaks, CA.

RODRÍGUEZ-JIMÉNEZ R.-M. et al. 2022. Embodied Learning for Well-Being, Self-Awareness, and Stress Regulation: A Randomized Trial with Engineering Students Using a

Mixed-Method Approach. Education Sciences. 2022; 12(2):111 https://doi.org/10.3390/educsci12020111

ROSETTE, H.L. et al., 1966. Personality and Cognitive Characteristics of Engineering Students: Implications for the occupational psychiatrist *American Journal of Psychiatry* 1147-1152

ROYAL ACADEMY OF ENGINEERING and MASSACHUSETTS INSTITUTE OF TECHNOLOGY (RAENG and MIT), 2012. Achieving Excellence in Engineering Education: the Ingredients of Successful Change. http://www.rhgraham.org/resources/Educational-change-summary-report.pdf

ROYAL COLLEGE OF PSYCHIATRISTS, 2011. Mental Health of Students in Higher Education. College Report CR166 The Mental Health of Students in Higher Education. Royal College of Psychiatrists. [online]. Available from: https://www.rcpsych.ac.uk/publications/collegereports/cr/cr166.aspx [Accessed 1 April 2019].

RUDLAND, JR, GOLDING, C, WILKINSON, TJ. 2019. The stress paradox: How stress can be good for learning. *Med Educ*. 2020; 54: 40–45. https://doi.org/10.1111/medu.13830

RUSLIN, R., MASHURI, S., RASAK, M.S.A., ALHABSYU, F and SYAM, H. 2022. Semi-Structured Interview: A methodological Reflection of the Development of a Qualitative Research Instrument in Educational Studies. IOSR Journal of Research & Method in Education (IOSR-JRME) e-ISSN: 2320–7388, p- ISSN: 2320-737x Volume 12, Issue 1 Ser. V (Jan. – Feb. 2022), 22-29 www.iosrjournals.org

SAGAR-OURIAGHLI, I., GODFREY, E., GRAHAM, S., and BROWN, J.S.L. 2020. Improving Mental Health Help-Seeking Behaviours for Male Students: A Framework for Developing a Complex Intervention. Int J Environ Res Public Health. 2020 Jul 9;17(14):4965. doi: 10.3390/ijerph17144965. PMID: 32660145; PMCID: PMC7400593.

SAH, L.K., SINGH, D.R., and SAH, R.K. 2020. Conducting Qualitative Interviews using Virtual Communication Tools amid COVID-19 Pandemic: A Learning Opportunity for Future Research. JNMA J Nepal Med Assoc. 2020 Dec 31;58(232):1103-1106. doi: 10.31729/jnma.5738. PMID: 34506374; PMCID: PMC8028517.

SALAHEDDIN, K., and MASON, B., 2016. Identifying Barriers to Mental Health Help-Seeking Among Young Adults in the UK: A Cross Sectional Survey. *British Journal of General Practice.* [online]. Available from: https://www.researchgate.net/publication/308754147_Identifying_barriers_to_mental_health_help-seeking_among_young_adults_in_the_UK_a_cross-sectional_survey

SALEH, A., and BISTA, K. 2017. Examining Factors Impacting Online Survey Response Rates in Educational Research: Perceptions of Graduate Students. *Journal of MultiDisciplinary Evaluation*, *13*(29), 63–74. https://doi.org/10.56645/jmde.v13i29.487

SALLAI, G., & VICENTE, J., & SHANACHILUBWA, K., and BERDANIER, C. 2022. Coping Landscapes: How graduate engineering students' coping mechanisms correspond with dominant stressors in graduate school Paper presented at 2022 ASEE Annual Conference & Exposition, Minneapolis, MN. https://peer.asee.org/40782

SAMARITANS. 2022. Suicides in England. [online] Available from: Suicides in England 2021 (samaritans.org)

SAMPSON, K. et al., 2022. Key questions: Research priorities for student mental health. BJPsych Open, 8(3), E90. doi:10.1192/bjo.2022.61

SANCHEZ-PENA, M.L. et al., 2021. Work in Progress: Measuring Stigma of Mental Health Conditions and Its Impact in Help-seeking Behaviors Among Engineering Students Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. https://peer.asee.org/38181

SANDHU, H.S., ARORA, A., and BRASCH, J. 2021. Correlates of explicit and implicit stigmatizing attitudes of Canadian undergraduate university students toward mental illness: A cross-sectional study. *Journal of American College Health*, 2021. Vol. 69, no.5 pp 567-571

SAUNDERS, N. K., LEWIS, P., and THORNHILL, A., 2019. Research Methods for Business Students, 8th Edn. London: Pearson Education.

SAVVY, WILLING AND ABLE, 2013. The Biopsychosocial Model Explained. [online]. Available from: https://savvywillingandable.wordpress.com/2013/09/25/the-biopsychosocial-model-explained/ [Accessed 14 April 2019].

SAYAL, K. et al., 2018. ADHD in children and young people: prevalence, care pathways, and service provision. *The lancet. Psychiatry*, *5*(2), 175–186. https://doi.org/10.1016/S2215-0366(17)30167-0

SCHAUFELI, W. B., and SALANOVA, M. 2007., Efficacy or inefficacy, that's the question: burnout and work engagement, and their relationships with efficacy beliefs. *Anxiety, stress, and coping*, *20*(2), 177–196. https://doi.org/10.1080/10615800701217878

SCOTT, E. 2020. Explanatory Styles and Their Role in Stress. VeryWellMind. Available from: Explanatory Styles and Their Role in Stress (verywellmind.com)

SCOTT, E., 2023. How Chronic Stress Impacts Your Health. VeryWellMind. Available from: Chronic Stress: Symptoms, Causes, Treatment, Coping (verywellmind.com)

SCOTTISH FUNDING COUNCIL. 2020. Institutional Gender Action Plan Guidance 2020-23 [online] Available from: https://www.sfc.ac.uk/publications-statistics/guidance/2020/SFCGD012020.aspx

SCOTTISH GOVERNMENT, 2016. *National Indicator: Improve Mental Wellbeing.* [online]. Available from: http://www.gov.scot/About/Performance/scotPerforms/indicator/wellbeing

SCOTTISH GOVERNMENT, 2020. Scottish Index Of Multiple Deprivation (SIMD). Scottish Index of Multiple Deprivation 2020 - gov.scot (www.gov.scot)

SCOTTISH GOVERNMENT HEALTH SURVEY, 2020. Scottish Health Survey – telephone survey – August/September 2020: main report - gov.scot (www.gov.scot)

SCOTTISH HEALTH SURVEY, 2022. The Scottish Health Survey 2022 – volume 1: main report. [Accessed 01 May 2024] Available from The Scottish Health Survey 2022 – volume 1: main report - gov.scot (www.gov.scot)

SOCIAL CARE INSTITUTE FOR EXCELLENCE (SCIE), 2015. Co-Production in Social Care: What it is and How to do it. Viewed Jan 2021. Co-production in social care: What it is and how to do it - Guide home (scie.org.uk)

SCOTTISH HEALTH SURVEY, 2021. The Scottish Health Survey 2021 - Volume 1: Main Report (www.gov.scot)

SCOTPHO PUBLIC HEALTH OBSERVATORY, 2017. *Suicide Summary.* [online]. Available from: https://www.isdscotland.org/Health-Topics/Public-Health/Publications/2017-08-02/2017-08-02-Suicide-Summary.pdf . [Accessed 4 April 2019].

SELIGMAN, M.E. 2004. Authentic happiness: using the new positive psychology to realize your potential for lasting fulfilment: Simon and Schuster; 2004.

SELIGMAN, M. E. P., 2011. Flourish: A visionary new understanding of happiness and well-being. Free Press.

SELIGMAN, M. 2018., PERMA and the building blocks of well-being, The Journal of Positive Psychology, DOI: 10.1080/17439760.2018.1437466

SEYMOUR, E., and HEWITT, N. M., 1997. Talking about leaving: Why undergraduates leave the sciences. Boulder, Colo: Westview Press.

SEYMOUR, E., and HUNTER, A.B., 2019. Talking about leaving revisited. Springer International Publishing. DOI: 10.1007/978-3-030-25304-2

SHACKLE, S., 2019. The way universities are run is making us ill: inside the student mental health crisis. 'The way universities are run is making us ill': inside the student mental health crisis | Mental health | The Guardian

SHAN, Y., 2021. Philosophical foundations of mixed methods research. Philosophy Compass, 17(1), e12804. https://doi.org/10.1111/phc3.12804

SHEEDY, C . 2022. Why engineers need to keep a close eye on their mental health. Create, 2022. Available from: Why engineers need to keep a close eye on their mental health - Create (createdigital.org.au)

SIDDIQUI, N.A., FATIMA, S., TAJ, F.B., SHAHID, A., and MOOSA, Z.A. 2020. Depression among undergraduate medical and engineering students: A comparative study. Pak J Med Sci. 2020;36(5):1096-1099. doi: https://doi.org/10.12669/pjms.36.5.1858et al., 2020. Depression among undergraduate medical and engineering students: A comparative study. Pak J Med Sci. 2020;36(5):1096-1099. doi: https://doi.org/10.12669/pjms.36.5.1858

SKROMANIS, S. et al., 2018. Health and Well-Being of International University Students, and Comparison with Domestic Students, in Tasmania, Australia. *International Journal of Environmental Research and Public Health.* 15: 1147. DOI: 10.3390/ijerph15061147

SOLMI M., RADUA, J., OLIVOLA, M. *et al.* Age at onset of mental disorders worldwide: large-scale meta-analysis of 192 epidemiological studies. *Mol Psychiatry* **27**, 281–295 (2022). https://doi.org/10.1038/s41380-021-01161-7

SON, J., and WILSON, J. 2012. Volunteer Work and Hedonic, Eudemonic, and Social Well-Being. *Sociological Forum*, *27*(3), 658–681. http://www.jstor.org/stable/23262183

SORBY,S., FORTENBERRY, N.L. and BERTOLINE, G. 2021. Stuck in 1955, Engineering Education Needs a Revolution. [online] Available from: Revolutionizing Engineering Education | Issues in Science and Technology

SORENSEN, S., 2014. Models of Mental Health and Disorder. [online]. Available from: https://stuartsorensen.files.wordpress.com/2014/09/the-care-guy-models-of-mental-health-and-disorder.png [Accessed 14 April 2019].

SORRELL, K., 2013. Pragmatism and moral progress: John Dewey's theory of social inquiry. *Philosophy and Social Criticism*, *39*(8), 809–824. https://doi.org/10.1177/0191453713494967

SRIVASTAVA, A. and THOMSON, S.B., 2009. Framework Analysis: A Qualitative Methodology for Applied Policy Research. Journal of Administration and Governance, 4, 72-79.

ST. GEORGE'S UNIVERSITY OF LONDON. 2023. Performing Qualitative Interviews Using Microsoft Teams. [online] Available from: Performing Qualitative Interviews Using Microsoft Teams (sgul.ac.uk)

STAIGER, T., STIAWA, M., MUELLER-STIERLIN, A.S., et al., 2020. Masculinity and Help-Seeking Among Men With Depression: A Qualitative Study. Front. Psychiatry 11:599039. doi: 10.3389/fpsyt.2020.599039

STANGROOM, J. 2023. Social Science Statistics. [online] Available from https://www.socscistatistics.com/tests/chisquare2/default2.aspx

STEFURAK, T, JOHNSON, R.B, and SHATTO, E., 2015. 'Mixed Methods and Dialectical Pluralism', in Leonard A. Jason, and David S. Glenwick (eds), Handbook of Methodological Approaches to Community-Based Research: Qualitative, Quantitative, and Mixed Methods

(New York, 2015; online edn, Oxford Academic, 1 Jan. 2016), https://doi.org/10.1093/med:psych/9780190243654.003.0034, accessed 22 June 2023.

STEVENS, S. 2023. Holism in Gestalt Psychology and Gestalt Therapy. [online]. Available from: Holism in Gestalt Psychology and Gestalt Therapy — Gestalt Therapy Blog

STERLING, M. 2011., General Health Questionnaire – 28 (GHQ-28). Journal of Physiotherapy. Vol. 57, Issue 4. https://doi.org/10.1016/S1836-9553(11)70060-1

STEWART-BROWN, S. et al., 2009. Internal construct validity of the Warwick-Edinburgh Mental Well-being Scale (WEMWBS): a Rasch analysis using data from the Scottish Health Education Population Survey. Health Qual Life Outcomes 7, 15 (2009). https://doi.org/10.1186/1477-7525-7-15

STOLL, L., MICHAELSON, J. and SEAFORD, C., 2012. Well-being evidence for policy: a review. New Economics Foundation, London. Well-being evidence for policy: A review | New Economics Foundation

STORRIE, K., AHERN, K., and TUCKETT, A., 2010. A systematic review: Students with mental health problems—A growing problem. Int J Nurs Pract 2010; 16: 1–6 [online]. Available from: https://onlinelibrary.wiley.com/doi/full/10.1111/j.1440-172X.2009.01813.x [Accessed 1 April 2019].

STUDENT MINDS, 2023. Student Minds Research Briefing – February ’23. [online] Available from: PowerPoint Presentation (studentminds.org.uk)

STURGIS, P., 2015. *An Introduction to Survey Research Methods*, Sage Video. [Streaming Video] London: Sage Publications Ltd. Available at: <https://doi.org/10.4135/9781473930131 & gt; [Accessed 10 Jul 2023].

SU, C., 2015. The effects of students' motivation, cognitive load and learning anxiety in gamification software engineering education: a structural equation modeling study. *Multimedia*

Tools and Applications. 75: 10013-10036. The effects of students' motivation, cognitive load and learning anxiety in gamification software engineering education: a structural equation modeling study | SpringerLink

SULDO, S. et al., 2008. Looking Beyond Psychopathology: The Dual-Factor Model of Mental Health in Youth. *School Psychology Review*. 37. [online]. Available from: https://www.researchgate.net/publication/228656864_Looking_beyond_psychopathology_The_dual-factor_model_of_mental_health_in_youth [Accessed 13 April 2019].

SUN, Y. et al., 2013. The Research on Negative Perfectionism Personality of Engineering Students from the Perspective of Game Theory. *The 19th International Conference on Industrial Engineering and Engineering Management.* [online]. Available from: https://link.springer.com/chapter/10.1007/978-3-642-37270-4_28 [Accessed 1 April 2019].

SWANNELL, C., 2016. Network Committed to Healthy Unis*. Medical Journal of Australia*. 204(7):C1 https://www.mja.com.au/journal/2016/204/7/network-committed-healthy-unis

SZAJNFARBER, Z. and GRALLA, E. 2017. Qualitative methods for engineering systems: Why we need them and how to use them. System Engineering. 2017; 20: 497–511. https://doi.org/10.1002/sys.21412

TABASSUM, F., MOHAN, J., and SMITH, P. 2016. Association of volunteering with mental well-being: a lifecourse analysis of a national population-based longitudinal study in the UK.

BMJ Open 2016;**6:**e011327. doi: 10.1136/bmjopen-2016-011327

TACKE, A., 2022. Self-Inefficacy: A Big Burnout Monster We Need To Overcome. CISCO Blogs Self-Inefficacy: A Big Burnout Monster We Need To Overcome (cisco.com)

TAIT, J., 2019. Time to Reflect on the Wellbeing of our Engineers. [online]. Available from: https://epc.ac.uk/guest-blog-time-to-reflect-on-the-wellbeing-of-our-engineers/

TAIT, J.E. et al., 2020. The Mental Wellbeing of Engineering Students [Internet]. *Open Science Framework*. https://osf.io/z3jxr/?view_only=9284abb885b94ef59e3a5d8d07565b45

TAIT, J.E. et al., 2022. Interventions to support the mental health and wellbeing of engineering students: A scoping review. Preprint. https://doi.org/10.35542/osf.io/msvqt

TAIT, J.E. et al., 2023. Interventions to support the mental health and wellbeing of engineering students: a scoping review. European journal of engineering education [online], (accepted). To be made available from: https://doi.org/10.1080/03043797.2023.2217658

TARABRINA, N., GRABOVSKAYA, E., TIKHONOV, A., and KRAEV, Y., 2020. Psychological Features of the Personality of Students of Different Specialties. International Journal of Higher Education. 9. 152. 10.5430/ijhe.v9n3p152.

