A Review of Mental Health Issues Prevalent in Science, Technology, Engineering & Mathematics (STEM) Subjects

INTRODUCTION

Studying mental health within software design is an emerging topic that has rapidly become a largely discussed issue, especially among Information Technology (IT) users both during their education and once they enter the job market. Unaddressed mental health issues in that sector are reported to have massive implications on users' productivity, long-term health, and career prospects (Rutner et al, 2011), (Mahapatra and Pati, 2018), (Rietze and Zacher, 2022),(Cao and Park, 2017), (Atouba and Lammers, 2018).

Science, Technology, Engineering and Mathematics (STEM) students in particular are reported to have more mental health issues than their counterparts in education (Baron-Cohen et al, 1997), (Windham et al, 2009). Success in STEM field involves diligence, skill, and patience, but perfection is often viewed as another expectation of these subjects. STEM subjects' high pressure and rigidity can trigger or exacerbate mental health difficulties, and the silence and stigma surrounding mental health make it even more difficult for students or employees to obtain the support they need and deserve (Galvin et al, 2022). This is complicated further as no two people experience mental health difficulties in the same manner, studying can be difficult, underscoring the need for a flexible yet systematic multi-dimensional approaches to manage these difficulties. These approaches can include (among others): changing studying habits, technological interventions, and/or making the learning experience more health-aware for STEM students.

According to research on student mental health, from a student's perspective, positive mental health is linked to improved cognitive and psychological functioning, including higher academic engagement, creativity, decision-making, problem-solving, concentration, productivity, retention, and outcomes, which also suggests a connection between wellbeing and academic performance (Pascoe et al, 2019). Conversely, poor mental health has a detrimental effect on students' experiences, wellbeing, and achievement (Salimzadeh et al, 2017).

From an employee's perspective, a positive work experience is correlated with optimal health, longevity, and life satisfaction, in addition to improved organization performance. Increasing work and productivity demands brought by organizations and technologization have consistently been associated with increasing work-related stress, burnout, and mental health difficulties (Andersen et al, 2022).

Studying both the educational and workplace settings serve multiple purposes: (a) Assist educators in designing curricula and choosing educational software that maximises the most important factors affecting mental health in the educational setting (b) Prepare STEM students to become productive employees in the STEM workplace (c) Assist employers in understanding the factors affecting incoming employees which have studied STEM subjects (d) Assist educators and employers in understanding the efforts available to them which they can utilise to create positive educational and workplace environments.

Despite the importance of addressing mental health in the STEM students and IT professionals (i.e. STEM in an educational and workplace setting), little has been done to study the mental health factors and systematic efforts done specifically for the STEM field. As such, the target problem of this chapter is to collate the most important factors affecting mental health in STEM specifically (both in educational and workplace settings), to identify what systematic efforts have been done to improve these factors, and to identify future research directions to address gaps in these efforts. As such, the contributions of this chapter are two-fold: (a) This chapter presents a working taxonomy of the most commonly reported factors affecting mental health in STEM along with a categorisation of the systematic efforts done to improve these factors both in an educational and workplace setting (b) This chapter identifies research gaps in systematic efforts which improve the factors identified in the taxonomy, paving the way for future research to fill these gaps.

Best effort was made to ensure these themes: (a) do not pre-determine the factors affecting mental health in STEM nor the systematic efforts to address them and (b) provide good coverage of the literature needed to address the target problem of the paper.

As many of these terms used overlap or can be ambiguous, Section 2 of this chapter clarifies these concepts and terminologies. Section 3 outlines the inclusion and exclusion criteria for the literature, which will help set the scene for the taxonomy. The three explored thematics include Mental Health, Technostress and Assistive Technology. These themes were chosen to explore the factors relevant to our taxonomy. Section 3 prunes this large field to identify literature relevant to mental health in STEM. As such, studying these themes is important to identify the existing systematic efforts to improve mental health in STEM and the research gaps in that field.

