Wellbeing of Graduate Engineering Students: A Systematic Review

Mr. Syed Ali Kamal, University at Buffalo, The State University of New York

Syed Ali Kamal is a doctoral student at the Department of Engineering Education at University at Buffalo. His research interests lie in the area of social justice and issues related to diversity, equity and Inclusion.

Syeda Fizza Ali, Texas A&M University

Syeda Fizza Ali is currently pursuing her PhD in Interdisciplinary Engineering (emphasis in Engineering Education) at Texas A&M University. She works as a graduate research assistant at the Department of Multidisciplinary Engineering. Her work focuses on instructional strategies in engineering, and educational technology. She is also passionate about student mental health and broadening participation in engineering.

Matilde Luz Sanchez-Pena, University at Buffalo, The State University of New York

Dr. Matilde Sánchez-Peña is an assistant professor of Engineering Education at the University at Buffalo – SUNY where she leads the Diversity Assessment Research in Engineering to Catalyze the Advancement of Respect and Equity (DAREtoCARE) Lab. Her research focuses on developing cultures of care and well-being in engineering education spaces, assessing gains in institutional efforts to advance equity and inclusion, and using data science for training socially responsible engineers.

Wellbeing of Graduate Engineering Students: A Systematic Review

1. Introduction

Recent studies show that students in graduate school often face difficulty in terms of their mental health and wellbeing which affects the quality of their learning and experiences. In this regard, Evans et al [1] found that graduate students face mental health challenges at a rate six times higher than the general population. This increased mental health crisis among graduate students is linked to specific aspects of their academic journey, such as difficulties in managing time, unclear and unpredictable academic processes, a feeling of not fitting in, financial strains, self-confidence issues, poor balance between work and personal life, and the nature of their interaction with faculty mentors [2]. The additional impact of gender and racial biases during graduate school intensifies the difficulties already present and results in decreased productivity and poorer academic performance, often leading to lower completion rates [3]. Therefore, it is important for education researchers to understand graduate students' wellbeing and mental health so that the quality of their experiences can be improved.

The causes of student's mental distress and wellbeing have been widely discussed across academic disciplines including engineering education. However, these discussions can often lead to confusion as the researchers often interchangeably use the terms, wellbeing, wellness, thriving and mental health. It is therefore important to determine what these terms mean and whether they refer to the same or entirely different concepts. Huppert [4] argues that the absence of a consensus regarding wellbeing's precise definition has led to a lack of a universally accepted method for its measurement. Moreover, the variation in the usage of terms can serve as an obstacle for researchers trying to find relevant literature. Therefore, there is a need to consolidate the literature on the subject and provide a clear definition for the term wellbeing.

Wellbeing can be understood as a fusion of experiencing positive emotions (from a hedonic standpoint) and functioning effectively (through the eudaimonic perspective). Moreover, Huppert [4] suggests that wellbeing is a multidimensional construct and therefore requires multiple measures that capture the entirety of the construct. In this systematic review, we review the literature on graduate engineering students' wellbeing and the methodologies used to investigate it. Specifically, we seek to answer the following research questions: 1) How has wellbeing been conceptualized for graduate engineering students? 2) How has wellbeing been measured among graduate engineering students?

2. Background

Wellbeing is a complex construct consisting of multiple interconnected elements spanning across diverse academic disciplines. This has led to a range of interpretations and conceptualizations. Within psychology, the discourse around wellbeing has been shaped by two broad viewpoints. The first viewpoint, which is often referred to as psychological or eudemonic in nature, conceptualizes wellbeing as the realization of an individual's authentic essence and capabilities [5]. In contrast, the second viewpoint referred to as subjective or hedonic, conceptualizes wellbeing based on a belief that the paramount goal of human existence lies in happiness and enjoyment [6], [7] .

Although both viewpoints are derived from different ideologies [8], there appears to be an overlap between the two since both viewpoints explain the state of the human mind.

Considering the overlap between the two ideological conceptions of wellbeing, Deci and Ryan [5] argue that subjective wellbeing and eudaimonic wellbeing have the potential to be integrated to fully understand human wellbeing. This argument has also been supported by Waterman [9] who argued that happiness or positive feelings may not inherently signify psychological wellness. Instead, wellbeing entails an ongoing process of self-realization, embracing virtuous potentials, and aligning one's life with intrinsic purpose.

Wellbeing has been extensively studied across various disciplines including the health sciences [10], the social sciences such as Psychology [7], [11] and education and sports sciences [8]. This widespread exploration of wellbeing has resulted in numerous conceptualizations which indicate a lack of consensus on a single definition. However, it is generally agreed that wellbeing is a multidimensional concept that encompasses positive emotions and effective functioning among many other context specific aspects of the studied population.

Within engineering education there has been an increased focus on exploring students' psychological state of mind in recent years. While more studies have focused on undergraduate students and investigated their mental health [12], [13] and subjective well-being [14], fewer studies have focused on graduate engineering students [15]. However, studies conducted outside of engineering on graduate students indicate that graduate students suffer from mental health conditions like depression and anxiety at a rate much higher than the general population [1]. The incidence of mental health conditions is linked with financial concerns, poor mentorship, discrimination, and lack of work life balance [1], [16].