TARIQ, S., and WOODMAN, J. 2013. Using mixed methods in health research. *JRSM Short Reports*. 2013;4(6). doi:10.1177/2042533313479197

TENNANT, R. et al., 2007. The Warwick-Edinburgh Mental Well-being Scale (WEMWBS): Development and UK Validation. *Health and Quality of Life Outcomes.* [online]. Available from: https://hqlo.biomedcentral.com/articles/10.1186/1477-7525-5-63 [Accessed 03 November 2020].

THINK STUDENT, 2020. The 10 Hardest University Degrees in the UK – Ranked for 2023. The 10 Hardest University Degrees in the UK - Ranked for 2023 (thinkstudent.co.uk)

THORLEY, C., 2017. Not By Degrees: Improving Student Mental Health in the UK's Universities. *Institute for Public Policy Research.* [online]. Available from: https://www.ippr.org/publications/not-by-degrees

THE MICHIGAN DAILY, 2014. *College of Engineering addresses mental health through event*. [online]. Available from: https://www.michigandaily.com/news/college-engineering-addresses-mental-health-through-event

TOOFAN, K., 2021. Are Engineers Underappreciated? 6 Reasons They Are. Are Engineers Underappreciated? 6 Reasons They Are | Engineer Calcs

TRAGODARA, K.S.C., 2021. Virtual tutoring from the comprehensive training model to Engineering students during the COVID-19 pandemic. 2021 IEEE World Conference on Engineering Education (EDUNINE), 2021, pp. 1-6, doi: 10.1109/EDUNINE51952.2021.9429115.

TREVELYAN, J. 2015. Why is it so hard to change engineering education? Online. Available from: Why is it so hard to change engineering education? « THE MAKING OF AN EXPERT ENGINEER (jamesptrevelyan.com)

TRICCO, A.C. et al., 2018. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Annals of Internal Medicine.* 69(7):467-473. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation - PubMed (nih.gov)

TROUTMAN, J., RILEY, D. R., and MALLOUK, K., 2022. Visualizing Stress and Relief: How stressors and coping mechanisms interact in engineering graduate student experiences. ASEE Annual Conference and Exposition, Conference Proceedings.

TURNER, A.P. et al., 2007. Coventry University Students' Experience of Mental Health Problems. *Counselling Psychology Quarterly.* 20:3, 247-252. [online]. Available from: https://pureportal.coventry.ac.uk/en/publications/coventry-university-students-experience-of-mental-health-problems-2

TURNER, D. 2020. Reflexive journals in qualitative research. Quirkos. [online] Available from: Reflexive journals in qualitative research (quirkos.com)

TWEHUES, A. 2013. Success and the Balance of Commitment and Time: Effects of

Perceived Time Management Control on College Student Performance. [online] Available from: https://encompass.eku.edu/cgi/viewcontent.cgi?article=1147&context=honors_theses

UKCES (UK Commission for Employment and Skills). 2016. Working Futures 2014-2024. Cambridge Econometrics and Warwick Institute for Employment Research. [online] Available from Working Futures, 2014-2024 (warwick.ac.uk)

UK GOVERNMENT, 2022. Gaps in University Mental Health Services to be Tackled. Online. Available from: Gaps in student mental health services to be tackled - GOV.UK (www.gov.uk)

UKRI (UK Research and Innovation). 2023. Consent. [online] Available from: Consent – UKRI

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP), 2018. Human Development Indices Indicators. 2018 Statistical Update. [online]. Available from: http://hdr.undp.org/sites/default/files/2018_statistical_annex.pdf

UUK (UNIVERSITIES UK), 2015. Student mental wellbeing in higher education: Good practice guide. https://www.universitiesuk.ac.uk/policy-and-analysis/reports/Documents/2015/student-mental-wellbeing-in-he.pdf

UUK (UNIVERSITIES UK), 2020. Stepchange: Mentally Health Universities. Online. Stepchange: mentally healthy universities (universitiesuk.ac.uk)

UNIVERSITY COLLEGE LONDON (UCL), 2020. Health and Wellbeing Strategy 2019-2021. https://www.ucl.ac.uk/students/sites/students/files/ucl_student_health_and_wellbeing_strategy_2019-2021_final.pdf

UNIVERSITY MENTAL HEALTH CHARTER, 2022. Together for Thriving Futures. Online. Available from: University Mental Health Charter

VATS, N. and SHARMA, A., 2017. Engineering Students Suffer from the Top Mental Health Problems and Challenges. *Journal of Advances and Scholarly Researches in Allied Education.* Engineering Students Suffer from the Top Mental Health Problems and Challenges - Ignited Minds Journals

VENTERS, N., 2018. The past, present and future of innovation in mental health. NHS Digital Blog. The past, present and future of innovation in mental health - NHS Digital

VENTURA, M. et al., 2014. Professional Self-Efficacy as a Predictor of Burnout and Engagement: The Role of Challenge and Hindrance Demands. The Journal of Psychology Interdisciplinary and Applied. 1-26. 10.1080/00223980.2013.876380.

VINJE, H.F., LANGELAND, E., and BULL, T., 2017. Aaron Antonovsky's Development of Salutogenesis, 1979 to 1994. In: , *et al.* The Handbook of Salutogenesis. Springer, Cham. https://doi.org/10.1007/978-3-319-04600-6_4

VITASARI, P. et al., 2010. A pilot study of pre- post anxiety treatment to improve academic performance for engineering students. *Procedia Social and Behavioral Sciences*. 15: 3826–3830. DOI: 10.1016/j.sbspro.2011.04.380

VITASARI, P et al., 2011. The Relationship between Study Anxiety and Academic Performance among Engineering Students. *Procedia Social and Behavioral Sciences*. 8: 490-497. The Relationship between Study Anxiety and Academic Performance among Engineering Students - ScienceDirect

VOLTMER, E., KÖSLICH-STRUMANN, S., WALTHER, A. et al., 2021. The impact of the COVID-19 pandemic on stress, mental health and coping behavior in German University students – a longitudinal study before and after the onset of the pandemic. *BMC Public Health* **21**, 1385 (2021). https://doi.org/10.1186/s12889-021-11295-6

WADEY, K., 2010. Explanatory Style: Methods of Measurement and Research Findings. [online] Available from Explanatory Style: Methods of Measurement and Research Findings (positivepsychology.org.uk)

WAGHACHAVARE, V.B. et al., 2013. A Study of Stress Among Students of Professional Colleges from an Urban Area in India. *Sultan Qaboos University Medical Journal.* Vol 13. [online]. Available from:

https://www.researchgate.net/publication/256190282_A_Study_of_Stress_among_Students_of_Professional_Colleges_from_an_Urban_area_in_India

WALTON G.M. et al., 2015. Two Brief Interventions to Mitigate a “Chilly Climate” Transform Women’s Experience, Relationships, and Achievement in Engineering. *Journal of Educational Psychology*, 2015; 107 (2):468–485. Two Brief Interventions to Mitigate a Chilly Climate

WANG, L. et al., 2022. Moderating Effect of Gender and Engineering Identity on the Association between Interpersonal Relationships and Mental Health of Female Engineering Students. Int J Environ Res Public Health. 2022 Aug 21;19(16):10425. doi: 10.3390/ijerph191610425. PMID: 36012062; PMCID: PMC9408545.

WANG, X., ZHANG, D., and WANG, J.L., 2011. Dual-Factor Model of Mental Health: Surpass the Traditional Mental Health Model. Psychology. 2. 10.4236/psych.2011.28117.

WARWICK MEDICAL SCHOOL, 2021a. The Warwick Edinburgh Mental Wellbeing Scale. [online]. Available from: About WEMWBS (warwick.ac.uk)

WARWICK MEDICAL SCHOOL, 2021b. Collect, Score, and Analyse WEMWBS. Collect, score, analyse and interpret WEMWBS (warwick.ac.uk)

WARWICK MEDICAL SCHOOL, 2022. What is the Warwick Edinburgh Mental Wellbeing Scale? The Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS)

WEALE, S. 2023. Parents outline ‘woeful’ mental health support for students at UK universities | Education | The Guardian

WEISBERG, H. 2008. The methodological strengths and weaknesses of survey research. SAGE Publications Ltd, https://doi.org/10.4135/9781848607910

WHATNALL, M.C. et al., 2019. Lifestyle behaviors and related health risk factors in a sample of Australian university students. *Journal of American College Health*. 1-8. https://pubmed.ncbi.nlm.nih.gov/31140957/

WHITE, M., 2009. The Industrial Revolution. British Library. [online] The Industrial Revolution | The British Library (bl.uk)

WHITE, R. 2013. Why so Rude? Packet Pushers. Online. Available from: Why so Rude? - Packet Pushers

WHITWER, M., WILSON, S., and HAMMER, J. 2023. "Engineering Student Mental Health and Help Seeking: Analysis of National Data from the Healthy Minds Study," in 2023 IEEE Frontiers in Education Conference (FIE), College Station, TX, USA, 2023 pp. 1-7.

doi: 10.1109/FIE58773.2023.10343045

WILKINS, K., SIMPSON, A., and SPARKS, P., 2019. Persisting Despite the Odds: Resilience and Coping Among Women in Engineering. 25. 353-368. 10.1615/JWomenMinorScienEng.2019026945.

WILKINS-YEL, K.G., ARNOLD, A., BEKKI, J. et al., 2022. “I can't push off my own Mental Health”: Chilly STEM Climates, Mental Health, and STEM Persistence among Black, Latina, and White Graduate Women. Sex Roles 86, 208–232 (2022). https://doi.org/10.1007/s11199-021-01262-1

WILKINSON, M. 2023. With an ‘epidemic[‘ of poor mental health, what can universities to help? Times Higher Education. Campus. 6th Jan 2023. Available from: What universities can do to support staff mental health | THE Campus Learn, Share, Connect (timeshighereducation.com)

WILSON, M. et al., 2015. Topic Report: Mental Health and Wellbeing. *The Scottish Health Survey.* Available from: http://www.gov.scot/Resource/0046/00469088.pdf

WILSON, S., and GOLDBERG, D., 2023. Strategies for Supporting Engineering Student Mental Health. Chemical Engineering Education. Vol. 57. No. 2. (2023): Spring 2023. https://doi.org/10.18260/2-1-370.660-132290

WIJNGAARDS, I., BURGER, M., and VAN EXEL, J. 2019. The promise of open survey questions-The validation of text-based job satisfaction measures. PLoS One. 2019 Dec 26;14(12):e0226408. doi: 10.1371/journal.pone.0226408. Erratum in: PLoS One. 2020 Jul 23;15(7):e0236900. PMID: 31877156; PMCID: PMC6932814

WOLFF, K., and BOOYSEN, M.J., 2019. The smart engineering curriculum. Available from (PDF) The smart engineering curriculum (researchgate.net)

WONG, P. T. P., 2021. Two Different Models of Human Flourishing: Seligman's PERMA Model Versus Wong's Self-transcendence Model. Dr. Paul T. P. Wong. Online. Available from: http://www.drpaulwong.com/two-different-models-of-human-flourishing-seligmans-perma-model-versus-wongs-self-transcendence-model/

WORLD ECONOMIC FORUM, 2022. How Universities Can Support Student Mental Health and Wellbeing. How universities support student mental health and wellbeing | World Economic Forum (weforum.org)

WORLD HEALTH ORGANISATION (WHO), 2004. Promoting Mental Health: Concepts, Emerging Evidence, Practice. [online]. Available from: https://www.who.int/mental_health/publications/promoting_mh_2005/en/ [Accessed 1 April 2019].

WORLD HEALTH ORGANIZATION (WHO), 2001. Basic documents. 43rd Edition. Geneva, *World Health Organization*. WHO | BASIC DOCUMENTS

WORLD HEALTH ORGANISATION (WHO), 2019. Definition of Mental Health. [online]. Available from: https://www.who.int/features/factfiles/mental_health/en/ [Accessed 1 April 2019]

WORLD HEALTH ORGANIZATION (WHO), 2022. Mental Health. Mental health (who.int)

WORLD SCHOLARS HUB, 2022. Top 10 Hardest Engineering Courses in the World. Top 10 Hardest Engineering Courses in the World (worldscholarshub.com)

WORSLEY, J., PENNINGTON, A., and CORCORAN, R., 2020. What interventions improve college and university students' mental health and wellbeing? A review of review-level evidence. *What Works Wellbeing.* https://whatworkswellbeing.org/wp-content/uploads/2020/03/Student-mental-health-full-review.pdf

WORSLEY, J.D., PENNINGTON, A., and CORCORAN, R. 2022. Supporting mental health and wellbeing of university and college students: A systematic review of review-level evidence of interventions. PLoS One. 2022 Jul 29;17(7):e0266725. doi: 10.1371/journal.pone.0266725. PMID: 35905058; PMCID: PMC9337666.).

WRIGHT, T, 2022. The UK's Engineer Shortage. Available from: The UK's engineer shortage - what you need to know - Quantum (quantumsas.com)

WRIGHT, C.J., HARGIS, L.E., USHER, E.L., HAMMER, J.H., et al., 2021. *Identifying Engineering Students' Beliefs About Seeking Help for Mental Health Concerns* Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. https://peer.asee.org/37269

WRIGHT, C. J., WILSON, S. A., HAMMER, J. H., HARGIS, L. E., et al. 2023. Mental health in undergraduate engineering students: Identifying facilitators and barriers to seeking help. *Journal of Engineering Education*, 1–24. https://doi.org/10.1002/jee.20551

WU, M.J., ZHAO, K. and FILS-AIME, F., 2022. Response rates of online surveys in published research: A meta-analysis. *Computers in Human Behavior Reports*, *7*, p.100206.

XIAO, R., ZHANG, C., LAI, Q., et al., 2021. Applicability of the Dual-Factor Model of Mental Health in the Mental Health Screening of Chinese College Students. Front Psychol. 2021 Jan 18;11:549036. doi: 10.3389/fpsyg.2020.549036. PMID: 33584399; PMCID: PMC7874216.

YANGDON, K. SHERAB, K. CHOEZOM, P, PASSANG, S, and DEKI, S. 2021. Well-being and academic workload: Perceptions of Science and technology students. 2021. Educational Research and Revies. Vol. 16 (11), pp. 418-427. DOI: 105897/ERR2021.4197

YANIK, P.M. et al., 2016. Sources of Anxiety among Engineering Students: Assessment and Mitigation. *ASEE Annual Conference and Exposition*, LA, USA. Sources of Anxiety among Engineering Students: Assessment and Mitigation American Society for Engineering Education (asee.org)

YAP, J., 2018. The Declining State of Student Mental Health in Universities and What Can Be Done. *Mental Health Foundation.* [online]. Available from:

https://www.mentalhealth.org.uk/blog/declining-state-student-mental-health-universities-and-what-can-be-done [Accessed 22 April 2019].

YERBO, 2022. State of Burnout in Tech 2022. https://report.yerbo.co/

YOUSEF, O., GRUNFELD, E., and HUNTER, M. 2015. A Systematic Review of the Factors Associated with Delays in Medical and Psychological Help-Seeking Among Men. *Health Psychology Review.* [online].

Available from: https://researchportal.bath.ac.uk/en/publications/a-systematic-review-of-the-factors-associated-with-delays-in-medi [Accessed 19t September 2023].

YUPANQUI-LORENZO, D., OLIVERA-CARHUAZ, E., REYNAGA ALPONTE, A. et al., 2023. Explanatory Model on Academic Self-Efficacy in Engineering Students: Role of Anxiety, Dysthymia, and Negative Affect. International Journal of Engineering Pedagogy (iJEP). 13. 91-103. 10.3991/ijep.v13i5.38577.

ZABIN, R., BOSACKI, S., and NOVAK, J., 2022. The Role of Emotional Intelligence in Ontario International Graduate Students: An Auto-Ethnography. *Journal of Comparative and International Higher Education*, *14*(4), 37–52. https://doi.org/10.32674/jcihe.v14i4.3425

ZAWEDDE, A. et al., 2010. Methodological Pluralism: An Emerging Paradigmatic Approach to Information Systems Research.