Section 4 delineates the taxonomy comprised of a literature review, following the guidelines for Systematic Literature Review (SLR) proposed in (Kitchenham, 2007).

Section 5 details the proposed taxonomy. Section 6 of this chapter findings are summarised and discussed in relation to the research gap to be explored. Section 7 of this chapter outlines the threats to validity related to this chapter's contributions. Section 8 concludes the chapter by reflecting on the significance of this chapter's contributions.

TERMINOLOGY

Mental Health is described as a person's level of mental and emotional health. Every person has mental health, which ranges from "good" to "poor," just like everyone has physical health. A number of elements influence mental health, such as stress, diet, sleep, and especially of particular relevance to this paper are the IT-related elements which influence mental health (Jeffers, 2022). It is a crucial element of health and well-being that supports both individual and group capacities to decide, form connections, and influence our surrounding world. A core human right is working and studying in environment that maintains and/or improves mental health. Additionally, it is essential for socioeconomic, community, and personal development, in order to increase self-awareness, self-esteem, increases skills, and fulfil aspirations (WHO, 2022).

Technostress was first coined in 1984 by American psychologist Craig Brod, who described it as "a modern adaption disorder brought on by the difficulty of coping with new computerized technologies in a healthy manner" (Chiappetta, 2017). However, with advancements in both technology and communications the internet has evolved into a universal informational resource. So now the term technostress acquires a new meaning. Technostress is a modern term commonly used today to describe stress brought on by extended usage of emerging Information and Communication Technology (ICT) like the Internet, mobile phones, laptops, teleworking, and online learning. Techno-stressors are the triggers, events, and circumstances that cause technostress (Torre et al, 2020).

Assistive Technology is frequently used to refer to devices or systems that support people with disabilities, limited mobility, or other impairments to carry out tasks that would otherwise be challenging or impossible. By easing or compensating for an injury or impairment, these tools help people maintain or improve their daily quality of life (GOV, 2022). People who require assistive technology—an umbrella word for products and services such as wheelchairs, spectacles, and hearing aids—do not constitute a minority group. People with disabilities, the elderly, people with communicable and noncommunicable diseases, people with mental health conditions, and people with gradual functional decline or loss of intrinsic capacity are among those who require a product that improves cognition, communication, hearing, mobility, self-care, or vision (Lancet, 2022). Of particular relevance to this chapter are assistive technologies targeting mental health conditions and/or those that aim for mental-health-related self-care (Rind, 1994).

RESEARCH METHODOLOGY

A systematic procedure defined by (Wohlin, 2014) specifically for the software engineering field was used to identify the literature relevant for this chapter. The databases referred to in this chapter are Scopus, Science Direct, IEEE Xplore, ACM Digital Library, SpringerLink, Google Scholar, Researchgate, NCBI. The search strings used were "mental health", "technostress", "assistive technology", "STEM", "student[s]", "undergraduate[s]", "employee[s]", "employment", "workplace", "organisation[s]", along with Boolean operators such as "OR", "AND" "AND NOT", to further narrow down the results. Snowballing (which refers to using the reference list of a paper or the citations to the paper to identify additional papers) was also applied by searching the previously discovered works for pertinent references in order to find other potential works (Wohlin, 2014). With journals, conferences and workshop publications being considered. Due to some overlap between the search engines and databases' databases, duplicate papers were suppressed from the results.

INCLUSION CRITERIA

EDUCATIONAL SETTING

- Contributions on mental health of students, regardless of their age group (basic vs. higher education) and regardless of the gender are included.
- Case studies on mental health of students, regardless of their age group (basic vs. higher education) and regardless of the gender are included.
- Literature reviews on mental health of students, regardless of their age group (basic vs. higher education) and regardless of the gender are included.

WORKPLACE SETTING:

- Any papers that mention mental health regardless of the age.
- Any papers that mention mental health related to technology usage regardless of the industrial domain in which the technology is being used.