While it is generally believed that mental health is an aspect of wellbeing, research [17] suggests that both have separate causes and psychological mechanisms. Kinderman et al. [17] argued that anxiety and depression are associated with negative life events, influenced by individuals' thinking, while low levels of subjective well-being are related to material deprivation and social isolation, mediated by an adaptive coping style. Thus, making mental health problems and subjective wellbeing the opposite ends of a single spectrum. However, in this study we do not adhere to any previously conceived conceptualization of wellbeing. Instead, we allow the systematic review process to guide how wellbeing has been conceptualized for graduate engineering students.

3. Methods

In this study, we used the systematic literature review approach proposed by Borrego et al [18] to search, review, and analyze the existing literature. Our chosen methodology consists of four interrelated methods including search, selection, coding, and synthesis.

3.1 Search

Our initial exploration of relevant literature involved searches within key engineering research databases: Compandex, Inspec and GeoRef, all hosted on the engineering village platform. Within this search we followed the search query outlined in Table 1, guided by our inclusion criteria

described in Table 2. We conducted this search using a specific search query twice, once during September 2023 and once in October 2023 and used the search results from the latter query.

Table I
SEARCH STRATEGY

Database	**Search Query**
Engineering Village	
Compendex (1208)	((((((Wellbeing OR Wellness)) WN ALL) AND (((Engineering And Graduate Students)) WN ALL))) AND (((cpx or c84 OR ins OR grf) WN DB) AND ({engineering education} WN CV) AND (({ca} OR {ja}) WN DT) AND ({english} WN LA) AND ((2023 OR 2022 OR 2021 OR 2020 OR 2019 OR 2018 OR 2017 OR 2016 OR 2015 OR 2014) WN YR)))
Inspec (327)	((((((Wellbeing OR Wellness)) WN ALL) AND (((Engineering And Graduate Students)) WN ALL))) AND (((cpx or c84 OR ins OR grf) WN DB) AND ({engineering education} WN CV) AND (({ca} OR {ja}) WN DT) AND ({english} WN LA) AND ((2023 OR 2022 OR 2021 OR 2020 OR 2019 OR 2018 OR 2017 OR 2016 OR 2015 OR 2014) WN YR)))
GeoRef (0)	((((((Wellbeing OR Wellness)) WN ALL) AND (((Engineering And Graduate Students)) WN ALL))) AND (((cpx or c84 OR ins OR grf) WN DB) AND ({engineering education} WN CV) AND (({ca} OR {ja}) WN DT) AND ({english} WN LA) AND ((2023 OR 2022 OR 2021 OR 2020 OR 2019 OR 2018 OR 2017 OR 2016 OR 2015 OR 2014) WN YR)))

Table II
INCLUSION/EXCLUSION CRITERIA USED TO GUIDE THE SEARCH

Inclusion Criteria	**Working definition**	**Example search Terms**
Wellbeing	Anything related to psychological wellbeing, mental health, or subjective wellbeing.	Wellness, Wellbeing, Well-being
Engineering	All disciplines of engineering	Engineering
Graduate Students	Students enrolled in a Master or PhD degree.	Graduate students, PhD students, Master Students
Additional Criteria		
Inclusion Criteria	**Working Definition**	**Implementation**
Peer reviewed journal/conference papers	Papers that have been peer reviewed	Verifying whether the paper is published with the peer review process
Studies based in US	Studies conducted on graduate students enrolled in any US university	Studies conducted on US engineering graduate students.
Last 10 years (since 2013)	Papers published in and after the year 2013	Database search restriction

Papers written in English.	Papers written in English language	Database search restriction

Our refined search string results provided us with a total of 1535 studies comprising two databases. We found 1208 studies from Compendex and 327 studies from Inspec. However, we found no studies from GeoRef. Our search results included both journal articles (299) and conference publications (1236). We removed 200 duplicates and were left with 1335 studies. We shortlisted the studies in two cycles. In the first cycle, we shortlisted the studies in terms of relevance based on title and abstract. Two authors discussed the relevance of each study to decide its inclusion. In this phase, studies using the terms wellbeing, wellness and mental health in the title or abstract were included. This process resulted in the elimination of 1304 studies, and we were left with 31 studies. Our elimination process followed the specific inclusion criteria including the presence of relevant search terms and the targeted student population as outlined in Table 1.