ZHOU, T. et al., 2022. Intolerance of uncertainty and future career anxiety among Chinese undergraduate students during COVID-19 perios: Fear of COVID-19 and depression as mediators. Front. Public Health, 29 November 2022. Sec. Public Mental Health Vol. 10-2022 https://doi.org/10.3389/fpubh.2022.1015446

ZIOLKOWSKI, T., 1984. “The Existential Anxieties of Engineering.” The American Scholar, vol. 53, no. 2, 1984, pp. 197–218. JSTOR, http://www.jstor.org/stable/41211029

Appendices

Appendix 1 Scoping Review Protocol

TAIT, J., ALEXANDER, L., HANCOCK, E. and BISSET, J. 2022. The mental wellbeing of engineering students: a scoping review protocol. [Protocol]. Hosted on OSF [online]. Available from: https://doi.org/10.17605/OSF.IO/Z3JXR

The mental wellbeing of engineering students: a scoping review protocol. [Protocol]

TAIT, J., ALEXANDER, L., HANCOCK, E. and BISSET, J.

2022

The Mental Wellbeing of Engineering Students: A Scoping Review Protocol Authors

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Introduction

The mental wellbeing (MW) of higher education students is a subject that has increased in visibility in recent years. In 2010, a systematic review looking at mental health in students worldwide highlighted that student mental health is poorer than the general population.[1] In a UK survey, 20% of students considered themselves to have poor MW with 13% reporting suicidal thoughts, and 92% identifying as having had feelings of mental distress.[2] The survey also highlighted that students generally do not disclose mental health issues with their institutions with 80% reporting stigma as a barrier[2]. In a report for the Royal College of Psychiatrists in 2011 it was noted that the time when the risk of development or onset of schizophrenia or bipolar disorder is highest is also the time when it is likely young adults are entering higher education[3]. The report discussed the high risk that young adults face in potentially developing a serious mental illness. Incidence of schizophrenia in males is significantly higher than in females.[3,4] In a recent publication by the Scottish Public Health Observatory in 2015,[5] the suicide rate for males in Scotland was more than two and a half times than that for females. In the UK in 2018 the male suicide rate was more than three times higher than for females, with 17.2 male deaths per 100,000 compared with 5.4 female deaths per 100,000[6]. Results from studies in 2007,[7] and 2016,[8] demonstrated only 36% of students screening positive for major depression had received treatment. Both studies highlighted that the perception that student stress is "normal" is a barrier to help-seeking.

Engineering degree programmes are challenging and competitive in nature with a male-skewed gender balance. The majority of engineering students are young adult males with nearly 85% of engineering undergraduates identified as men in the UK. In Australia, it is 84.4% , Canada 86.3%, USA 81.3% . and EU 72.6%.[9],[10]. In addition to the published research related to the mental health and wellbeing of young adult men, it has also been reported that female engineering students report poorer mental wellbeing than their male counterparts.[13] There is a global shortage of engineers,[11,12] and while the reasons for this are as yet not clear, mental wellbeing can impact on student attainment and so calls for education reform are beginning to grow.[12]

Before carrying out a systematic review to identify the effectiveness of interventions for mental wellbeing in engineering students, it is important to identify existing research in this area. A scoping review to map the available evidence of mental wellbeing in engineering students should therefore be carried out. An initial search of the JBI Database of Systematic Reviews and Implementation Reports, Prospero and Cochrane Library have not identified any systematic reviews or protocols on this topic area. Considering the lack of mapping of existing research, it is appropriate that a systematic scoping review is conducted on this topic. A systematic scoping review would potentially highlight key themes relating to the mental wellbeing of engineering students.[13]

Considering the evidence available for students as a population indicates higher risk of mental ill health, the challenging nature of engineering courses and the majority of the engineering student population being a higher risk group (male, aged 18-25) and the minority population reporting poorer mental health it is appropriate that a scoping review is conducted to map the evidence to support mental wellbeing in engineering students.

Review Question

What research has been conducted to support mental wellbeing in engineering student populations?

- What types of research studies have been conducted to support wellbeing in engineering populations?
- What mental wellbeing interventions have been carried out with engineering students?
- What outcomes have been reported for mental wellbeing interventions in engineering student populations?

Keywords

Engineering Students; Mental Wellbeing; Scoping Review Inclusion Criteria

Participants

The scoping review will consider studies that include participants over the age of 17 who are engineering students of any gender. The types of engineering student where possible will be categorised using the principal subject codes outlined by HESA14 (Higher Education Statistics Agency):

(H0) Broadly-based programmes within

engineering & technology

(H1) General engineering

(H2) Civil engineering

(H3) Mechanical engineering

(H4) Aerospace engineering

(H5) Naval architecture

(H6) Electronic & electrical engineering

(H7) Production & manufacturing engineering

(H8) Chemical, process & energy engineering

(H9) Others in engineering

The search strategy includes the term engineer in addition to “engineering

student” to ensure all available literature is identified. The focus of the review however is engineering students or student engineers and therefore papers only looking at professional engineers will be excluded.

Concept

To identify studies with a focus on mental wellbeing in the engineering student population. The focus of the protocol is on mental wellbeing rather than diagnosed mental illness therefore studies that focus on mental health illness will be excluded.

Context

The context of the review is within the engineering population in an academic setting i.e. university or college in any country.

Types of Sources

This scoping review will consider both experimental and quasi-experimental study designs including randomized controlled trials, non-randomized controlled trials, before and after studies and interrupted time-series studies. In addition, analytical observational studies including prospective and retrospective cohort studies, case-control studies and analytical cross-sectional studies will be considered for inclusion. This review will also consider descriptive observational study designs including case series, individual case reports and descriptive cross-sectional studies for inclusion.

Qualitative studies will also be considered that focus on qualitative data including, but not limited to, designs such as phenomenology, grounded theory, ethnography, qualitative description, action research and feminist research. In addition systematic reviews that meet the inclusion criteria will also be considered. Text and opinion papers will also be considered for inclusion in this scoping review in order to be fully inclusive.

Methods

Search Strategy

The proposed scoping review will be conducted in accordance with the Joanna Briggs Institute Reviewer's Manual methodology for scoping reviews utilizing a three-step search strategy.[13] An initial limited search of MEDLINE, CINAHL, JBI Evidence Synthesis and Cochrane Library was undertaken followed by analysis of the text words contained in the title and abstract and of the index terms used to describe the article. The following initial keywords were used: engineers or engineering students, and mental health.

The second step, using all identified keywords and index terms, was developed and will be undertaken across all included databases: Business Source Complete, CINAHL, Cochrane Library, Compendex, Emerald, Epistemonikos, EPPI Centre, ERIC, JBI Evidence Synthesis, MEDLINE, PsycARTICLES, Scopus, SocINDEX, and Web of Science. The final step will be screening of the reference lists of all included studies for additional studies. A full search strategy example for CINAHL is detailed in Appendix I.

A search of grey literature will be carried out on Google and Google Scholar, the British Library Thesis Index (EThOS), World Health Organization's library database (WHOLIS), ProQuest Digital Dissertations, OpenGrey, Royal Academy of Engineers, IEAust, NSPE and The Conference Papers Index. A modified search using the terms “engineers AND mental health” and “engineering students AND mental health” will be applied to grey literature sources.

Studies published in English will be included. A lack of funding to support translation prevents the inclusion of studies in other languages. Studies published since inception will be included as this search has not been carried out before and earlier publications may still hold relevance.

Study Selection

Following the search, all identified citations will be collated and uploaded into REFWORKS (ProQuest) and duplicates removed. All sources of evidence retrieved will then be uploaded to Covidence to facilitate screening. Titles and abstracts will be screened by two independent reviewers for assessment against the review inclusion criteria. Sources of evidence that meeting this criteria will then be retrieved in full and assessed in detail against the inclusion criteria independently by two reviewers. Full text studies that do not meet the inclusion criteria will be excluded and reasons for exclusion will be provided in an appendix in the final scoping review report. The results of the search will be reported in full in the final report and presented in a PRISMA flow diagram.[15] Any disagreements that arise between the reviewers will be resolved through discussion, or with a third reviewer.

Data Extraction

Data relevant to this review will be extracted from included sources of evidence by two independent reviewers using the standardized Joanna Briggs Institute data extraction tool.[14] The data extracted will include specific details about the population, concept, context, study methods and key findings relevant to the review objectives such as interventions (including delivery method, content, frequency, length, who delivers) and outcomes. A draft charting table is provided (see Appendix 2).

The draft data extraction tool will be modified and revised as necessary during the process of extracting data from each included study. Any modifications will be detailed in the full scoping review report. Any disagreements that arise between the reviewers will be resolved through discussion, or with a third reviewer. Authors of papers will be contacted to request missing or additional data, where required. As per Scoping review methods, no critical appraisal of included sources of evidence will be conducted in this review.[13]

Data Presentation

The extracted data will be presented visually in diagrammatic or tabular form in a manner aligning with the objective of this scoping review. A narrative summary will accompany the tabulated and/or charted results and will describe how the results relate to the review's objective and questions.

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The authors declare no conflict of interest.

References

1. Storrie K, Ahern K, Tuckett A. A systematic review: Students with mental health problems—A growing problem. Int J Nurs Pract 2010; 16: 1–6 [internet] 2010 January [cited 2020 May 12].

Available from: https://onlinelibrary.wiley.com/doi/full/10.1111/j.1440- 172X.2009.01813.x

2. National Union of Students, Scotland. Silently Stressed: A Survey info Student Mental Wellbeing [Internet] 2010 November [cited 2020 May 12] Available from: https://www.nus.org.uk/PageFiles/12238/THINK-POS- REPORT-Final.pdf

3. Royal College of Psychiatrists. Mental Health of Students in Higher Education. College Report CR166 The Mental Health of Students in Higher Education [Internet] 2011 September. Royal College of Psychiatrists. [Internet] 2011. [cited 2020 May 12] Available from: https://www.rcpsych.ac.uk/publications/collegereports/cr/cr166.aspx

4. McGrath, J. Variations in the Incidence of Schizophrenia: Data Versus Dogma, Schizophrenia Bulletin, Volume 32, Issue 1, 2006, Pages 195–197

5. SCOTPHO PUBLIC HEALTH OBSERVATORY., 2019. Suicide: Key Points

[Internet] 2019 [cited 2020 May 12] Available from: http://www.scotpho.org.uk/health-wellbeing-anddisease/suicide/key- points.

6. Office for National Statistics., Suicides in the UK- Office for National Statistics - 2018 Registrations. [Internet] 2019 September [cited 2020 May 12] Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsand marriages/deaths/bulletins/suicidesintheunitedkingdom/2018registrations

7. Eisenberg, D., Golberstein, E., & Gollust, S. E., 2007. Help-seeking and access to mental health care in a university student population. Medical Care, 45(7), 594-601.

8. Laidlaw ,A., McLellan, J., and Ozakinci, G., 2016. Understanding Undergraduate Student Perceptions of Mental Health, Mental Well-being and Help-seeking Behaviour. Studies in Higher Education, 41:12, 2156- 2168

9. Peers, S. Statistics on Women in Engineering. Stevenage: The Women's Engineering Society, p.2.[Internet] 2018 January [cited 2020 May 12] Available from: http://www.wes.org.uk/sites/default/files/2018-01/Women%20in%20Engineering%20Statistics%20-

%20January%202018%20-%20created%20by%20Sarah%20Peers_0.pdf

10. Catalyst, Quick Take: Women in Science, Technology, Engineering, and Mathematics (STEM) [Internet] 2019 June (cited 2020 May 12). Available from: https://www.catalyst.org/knowledge/women-science-technology- engineering-and-mathematics-stem

11. Pozniak, H. The Great UK Engineering Shortage. [Internet] 2017 June [cited 2020 May 12] Available from: https://www.telegraph.co.uk/education/stem-awards/energy/the-great- uk-engineering-shortage/

12. Donelly, M. Shortage of Engineers Could Restrict Global Growth. [Internet] 2018 March [Cited 2020 May 12] Available from: https://www.fircroft.com/blogs/shortage-of-engineers-could-restrict- global-growth-88829181061

13. Peters MDJ, Godfrey C, McInerney P, Munn Z, Tricco AC, Khalil, H. Chapter 11: Scoping Reviews (2020 version). In: Aromataris E, Munn Z (Editors). Joanna Briggs Institute Reviewer's Manual, JBI, 2020. Available from https://reviewersmanual.joannabriggs.org/

14. Higher Education Statistics Agency. http://www.hesa.ac.uk [internet] 2013 [cited 2020 May 1]. Available from: https://www.hesa.ac.uk/support/documentation/jacs/jacs3-principal

15. BMJ (OPEN ACCESS) Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, et al. (2009) The PRISMA Statement for Reporting Systematic Reviews and Meta-Analyses of Studies That Evaluate Health Care Interventions: Explanation and Elaboration. BMJ 2009;339:b2700, doi: 10.1136/bmj.b2700

Appendix 2 Scoping Search Strategy

All searches were conducted on databases via EBSCoHost in January 2019, 2020, and March 2022

CINAHL

1, (TX "Engineers") AND ((MH "Mental Health") OR TX “wellbeing”)

2, (TX "Engineers") AND (TX "Anxiety")

3, (TX "Engineers") AND (TX "depression OR “depressive disorder” OR “depressive symptoms” OR “major depressive disorder")

4, (TX "Engineers") AND (TX “self-esteem” OR “self-concept” OR “self-worth” OR “self-evaluation” OR “self-perception”)

5, (TX "Engineers") AND (TX “Stress”)

6, (TX ("Engineering Students") AND ((MH "Mental Health") OR TX “wellbeing”)

7, (TX "Engineering Students") AND (TX "Anxiety")

8, (TX "Engineering Students") AND (TX “depression” OR “depressive disorder” OR “depressive symptoms” OR “major depressive disorder”)

9, (TX "Engineering Students") AND (TX “self-esteem” OR “self-concept” OR “self-worth” OR “self-evaluation” OR “self-perception”)

10, (TX "engineering Students") AND (TX “Stress”)

11, #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10

12, limit to English language, Age: Young Adulthood (18-29); Thirties (30-39); Forties (40-49); Adulthood (18 years and older)

Medline:

TX "Engineers" AND TX,MH "Mental Health" OR TX Wellbeing

TX "Engineers" AND TX "Anxiety"

TX "Engineers" AND TX ("depression” OR “depressive disorder” OR “depressive symptoms” OR “major depressive disorder")

TX "Engineers" AND TX (“self-esteem” OR “self-concept” OR “self-worth” OR “self-evaluation” OR “self-perception”)

TX "Engineers" AND TX “stress”

TX "Engineering Students" AND (TX,MH "Mental Health" OR TX ”Wellbeing”)

TX "Engineering Students" AND TX "Anxiety"

TX "Engineering Students" AND TX (“depression” OR “depressive disorder” OR “depressive symptoms” OR “major depressive disorder”)

TX "Engineering Students" AND TX (“self-esteem” OR “self-concept” OR “self-worth” OR “self-evaluation” OR “self-perception”)

TX "Engineering Students" AND TX “stress”

#1 OR #2 OR’ #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10

Limits: Adolescence (13-18 years–to capture data on young students at university); Adult (19-44 years); Middle Aged + Aged (45+ years)

PsycARTICLES

TX "Engineers" AND MH "Mental Health"

TX "Engineers" AND MH "Anxiety"

TX "Engineers" AND TX, MH ("depression” OR “depressive disorder” OR “depressive symptoms” OR “major depressive disorder"

TX "Engineers" AND TX, MH (“self-esteem” OR “self-concept” OR “self-worth” OR “self-evaluation” OR “self-perception”

TX "Engineers" AND TX, MH “Stress”

TX "Engineering Students" AND MH "Mental Health"

TX "Engineering Students" AND MH "Anxiety"

TX "Engineering Students" AND TX, MH (“depression” OR “depressive disorder” OR “depressive symptoms” OR “major depressive disorder”

TX "Engineering Students" AND TX, MH (“self-esteem” OR “self-concept” OR “self-worth” OR “self-evaluation” OR “self-perception”

TX "Engineering Students" AND TX, MH “Stress”

#1 OR #2 OR’ #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10

Adolescence (13-18 years – to capture data on young students at university); Adult (19-44 years); Middle Aged + Aged (45+ years)

Business Source Complete:

AB “Engineers" AND AB "Mental Health"

AB "Engineers" AND AB "Anxiety"

AB "Engineers" AND AB ("depression” OR “depressive disorder” OR “depressive symptoms” OR “major depressive disorder")