EXCLUSION CRITERIA

EDUCATIONAL SETTING:

- Any papers that target the mental health of higher education (HE) professionals rather than students were not considered. The reason is that students are the main beneficiaries of educational settings. Nevertheless, the state-of-the-art in the workplace settings will be studied to see if any contributions there are applicable to the educational setting. Moreover, the reported mental health issues are more on the student side rather than academic side.

WORKPLACE SETTING:

- Any papers that mention physical or mental health outside the scope of workplace/organizational environment.

Due to the broad (and rising) diversity of approaches, it is not possible to present an entire list of values for the majority of the concepts.

RELATED WORK

This section summarises existing related work and/or literature reviews which study mental health, technostress, and assistive technologies in educational and workplace settings.

MENTAL HEALTH IN EDUCATIONAN SETTING

There has been a sixfold increase in student mental ill health since 2010, resulting in a steady growth of research on mental health and well-being in university students over the last decade (Susan Hubble, 2020)(Hernández-Torrano et al, 2020). Students who experience mental health issues may suffer major effects, including academic failure, dropping out, poor career prospects, and, in the worst cases, suicide. Young adults today are more likely than earlier generations to encounter mental illness, findings by (Johnson, 2018) reveal an increase in the prevalence of common mental disorders (CMDs) for those aged 16 to 24, which has an knock-on effects on the quality of life in university students (Ribeiro et al, 2018). Given that the peak beginning for mental health problems is before the age of 24, age is unquestionably a significant factor in explaining the rise in students with serious mental health problems seeking university counselling (Macaskill, 2013). Second year students are more likely to experience the most significant increases in metal health, with third year scores higher than first year scores (Macaskill, 2013). Given the male dominance within the STEM field, male STEM students are at more risk of these mental health issues (Van Veelen et al, 2019), (Catherine Hill, 2010), (Catalyst, 2022).

Academic demands can be a significant source of stress, with students feeling stressed trying to perform well in tests and coursework whilst keeping up with their studies and competing in the ever growing and extremely competitive STEM graduate job market. Performance, engagement, and completion are short-term outcomes associated with early adulthood psychological distress, with longer-term outcomes being recurrent mental health problems, university dropout, lower rates of employment, and reduced personal income, with studying identified as university students' top source of stress (Hernández-Torrano et al, 2020), (Johnson, 2018). The authors (Zada et al, 2021) investigated the relationship between academic success and mental health issues among university students. Findings show that the rise in mental health issues lowers university students' academic performance. This then leads to negatively affecting the professional and personal lives of students. While some university students are able to handle increased stress or obstacles while maintaining their academic success, others are unable to manage the stress, which negatively impacts their academic performance and may cause them to drop out of school without earning a degree (Chemers et al, 2001).

Work by (Humphrey and McCarthy, 1998) found no connection between student stress levels and debt (measured in expenditure terms). They stated that student loan debt might now be viewed as a normal aspect of collegiate life. However, other research's suggest stressing factors also included financial stressors. Due to the increase in tuition costs today's students have greater debt loads than their forebears. Additionally, students will also experience financial stress as they manage their own funds for the first time. Thus, financial concerns have been linked to be partial contribution of the cause of poorer mental health. Financially struggling students are more likely to experience anxiety and sadness, which can harm their academic performance and even result in dropouts. As a result, corporations should be concerned about students in universities who are experiencing financial hardship in addition to administrators and

teachers (Lim and Teo, 1997). Findings suggest that there is a considerable link between a student's actual financial situation and mental health, as well as their perception of their financial situation. As (Benson-Egglenton, 2018) examined the connection between students' financial situations and wellness in the present HE environment of rising tuition costs, rising student debt, and rising use of university mental health services. It established that a student's mental health is related to some financial aspects. In general, students who reported feeling less well-being were more likely to be in difficult financial situations: having some personal debt, coming from a low-income family, receiving a bursary, and not having parental financial support. It was discovered that students with high financial concerns scored higher on tests of stress, anxiety, or nervousness, difficulty falling asleep, and feeling judged by others. Financial worries increase with time, having a greater impact on mental health indicators in the third year than in the second or first year. Financial worries appear to grow as students finish their degrees, as the mental health averages for the second and third years are nearly identical (Cooke et al, 2004). This is understandable given that by their third year, students will have racked up more debt and may be seriously concerned about repaying it when they earn their degree.