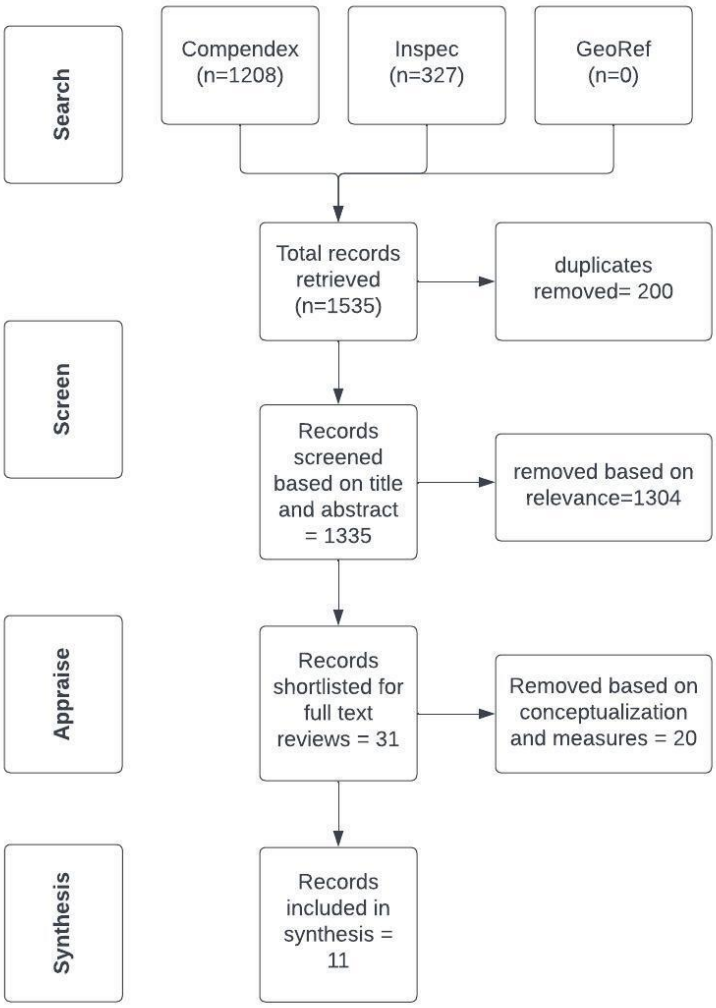

Fig. 1. Inclusion Criteria Flowchart based on PRISMA-Flow of information through stages [19]

In the second cycle, we conducted a full text review of studies to further shortlist the studies based on the conceptualization of wellbeing. After conducting 31 full text reviews, we were left with a total of 11 studies. The diagram in Figure 1 illustrates the flow of study inclusion and exclusion, following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines for our investigation[19]. This checklist, widely utilized for systematic reviews and meta-analyses in various fields, ensures high-quality reviews.

3.2 Procedure and analysis

The shortlisted studies were then read and coded in terms of the conceptualizations of wellbeing and the measures used. Two of the researchers coded each paper individually. The codes were then cross checked to meet interrater reliability. In the next step, similar codes were combined into overarching themes that represented the comprising set of codes. The following section presents the emergent themes.

4. Findings

4.1 Conceptualization of wellbeing

Various conceptualizations of wellbeing have been used in the shortlisted studies. We conducted a thematic analysis to categorize those conceptualizations and found three primary themes i.e., eudaimonic and hedonic traditions, mental health, and thriving. Out of the eleven papers studying wellbeing, 3 studies used the traditional approach encompassing eudaimonic and hedonic traditions, 7 studies conceptualized wellbeing through mental health and only 1 study conceptualized wellbeing in terms of thriving.

4.1.1 Eudemonic and Hedonic Traditions: The studies under this theme considered wellbeing as a multidimensional construct and used multiple scales to capture the multidimensional nature of wellbeing. These studies used measures of wellbeing consistent with the traditional eudaimonic and hedonic schools of thought [20], [21], [22].

Two frameworks were used across these studies for combining the various aspects of wellbeing: 1) PERMA framework [23] and 2) the Oxford Happiness Questionnaire developed by Hill & Argyle [24].

The PERMA framework states that wellbeing can be understood with five different constructs: positive emotion, engagement, relationships, meaning and achievement. All five of these constructs encompass the eudemonic as well as hedonic elements of wellbeing. Similarly, the Oxford Happiness Questionnaire (OHQ) consists of three constructs i.e., life satisfaction, positive affect and self-concept that encapsulate the eudaimonic and hedonic elements of wellbeing. Table 3 presents an overview of the studies under this theme.

Table III
STUDIES CATEGORIZED UNDER EUDAIMONIC AND HEDONIC TRADITIONS

Title	Author	Constructs

Understanding international graduate engineering students' well-being: What do they need to thrive? (Work in Progress)	Baquero-Sierra et al [20]	PERMA framework (positive emotion, engagement, relationship, meaning and achievement)
Investigating the tension between persistence and well-being in engineering doctoral programs	Shanachilubwa et al [25]	PERMA framework (positive emotion, engagement, relationship, meaning and achievement)
A study of Well-being Among College of Engineering Graduate Students	Wang & Clark [22]	Oxford Happiness Questionnaire, Life satisfaction, positive affect, self-concept

4.1.2 Mental Health: The shortlisted studies under the second theme conceptualized wellbeing in terms of mental health. These studies considered mental health to be a part of wellbeing and explored two dimensions of mental health: psychological illness and emotional wellness. Studies focusing on psychological illness focused on mental health conditions such as depression, anxiety and suicidal ideation[26], [27], [28]. Whereas those that emphasized emotional wellness used constructs such as sense of belonging, social self-efficacy, social support, and flourishing. Many shortlisted studies identified under the mental health theme considered both dimensions of mental health to get a complete picture of psychological well-being. For instance, Bork and Mondisa [26] , and Bork et al [29] considered both dimensions of mental health encapsulating elements of both psychological illness and emotional wellness. Table IV provides the details of studies identified under the second theme.