AB "Engineers" AND AB (“self-esteem” OR “self-concept” OR “self-worth” OR “self-evaluation” OR “self-perception”)

AB "Engineers" AND AB “Stress”

AB "Engineering Students" AND AB "Mental Health"

AB "Engineering Students" AND AB "Anxiety"

AB "Engineering Students" AND AB (“depression” OR “depressive disorder” OR “depressive symptoms” OR “major depressive disorder”)

AB "Engineering Students" AND AB (“self-esteem” OR “self-concept” OR “self-worth” OR “self-evaluation” OR “self-perception”)

AB “Engineering Students" AND AB “Stress”

#1 OR #2 OR’ #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10

Cochrane Register of Controlled Trials and Systematic Reviews

"Engineers" AND "Mental Health"

"Engineers" AND "Anxiety"

"Engineers" AND "depression” OR “depressive disorder” OR “depressive symptoms” OR “major depressive disorder"

"Engineers" AND “self-esteem” OR “self-concept” OR “self-worth” OR “self-evaluation” OR “self-perception”

"Engineers" AND “Stress”

"Engineering Students" AND "Mental Health"

"Engineering Students" AND "Anxiety"

"Engineering Students" AND “depression” OR “depressive disorder” OR “depressive symptoms” OR “major depressive disorder”

"Engineering Students" AND “self-esteem” OR “self-concept” OR “self-worth” OR “self-evaluation” OR “self-perception”

"Engineering Students" AND “Stress”

#1 OR #2 OR’ #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10

Compendex

AB "Engineers" AND AB "Mental Health"

AB "Engineers" AND AB "Anxiety"

TX "Engineers" AND TX "depression" OR "depressive disorder" OR "depressive symptoms" OR "major depressive disorder"

AB "Engineers" AND AB "self-esteem" OR "self-concept" OR "self-worth" OR "self-evaluation" OR "self-perception"

AB "Engineers" AND AB "Stress"

AB "Engineering Students" AND AB "Mental Health"

AB "Engineering Students" AND AB "Anxiety"

TX "Engineering Students" AND TX "depression" OR "depressive disorder" OR "depressive symptoms" OR "major depressive disorder"

TX "Engineering Students" AND TX "self-esteem" OR "self-concept" OR "self-worth" OR "self-evaluation" OR "self-perception"

TX "Engineering Students" AND TX "Stress"

#1 OR #2 OR' #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10

Emerald

AB "Engineers" AND Anywhere ("Mental Health")

AB "Engineers" AND Anywhere "Anxiety"

AB "Engineers" AND Anywhere ("depression" OR "depressive disorder" OR "depressive symptoms" OR "major depressive disorder")

AB "Engineers" AND Anywhere ("self-esteem" OR "self-concept" OR "self-worth" OR "self-evaluation" OR "self-perception")

AB "Engineers" AND Anywhere "Stress"

AB "Engineering Students" AND Anywhere "Mental Health"

AB "Engineering Students" AND Anywhere "Anxiety"

AB "Engineering Students" AND Anywhere ("depression" OR "depressive disorder" OR "depressive symptoms" OR "major depressive disorder")

AB "Engineering Students" AND Anywhere ("self-esteem" OR "self-concept" OR "self-worth" OR "self-evaluation" OR "self-perception")

AB "Engineering Students" AND Anywhere “Stress”

#1 OR #2 OR’ #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10

Epistemonikos

"Engineers" AND "Mental Health"

"Engineers" AND "Anxiety"

"Engineers" AND ("depression” OR “depressive disorder” OR “depressive symptoms” OR “major depressive disorder")

"Engineers" AND (“self-esteem” OR “self-concept” OR “self-worth” OR “self-evaluation” OR “self-perception”)

"Engineers" AND “Stress”

"Engineering Students" AND "Mental Health"

"Engineering Students" AND "Anxiety"

"Engineering Students" AND (“depression” OR “depressive disorder” OR “depressive symptoms” OR “major depressive disorder”)

"Engineering Students" AND (“self-esteem” OR “self-concept” OR “self-worth” OR “self-evaluation” OR “self-perception”)

"Engineering Students" AND “Stress”

#1 OR #2 OR’ #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10

ERIC

1. TX "Engineers" OR “Engineering students” AND TX "Mental Health"

2. TX "Engineers" OR “Engineering Students” AND TX "Anxiety"

3. TX "Engineers" OR “Engineering students” AND TX "depression” OR “depressive disorder” OR “depressive symptoms” OR “major depressive disorder"

4 TX "Engineers" OR “Engineering students” AND TX “self-esteem” OR “self-concept” OR “self-worth” OR “self-evaluation” OR “self-perception”

5. TX "Engineers" OR “Engineering students” AND TX “Stress”

6. #1 OR #2 OR’ #3 OR #4 OR #5

JBI Evidence Synthesis:

1. "Engineers" AND "Mental Health"

2. "Engineers" AND "Anxiety"

3. "Engineers" AND ("depression" OR "depressive disorder" OR "depressive symptoms" OR "major depressive disorder")

4. "Engineers" AND ("self-esteem" or self-concept" OR "self-worth" OR "self-evaluation" OR "self-perception")

5. "Engineers" AND Stress

6. "Engineering Students" AND "Mental Health"

7. "Engineering Students" AND "Anxiety"

8. "Engineering Students" AND ("depression" OR "depressive disorder" OR "depressive symptoms" OR "major depressive disorder"

9. "Engineering Students" AND ("self-esteem" OR "self-concept" OR "self-worth" OR "self-evaluation" OR "self-perception")

10. "Engineering Students" AND "Stress"

11. #1 OR #2 OR' #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10

Scopus

1."Engineers" AND "Mental Health"

2. "Engineers" AND "Stress"

3. "Engineers" AND "Anxiety"

4. "Engineers" AND "Depression"

5. "Engineers" AND "Self-esteem"

6. "Engineering Students" AND "Mental Health"

7. "Engineering Students" AND "Stress"

8. "Engineering Students" AND "Anxiety"

9. "Engineering Students" AND "Depression"

10. "Engineering Students" AND "Self-esteem"

11. #1 OR #2 OR' #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10

SocINDEX

1.TX "Engineers" AND TX "Mental Health"

2. TX "Engineers" AND TX "Anxiety"

3. TX "Engineers" AND TX ("depression” OR “depressive disorder” OR “depressive symptoms” OR “major depressive disorder")

4. TX "Engineers" AND TX (“self-esteem” OR “self-concept” OR “self-worth” OR “self-evaluation” OR “self-perception”)

5. TX "Engineers" AND TX “stress”

6. TX "Engineering Students" AND TX "Mental Health"

7. TX "Engineering Students" AND TX "Anxiety"

Appendix 3 Characteristics of Included Sources

Cat* = Category: Ed = Educational, Psy =Psychological, Phys= Physiologcal

Source	Author	Title	Study Type	Intervention	Cat*	N	Outcome Measures	Results	Conclusions
1	Abiade & Moliski, 2020, USA	Work in Progress: Identity and transitions laboratory: Utilizing acceptance and commitment therapy framework to support engineering student success	Pilot	6-week program (Identity and Transitions Laboratory) including information on Acceptance and Commitment Therapy, imposter syndrome, stress management, and identifying signs of a mental or emotional disorder.	Ed	Cohort 1 n=33 Cohort 2 n=27	Written feedback, follow-up survey, grades, and retention. Cohort 2 anonymous feedback, 3 end of program assessments and follow-up survey.	Improvement in GPA, other results ongoing	Positive responses and improved GPA indicate the program is helpful, authors will continue to monitor both cohorts.
2	Altun, 2008, Turkey	Effect of a health promotion course on health promoting behaviours of university students	Quasi experimental non-equivalent pilot	15-week course which included 30â€…h of classroom lectures, group discussions, and demonstrations â€“ included definition and purpose of health promotion, concepts of health promotion, disease, lifestyle, stress management.	Ed	41	Exercise of Self-care agency scale and Health Promotion Lifestyle Profile II Scale	Statistically significant improvement in health responsibility and health promoting behaviours on both scales. ESCA increase statistically significant suggesting increased self-care abilities.	Course was beneficial to students as it helped improve self-care behaviour. Health promotion courses should be more widely used. Recommended that this type of course becomes a part of curriculum.
3	Aree et al. 2020, Thailand	An approach for mental preparation for first-year college students: A case study of engineering students	Case Study/Pilot	3-hour mindfulness training course	Psy	44	Survey	Improvement in knowledge, and decrease in anxiety and depression	Stress management through medication/mindfulness could reduce anxiety in engineering students.
4	Berger, Lampe, & Caruccio, 2015, USA	Just-in-time support: An evidence-based academic-student affairs partnership to enable engineering student success	Pilot	New partnership fully contextualised to engineering and located within the engineering school providing academic and pastoral support. This was different from the standard centralised services	Psy	Cohort 1: n=152, Cohort 2: n=114, Cohort 3: n=31,	Data from handwritten notes at staff meetings where student situations discussed, student demographics (gender, academic major) & academic outcomes â€“ progress towards graduation	Outcomes achieved by students in different Cohorts were 'similar or improved'. Physical location and training in engineering issues key to providing support. Merging support benefited students in terms of success rates (graduation). Women better served by the new model in particular African American women.	Bringing student support services into a School of Engineering can improve achievement rates and may benefit women and women of colour in particular most.

5	d'Entremont et al. 2019 Canada	Student Mental Wellbeing Interventions with a Second-Year Engineering Cohort	Pilot	1 information session, 1 reflection exercises based on a video about stress, 1 workshop on stress and stress reduction methods, deployed consecutively over a term.	Ed	18	4 surveys (including MSLQ, Academic Buoyancy) analysis of reflection responses, preâ€“post intervention surveys	8/18 respondents felt wellness interventions had a positive effect on their student experience, 4/8 indicated interventions provided tools to deal with stress. 8/18 felt interventions were not helpful. Anecdotally, faculty and staff saw a decrease in number of visits from students in emotional distress.	Good preliminary evidence that the intervention helped to dampen the effects that entering the program has on wellbeing.
6	Eren-Sisman, Cigdemoglu, & Geban 2018 USA	The effect of peer-led team learning on undergraduate engineering studentsâ€™ conceptual understanding, state anxiety, and social anxiety	Experimental	Introduction of peer-led team learning. Control group: instructed using traditional college instruction. Experimental group: instructed using the PLTL model.	Ed	128	General Chemistry Concept Test, State Trait Anxiety Inventory, Social Anxiety Questionnaire for Adults	PLTL approach had significant effect on performance (not as much as was expected) but STAI was significantly improved in the PLTL group. Social anxiety was not affected and remained high in both groups.	Model may be helpful in improving learning and alleviating state anxiety. It was not as effective in reducing social anxiety when compared to traditional college instruction.
7	Estrada & Dalton, 2019 USA	Impact of Student Mindfulness Facets on Engineering Education Outcomes: An Initial Exploration	Pilot	4-week mindfulness-based stress reduction intervention	Psy	21	Survey â€“ Five Facet Mindfulness Questionnaire (FFMQ) and ABET Outcomes	Significantly increased engineering students' trait mindfulness, engagement in mindfulness outside of sessions and intellectual curiosity and exploration but not perceived stress	Supports the feasibility of further mindfulness-based intervention for engineering students.
8	Grasty et al. 2021 USA	Benefits of Utilizing Counseling Services Among Doctoral Women of Color in STEM	Case Study	Impact of Counselling services	Psy	1	Interview data	Engineering student continued studies and felt counselling contributed to this. The benefit of feeling heard was noted and counselling helped to set boundaries and improve interpersonal skills	Counselling proved effective for this student.
9	Huerta 2021 USA	Inner engineering: Evaluating the utility of mindfulness training to cultivate intrapersonal and interpersonal competencies among first-year engineering students	Pilot	4-session mindfulness-based program	Psy	35	Survey and Interview data	Improvements in confidence and reduced anxiety.	Mindfulness training can support self-efficacy and improve aspects of mental wellbeing.
10	Johnson-Glauch, Cooper & Harding 2020 USA	Goal setting as a means of improved mental health outcomes for materials and mechanical engineering students	Pilot	Pilot mental health action plan assignment	Psy	27	Pre and post surveys including a 17-item validated self-efficacy instrument, content analysis of the action plans and of the free text areas on the survey	No statistically significant difference in self-efficacy overall. Those with large gains had scored low initially.	Result suggests that these types of assignments may preferentially benefit students with low self-efficacy.

11	Joshi & Kiran 2020 India	Gauging the effectiveness of music and yoga for reducing stress among engineering students: An investigation based on Galvanic Skin Response	Experi mental	Experimental group underwent yogic breathing and listening to religious and flute music. The Control group did not.	Physl, Psy	123	Skin conductivity	Experimental group reported reduction in mean value in Galvanic Skin Response (GSR) from deep yogic breathing, listened to religious hymns and listening to flute music.	Listening to flute music emerged from these three drills as the most effective stimulus for stress management.
12	Joshi, Kiran, & Sah 2017a, India	An Experimental Analysis to Monitor and Manage Stress Among Engineering Students Using Galvanic Stress Response Meter	Experi mental	Experimental group listened to hymns, the Control group did not.	Psy	471	Skin conductivity	Statistically significant improvement in skin conductivity post session for both the control and the experimental group. Results reflected yogic breathing had a significant effect on skin conductivity.	Deep breathing techniques can reduce skin conductivity and in turn stress levels of engineering students. Basic yogic breathing could be included in core curriculum to reduce and manage stress among engineering students.
13	Joshi, Kiran, & Sah, 2017b, India	Stress monitoring through non-invasive instrumental analysis of skin conductivity	Experi mental	Experimental group underwent yogic breathing, the Control group did not.	Phys	400	Skin conductivity	Statistically significant increase in GSR for the control group after 300 s ($p < 0.01$), whereas significant reduction ($p < 0.01$) in GSR after listening to hymns in the experimental group.	Listening to hymns could provide a strategy to manage stress in educational institutions for student with high levels of self-reported stress
14	Joshi et al. 2016, India	Stress management through regulation of blood pressure among college students	Experi mental	Experimental group carried out deep breathing	Phys	400	Blood pressure	Deep breathing technique had a statistically significant reduction on systolic and diastolic blood pressure in engineering students with high academic stress.	Deep breathing techniques could be beneficial in improving students learning and efficiency.
15	Khan, Poole, & Beaton, 2018, Canada	Measuring the Impact of a Weeklong Fall Break on Stress Physiology in First Year Engineering Students	Pilot	A weeklong break during 1st semester, intervention group and control group (Same intervention as 27)	Ed (see 27)	16	DHEA levels in saliva measuring cortisol	Students without a break had marginally higher cortisol and DHEA levels. Engineering students that did not have a break (control group) had slightly greater output of cortisol to DHEA than those that experienced time away from school (experimental group).	A break may be helpful in reducing stress, but the sample size was small and more research needed
16	Lal et al. 2019 Canada	Effect of Dispositional Mindfulness on Perceived Stress Scores of Engineering Students: An Empirical Study	Experi mental	Meditation	Psyl	100	Perceived stress scale [PSS] and Mindfulness Attention Awareness Scale [MAAS] was administered on both groups of students.	Significant decreases in stress perception level among those students who are practicing meditations and high level of stress perception level among those who are not practicing any techniques to cope with stress respectively.	Meditation showed promise in reducing stress among college students.