Students also mentioned negative emotions associated with workloads, deadlines, and assessments, such as worry, tension, and anxiety. Analysis of data from (Riva et al, 2020) study outlines that student-centred learning and assessment are enablers of student wellbeing and can stimulate student being more valued, engaged and noticed. However, student-centred learning experiences can potentially have a negative impact on wellness. (Riva et al, 2020) contends that this occurs when such actions are not properly planned and executed. In order to achieve openness, activeness, and engagement, it is critical to strike a balance between not imposing engagement and providing clear, flexible support and feedback. There has not yet been a thorough investigation into how evaluation techniques affect students' wellbeing in UK higher education assesses tensions which can arise in assessment design and strategy when seeking to balance the wellbeing of students (Jones et al, 2020). The study highlights the need to acknowledge the pressures of assessment on student wellbeing. Students highlighted assessment as the 'first point of failure'. Findings outline that giving students more control over assessments could boost their sense of individuality and ownership. Students required the freedom to create their own methods for finishing assessments. While some students may feel that their freedom gives them more ownership and control over their work, less self-assured pupils may find it stressful. Similarly, giving feedback versus getting criticism also highlighted the challenge of juggling the demands of practise with the objective of individualised, detailed feedback. This puts a strain on staff and resources due to high student enrolment and intense grading. Zooming out from specific ways to wellbeing, as (Lister et al, 2021) examined how mental health affects higher education, exploring the barriers and enablers that students encounter. The study finds a variety of, study, skill, and environmental barriers and enablers. The discovered themes that are present across the learning environment, and they show how the barriers students encounter can transformed into enablers such as those presented in (Ann-Marie Houghton, 2017), (Harward, 2009), (Aked et al, 2008).

Student engagement, active participation, and dedication to learning, is seen to be vital for students' success in higher education. It is believed that taking an active and participatory role in learning can improve learning outcomes and processes. Students collaborating with faculty members in developing pedagogical methods encouraged the students to feel a greater feeling of involvement, motivation, and enthusiasm (Bovill et al, 2011). As (Wornast, 2018) outlined, amongst other factors all students linked curriculum; resources, activities and teaching as being influential on their ability to engage with their studies and led to negative emotions with the coping but also, their motivation for studying. The findings support the idea that diversified teaching styles are most beneficial across bigger student cohorts, but they also emphasise the necessity of active learning opportunities. Educators cannot just assume that students will like their curriculum design. As (Brooman et al, 2014) study highlights, staff efforts to redesign a curriculum were appreciated and added value when the students' voices were heard. One important factor of curriculum design is the technologies used in delivering that curriculum. As (Brooman et al, 2014) suggests, there is

space for more inclusive curriculum design. One dimension of inclusivity is mental health awareness. Therefore, there is space for designing more mental health aware technologies to enhance curricula.

As outlined, factors such as: performance, engagement, finance, assessment, and curriculum are all influential on the impact mental health. Such factors will have a knock-on effect on student happiness and achievement. Students who had higher level of happiness and satisfaction, had higher academic achievements, resulting in general happiness status in their life (Khodabakhsh et al, 2019). Students that aim to accomplish their objectives make every effort to do so, even if they do so pragmatically and strategically. This frame of view inspires them to make plans for their research. They aim to make the most of their time by learning the material quickly and passing their tests well. As a result, they achieve their goals and will experience happiness and good sentiments as a result. Management and control of the situation allows them to carry out their goals without interference from other forces. Relying on their own abilities improves their happiness, and as a result of completing their academic goals, this cycle continues and their level of happiness will rise (Meimanat Tabbodi, 2015).