Table IV
STUDIES CATEGORIZED UNDER MENTAL HEALTH

Title	**Author**	**Constructs**
Science, engineering, and mathematics graduate student mental health insights from the healthy minds network dataset	Bork & Mondisa [26]	Depression, suicidal ideation, self-sufficiency, sense of belonging, and social self-efficacy
Engineering graduate students' mental health: A scoping literature review	Bork & Mondisa [30]	Social support and sense of belonging, student–advisor relationship, cultural barriers,
Exploring the Relationship Between Culture and Science, Engineering, and Mathematics Graduate Students' Mental Health (Full-Paper)	Bork et al [29]	Mental health measured by depression, suicidal ideation and flourishing (as positive mental health) and anxiety
Characterizing mental health and wellness in students across engineering disciplines	Danowitz and Beddoes [28]	Mental health and wellness conditions
Examining Faculty and Graduate Student Attitudes on Stress and Mental Health	Feil-Seifer et al [31]	Perceptions and experiences of mental health
Understanding Stress and Relief: How Engineering Graduate Students Experience and Cope with Stress	Riley and Mallouk [32]	Stress as a proxy of mental health, coping mechanisms

Visualizing Stress and Relief: How stressors and coping mechanisms interact in engineering graduate student experiences	Troutman et al [33]	Stress as a proxy of mental health, coping mechanism

4.1.3 Thriving: The third theme conceptualized wellbeing in terms of thriving. While it can be argued that thriving is a construct on its own, like wellbeing, Zerbe et al, [34] used the concept of thriving adopted from the socially embedded model for thriving at work aiming to measure graduate engineering students' wellbeing. Zerbe et al [34] define thriving as not only enduring or surviving an adverse event but, more importantly, experiencing improvement, growth, and achieving a better state after overcoming challenges. While thriving requires context, Zerbe et al[34] explored thriving in the context of graduate students who chose to continue in their graduate programs.

Table V
STUDIES CATEGORIZED UNDER THRIVING

Title	**Author**	**Constructs**
Understanding Engineering graduate student wellbeing among those students who persisted in their programs.	Zerbe et al [34]	Thriving, surviving

4.2 Methodological approach

The shortlisted papers represented a range of methodologies and methods used to measure and study wellbeing. Based on the methodology, we have categorized the articles as qualitative, quantitative, and mixed-method studies. Out of eleven papers, six employed quantitative methods, three used qualitative methods, and two used mixed methods. Tables VI to VIII list the methods used for each study.

4.2.1 Qualitative: The studies in this category used qualitative modes of data collection and analysis. Two of the three studies used interviews to collect participants' perceptions [31], [34] and one provided a review of existing studies on engineering graduate student mental health [30]. The studies used thematic analysis, interpretative phenomenological analysis, and phenomenography as analysis techniques.

Table VI
STUDIES CATEGORIZED AS QUALITATIVE

Title	**Author**	**Method**
Engineering graduate students' mental health: A scoping literature review	Bork & Mondisa [30]	Systematic review method, Qualitative coding
Examining Faculty and Graduate Student Attitudes on Stress and Mental Health	Feil-Seifer et al [31]	Qualitative Multi method design, Interpretive phenomenological analysis, Phenomenography

Surviving, thriving, departing, and the hidden competencies of engineering graduate school	Zerbe et al [34]	Qualitative Analysis	Abductive

4.2.2 Quantitative: The six studies that used quantitative methods used a variety of pre-existing instruments to measure aspects of wellbeing [26], [28], [29]. One of the most used survey instruments to collect data about wellbeing in studies that conceptualized wellbeing as mental health conditions was the Patient Health Questionnaire (PHQ) developed by Kroenke et al [35]. It is a nine-item scale that measures the prevalence of depressive symptoms among participants for a period of two weeks.

Another survey instrument adopted by studies exploring graduate students' wellbeing was the Perceived Stress Scale (PSS). The Perceived Stress Scale is a ten-item scale used to measure the perceptions of stress among different populations [36]. Among the six shortlisted studies using quantitative methods to study well-being conceptualized as mental health, two studies used the PSS to measure stress levels among graduate students [22], [33]. One shortlisted study [28] used multiple scales to obtain data about multiple mental health indicators. These included The Kessler Scale (K10), a 10-item scale that measures participants' emotional state on a 5-point response scale [37], The CAGE-AID [38] survey used to measure the prevalence of substance abuse among respondents and The Primary Care – Post-traumatic Stress Disorder (PC-PTSD) survey [39] used to screen individuals for PTSD.

Among the shortlisted studies that conceptualized wellbeing as a multidimensional construct, we found two survey instruments. One of them used by Baquero-Sierra et al [20] is the PERMA Profiler, a 23 item scale consisting of five wellbeing constructs i.e., Positive emotion, Engagement, Relationships, Meaning and Accomplishment along with a few items about negative affect, physical health, and loneliness [40].The PERMA Profiler Measure uses an 11-point Likert scale (0-10) where participants are asked to respond from never (0) to always (10) or not at all (0) to completely (10). The other instrument used by Wang & Clark [22] is The Oxford Happiness Questionnaire (OHQ) which is a 29 item scale used to measure psychological well-being on a 6 point Likert scale [24]. Table VII shows the list of studies that used quantitative methods for exploring wellbeing.