17	Maxson & Tomasko, 2020 USA	Supporting the Mental Health and Wellness of Chemical Engineering Students at the Department and College Levels June 2020	Experimental	Introduction of a Wellness Committee with a number of activities aiming to improve mental wellbeing	Ed		Questionnaires and academic performance	Improved MH and MW awareness, improved pastoral skills, improved perception	Publication is a work in progress, but the overall intervention has been received positively
18	Mazumder, 2012 USA	Improvement of Confidence and Motivation Using Online Metacognition Tool	Case Study	Metacognition-based software Lecture Tools (http://www.lecturetools.com) providing interactive environment for the students.	Ed	Phase 1 –23 Phase 2 - 32	Engagement and feedback	Interaction positively contributed to students paying more attention. Increased interactions resulted in higher exam scores. Communication apprehension reduced. Use of interactive technology followed by group discussions and class assignments greatly enhanced students' comprehension of scientific facts and their ability to explain them.	Interactive software in modules may help with motivation and communication apprehension. Increased interactions improved their level of understanding of the subject matter, which resulted in higher exam scores. It is possible that clarification and further understanding of any questions could have resulted from the group discussion and not necessarily from the use of technology.
19	Miller et al.2021 USA	WIP: Supporting Student Mental Health: Understanding the Use of Biometrics Analysis in an Engineering Design Project to Promote Wellness	Pilot	16 mindfulness sessions after online lessons	Psy	20	Course evaluation	20 students that participated self-reported improved relaxation as a benefit.	Mindfulness training embedded in a design project may benefit students' wellbeing.
20	Miller & Jensen, 2020 USA	Introduction of Mindfulness in an Online Engineering Core Course During the COVID-19 Pandemic	Pilot	A design exercise for students focusing on the measurement of physiological changes through mindfulness. (same intervention as 21)	Ed (see 21)	62	Surveys	Positive responses to the addition of mindfulness activities.	Introduction of wellness activities may promote cultures of student wellness.
21	Miller et al. 2022 USA	Development and Implementation of a Biometrics Device Design Project in an Introductory BME Course to Support Student Wellness.	Pilot	Introduction of a biosensor project with experiments to reduce stress. (same intervention as 20)	Ed (see 20)		Pre &post survey and feedback	Students noted collecting their own biometric data was convincing of the effectiveness of wellness practices. Students noted the project applied engineering principles while also providing students with valuable life skills. At the end of the, 88% of students voted to continue meditating daily at the start of class.	Integration of wellness into the core curriculum can normalise the use of these resources in engineering departments and equip students with stress management tools for their careers.

22	Moran & Benson, 2016, Mexico	Effects of an intensive mathematics course on freshmen engineering studentsâ€™ mathematics anxiety perceptions	Pilot	Four-week maths course designed to standardise maths knowledge. Students met 5 x per week for 2â€…h duration to review basic maths knowledge. Completed 3 weekly tests and a final test at the end of week 4.	Ed	809	Items from the Mathematics Anxiety Rating Scale 30 and other items not relating to the paper pre and post.	Math anxiety increased after the 4-week course. Females reported higher anxiety than males. Gender, type of high school, and students' origin increased math anxiety for both math test and math activities. Math test anxiety was higher than math activities showing most of the stress is related to the tests. Math anxiety increase was significant for males and females but effects > for females post course ($p < 0.05$). Outcomes achieved across 3 cohorts were similar or improved	Fast-paced maths courses could increase anxiety levels and lead to maths avoidance and negative affective reactions performing maths activities. This may be more problematic for women engineering students. Significant increase in maths anxiety measurements from before to after an intensive course particularly for maths test anxiety. Females also experienced higher levels of maths test anxiety but not maths activities anxiety. Educators should therefore be aware of designing maths courses acknowledging the stress related to maths tests.
23	Nolte, Huff, and McComb, 2022, USA	No time for that? An investigation of mindfulness and stress in first-year engineering design	Pilot	First-year engineering design students completed three 30-minute experimental sessions during an engineering design course, where their stress and mindfulness during three principal stages of the design process were investigated. Each session consisted of a short video followed by a 10-minute design task.	Ed, Psy	80	Pre and post surveys including Toronto Mindfulness Scale, Short Stress State Questionnaire, modified NASA-RTLC, and author developed stress questions	Mindfulness-based video increased students decentreing overall, but effect is small. Written feedback: five students would do this type of activity again in the future or would like to incorporate more mindfulness into their lives. a mindfulness-based video did not noticeably impact perceived sources of stress during design tasks. Students' top perceived source of stress was time limitation.Overall, mindfulness-based body scan video increased students' decentreing. However, students' total TMS scores and curiosity were not affected.	Increase in students' state mindfulness was not found to have an observable impact on students' stress experience. Students were receptive to completing a mindfulness-based activity in-class and perceived multiple benefits. While students currently utilise many mechanisms for coping with task-induced stress, teaching engineering students mindfulness is still a promising avenue for helping students manage the stress of engineering and design.

24	Paniagua et al. 2019, Spain	Study of Binqui. An application for smartphones based on the problems without data methodology to reduce stress levels and improve academic performance of chemical engineering students		Use of gamification software for teaching. Group A: elements of gamification were incorporated into the teaching Group B: control group no gamification incorporated	Ed	82	Hamilton Anxiety Scale and academic performance	Using the app improved comfort and stress levels significantly. Academic results also showed improvement.	Reduction in perceived stress and improvement of academic performance showed the introduction of the PWD model app was beneficial to the course.
25	Paul et al. 2021 Canada	Impact of integrating mental wellness and personal learning reflections into first-year undergraduate engineering courses.	Pilot	A mental health promotion program integrated into the 1st year engineering curriculum (same intervention as 26)	Ed (see 26)		Analysis of feedback	Stress was a significant predictor of overall GPA after first year. Negative relationship between stress and overall GPA was buffered by resilience but enhanced by student engagement (i.e. resilient students seemed to manage stress better). Students also prioritise academics first and social life second, physical activity comes third, while mental health was mentioned least, it is also a factor to consider for responses from social wellness.	Personal reflection in the curriculum provided several benefits.
26	Paul et al.2020 Canada	The â€˜Engineers have feelingsâ€™ Project: Integrating Mental Wellness and Lifelong Learning Skills in First-Year Undergraduate Engineering Courses	Pilot	A mental health promotion program integrated into the 1st year engineering curriculum.	Ed (See 25)		End of year survey with additional wellness and identity validated scales	Students preferred shorter sessions, but there was acknowledgement this wasn't their top priority.	Study highlighted some benefits to incorporating concepts of student wellness and lifelong learning into the engineering curriculum. Further results will be reviewed in Paul et al. (Citation2021). (Ref 25)
27	Poole, Khan, and Agnew 2017 Canada	One Week, Many Ripples: Measuring the Impacts of the Fall Reading Week on Student Stress		A weeklong break during 1st semester with survey before and after and text message during. (Same intervention as 15)	Ed (see 15)	16	Survey (Perceived Stress Scale) and Focus Groups, and DHEA levels in saliva	Students with fall break demonstrated lower ratio of cortisol to DHEA after the break suggesting students with a break had less stress on their return to class ($p = 0.052$).	Break may be beneficial from stress hormones data, but these results are limited due to small sample size and no significant statistical effect.

28	Rodríguez-Jiménez 2022 Spain	Embodied Learning for Well-Being, Self-Awareness, and Stress Regulation: A Randomized Trial with Engineering Students Using a Mixed-Method Approach	Experi mental	A body awareness program based on Dance Movement Therapy Experimental. Group attended 10 sessions of 90â€…min twice a week.	Phys	37	Satisfaction with Life Scale SWLA, Perceived Stress Scale, the TECA (Cognitive and Affective Empathy Test), WHO-5, Body Awareness Questionnaire (BAG) Scale Body Connection, Heart Rate Viability. Saliva cortisol, D2 test (selective attention and mind concentration), RP 30 â€“ problem-solving cognitive abilities, reflective diary	Results showed improvements in stress levels, well-being, and life satisfaction, along with an increase in the levels of self-awareness and self-knowledge	Dedicating time and resources to interventions can help students to increase their level of awareness and health and generate healthier educational environments.
29	Su 2016 Taiwan	The effects of studentsâ€™ motivation, cognitive load and learning anxiety in gamification software engineering education: a structural equation modeling study	Pilot	Introduction of gamification software	Ed	107	Gamification Learning Scale, Learning Motivation Scale, Cognitive Load Scale, Learning Anxiety Scale, Academic Performance Scale	Software had significant positive effect on learning motivation, academic achievement, and decreased cognitive load. Decreased cognitive load associated with decreased learning anxiety. Decreased learning anxiety is associated with strong learning motivation.	Improvements to motivation cognitive load and learning anxiety were statistically significant and may be useful in course enhancement.
30	Tragodara 2021 Peru	Virtual tutoring from the comprehensive training model to Engineering students during the COVID-19 pandemic	Pilot	Online personal tutoring during Covid including positive psychology sessions, flow sessions	Psy	407	Interview data and questionnaires, attendance monitoring	Main demand of students related to the academic subject time management and study techniques. Main reason students requested counseling was anxiety, followed by demotivation.	Virtual tutoring supported the wellbeing of the students
31	Vitasari 2011 Malaysia	A pilot study of pre-post anxiety treatment to improve academic performance for engineering students	Pilot	6 sessions of treatment to include breathing exercises, relaxation, and study skills	Phys, Psy, Ed	6	BPM and GPA. Breath per minute measured using stress sweeper device.	Breath per minute significantly reduced post intervention, Grade Point Average improved but not statistically significant. Anxiety reduced significantly ($p < 0.05$).	Intervention was effective in reducing anxiety levels – but 6 sessions were not enough to significantly improve academic performance. Subjects improved GPA as compared to pretreatment.

32	Walton 2015 Canada	Two brief interventions to mitigate a “chilly climate”transform women's experience, relationships, and achievement in engineering	RCT	Intervention included social belonging intervention and affirmation training intervention	Psy	228	Pre-Intervention Survey â€“ belonging/confidence. Post â€“ GPA, diaries, survey	Both interventions raised women's engineering grade-point-average (GPA) eliminating gender differences. Both led women to view daily adversities as more manageable and improved women's academic attitudes. The 2 interventions had divergent effects on women's social experiences. Gender differences and intervention effects were concentrated in male-dominated majors (~20% women).	Results highlight how social marginalisation contributes to gender inequality in quantitative fields and 2 potential remedies. Social belonging intervention helped women integrate into engineering. Affirmation training helped women develop external resources, deepening their identification with their gender group.
33	Yanik 2016 USA	Sources of anxiety among engineering students: Assessment and mitigation	Pilot	Control group: cohort 1 study skills and cohorts 2 and 3 outcomes related to attention and effort.Periodic vertically integrated discussion groups with faculty mentors and their peers at multiple levels of seniority, introduced to university resources designed to address specific student needs.	Ed	27	Analysis of journals and discussions	Identified 3 themes: anxiety related to time management (procrastination and effect on work, having a balanced life with studies and other roles), anxiety related to success and completion of their degree (lack of confidence in academic ability, deficits in academic preparation) and anxiety related to life post-graduation (concerns about finding a job, uncertainty on ability for employer). Other sources in isolated cases included accumulation of debt, loneliness, and inability to take full advantage of opportunities available through the college experience. Group discussions had greatest perceived value, with time management practices, completion strategies and what comes after graduation of most benefit.	Reflection had a positive effect on students' understandings of the courses and possible remedies for commonly occurring anxieties. Activities were easily implemented and fostered both self-awareness among individuals and cohesion among the larger group.

Appendix 4 Scoping Excluded Sources

Studies ineligible following full text review (133)

Appendix 7: Studies ineligible following full text review (133)

Intervention not carried out (130)

1. Abhay B, Krishnakumar MK, Paul C, Shashidhar, G. Differences in perceived stress and its correlates among students in professional courses. *Journal of Clinical and Diagnostic Research*. 2012; 5: 1228-1233.

2. Adams RV, Blair E. Impact of Time Management Behaviors on Undergraduate Engineering Students' Performance. *SAGE Open*. 2019; Vol.9 (1).

3. Agrawal R, Chahar S. Examining role stress among technical students in India. *Social Psychology of Education*. 2007.

4. Al-Gamal E, Alzayyat A, Ahmad, M. Prevalence of Internet Addiction and its Association With Psychological Distress and Coping Strategies Among University Students in Jordan. *Perspectives in Psychiatric Care.* 2015; 52(1).

5. Al-Krenawi A, Graham J. Mental health help-seeking among Arab university students in Israel, differentiated by religion. *Mental Health Religion & Culture.* 2011; 14: p157-167. Available from:https://www.tandfonline.com/doi/abs/10.1080/13674670903454229

6. Alves M, Rodrigues C, Rocha A, Coutinho C. Self-efficacy, mathematics' anxiety and perceived importance: an empirical study with Portuguese engineering students. *European Journal of Engineering Education*. 2015; 41: 1-17. Available from: https://www.tandfonline.com/doi/abs/10.1080/03043797.2015.1095159?journalCode=ceee20

7. Ali A, Rao MH, Ali S, Ahmed T, Safi M, Malik A, Husan B. Prevalence of anxiety and depression and their associated risk factors among engineering students in Karachi, Pakistan. *International Journal of Emerging Technology and Advanced Engineering*, 2014; 4(9): 52–55. Available from: https://pdfs.semanticscholar.org/79d4/ea1bd4515ab8ac79d780da0b6a4a970f3fcf.pdf

8. Prakash A, Bajpai P. Stress among engineering students: Who are responsible. *Advances in psychology research*. 2015. Available from: https://www.researchgate.net/publication/281447289_Stress_among_engineering_students_Who_are_responsible

9. Barahmand U, Abolghasemi A, Jahanmohammadi S. Using Metacognitions to Identify Emotionally Vulnerable College Students. *American Journal of Health Behavior*. 2008; 32(6):604-13. Available from: https://www.researchgate.net/publication/5410739_Using_Metacognitions_to_Identify_Emotionally_Vulnerable_College_Students

10. Bayarsaikhan A. Engineering Undergraduate Wellness Survey. EUS Wellness Committee. 2018. Montreal, QB.

11. Bayram N, Bilgel N. The prevalence and socio-demographic correlations of depression, anxiety and stress among a group of university students. *Social Psychiatry and Psychiatric Epidemiology.* 2008; 43: 667-72. Available from: https://www.researchgate.net/publication/5453268_The_prevalence_and_socio-demographic_correlations_of_depression_anxiety_and_stress_among_a_group_of_university_students

12. Behere SP, Yadav R, Behere PB. A comparative study of stress among students of medicine, engineering, and nursing. *Indian Journal of Psychological Medicine.* 2011;33: 145–8.

13. Bellinger D, DeCaro M, Ralston P. Mindfulness, anxiety, and high-stakes mathematics performance in the laboratory and classroom. *Consciousness and Cognition*. 2015; 37: 123-132.

14. Bennet D, Male S. An Australian study of possible selves perceived by undergraduate engineering students, *European Journal of Engineering Education.* 2017; 42:6: 603-617.

15. Boles W, Whelan K. Barriers to student success in engineering education. *European Journal of Engineering Education*. 2016; 42: 1-14.

16. Bostanci M, Ozdel O, Oguzhanoglu N, Ozdel L, Ergin A, Ergin N, et al. Depressive Symptomatology among University Students in Denizli, Turkey: Prevalence and Sociodemographic Correlates. *Croatian Medical Journal*. 2005; 46: 96-100.

17. Bux I, Memon R.A, Sartaj S, Bhatti J, Gopang A.S, Muhammad N. Classroom Sources of English Language Anxiety: A Study of Fresh Engineering Students at Mehran UET, Pakistan. *International Journal of English Linguistics*. 2019; 9(2): 30-41.

18. Canadian Federation of Engineering Students. Student Mental Health and Workload. 2018. Available from: https://cfes.ca/wp-content/uploads/2018/04/EN-Student-Mental-Health-Workload.pdf

19. Carberry A.R. Work in progress — Assessing engineering service students' characteristics. IEEE Frontiers in Education Conference (FIE), Washington, DC, 2010; pp. T2D-1-T2D-3.

20. Cech EA, Waidzunas TJ, Farrell S. The inequality of LGBTQ students in U.S. Engineering education: Report on a study of eight engineering programs. *ASEE Annual Conference and Exposition, Conference Proceedings.* 2017; 107(4).

21. Chachra D, Kilgore D, Yasuhara K, Atman C. Exploring gender and self-confidence in engineering students: a multi-method approach. Paper presented at the *American Society for Engineering Education Annual Conference*. 2009.

22. Chasmar J. Connections between future time perspectives and self-regulated learning for mid-year engineering students: a multiple case study. *All Dissertations*. 2013. Available from: https://tigerprints.clemson.edu/all_dissertations/2013

23. Cheng K.C. Future Time Perspective, Socio-Emotional Regulation, and Diurnal Cortisol Patterns in Post-Secondary Engineering Students. 2017. *Arizona State University*. Arizona, USA.

24. Collins A, Frankenhaeuser M. Stress responses in male and female engineering students. *Journal of Human Stress*. 1978;4(2):43-48.