MENTAL HEALTH IN WORKPLACE SETTING

Mental health is considered to be a wide category that includes several workplace factors. Employee engagement, which is a confluence of cognitive and emotional antecedent characteristics in the workplace, leads to a higher frequency of positive affects within the broader category of mental health (job satisfaction, commitment, joy, fulfilment, interest, caring). The effective application of work, employee retention, innovation, and ultimately corporate success are all related to positive mental health.

Poor mental health negatively impacts a person's physical health and well-being in relation to their work. It also negatively impacts their cognitive, behavioural, emotional, social, and relational functioning. As a result, a person's capacity to participate in work may be compromised through decreased productivity and performance, decreased ability to work safely, or trouble retaining or obtaining employment. According to World Health Organisation (WHO)(Organization, 2022) 15% of working-age adults are thought to be suffering from a mental illness. Around the world, as of 2019, 301 million people had anxiety, 1280 million had depression, 164 million had schizophrenia or bipolar disease, and every year, 703 000 people committed suicide. Many of these individuals were of working-age. It is estimated that on an annual basis, up to £56 billion is lost annually by UK companies due to poor mental health as a result of increased absenteeism, burnout and turnover, lower productivity and performance (Deloitte, 2022)

Early retirement, disability, and absence from work are all disproportionately impacted by mental health illness. When people experience mental health issues, they are more likely to experience longer periods of unemployment, become disabled, and retire earlier (Wynne et al, 2014).

Stress, depression, anxiety, well-being, self-efficacy, and perceived health status all have an impact on mental health. As (Hwang and Jo, 2021) research indicates that, in order to improve wellness, mental health should be improved in adult workers. Suggesting that programmes for reducing stress, sadness, and anxiety should be developed, and that these programmes should include techniques for boosting self-efficacy. Only a few studies have been done to determine whether interventions help improve recovery and employee wellbeing (Richardson, 2017).

Given the significant prevalence of mental health issues in the UK population, every employer will probably encounter this difficulty at some point. There are convincing, strong arguments in favour of confronting workplace mental health issues. They can have negative effects on absence, productivity, and other elements of health, which can be detrimental to both businesses and individuals. Employee wellbeing may be in the best interests of the employer. An analysis of the happy-productive worker reveals a definite correlation between emotional wellbeing and work (O'Regan, 2017).

When compared to unhappy employees, cooperative employees are more helpful to their co-workers, more punctual and time efficient, show up for more days of work, and stay with the company longer (Harter et al, 2003). Positive feelings at work have been linked to creativity, innovation, and innovative thinking (Wright, 2006). Moreover, this also has a knock-on effect in client contact intensive positions, where employee positive/negative feelings can influence their engagement with clients, such as their enthusiasm and excitement**.**

Employees' burnout is another consequence of poor mental health, which has a significant negative impact on their capacity to make meaningful contributions in both their personal and professional life. Many people leave their jobs because of mental health issues. Subsequently, as (Rajgopal, 2010) evaluates, tackling mental health in the workplace can enhance productivity of the business, improve employee health, improve employee performance and improve community well-being. Nevertheless, it is acknowledged that tackling mental health is not the sole important factor in enhancing employee productivity and performance. Other factors include (among others): the workplace arrangements, working hours, workload and policies.

TECHNOSTRESS IN EDUCATIONAL SETTING

Students at all higher education institutions being able to successfully employ self-directed learning is the context of the new normal. Students should be independent and capable of adjusting to their learning environment's demands, it is considered that they are intrinsically and academically driven. However, in the context of technostress there is little research that looks at how technostress factors affect students in the education setting.

Academic achievement and students' level of ICT proficiency are significantly correlated. Students with more advanced ICT knowledge will outperform those with less advanced ICT knowledge. Students who lack skills in ICT may experience anxiety, stress and confusion while searching for information resources on the web (Sriyalatha, 2016).