Table VII
STUDIES CATEGORIZED AS QUANTITATIVE

Title	**Author**	**Methods**
Understanding international graduate engineering students' well-being: What do they need to thrive? (Work in Progress)	Baquero-Sierra et al [20]	PERMA Profiler, Network Connection Scale
Science, engineering, and mathematics graduate student mental health insights from the healthy minds network dataset	Bork & Mondisa [26]	Patient Health Questionnaire (PHQ),

Exploring the Relationship Between Culture and Science, Engineering, and Mathematics Graduate Students' Mental Health (Full Paper)	Bork et al [29]	Patient Health Questionnaire (PHQ), Psychological Wellbeing scale for flourishing
Characterizing mental health and wellness in students across engineering disciplines	Danowitz & Beddoes [28]	Patient Health Questionnaire (PHQ), Kessler survey instrument
Visualizing Stress and Relief: How stressors and coping mechanisms interact in engineering graduate student experiences	Troutman et al [33]	Perceived Stress Questionnaire (PSQ), Resource networks
A study of Well-being Among College of Engineering Graduate Students	Wang & Clark [22]	Oxford Happiness Questionnaire (OHQ), Perceived Stress Scale (PSS-14) General health Items Analysis: ANOVAs and correlations

4.2.3 Mixed methods: Two of the shortlisted studies used a mixed methods approach for the research. One study followed a sequential explanatory mixed methods approach [32]. Using stress as a proxy for mental health, the first round of data collection used the Perceived Stress Questionnaire (PSQ) to measure stress. The second round consisted of interviews followed by thematic content analysis of the qualitative data. The other study [21] in this category used an embedded qualitative dominant mixed methods approach. The study collected quantitative data using the PERMA Profiler survey instrument followed by interviews of select survey participants. The interviews were then analyzed using narrative analysis. Table VIII details the studies that used mixed methods approach.

Table VIII
STUDIES CATEGORIZED AS MIXED METHOD

Title	**Author**	**Research Design/Method**
Understanding Stress and Relief: How Engineering Graduate Students Experience and Cope with Stress	Riley & Mallouk, [32]	Explanatory sequential mixed methods design
Investigating the tension between persistence and well-being in engineering doctoral programs	Shanachilubwa et al [21]	embedded QUAL (Quan) mixed methods design

5. Discussion

In this study, we conducted a systematic review of literature on graduate engineering students' wellbeing to identify how wellbeing has been conceptualized across literature and how it has been measured. We shortlisted a total of eleven studies published between 2014 to 2023, based on our systematic review process. Using qualitative thematic analysis, we classified the studies into three themes (1) Eudemonic and Hedonic Traditions, (2) Mental Health and (3) Thriving. In the 3 studies classified under the theme eudaimonic and hedonic traditions, wellbeing was conceptualized as a complex construct and multiple elements of an individuals' life were considered. These conceptualizations are in line with the recommendations discussed in the literature [4]. We referred to this theme as the traditional approach because wellbeing is a well-established construct in other disciplines [41]. On the contrary, the 7 studies classified under the theme Mental health conceptualized wellbeing by focusing on one dimension of psychological health. These studies posed questions to investigate how elements of graduate engineering education influenced students' psychological health. Moreover, these studies focused on mental health conditions such as depression, anxiety, and stress. These studies provided evidence that mental health is not just a major challenge for engineering graduate students but also a cause for concern for engineering educators.

In terms of measures used to study wellbeing, we classified the studies into three themes as (1) Quantitative, (2) Qualitative, (3) Mixed methods. Our aim with this research question was to explore the methods used to study wellbeing in engineering education. The analysis showed that a variety of methods have been used to study wellbeing of graduate engineering students. Our synthesis showed that six out of the eleven selected studies used quantitative methods, three used qualitative methods and two studies used mixed methods research design.

It is also interesting to note that although our search parameters spanned from 2014 to 2023, nine of the eleven studies were published in the year 2022 and 2023, and only two were published in the years 2018 and 2019. This shows that the exploration of wellbeing in engineering education is still in its early stages. We expect that as new studies are published, new and diverse conceptualizations as well as measures will be explored to study wellbeing in this space. The findings presented here should encourage researchers to adopt innovative strategies to further expand this area of study.

6. Limitations

The findings of the study should be interpreted with the following limitations in mind. Although we followed a transparent method for inclusion and selection of studies, like most systematic review studies our study is limited by publication bias as discussed by Borrego et al [18]. We tried to overcome the publication bias by selecting studies based on our inclusion criteria instead of looking for positive results. Another limitation of this systematic review is that we selected only three engineering related databases considering the scope of this paper. It is possible that with more databases, more distinct findings would have emerged. Future studies should consider using a greater number of databases from both engineering as well as education domains. Similarly, the selection process significantly reduced the number of studies included in the synthesis. However, a broader criterion such as including more synonyms might have yielded more results. Lastly, this review did not discriminate based on the quality of publications, the only quality criteria we searched for was peer reviewed articles in journals and conference papers.