25. Concannon J.P, Serota S.B, Fitzpatrick M.R, Brown P.L. How Interests, self-efficacy, and self-regulation impacted six undergraduate pre-engineering students' persistence. *European Journal of Engineering Education*. 2019; 44:4, 484-503.

26. Cook S. Mental Health Report of Engineering undergraduates at the University of Cambridge. 2017. Available from: https://medium.com/@sineadcook/mental-health-report-of-engineering-undergraduates-at-the-university-of-cambridge-88b6cff5e66d

27. Crocker J, Karpinski A, Quinn D, Chase S. When Grades Determine Self-Worth: Consequences of Contingent Self-Worth for Male and Female Engineering and Psychology Majors. *Journal of personality and social psychology*. 2003; 85: 507-16.

28. Cross S, Vick N. The Interdependent Self-Construal and Social Support: The Case of Persistence in Engineering. *Personality and Social Psychology Bulletin*. 2001; 27: 820-832.

29. Danowitz Andrew, Beddoes K. Characterizing mental health and wellness in students across engineering disciplines. *Collaborative Network for Engineering and Computing Diversity*. Conference. 2018. Available from: https://www.researchgate.net/publication/325022546_Characterizing_Mental_Health_and_Wellness_in_Students_Across_Engineering_Disciplines

30. Danowitz A, Benson B, Callenes J, Hummel P. (2018). Differences in Mental Health between Students in a Jointly Offered Computer Engineering Program and the two Home Departments. IEEE Frontiers in Education. Conference. 2018; 1: 1-5.

31. De Souza M, Lemkuhl I, Bastos J. Discrimination and common mental disorders of undergraduate students of the Universidade Federal de Santa Catarina. *Revista Brasileira de Epidemiologia*. 2015; 18: 525-37.

32. Dehing Fons, Jochems W, Baartman L.K.J. Development of an engineering identity in the engineering curriculum in Dutch higher education: An exploratory study from the teaching staff perspective. *European Journal of Engineering Education*. 2013; 38(1): 1-10.

33. Deziel M, Olawo D, Truchon L, Golab L. (2013). Analyzing the Mental Health of Engineering Students using Classification and Regression. *EDM.* Conference. 2013; 228-231.

34. Dixit S. Meaning and Explanations of Mental Illness: A Social Representations Approach. *Psychology & Developing Societies*. 2005; 17: 1-18.

35. Dolenc B, Sprah L, Dernovšek M, Akiskal K, Akiskal H. Psychometric properties of the Slovenian version of temperament evaluation of Memphis, Pisa, Paris, and San Diego-Autoquestionnaire (TEMPS-A): Temperament profiles in Slovenian university students. *Journal of affective disorders*. 2013; 144(3): 253-62.

36. Einarson MK, Santiago AM. Background Characteristics as Predictors of Academic Self-Confidence and Academic Self-Efficacy among Graduate Science and Engineering Students: An Exploration of Gender and Ethnic Differences. *AIR* 1996 Annual Forum Paper. 1996. Available from: https://files.eric.ed.gov/fulltext/ED397706.pdf

37. El Ansari W, Labeeb S, Moseley L, Kotb S, El-Houfey A. Physical and Psychological Well-being of University Students: Survey of Eleven Faculties in Egypt. *International journal of preventive medicine.* 2013; 4: 293-310.

38. Ercan I, Irgil E, Sigirli D, Ozen NS, Kan I. Evaluation of anxiety among medical and engineering students by factor analysis. *Studia Psychologica*. 2008; 50(3):267-275.

39. Eschenbach EA, Virnoche M, Cashman EM, Lord SM and Camacho MM. Proven practices that can reduce stereotype threat in engineering education: A literature review. Proven practices that can reduce stereotype threat in engineering education: A literature review. *44th Annual Frontiers in Education Conference, FIE* 2014.

40. Felder RM, et al. Gender Differences in Student Performance and Attitudes. A Longitudinal Study of Engineering Student Performance and Retention. North Carolina State University. 1994. Report No. NCSU-94A.

41. Firouzian F, Fadaei M, Ismail Z, Firouzian S, Yusof YM. Relationship of mathematics anxiety and mathematics confidence among engineering students. *Advanced Science Letters.* 2015; 21(7):2400-2403.

42. Foong LM, Ahmad RJ. Mind matters: An approach to increase understanding of mental illness among the engineering students. *ARPN Journal of Engineering and Applied Sciences.* 2016; 11(24):14121-14124.

43. Gerardi S. Academic self-concept as a predictor of academic success among minority and low-socioeconomic status students. *Journal of College Student Development.* 1990; 31(5): 402–407.

44. Gomati P.T.S, Settu N, Rajasekhara B.M, Deepa S.P. Internet addiction: Prevalence among engineering students and its impact on academic performance. *International Journal of Pharmacy and Technology.* 2016; 8(3):18149-18158.

45. Goodwin ME. Reinventing the first-year seminar and student support programs to decrease the number of failed grades in the first semester and to reach a 90 percent first-year retention rate. Reinventing the first-year seminar and student support programs to decrease the number of

failed grades in the first semester and to reach a 90 percent first-year retention rate. *ASEE Annual Conference and Exposition, Conference Proceedings*; 2017.

46. 6208) Groen C, Simmons DR, Turner M. Developing Resilience: Experiencing and Managing Stress in a US Undergraduate Construction Program. *Journal of Professional Issues in Engineering Education and Practice.* 2019; 145(2).

47. Hackett G, Betz NE, Casas JM, Rocha-Singh I. Gender, ethnicity, and social cognitive factors predicting the academic achievement of students in engineering. *Journal of Counseling Psychology.* 1992; 39(4): 527-538.

48. Han S, Lee, S, Choi W, Kim S, Park S, Lee SY. Depression and its influencing factors among Korean medical and engineering students in urban areas using Zung Self-Rating Depression Scale. *Korean Journal of Family Medicine.* 2009; 30(7): 539-548.

49. Herawan T, Vitasari P, Abdullah Z. Mining critical least association rules of student suffering language and social anxieties. *International Journal of Continuing Engineering Education and Life-Long Learning.* 2013; 23(2): 128-146.

50. Hirshfield LJ, Chachra D. Comparing the Impact of Project Experiences across the Engineering Curriculum. *International Journal of Research in Education and Science.* 2019; 5(2): 468-487.

51. Hsieh P, Sullivan JR, Sass DA, Guerra NS. Undergraduate Engineering Students' Beliefs, Coping Strategies, and Academic Performance: An Evaluation of Theoretical Models. *Journal of Experimental Education.* 2012; 80(2): 196-218.

52. Huerta MV. Inner engineering: A convergent mixed methods study evaluating the use of contemplative practices to promote resilience among Freshman engineering students. Inner engineering: A convergent mixed methods study evaluating the use of contemplative practices to promote resilience among Freshman engineering students. *ASEE Annual Conference and Exposition, Conference Proceedings*; 2018.

53. Husman J, Cheng KC, Puruhito K and Fishman EJ. Understanding engineering students stress and emotions during an introductory engineering course. Understanding engineering students stress and emotions during an introductory engineering course. *ASEE Annual Conference and Exposition, Conference Proceedings*.

54. Ibrahim A, Kelly S, Glazebrook C. Socioeconomic status and the risk of depression among UK higher education students. *Social psychiatry and psychiatric epidemiology*. 2013; 48(9):1491-1501.

55. Ramteke P.V, Ansari R.J. Stress and Anxiety Among First Year and Final Year Engineering Students. *International Journal of Advanced Research in Education & Technology (IJARET).* 2016; Vol. 3, Issue 4: 17-21. Available from: https://www.ijaret.com/vol-3-issue-4/

56. Jamil SJ, Saad S, Jaafar WNW and Abdullah N. An of investigation of mathematics anxiety among diploma engineering students. *3rd International Congress on Engineering Education: Rethinking Engineering Education, The Way Forward, ICEED*. 2011;180-183.

57. Jensen K, Cross KJ. Work in progress: Understanding student perceptions of stress as part of engineering culture. ASEE Annual Conference and Exposition, Conference Proceedings. 2018 Jun 23;2018-June.

58. Jing Ling TAY, XIA XS, TAN CLR, Yuanrong QU, LOH CJ, Ying LAU, et al. Evaluating predicting factors of psychological well-being among university and polytechnic students. *Singapore Nursing Journal.* 2018; 45(1):2-12.

59. Jones BD, Ruff C, Paretti MC. The impact of engineering identification and stereotypes on undergraduate women's achievement and persistence in engineering. *Social Psychology of Education.* 2013; 16(3):471-493.

60. Kotter T, Tautphaus Y, Scherer M, Voltmer E. Health-promoting factors in medical students and students of science, technology, engineering, and mathematics: design and baseline results of a comparative longitudinal study. *BMC Medical Education.* 2014; 14:134-134.

61. Karthikeson PS, Jagannathan N. Dimensions of stress amongst students of various professional courses-a questionnaire based study. *Journal of Pharmaceutical Sciences and Research.* 2016; 8(8):888-891.

62. Ketchen Lipson S, Zhou S, Wagner B, Beck K, Eisenberg D. Major Differences: Variations in Undergraduate and Graduate Student Mental Health and Treatment Utilization Across Academic Disciplines. *Journal of College Student Psychotherapy*. 2016; 30: 23-41.

63. Khosravizadeh P, Bahrami A, Torabi F. Computer Anxiety and Foreign Language Classroom Anxiety among Male and Female Engineering Students. *Modern Journal of Language Teaching Methods.* 2017; 7(12):300-306.

64. Kumar K, Chaturvedi, R. An empirical study of social support, stress and life satisfaction among engineering graduates: mediating role of perceived work/study life balance. International Journal of Happiness and Development. 2018; 4. 25-39.

65. Kumar S, Bhukar J.P. *Journal of Physical Education and Sports Management.* 2013; Vol. 4(1): pp. 5-11.

66. Leahy CM, Peterson RF, Wilson IG, Newbury JW, Tonkin AL, Turnbull D. Distress levels and self-reported treatment rates for medicine, law, psychology and mechanical engineering tertiary students: cross-sectional study. *Australian & New Zealand Journal of Psychiatry.* 2010; 44(7):608-615.

67. Lee MF, Wan Adam WMH. A comparison study of methods to solve the mental health problem between the engineering and non-engineering students. A comparison study of methods to solve the mental health problem between the engineering and non-engineering students. *2016 International Conference on Industrial Engineering and Engineering Management, IEEM.*

68. Lee W, Lunsford D. Communication apprehension in undergraduate engineering students: The influence of performing arts participation. Communication apprehension in undergraduate

engineering students: The influence of performing arts participation. *ASEE Annual Conference and Exposition, Conference Proceedings*; 2007.

69. Leppavirta J. The impact of mathematics anxiety on the performance of students of electromagnetics. *Journal of Engineering Education.* 2011; 100(3): 424-443.

70. Levere KM, Kahlon PK. Investigating mathematics anxiety over time in university engineering students. *International Journal of Learning, Teaching and Educational Research.* 2019; 18(7): 51-69.

71. Lindsay, E. The relationship between first year engineering students' perceptions of workload and stress. Research in Engineering Education Symposium, REES 2009.

72. Lindsay, E.D. The impact of task value upon the stress and workload levels of first year engineering students. Engineering Education 2010: Inspiring the Next Generation of Engineers.

73. Liu Y.-Y, Snyder K, Ralston P.A. Changes in motivational beliefs among first-year engineering students: Relations to academic achievement and retention status. ASEE Annual Conference and Exposition, Conference Proceedings. 2015; 122.

74. Lynch P, Sangelkar S, Demeo G, Morkos B. The I-C-D-M methodology improving undergraduate engineering student motivation, satisfaction, and performance. IEEE Frontiers in Education Conference. 2017; 1-7.

75. MACASKILL A. The mental health of university students in the United Kingdom. *British Journal of Guidance and Counselling*, 2012; 41 (4): 426-441.

76. Madhusudan KS. A study on mobile-learning an innovative approach for a stress-free learning environment in engineering colleges in around Chennai. *International Journal of Innovative Technology and Exploring Engineering.* 2019; 8(5): 1031-1034.

77. Madhusudan KS, Harihara Sudhan R. In competencies among engineering students as an antecedents in stress among engineering students in around Chennai. *International Journal of Recent Technology and Engineering.* 2019; 8(1): 113-117.

78. Madhusudan KS, Varghese G, Vanitha. Social robots a strategic antidote for stress among engineering students in around Chennai. *International Journal of Recent Technology and Engineering.* 2019; 8(4): 2316-2319.

79. Martínez R, Salazar-Ramirez A, Arruti A, Irigoyen E, Martín JI, Muguerza J. A Self-Paced Relaxation Response Detection System Based on Galvanic Skin Response. *IEEE Access,* 2019; Vol 7: 43730-43741

80. Mayildurai R, Ashokkumar R, Karthik K, Shanmugaprakash M. Research on stress among the engineering college students in Coimbatore, India. *International Journal of Engineering and Advanced Technology.* 2019; 8(6): 73-75.

81. Mazloumiyan S, Akbari A.R, Rastegar A, Jahromi R. Comparing computer anxiety of humanistic, basic science, and technical and engineering students in the University of Tehran regarding gender. *Procedia - Social and Behavioral Sciences.* 2011; 30: 1246-1250.

82. McGee EO. Race, Identity, and Resilience: Black College Students Negotiating Success in Mathematics and Engineering. Dissertation. University of Illinois, USA. 2009.

83. McGee EO, Griffith DM, Houston S.II. "I Know I Have to Work Twice as Hard and Hope That Makes Me Good Enough": Exploring the Stress and Strain of Black Doctoral Students in Engineering and Computing. Teachers College Record. 2019; 121(4).

84. McGee EO, Martin DB. "You Would Not Believe What I Have to Go through to Prove My Intellectual Value!" Stereotype Management among Academically Successful Black Mathematics and Engineering Students. *American Educational Research Journal.* 2011; 48(6): 1347-1389.

85. Morocz R. J, Levy B, Forest C, Nagel R.L, Newstetter W.C, Talley K.G, Linsey J.S. Relating Student Participation in University Maker Spaces to their Engineering Design Self-Efficacy Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana. 2016.

86. Naveen S, Swapna M, Jayanthkumar K, Manjunatha S. Stress, anxiety and depression among students of selected medical and engineering colleges, Bangalore-a comparative study. *International Journal Of Public Mental Health And Neurosciences* 2015;2(2): 14-18.

87. Negi AS, Khanna A, Aggarwal R. Psychological health, stressors and coping mechanism of engineering students. *International Journal of Adolescence and Youth.* 2019; 24(4): 511-520.

88. Ngambeki IB. Finding a Home in Engineering: Examining Students' Choice of Engineering Discipline. Dissertation. Purdue University, USA. 2012.

89. Nordin S.K.S, Samat K, Sultan M.A.A, Halim B.A, Siti I. Adaptation of Abbreviated Mathematics Anxiety Rating Scale for Engineering Students. Conference: International Conference on Mathematics, Engineering and Industrial Application. Malaysia. 2015; 1660.

90. Oktavia WK, Urbayatun S. The Role Of Peer Social Support And Hardiness Personality Toward The Academic Stress On Students. International Journal of Scientific & Technology Research. 2020 VOLUME 8 ISSUE 12. 2903-2907.

91. Owusu-Manu D, Edwards DJ, Kukah AS, Pärn EA, El-Gohary H, Aigbavboa C. An Assessment of the Level of Emotional Intelligence Attributes of Undergraduate Built Environment Students in Developing Countries. *Industry and Higher Education.* 2019; 33(2):108-115.

92. Paimin AN, Hadgraft R, Prpic J. An exploration of the conative domain among engineering students. Research in Engineering Education Symposium, REES 2009.

93. Pan Z. Analysis on Developmental Characteristics of Undergraduate Students' Mental Health in Local Science and Engineering Colleges. 4th International Symposium on Education Management and Knowledge Innovation Engineering. 2011; Vols 1 and 2. PEOPLES R CHINA

94. Panger G. Graduate Student Happiness & Well-Being Report. The Graduate Assembly. Berkeley University. USA. 2015.

95. Picon P, Gauer G, Hirakata V, Haggsträm L, Beidel D, Turner et al. Reliability of the Social Phobia and Anxiety Inventory (SPAI) Portuguese version in a heterogeneous sample of Brazilian university students. *Revista brasileira de psiquiatria.* 2005; 27: 124-30.