A conceptual framework by (Perera, 2021) outlined that techno-overload, techno-invasion, techno-complexity, techno-insecurity and techno-uncertainty as all being linked and negatively affecting academic performance, as a result of digital literacy, accessibility and lack of ICT skills. A study by (Essel et al, 2021) further supports this as their study also outlined digital literacy was also highlighted as major causes of technostress. With technostress having a negative impact on academic performance and productivity**,** with the contributing factors being techno-complexity and techno-invasion. poor academic achievement, as a result of technostress arises from situations where the ICTs used to promote learning are too complex to understand. Students that have high levels of digital literacy experience less technology-related stress. It was concluded that increasing digital literacy can greatly reduce technostress brought on by technology's complexity and insecurity.

A study by (Aziz et al, 2021) examined the relationship between student satisfaction and performance among university students and the aspects of technostress (techno-overload, techno-complexity, techno-insecurity, and techno-uncertainty) in relation to those factors. Findings revealed that in comparison to techno-uncertainty, techno-complexity shows a more notable impact on student satisfaction and performance expectations. However, the findings expressly show that there is no substantial relationship between students' happiness/performance and techno overload and technological insecurity.

Students with less ICT expertise, postgraduates, and older students had greater levels of technostress, this had an negative impact of technostress on academic productivity. Technostress caused by technological uncertainty was determined to be the least distressing of the five dimensions of technostress. Techno-invasion was discovered to be the most significant source of technostress among students. This could be attributed to the rising pervasiveness of technology, which has resulted in the invasion of personal time. Techno-complexity was also induced amongst students, particularly the younger generation of students who perceive technology as complex (Upadhyaya and Vrinda, 2020).

Stress, anxiety, and depression can result from coping with the complexity of technology and/or the unpredictability that comes with ongoing innovations, upgrades, and changes in ICT. Institutions that offer their students accessible ICT services, training, workshops, as well as detailed online ICT instructions and resources can enhance techno-ease and problem-focused solutions (Galvin et al, 2022).

TECHNOSTRESS IN WORKPLACE SETTING

Maintaining a work-life balance continues to be difficult for employees using technologies, a phenomenon that may have a negative impact on their job performance. Despite the fact that work-related technologies are quickly becoming more sophisticated and blurring "work-life balance for many employees. The results of (Ibrahim et al, 2021) study show that technostress creators are bad for employees' work-life balance and have become important causes of stress, strain, worry, and pressure in organisations. Utilizing well-designed systems and ICTs will enable employees to save time and effort while maintaining their work-life balance and preventing techno-invasion, techno-strain, and techno-addiction.

The adoption of information and communication technologies (ICT) in the workplace has increased recently thanks to the coronavirus disease 2019 (COVID-19) pandemic, which required remote and, consequently, digital working arrangements. A review by (Rohwer et al, 2022) of existing research reveals that, while some findings on resources and coping methods are available, no preventive approaches have been rigorously assessed.

Technostress triggers affect how well employees can function at work. Employees should be aware that if they approach technostress in a healthy way, it is not awful. For instance, emphasising the motivational benefits of using ICTs for work might improve challenge appraisal results, which aids in problem-solving and providing positive outcomes. Additionally, employees should refrain from complaining or expressing their anger because doing so may impair their judgement and have detrimental impacts (Zhao et al, 2020). Younger employees, like millennials, who are accustomed to using various media on a regular basis may be less susceptible to technostress because they are digital natives, but older workers may have lesser levels of digital literacy (Gimpel et al, 2018).