7. Conclusion

This systematic literature review explored the conceptualization and the different measures that have been used to study wellbeing among graduate engineering students. We explored three engineering databases using a specific search string and exclusively focused on journal and conference papers published between 2014 to 2023 to showcase the most recent developments on graduate engineering students' wellbeing in engineering education. After shortlisting the studies, we presented the synthesis of eleven articles in this paper. The findings of this study are meant to serve as a reliable resource for researchers interested in exploring the wellbeing of graduate engineering students. Moreover, the findings should encourage educators and policy makers to consider the various aspects of wellbeing for the design of instruction as well as policy.

Acknowledgements

We thank Erin Rowley, the engineering librarian at the University at Buffalo, for her support in the database selection and helpful recommendations for conducting this systematic review. We also thank Joseph McCusker, engineering student at University at Buffalo, and an undergraduate researcher at *DARE to CARE lab,* for his invaluable assistance with the review of the studies.

This material was partially supported by the National Science Foundation Grant No. 2147193. Any opinions, findings, and conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation

Appendix 1

Table
Shortlisted Studies

Authors	Title	Year	Article type
M. J. A. Baquero-Sierra, C. E. Vargas-Ordonez, J. E. Mc Dermott, and S. M. McBride	Understanding international graduate engineering students' well-being: What do they need to thrive? (Work in Progress)	2023	Conference paper
S. J. Bork and J.-L. Mondisa	Science, engineering, and mathematics graduate student mental health insights from the healthy minds network dataset	2019	Conference paper
S. J. Bork and J.-L. Mondisa	Engineering graduate students' mental health: A scoping literature review	2022	Journal paper
S. J. Bork, N. Young and J.-L. Mondisa	Exploring the Relationship Between Culture and Science, Engineering, and Mathematics Graduate Students' Mental Health (Full Paper)	2022	Conference paper
A. Danowitz and K. Beddoes	Characterizing mental health and wellness in students across engineering disciplines	2018	Conference paper
D. Feil-Seifer, M. C. Parker and A. Kirn	Examining Faculty and Graduate Student Attitudes on Stress and Mental Health	2022	Conference paper
D. R. Riley and K. Mallouk	Understanding Stress and Relief: How Engineering Graduate Students Experience and Cope with Stress	2023	Conference paper
K. Shanachilubwa, G. Sallai and C. G. P. Berdanier	Investigating the tension between persistence and well-being in engineering doctoral programs	2023	Journal paper
J. Troutman, D. R. Riley and K. Mallouk	Visualizing Stress and Relief: How stressors and coping mechanisms interact in engineering graduate student experiences	2022	Conference paper
Y. Wang and C. Clark	A study of Well-being among College of Engineering Graduate Students	2022	Conference paper

E. Zerbe, G. Sallai and C. G. P. Berdanier	Surviving, thriving, departing, and the hidden competencies of engineering graduate school	2023	Journal paper

References

[1] T. M. Evans, L. Bira, J. B. Gastelum, L. T. Weiss, and N. L. Vanderford, "Evidence for a mental health crisis in graduate education," *Nat Biotechnol*, vol. 36, no. 3, pp. 282–284, 2018, doi: 10.1038/nbt.4089.

[2] J. Cornwall, E. C. Mayland, J. Van Der Meer, R. A. Spronken-Smith, C. Tustin, and P. Blyth, "Stressors in early-stage doctoral students," *Studies in Continuing Education*, vol. 41, no. 3, pp. 363–380, Sep. 2019, doi: 10.1080/0158037X.2018.1534821.

[3] T. John and P. Denicolo, "Doctoral Education: A Review of the Literature Monitoring the Doctoral Student Experience in Selected OECD Countries (Mainly UK)," *Springer Science Reviews*, vol. 1, no. 1–2, pp. 41–49, Dec. 2013, doi: 10.1007/s40362-013-0011-x.

[4] F. A. Huppert, "Challenges in Defining and Measuring Well-Being and Their Implications for Policy," in *Future Directions in Well-Being: Education, Organizations and Policy*, M. A. White, G. R. Slemp, and A. S. Murray, Eds., Cham: Springer International Publishing, 2017, pp. 163–167. doi: 10.1007/978-3-319-56889-8_28.

[5] E. L. Deci and R. M. Ryan, "Hedonia, eudaimonia, and well-being: an introduction," *J Happiness Stud*, vol. 9, no. 1, pp. 1–11, Jan. 2008, doi: 10.1007/s10902-006-9018-1.

[6] R. Biswas-Diener, "The subjective well-being of small societies," *Handbook of Well-Being*, p. 849, 2018.

[7] C. D. Ryff and C. L. M. Keyes, "The structure of psychological well-being revisited.," *Journal of personality and social psychology*, vol. 69, no. 4, p. 719, 1995.