96. Poh BLG, Muthoosamy K, Lai CC, Gee OC. Assessing the Metacognitive Awareness among Foundation in Engineering Students. *IAFOR Journal of Education.* 2016; 4(2):48-61.

97. Pryor M. Real-time Monitoring of Student Procrastination in a PSI First-year Programming Course 2012 ASEE Annual Conference & Exposition, San Antonio, Texas. Available from: https://peer.asee.org/21856

98. Qin H, Chen M, Wang M. Mental Health Education of the Minority Engineering College Students. Proceedings of the 2016 International Conference on Humanity, Education and Social Science. (370-374). Available from: https://dx.doi.org/10.2991/ichess-16.2016.81

99. Radzuan R, Kaur S. Engineering students' self-perceived communication competence and technical presentation anxiety: A case study. New Media Communication Skills for Engineers and IT Professionals: Trans-National and Trans-Cultural Demands. 2012; 115-131.

100. Ramming CH, Mosier R. Time limited exams: Student perceptions and comparison of their grades versus time in engineering mechanics: Statics. 2018 ASEE Annual Conference & Exposition. Available from: https://www.asee.org/public/conferences/106/papers/23818/view

101. Ravikanth B. Self-Esteem among Technical Students during Recession: An Empirical Study. *The IUP Journal of Soft Skills*, 2010; Vol. 4, Nos. 1 & 2 18-28. Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1610043

102. Rizwan A, Farooq S, Alvi MSI, Nawaz S. Analysis of Factors Affecting the Stress Level of Female Engineering Students. *Global Journal of Human Social Science, Arts & Humanities. 2012*; Volume 12 Issue 10 Version 1.0. Available from: https://globaljournals.org/GJHSS_Volume12/4-Analysis-of-Factors-Affecting-the.pdf

103. Rizwan A, Choudhary M, Jahanzaib M, Imran A, Manzoor U, Ali A. Analysis of Factors Affecting the Stress Level of Engineering Students from Remote Areas. *International Journal of Engineering Education*. 2013; 29: 926-932.

104. Rizwan A, Alvi MSI, Saeed MUD. Analysis of factors affecting the stress level of engineering students. *International journal of engineering education*. 2010; Vol. 26, no. Extra 3: 681-686

105. Rohde J, Musselman L, Benedict B, Verdin D, Godwin A, Kirn A, et al. Design Experiences, Engineering Identity, and Belongingness in Early Career Electrical and Computer Engineering Students. *IEEE Transactions on Education.* 2019; 62(3):165-172.

106. Saeed Z.Atif M, Bilal, B. An observational study done to determine the contrast in stress levels between medical and non-medical students conducted in different institutes in Karachi. *Medical Forum Monthly*. 2015; 26: 35-39.

107. Samoilova V, Thanh VD, Wilang JD. Anxiety among Engineering Students in a Graduate EFL Classroom. 2017; Conference: The 3rd International Conference on Innovation in Education. Thailand: Institute for Innovative Learning, Mahidol University. Bangkok, Thailand

108. Saplavska J, Jerkunkova A. Academic procrastination and anxiety among students. *Engineering for Rural Development.* 2018; 1192-1197. Available from: http://tf.llu.lv/conference/proceedings2018/Papers/N357.pdf

109. Seabi J. Relating Learning Strategies, Self-Esteem, Intellectual Functioning with Academic Achievement among First-Year Engineering Students. *South African Journal of Psychiatry*. 2011; 41:2: 239-249.

110. Sheppard S, Gilmartin S, Chen HL, Donaldson K, Lichtenstein G, Eris O, et al. Exploring the Engineering Student Experience: Findings from the Academic Pathways of People Learning Engineering Survey (APPLES). 2010; Center for the Advancement of Engineering Education. USA. 2010; TR-10-01. Available from: http://www.engr.washington.edu/caee

111. Shields N. Stress, Active Coping, and Academic Performance Among Persisting and Nonpersisting College Students. *Journal of Applied Biobehavioral Research*. 2008; 6. 65 - 81.

112. Sun Y, Yang Y-Y, Feng C-X, Zhang H.The Research on Negative Perfectionism Personality of Engineering Students from the Perspective of Game Theory. 19th International Conference on Industrial Engineering and Engineering Management. 2013; 289-297.

113. Swart A. The Impact of Stress on Student Tardiness and Subsequent Throughput Rate of Engineering Students: A Case Study. *International Journal of Engineering Education*. 2008; Vol 24, number 4, part 2. (1-8). Available from: https://www.researchgate.net/publication/263602563_The_Impact_of_Stress_on_Student_Tardiness_and_Subsequent_Throughput_Rate_of_Engineering_Students_A_Case_Study

114. Tang M, Oliffe J, Galdas P, Phinney A, Han C. College men's depression-related help-seeking: A gender analysis. *Journal of mental health*. 2014; 23. Available from: https://pubmed.ncbi.nlm.nih.gov/24784166/

115. Tate ED, Linn MC. How Does Identity Shape the Experiences of Women of Color Engineering Students? *Journal of Science Education and Technology.* 2005; 14(5-6):483-493.

116. Thumin FT. Personality characteristics of diverse occupational groups. Personnel and Guidance Journal, 1965; Volume 5, 468–470. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1002/j.2164-4918.1965.tb02784.x

117. Turner A, Hammond CL, Gilchrist M, Barlow J. Coventry university students' experience of mental health problems. *Counselling Psychology Quarterly*. 2007; 20. 247-252.

118. Vitasari P, Herawan T, Wahab N, Othman A, Sinnadurai SK. Exploring Mathematics Anxiety among Engineering students. *Procedia - Social and Behavioral Sciences*. 2010; 8. 482-489.

119. Vitasari P, Wahab N, Herawan T, Sinnadurai SK.suriya kumar. Representation of social anxiety among engineering students. *Procedia - Social and Behavioral Sciences*. 2011; 30. 620-624.

120. Vitasari P, Wahab MNA, Othman A, Herawan T, Sinnadurai SK. The relationship between study anxiety and academic performance among engineering students. *Procedia - Social and Behavioral Sciences.* 2010;8:490-7.

121. Vo T, Samoilova V, Wilang J. Debilitating Effects of Anxiety on Engineering Students' Language Performances. The 3rd International Conference on Innovation in Education. Thailand: Institute for Innovative Learning, Mahidol University (ECIE 2017). Bangkok, Thailand. Available from: https://www.researchgate.net/publication/331430955_Debilitating_Effects_of_Anxiety_on_Engineering_Students%27_Language_Performances

122. Waghachavare V, Dhumale G, Kadam Y, Gore A. A Study of Stress among Students of Professional Colleges from an Urban area in India. *Sultan Qaboos University medical journal*. 2013; 13. 429-36.

123. Wahbeh H, Radin D, Mossbridge J, Vieten C, Delorme A. Exceptional experiences reported by scientists and engineers. *Explore* (New York) 2018; 14(5):329-341. https://www.researchgate.net/publication/326777496_Exceptional_experiences_reported_by_scientists_and_engineers

124. Whigham, Myrna A. Gender-Related Differences in Engineering Students. *NACADA Journal*, v8 n1 p35-45 Spr 1988. Available from: http://shorturl.at/jlqwI

125. Yadav R, Khanna A, Singh D. Exploration of Relationship Between Stress and Spirituality Characteristics of Male and Female Engineering Students: A Comprehensive Study. *Journal of Religion and Health*. 2017;56(2):388-399.

126. Yang X, Wang X, Zhang L, Weidman JC. Gender role conflict, professional role confidence, and intentional persistence in engineering students in China, *Studies in Higher Education*, 2017; 42:2, 248-263

127. Yazid NM, Azziz NA, Zakaria S, Desa MA. Anxiety level on mathematics among Engineering Technology undergraduates in UniMAP. 2016.

128. Zastavker, Y. V., Ong, M., Ong and Page, L. Women in Engineering: Exploring the Effects of Project-Based Learning in a First-Year Undergraduate Engineering Program. Proceedings. Frontiers in Education. 36th Annual Conference, San Diego, USA. 2006; 1-6.

129. Zhao N, Zhan Q. Investigation on Mental Health of Engineering Undergraduates. Proceedings of 2009 International Conference on Education Management and Engineering. 936-940. Available from: http://www.seidatacollection.com/upload/product/200909/2009jyhy04a39.pdf

130. Zolfaghari A, Fathi D, Hashemi M. The Study of Mental Health Status of Payame-Noor University Students in Toyserkan, Iran. *Procedia - Social and Behavioral Sciences*. 2011; 30. 1795-1797.

1. **Not the Concept/Phenomenon**

131. McLean HM, Kalin R. Congruence between self-image and occupational stereotypes in students entering gender-dominated occupations. *Canadian Journal of Behavioural Science / Revue canadienne des sciences du comportement*, 1994; 26(1), 142–162.

132. Nazligul MD et al. Interactive three-dimensional virtual environment to reduce the public speaking anxiety levels of novice software engineers. *IET Software*, vol. 13, no. 2, 152-158.

1. **Population not Stratified**

133. Reddy TL, Ammani S. Stress Management: A Case Study of Professional Students on Impact of Meditation and Yoga on stress levels. *i-manager's Journal on Educational Psychology*. 2013; 6. 42-47.

Appendix 5 Ethical Approval

HS

ROBERT GORDON UNIVERSITY ABERDEEN

SCHOOL OF HEALTH SCIENCES
The Ishbel Gordon Building
Robert Gordon University
Garthdee Road
Aberdeen
AB107QG
United Kingdom
Tel: 01224 263250
www.rgu.ac.uk

28th November, 2019

Dear Jo-Anne,

Re: School of Health Sciences Research Review Group (SRRG) Application
Study title: The Mental Health and Wellbeing of Engineering Students
Reference number: SHS/18/14

Thank you for addressing the reviewers' points in a satisfactory manner. I can now confirm that you have approval to commence your study as described in the submitted proposal and supporting documentation. Should you wish to amend the study in any way please seek approval to do so by submitting an Amendment form.

Wishing you every success with this study.

Yours sincerely,

Dr. Hector Williams, SRRG Convenor.

INVESTOR IN PEOPLE

Head of School
Dawn Mitchell
MSc PGCertHELT BSc OT DipCOT

Appendix 6 Survey

The Mental Health and Wellbeing of Engineering Students

Survey Welcome

The Mental Health and Wellbeing of Engineering Students in the UK

We would like to invite you to take part in a PhD study that aims to gain insight into the mental wellbeing of engineering students within the UK. Your input is extremely valuable to the research and will potentially help change how we teach engineering to students.

The survey should take approximately 20 minutes to complete. It is an anonymous survey, however some personal information is asked for, for example your age, year of study and type of engineering course. All information you provide will be anonymised and held securely within Robert Gordon University servers in a research project file only accessible by the research team.

The purpose of the survey is to identify key information about the mental health and wellbeing of engineering students in the UK and to help design interview questions for engineering students who volunteer to participate in later interviews.

Ethical approval to conduct this survey has been given by the School of Health Sciences Research Review Group (SHS18/14).

Participation in this study is completely voluntary. If you decide not to participate there will not be any negative consequences. If you decide to participate, you may stop participating at any time and you may decide not to answer any specific question.

The researcher will maintain the confidentiality of the research records or data.

By submitting the survey you are indicating that you have read the description of the study, are over the age of 16 if you are in Scotland, 18 if you are in England, Wales or Northern Ireland or you have consent to participate from a parent or guardian.

If you have any questions about the survey please contact Jo-Anne Tait on j.tait5@live.rgu.ac.uk . **Please click next to proceed to the survey**

Please indicate what area of Engineering you are studying: (select one only)

- General Engineering
- Civil Engineering
- Mechanical Engineering
- Aeronautical Engineering
- Electrical Engineering
- Electronic Engineering
- Production Engineering
- Chemical Engineering
- Other Engineering
- Other

If you selected Other, please specify:

Please indicate what type of qualification you are working towards: (select one only).

- HNC HND
- BSc BEng
- MEng MSc
- MSc/PhD
- MRes PhD
- EngD
- Other

If you selected Other, please specify:

Are you:

- A full-time student A
- part-time student
- A Graduate Apprentice
- An online (distance learning) student
- Other

If you selected Other, please specify:

Which stage of study are you in?

- 1st year College/FE 2nd
- year College/FE 3rd
- Year College/FE
- 1st year Undergraduate (university) 2nd
- year Undergraduate (university) 3rd year
- Undergraduate
- 4th year Undergraduate
- 5th year Undergraduate
- 1st year Postgraduate 2nd
- year Postgraduate Pre-
- Transfer PhD/EngD Post-
- Transer PhD/EngD Other

If you selected Other, please specify:

Is your course accredited by a professional body?

- No
- Don't know
- BCS, The Chartered Institute for IT
- British Institute of Non-Destructive Testing (BINDT)
- Chartered Institute of Plumbing and Heating Engineering
- (CIPHE) Chartered Institution of Building Services Engineers
- (CIBSE) Chartered Institution of Highways & Transportation
- (CIHT)
- Chartered Institution of Water and Environmental Management
- (CIWEM) Energy Institute (EI)
- Institute of Acoustics (IOA)
- Institute of Cast Metals Engineers (ICME)
- Institute of Healthcare Engineering and Estate Management
- (IHEEM) Institute of Highway Engineers (IHE)
- Institute of Marine Engineering, Science & Technology
- (IMarEST) Institute of Materials, Minerals and Mining (IOM3)
- Institute of Measurement and Control
- (InstMC) Institute of Physics (IOP)
- Institute of Physics and Engineering in Medicine
- (IPEM) Institute of Water
- Institution of Agricultural Engineers
- (IAgrE) Institution of Chemical Engineers
- (IChemE) Institution of Civil Engineers
- (ICE)
- Institution of Engineering and Technology
- (IET) Institution of Engineering Designers
- (IED) Institution of Fire Engineers (IFE)
- Institution of Gas Engineers and Managers
- (IGEM) Institution of Lighting

Professionals (ILP) Institution of

Mechanical Engineers (

What age are you? (Enter age)

How would you describe your gender?

- Female
- Male
- Non-binary
- Prefer to self-describe
- Prefer not to say

If you prefer to self-describe please feel free to do so below.

Mental Wellbeing Section

	Below are some statements about feelings and thoughts. Please tick the box that best describes your experience of each over the last two weeks. *Optional*				
	None of the time	Rarely	Some of the time	Often	All of the time
I've been feeling optimistic about the future					
I've been feeling useful					
I've been feeling relaxed					
I've been feeling interested in other people					
I've had energy to spare					
I've been dealing with problems well					
I've been thinking clearly					
I've been feeling good about myself					
I've been feeling close to other people					
I've been feeling confident					

I've been able to make up my own mind about things					
I've been feeling loved					
I've been interested in new things					
I've been feeling cheerful					

Have you ever been diagnosed or treated for a mental health condition?

No, Yes, or Prefer not to say

If Yes

Please indicate which condition(s): (Select all that apply)

- Anxiety disorder
- Attention deficit hyperactivity disorder (ADHD)
- Autism spectrum disorder (ASD)
- Bipolar disorder
- Borderline personality disorder (BPD)
- Depression
- Eating disorder
- Obsessive compulsive disorder (OCD) Post-
- traumatic stress disorder (PTSD) Psychosis
- Dissociation and dissociative identity disorder
- Schizoaffective disorder
- Other
- Prefer not to say

If you selected Other, please specify:

When were you first diagnosed/treated?

- 0-3 months ago
- 4-6 months ago
- 7-12 months ago
- 13-24 months ago
- 2-5 years ago

Do you consider your condition to be well-managed?

Please don't select more than 1 answer(s) per row.

	Very poorly managed	Poorly managed	Unsure	Well managed	Very well managed
.					

Have you shared your diagnosis with others? Select all that apply.

- No
- Not sure
- Parent or guardian
- Carer
- Sibling
- Friend
- Partner
- Religious leader
- Lecturer
- Course administrator
- Personal tutor School
- technician Other

If you selected Other, please specify:

Do you think you would talk to a member of staff in your department/School if you were feeling low or unwell mentally?

- Yes No
- Not sure

Can you please explain why?

How important do you feel it is to look after your mental wellbeing?

Please don't select more than 1 answer(s) per row.

	Not important at all	Of little importance	Of average importance	Important	Absolutely essential
Looking after my mental wellbeing is:					

Can you please explain your answer?