Employees who are lonely are less engaged to their organisation and perform poorer as a result. Employees feel more alone, and this makes it harder for them to be productive or even feel like they're doing a good job. This can result in employees being less likely to trust in their own talents, which can impair their performance at work. As (Taser et al, 2022) study indicated that loneliness and technostress are positively correlated, and that excessive use of technology could prevent employees from forming and maintaining social relationships. ICT use for an extended period of time impairs social skills, increases time spent alone, isolation from others, and introversion. Furthermore, technostress can also result in non-beneficial and costly effects like decreasing employee performance and job burnout. As (Pflügner et al, 2021) discusses, when faced with a stressful scenario, mindful people are more likely to use adaptive coping mechanisms, also the possibility that users may feel techno-stressors is decreased by mindfulness. A survey conducted by (Ferziani et al, 2018) concluded that communication technostress is the type of technostress that company employees suffer the most frequently, followed by society technostress, and boundary technostress. Communication technostress was caused by technology's inability to make communication simple, causing employees to lose sight of the value of genuine conversation, due to online communication is so quick. Society technostress was caused by employees they grow overly dependent on their own technology and sink in them, thus becoming isolated from the social environment, even more so with the rapid development of ICT. Boundary technostress was caused by ICT usage in employee lives becoming unrestricted, and they are becoming more dependent on technology. They gradually get dependent on ICT because they believe that technology can be used for all tasks. Thus, incorporate technology into their self-image. When they are separated from the ICT devices, they will start to feel nervous. A study by (Oksa et al, 2021) examined millennials motivations for using social media and their level of happiness at work. Findings indicated that millennials utilised social media more frequently for work-related goals and

reported higher levels of psychological discomfort, burnout, and technostress, despite the fact that they might be better technologically equipped. This may be due to the fact that social media has overstimulated their personal and professional lives, which can lead to exhaustion, strain, and stress for them.

Companies should use the theoretical concept of technostress inhibitors to adopt strategies for dealing with technostress. According to (Fuglseth and Øystein Sørebø, 2014) study findings, traditional approaches such as a help desk, end-user training, and user participation are effective strategies for lowering technostress. The study also suggests that companies should actively encourage staff to test out new ICT and reward staff for doing so. Thereby increasing employee satisfaction.

ASSISTIVE TECHNOLOGY IN EDUCATIONAL SETTING

Assistive technology (AT) is crucial to closing the performance gap between students with learning difficulties and their able counterparts. In today's the digital age, students who are unable to use technology will be at a clear disadvantage to their peers. Students with significant physical and cognitive disabilities may not be able to participate fully in their educational programme if they are unable to use technology.

The use of AT will enable students with more complex educational needs to access the general education curriculum and to develop the technological skills that will be useful to them in later life, in higher education, and in the social sphere. One of the skills required for lifelong learners to continue to progress is the ability to use technology. AT is useful to SWD as well as to students without disabilities. In the studies explored by (McNicholl et al, 2019) AT was viewed as facilitating change rather than driving it in terms of academic involvement; it facilitated participation rather than instigating it. By reducing learning barriers, compensating for students' deficiencies in specific abilities, and focusing on their strengths, the usage of AT helps all students in a classroom who are able and disabled to learn and understand a comparable topic or concept in a different way (Giek, 2021).

A systematic review by (Fernández-Batanero et al, 2022) revealed that AT increases the accessibility and inclusion of students with disabilities. Engagement ina academics is significantly impacted by AT. According to (Malcolm and Roll, 2016) it was observed that these techniques helped students with disabilities perform better academically, whilst promoting engagement and active participation in classes (Maribeth N. Lartz, 2008), (Smith-Osborne, 2014). Findings also indicate that social skill learning increased whilst promoting motivation and increasing students' attention. SWD were able to perform typical academic assignments more quickly and effectively thanks to AT. Overall, using AT was linked to better performance on educational tasks like taking notes, studying, taking tests, and reading and writing.

Maintaining high academic standards is essential to SWDs sense of identity as students, but they also report higher rates of coursework difficulty, lower grades, higher dropout rates, and failure of modules as compared to peers without disabilities. Another systematic review by (McNicholl et al, 2020) also highlighted that the usage of AT can help with academic performance and engagement in learning. However, this study looked beyond the benefits of these factors and also highlighted that those whose AT needs were fully met scored significantly higher on certain aspects of educational engagement such as academic self-efficacy, stress, time pressure and class communication compared to those with unmet AT needs.