[8] C. Lundqvist, "Well-being in competitive sports—The feel-good factor? A review of conceptual considerations of well-being," *International Review of Sport and Exercise Psychology*, vol. 4, no. 2, pp. 109–127, Sep. 2011, doi: 10.1080/1750984X.2011.584067.

[9] A. S. Waterman, "Two conceptions of happiness: Contrasts of personal expressiveness (eudaimonia) and hedonic enjoyment.," *Journal of personality and social psychology*, vol. 64, no. 4, p. 678, 1993.

[10] E. Cameron, J. Mathers, and J. Parry, "'Health and well-being': Questioning the use of health concepts in public health policy and practice," *Critical Public Health*, vol. 16, no. 4, pp. 347–354, 2006, doi: 10.1080/09581590601128166.

[11] E. Diener, "Guidelines for national indicators of subjective well-being and ill-being.," in *Journal of Happiness Studies: An Interdisciplinary Forum on Subjective Well-Being*, Springer, 2006.

[12] K. J. Jensen and K. J. Cross, "Engineering stress culture: Relationships among mental health, engineering identity, and sense of inclusion," *Journal of Engineering Education*, vol. 110, no. 2, pp. 371–392, 2021, doi: 10.1002/jee.20391.

[13] K. J. Jensen, J. F. Mirabelli, A. J. Kunze, T. E. Romanchek, and K. J. Cross, "Undergraduate student perceptions of stress and mental health in engineering culture," *IJ STEM Ed*, vol. 10, no. 1, p. 30, 2023, doi: 10.1186/s40594-023-00419-6.

[14] M. Asghar, A. Minichiello, and A. Iqbal, “Perceived factors contributing to the subjective wellbeing of undergraduate engineering students: An exploratory study,” *International Journal of Environmental Research and Public Health*, vol. 19, no. 23, p. 16284, 2022.
[15] S. J. Bork and J.-L. Mondisa, “Engineering graduate students’ mental health: A scoping literature review,” *Journal of Engineering Education*, vol. 111, no. 3, pp. 665–702, 2022, doi: 10.1002/jee.20465.
[16] S. T. Charles, M. M. Karnaze, and F. M. Leslie, “Positive factors related to graduate student mental health,” *Journal of American College Health*, vol. 70, no. 6, pp. 1858–1866, 2022, doi: 10.1080/07448481.2020.1841207.
[17] P. Kinderman, S. Tai, E. Pontin, M. Schwannauer, I. Jarman, and P. Lisboa, “Causal and mediating factors for anxiety, depression and well-being,” *The British Journal of Psychiatry*, vol. 206, no. 6, pp. 456–460, 2015, doi: 10.1192/bjp.bp.114.147553.
[18] M. Borrego, M. J. Foster, and J. E. Froyd, “What Is the State of theArt of Systematic Reviewin Engineering Education?: Review of Systematic Reviews in Engineering Education,” *J. Eng. Educ.*, vol. 104, no. 2, pp. 212–242, Apr. 2015, doi: 10.1002/jee.20069.
[19] D. Moher, A. Liberati, J. Tetzlaff, and D. G. Altman, “Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement,” *Ann Intern Med*, vol. 151, no. 4, pp. 264–269, Aug. 2009, doi: 10.7326/0003-4819-151-4-200908180-00135.
[20] M. J. A. Baquero-Sierra, C. E. Vargas-Ordóñez, J. E. McDermott, and S. M. McBride, “Understanding international graduate engineering students’ well-being: What do they need to thrive?(Work in Progress),” in *2023 ASEE Annual Conference & Exposition*, 2023. Accessed: Nov. 20, 2023. [Online]. Available: https://peer.asee.org/understanding-international-graduate-engineering-students-well-being-what-do-they-need-to-thrive-work-in-progress
[21] K. Shanachilubwa, G. Sallai, and C. G. P. Berdanier, “Investigating the tension between persistence and well-being in engineering doctoral programs,” *Journal of Engineering Education*, vol. 112, no. 3, pp. 587–612, 2023, doi: 10.1002/jee.20526.
[22] Y. Wang and C. Clark, “A study of Well-being among College of Engineering Graduate Students,” in *2022 ASEE Annual Conference & Exposition*, 2022. Accessed: Jan. 21, 2024. [Online]. Available: https://peer.asee.org/40710.pdf
[23] M. Seligman, “PERMA and the building blocks of well-being,” *The Journal of Positive Psychology*, vol. 13, no. 4, pp. 333–335, 2018, doi: 10.1080/17439760.2018.1437466.
[24] P. Hills and M. Argyle, “The Oxford Happiness Questionnaire: a compact scale for the measurement of psychological well-being,” *Personality and individual differences*, vol. 33, no. 7, pp. 1073–1082, 2002.
[25] K. Shanachilubwa, M. Ellery, G. M. Sallai, and C. G. P. Berdanier, “‘I Wish I Would Have Known...’: Characterizing Engineering Students’ Reflections on Their Graduate Experiences,” in *2021 ASEE Virtual Annual Conference, ASEE 2021, July 26, 2021 - July 29, 2021*, in ASEE Annual Conference and Exposition, Conference Proceedings. Virtual, Online: American Society for Engineering Education, 2021.
[26] S. J. Bork and J.-L. Mondisa, “Science, engineering, and mathematics graduate student mental health insights from the healthy minds network dataset,” in *126th ASEE Annual Conference and Exposition: Charged Up for the Next 125 Years, ASEE 2019, June 15, 2019 - June 19, 2019*, in ASEE Annual Conference and Exposition, Conference Proceedings. Tampa, FL, United states: American Society for Engineering Education, 2019.