Looking back on the past 2 weeks, in terms of looking after your mental wellbeing, select the statement that best applies to you.

- I did not look after my mental wellbeing at all I
- rarely looked after my mental wellbeing
- I sometimes did something to improve my mental wellbeing I
- often looked after my mental wellbeing
- I looked after my mental wellbeing most of the time

Thinking about the last 2 weeks, please select any of the habits and activities that apply to you.

	Frequency				
	Never	Rarely	Sometimes	Often	All the time
I smoke/vape					
I drink alcohol					
I play computer games alone					
I play computer games with others					
I play board games					
I take non prescribed drugs					
I exercise alone					
I exercise with others					
I make Art					
I listen to music					
I watch tv/films					
I play music					
I write music					
I go to a place of religious worship					
I read					
I write					
I eat healthy food					
I eat unhealthy food					
I sleep a lot					
I sleep very little					

I self-harm					
I meditate					
I talk with friends or family					
I talk to a counsellor					

Reflecting on your experiences as an engineering student and on your mental wellbeing, can you tell us what advice would you give someone beginning an engineering course?

And finally, would you be interested in taking part in a one-to-one interview about the mental health and wellbeing of engineering students? If yes, please enter your contact details - an email address or phone number and your name. If not, please click Next.

Thank you for taking the time to complete this survey. If you would like support for mental health or wellbeing issues the following links are places that can offer help.

https://www.mind.org.uk/

https://www.thecalmzone.net/

http://www.penumbra.org.uk/

https//www.samaritans.org/

If you have any questions about this survey please contact Jo-Anne Tait on j.tait5@live.rgu.ac.uk .

Appendix 7 Engineering Professor Council Guest Blog

Guest blog: Time to Reflect on the Wellbeing of our Engineers

October 10, 2019 By Stella Fowler 2 Comments

By Jo-Anne Tait – Academic Strategic Lead, School of Engineering, Robert Gordon University

Students' mental health is a deservedly hot topic in higher education. But is the conversation more difficult when it comes to engineering? Are the challenges greater?

When I am asked about the topic of my PhD I have noticed the responses are interesting. Engineers for the most part look puzzled, and wonder why I might think this is worthy of investigation. Some even show signs of annoyance that this is even a thing. Non-engineers on the other hand, their eyes open wider in fascination and regale me with tales of the (not so positive) habits of the engineers they know.

I am studying the mental wellbeing of engineering students. I believe there is something wrong with how we approach this topic in engineering education in relation to future engineers. In fact, it appears we don't really approach it at all.

I was a geologist by trade before I entered engineering academia, teaching drilling engineering students. Nearly 20 years later, I look after the teaching, learning and student experience in a School of Engineering. I see my job as helping the engineers of the future and I take it very seriously.

I realise I am preaching to the converted somewhat but in case anyone isn't clear, engineers are absolutely vital in addressing global challenges: energy, sustainability, transport, infrastructure, and medication are just a few.

But despite the importance placed on the role of the engineer in our future, the UK has a serious shortage of engineers. This phenomenon is echoed in the U.S., China, South Africa and Germany with reports of demand far outstripping supply. Calls for education reform are growing and there has been an increase in the diversification of engineering education through degree apprenticeships and widening participation activities.

From my seat at the table I am seeing a worrying rise in mental health and wellbeing issues in engineering students. Often by the time I am made aware of a student's situation it is at or near crisis point rather than earlier, when more support might be possible. I raised my concerns and discovered that, anecdotally, engineering students sought help in far fewer numbers than students of other disciplines. Further reading told me this was not unusual in engineering higher education and so I began to dig further.

Given the mental health and wellbeing of university and college students has been the subject of considerable discussion nationally and internationally it might surprise you to discover that engineering students are not well represented in this literature. It certainly surprised me, given the challenging and competitive nature of engineering degree programmes and the male-skewed gender balance of the discipline.

Men, and young men in particular have a higher risk of suicide and the incidence of schizophrenia in males is reported to be significantly higher than in females. Young adults are at higher risk of developing serious mental illnesses and it has also been reported that female engineering students report even poorer mental wellbeing than their male counterparts. An American institution found that engineering students had a higher prevalence of mental health problems than the general student population, were less likely to use mental health services than students from other disciplines, were "significantly less likely to report suicidal ideation" and there was a "significantly decreased likelihood of seeking help".

The NUS reported well over half of students reporting mental distress attributed this to heavy workload and coursework deadlines and engineering courses are well-known for heavy workloads and assessment schedules. So, engineering students are potentially at higher risk of suffering from poor mental wellbeing, and are also less likely to seek assistance than students of other disciplines. To me this points to an unmet need of engineering students and so I decided to undertake a PhD in this area. I chose to focus my efforts on engineering students because I feel that is where I may have most impact, but it is likely the problems I am identifying in students also exist in the engineering profession itself.

A recent report on masculinity in engineering highlighted over a fifth of respondents reporting having had to take time off work because of mental ill health. Distressingly, the report also notes that nearly a fifth of respondents stated they had lost an engineering colleague to suicide. When asked if they experienced stress, sleeping issues, thoughts on self-harm or being bothered by feeling anxious, depressed, irritable or sad, 77% of participants answered yes.

By investigating the mental wellbeing of engineering students, I am hopeful that we can uncover a unique insight into a population that has been overlooked in mental wellbeing studies and may be at increased risk of mental ill health and poor mental wellbeing.

Given the shortage of engineers in the UK, it is time we looked more closely at the mental wellbeing of our engineers, both current and future. Because, increasingly, more is expected of engineers. They need to be more mentally agile and more able to drive change and innovation than ever before.

For that they need to have skills we don't always shine a light on so much in university engineering education: resilience, empathy, active listening, self-preservation, conflict resolution and, essentially, metacognition.

I appreciate we are some years away from a UKSPEC review, but one way of encouraging engineers to look after their mental wellbeing is to support metacognition activities more explicitly through the UKSPEC's section D, to include development of intrapersonal skills. Placing an importance on this at the heart of what it is to be a

professional engineer will feed through to AHEP and AQAH requirements and may be a way to support institutions in working towards building a supportive environment for engineering personal development.
Meanwhile, let's try to normalise conversations about mental health and wellbeing and support our engineering colleagues and friends whenever we can.
And for my part, I will continue to support engineers and engineering students by finishing my PhD and providing some recommendations!
Filed Under: Uncategorized

Comments

1. **Dr Roger Penlington says**

December 2, 2019 at 20:51
This is a very important topic to raise for discussion, as you suggest there is too little specific literature within the studies of engineering students.
May I add another reason for your study, that of engineering academics who are fundamentally recruited from these very engineering students who are reluctant to seek support. Therefore it may be presumed that they will also likely suffer the same response to the high workloads and deadlines we are all familiar with.
The significance of this is that these are the academics supposedly providing pastoral care to the vulnerable students – in this situation it is likely that this care is not as effective as we would like it t be.

   - **Jo-Anne Tait says**

December 10, 2019 at 11:12
Hi Roger,
Absolutely agree with you. Supporting engineering academics will be vital in any move forward as more and more is asked of them/us.

Appendix 8 Press and Journal Article

RGU study to focus on mental health of engineering students

by Kieran Beattie

December 14, 2019, 8:09 am

-

Engineering students

Sign up to our **Daily** newsletter

The mental health of engineering students is the subject of a new study being carried out by an academic at Robert Gordon University.

Jo-Anne Tait, academic strategic lead in the university's School of Engineering, is halfway through her PhD on the mental wellbeing of students studying the field of engineering.

She said she decided to pursue the study to find out if "engineering students are suffering in silence", and is appealing for volunteers to take part in her research.

Ms Tait said: "I've worked with engineering students for 15 years in a teaching and pastoral role, and I had noticed that engineering students rarely sought advice for mental health and wellbeing issues from their personal tutors or the student support departments.

"This is despite the majority of engineering students being in potential higher risk groups.

"Having done an initial scoping review of literature in this area I discovered that engineering students don't really appear much, other than as a comparator for other subjects."

Ms Tait said she believes the work could help to uncover some of the strains being put upon the next generation of engineers.

She added: "In the future our engineers will need to be more agile than ever, and for this we need them to be far more self-aware."

To volunteer, email Ms Tait on j.tait5@live.rgu.ac.uk

Appendix 9 Student Engineer Article

Student engineers wanted for study on mental health

11th December 2019 2:23 pm

A new academic study looking at the mental health of engineering students is seeking volunteers to take part in the research.

Main plaza at The Robert Gordon University's campus at Garthdee, Aberdeen, UK (Credit: Jackofhearts101 via CC)

The work is being led by Jo-Anne Tait, a strategic lead in the School of Engineering at Aberdeen's Robert Gordon University. Tait is halfway through her PhD on the mental wellbeing of engineering students and has recently received ethical approval for a survey that will hopefully shed some light on the topic.

MORE FROM THE STUDENT ENGINEER

"I've worked with engineering students for 15 years in a teaching and pastoral role and I had noticed that engineering students rarely sought advice for mental health and wellbeing issues from their personal tutors or the student support departments," Tait told *The Student Engineer*. "This is despite the majority of engineering students being in potentially higher risk groups (young men, students, stressful courses).

"Having done an initial scoping review of literature in this area I discovered that engineering students don't really appear much, other than as a comparator for other subjects. I decided to develop a survey focusing on engineering students because it seems to me the main question is: are engineering students suffering in silence?"

The purpose of the survey is to gather information about the mental health and wellbeing of engineering students in the UK be they full-time, part-time, distance learning or graduate apprentices and to help design interview questions for engineering students who volunteer to participate in later interviews. Those who decide to take part in the study can do so via an online questionnaire that should take about 20 minutes to complete. If the online survey is started but not completed, that information will be excluded from the survey results and data deleted.

The survey is anonymous, but some personal information is asked for, including age, year of study and type of engineering course. All information provided will be anonymised and held securely within Robert Gordon University servers in a project file only accessible by the research team. Tait says the work could help uncover some of the strains that modern engineering is placing on the next generation of engineers.

"There are calls for engineering education reform to meet the needs of industry 4.0, but we appear to be missing personal development and resilience from our curricula or rely on group projects to enhance 'soft skills'," she said. "In the future our engineers will need to be more agile than ever and for this we need them to be far more self-aware."

Additional information on the survey can be found here.

Appendix 10 Chamber of Commerce Article

Search

Student engineers wanted for RGU study on mental health

Member News | December 17, 2019 | by Robert Gordon University

Student engineers wanted for RGU study on mental health

A new academic study, conducted by Robert Gordon University (RGU), whicl is looking at the mental health of engineering students is seeking volunteers take part in the research.

Join AGCC

The work is being led by Jo-Anne Tait, academic strategic lead in the School Engineering at RGU, who is halfway through her PhD on the mental wellbeing of engineering students.

"I've worked with engineering students for 15 years in a teaching and pastoral role and I had noticed that engineering students rarely sought advice for mental health and wellbeing issues from their personal tutors or the student support departments," Jo-Anne commented.

"This is despite the majority of engineering students being in potentially higher risk groups.

"Having done an initial scoping review of literature in this area I discovered that engineering students don't really appear much, other than as a comparator for other subjects.

“I decided to develop a survey focusing on engineering students because it seems to me the main question is: are engineering students suffering in silence?”

The purpose of the survey is to gather information about the mental health and wellbeing of engineering students in the UK.

Jo-Anne believes the work could help uncover some of the strains that modern engineering is placing on the next generation of engineers.

“There are calls for engineering education reform to meet the needs of industry 4.0, but we appear to be missing personal development and resilience from our curricula or rely on group projects to enhance ‘soft skills’.

“In the future our engineers will need to be more agile than ever and for this we need them to be far more self-aware.”

Those who decide to take part in the study can do so via an online questionnaire that should take about 20 minutes to complete. The survey closes on January 20, 2020.

The survey is anonymous, but some personal information is asked for, including age, year of study and type of engineering course. All information provided will be anonymised and held securely within Robert Gordon University servers in a project file only accessible by the research team.

Additional information on the survey can be found here.

Jo-Anne Tait
Jo-Anne Tait

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Appendix 11 Zenopa Article

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Send us a message or CV

Your name

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I am recruiting I am job seeking

Choose File No file chosen

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TALENT DRIVEN ▲
CULTURE FOCUSED

News >
A mental health survey to be conducted on engineering students

A mental health survey to be conducted on engineering students

20 December 2019 Service Engineering

Contact Us ▲

a strategic leader in the School of Engineering at the Robert Gordon University, Aberdeen, Jo-Anne Tait, is requesting for engineering students from all levels to come forward and participate in an anonymous, online questionnaire, as part of her PhD on the on the mental well being of engineering students. The purpose of the survey is to analyse the mental health of UK engineering students, and to collect information in order to create interview questions for volunteers who choose to participate in future interviews.

"A mental health survey to be conducted on engineering students"

Ms Tait stated: "I've worked with engineering students for fifteen years in a teaching and pastoral role and I had noticed that engineering students rarely sought advice for mental health and wellbeing issues from their personal tutors or the student support departments. This is despite the majority of engineering students being in potentially higher risk groups.

Appendix 12 Interview Guide

Interview Guide for Researcher

Introduction

Hello, am I speaking with (insert name of participant)? This is (insert name of interviewer) from Robert Gordon University, calling to interview you as part of the mental health and wellbeing research study.

Before we begin the interview, I need to get your consent for this recorded so I am going to make some statements and I need to you to say if you agree with that or not after each statement:

1. I confirm that I have read the information sheet dated 21/01/2020 (version SPI002/1) for the study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my education or legal rights being affected.
3. I understand that the information collected about me will be used to support other research in the future, and may be shared anonymously with other researchers.
4. I agree to my interview being audio recorded for research purposes and stored on
   Robert Gordon University servers and for my interview to be transcribed.
5. I agree to take part in interviews which will be audio recorded. I give permission for anonymised quotes from my interview being used in any research output (e.g. academic articles, professional papers, conference presentations) from this study.
6. I agree to take part in the above study.

Demographic information

To start with, can you tell me a bit about your engineering course?
How did you choose engineering?
– relative or close family member an engineer?
Are you studying close to home?
What year are you in?
How old are you?
Are you comfortable to share which college or university you attend?
if so, where do you attend?

The course

I'd like to talk about your course –

How do you feel/what do you think about the teaching on your course?

- What types of teaching do you receive?
- How is technology used in the classroom/lecture hall?
- Are there practical activities?
- How does the general teaching approach suit your needs?

How do you feel/what do you think about the assessments on your course

- Would you say there are a lot?
- What type of exam formats have you had? E.g. closed book, essay, portfolio?
- Are they stressful? Are you anxious?
- Maybe explore whether they feel there's been an impact on their wellbeing from that.

how do you find the engineering staff in regard to student personal support?"

- Can you tell me a little bit about your experience in this?

Your mental health and wellbeing

I'd like to ask you now about your wellbeing. By this I mean feeling positive, thinking clearly, having energy…

How have you been over the last few months? How do you keep well?

To be asked if they have disclosed a mental illness:

- Do you think/do you feel your mental illness is well managed?

What support do you think/feel your engineering school could offer in terms of mental wellbeing?

What do you do outside of classes? Are you physically active? Do you hang out with friends?

What do you do when you are under pressure at university? How do you manage your time? Do you use poor health behaviours to cope? (drinking, all nighters)

Do you actively do things to help yourself or support your mental wellbeing and good mental health?

- Could you tell us what you do or have tried before?
- Do these activities/behaviours help/work?

The Engineering Profession and mental health and wellbeing

Can you tell me about your impressions of how mental health and wellbeing is viewed in the engineering profession?
How would you feel if another engineering student disclosed a mental health condition such as depression, anxiety or bipolar disorder to you?
If someone in your class was acting out of character, how do you think would you handle it?

Closing out

This has been really helpful thank you. I feel we have covered all the areas I had hoped to find out more about. Is there anything else at all that comes to mind that you would like to talk about?

I just want to remind you that the information you have shared will remain confidential and responses from all people being interviewed are pulled together for analysis. I realise some of the things we discussed may have been sensitive so also would like to remind you of the support numbers that are available should you feel you need to talk to someone about how you are feeling.

Thank you so much for your time, this has been really helpful. Your contribution will make a huge impact on the study and I really appreciate you taking the time to talk with me about your experiences.