[27] S. Bork, “Examining Factors Related to Engineering Graduate Students’ Mental Health Experiences,” PhD Thesis, 2023. Accessed: Apr. 21, 2024. [Online]. Available: https://deepblue.lib.umich.edu/handle/2027.42/177955
[28] A. Danowitz and K. Beddoes, “Characterizing mental health and wellness in students across engineering disciplines,” in *2018 Collaborative Network for Engineering and Computing Diversity Conference, CoNECD 2018, April 29, 2018 - May 2, 2018*, in CoNECD 2018 - Collaborative Network for Engineering and Computing Diversity Conference. Crystal City, VA, United states: American Society for Engineering Education, 2018.
[29] S. J. Bork, N. Young, and J.-L. Mondisa, “Exploring the Relationship Between Culture and Science, Engineering, and Mathematics Graduate Students’ Mental Health (Full Paper),” in *129th ASEE Annual Conference and Exposition: Excellence Through Diversity, ASEE 2022, June 26, 2022 - June 29, 2022*, in ASEE Annual Conference and Exposition, Conference Proceedings. Minneapolis, MN, United states: American Society for Engineering Education, 2022.
[30] S. J. Bork and J.-L. Mondisa, “Engineering graduate students’ mental health: a scoping literature review,” *Journal of Engineering Education*, vol. 111, no. 3, pp. 665–702, 2022, doi: 10.1002/jee.20465.
[31] D. Feil-Seifer, M. C. Parker, and A. Kirn, “Examining Faculty and Graduate Student Attitudes on Stress and Mental Health,” in *129th ASEE Annual Conference and Exposition: Excellence Through Diversity, ASEE 2022, June 26, 2022 - June 29, 2022*, in ASEE Annual Conference and Exposition, Conference Proceedings. Minneapolis, MN, United states: American Society for Engineering Education, 2022.
[32] D. R. Riley and K. Mallouk, “Understanding Stress and Relief: How Engineering Graduate Students Experience and Cope with Stress,” in *2023 ASEE Annual Conference & Exposition*, 2023. Accessed: Feb. 01, 2024. [Online]. Available: https://peer.asee.org/understanding-stress-and-relief-how-engineering-graduate-students-experience-and-cope-with-stress
[33] J. Troutman, D. R. Riley, and K. Mallouk, “Visualizing Stress and Relief: How stressors and coping mechanisms interact in engineering graduate student experiences,” in *129th ASEE Annual Conference and Exposition: Excellence Through Diversity, ASEE 2022, June 26, 2022 - June 29, 2022*, in ASEE Annual Conference and Exposition, Conference Proceedings. Minneapolis, MN, United states: American Society for Engineering Education, 2022.
[34] E. Zerbe, G. Sallai, and C. G. P. Berdanier, “Surviving, thriving, departing, and the hidden competencies of engineering graduate school,” *Journal of Engineering Education*, pp. 147–69, 2023, doi: 10.1002/jee.20498.
[35] K. Kroenke, R. L. Spitzer, and J. B. W. Williams, “The PHQ-9: Validity of a brief depression severity measure,” *J Gen Intern Med*, vol. 16, no. 9, pp. 606–613, Sep. 2001, doi: 10.1046/j.1525-1497.2001.016009606.x.
[36] S. Cohen, T. Kamarck, and R. Mermelstein, “Perceived stress scale,” *Measuring stress: A guide for health and social scientists*, vol. 10, no. 2, pp. 1–2, 1994.
[37] G. Andrews and T. Slade, “Interpreting scores on the Kessler psychological distress scale (K10),” *Australian and New Zealand journal of public health*, vol. 25, no. 6, pp. 494–497, 2001.

[38] R. L. Brown and L. A. Rounds, “Conjoint screening questionnaires for alcohol and other drug abuse: criterion validity in a primary care practice.,” *Wisconsin medical journal*, vol. 94, no. 3, pp. 135–140, 1995.
[39] R. P. Cameron and D. Gusman, “The primary care PTSD screen (PC-PTSD): development and operating characteristics,” *Primary care psychiatry*, vol. 9, no. 1, pp. 9–14, 2003.
[40] J. Butler and M. L. Kern, “The PERMA-Profiler: A brief multidimensional measure of flourishing,” *International Journal of Wellbeing*, vol. 6, no. 3, Art. no. 3, 2016, doi: 10.5502/ijw.v6i3.526.
[41] V. L. Placa, A. McNaught, and A. Knight, “Discourse on wellbeing in research and practice,” *International Journal of Wellbeing*, vol. 3, no. 1, Art. no. 1, Mar. 2013, Accessed: Feb. 07, 2024. [Online]. Available: https://www.internationaljournalofwellbeing.org/index.php/ijow/article/view/177