Ultimately, students are likely to become more involved in school when they feel empowered and confident. Theoretically, routines that incorporate technology for SWD may see an increase in emotional energy due to a sense of empowerment. These students can now start to identify as members of a group, even though they may have previously been excluded from routines or, to put it another way, had little emotional energy to draw from them. Through the development and use of their digital abilities, SWD can now feel more connected to their peers and to learning, which can foster solidarity and higher levels of emotional energy (Rizk and Hillier, 2022).

ASSISTIVE TECHNOLOGY IN WORKPLACE SETTING

People with disabilities find it difficult to improve their quality of life due to the cost of AT. The cost of specialised AT can reach thousands of pounds, thus, resulting in abandonment due to either a lack of functionality or cost (Phillips and Zhao, 1993). Even commonplace devices, like a basic smartphone, can be out of reach for those with disabilities living on a tight budget. However, a lack of AT can make people with disabilities feel isolated, preventing them from taking advantage of the numerous opportunities it offers.

One of the largest obstacles for people with disabilities seeking employment continues to be employer attitudes. Nearly three-quarters (73%) of managers would be concerned that people with disabilities would struggle to perform the job, making them less likely to hire them. Employers can be concerned about racking up extra costs due to either missed productivity or having to pay for adaptations (of Commons, 2018).

Assistive technology has a potentially important role to play in opening up new opportunities to people with disabilities and increasing the range of options open to them. A SLR by (Sauer et al, 2010) outlined that the usage of AT showed enhanced accuracy and task completion rates, increased independence, and improved generalisation abilities among employees with cognitive disorders.

A study conducted by (Jakovljevic and Buckley, 2011) found that there were low employment rates for people with disabilities, low levels of technology availability and utilisation of assistive technologies, and employment barriers for people with disabilities. Barriers included: (a) expenses associated with use of assistive technologies, (b) low skill level and job applicability, (c) stigma, with employers who are uncomfortable around workers with disabilities are likely to be hesitant to hire or work with them.

The vast amount of research in assistive technology focuses on the interaction between a single user and a technical system. However it is also important to understand how social connections may influence the adoption of assistive technologies, as (Branham and Kane, 2015) explored, there are a large number of workplace accessibility difficulties, including many issues in disability-friendly workplaces, and that overcoming these barriers through the adoption of AT can help break down communication barriers and make it easier for employees with varying abilities to communicate better, which can improve collaboration and increase productivity. It was highlighted that employees frequently avoided employing AT that attracted undue attention to their disability (Shinohara and Wobbrock, 2011). AT needs to be introduced in a way that will not negatively impact how others perform at work. A lot of offices share equipment. Therefore, for everyone doing a specific work activity, the technology must either be optional or functional to not adversely impact another's ability to perform the job (Strobel and Mcdonough, 2003).

If AT is to be used effectively, it must be tailored to the individual's personal needs and preferences, with training given on how to utilise AT (Jonge and Rodger, 2006). Employees are more likely to be motivated and effective when they feel respected and included at work. A culture of inclusivity can also promote in attracting in great talent, retaining it, and increasing consumer loyalty.

SUMMARY

The most studied field across the three themes is mental health, more specifically in the educational setting was the most studied. Both technostress and assistive technology were equally studied, however amongst the two themes technostress in the educational setting was the least studied.

The fact that mental health is highly studied aligns with the motivation behind this chapter which is the importance of reviewing the mental health issues prevalent in STEM. Moreover, mental health focused assistive technologies are less studied than mental health. This preliminarily means that the problem (i.e., mental health issues) is less studied than the solution (i.e., mental health focussed assistive technologies).

This leaves space for both contributions of this chapter: identifying the most important mental health factors to be addressed and identifying the research gaps to manage them.

REPORTING ON RESULTS

The following section reports on the main findings for approaches conducted in Mental Health, Technostress and Assistive Technology in Educational and Workplace settings.

MENTAL HEALTH IN EDUCATIONAL SETTING

The StudentLife sensing app by (Wang et al, 2014) evaluates the effects of workload on stress, sleep, activity, mood, sociability, mental health, and academic **performance** on a daily and weekly basis. The study statistics demonstrate that students begin the term with high levels of positive mood and discourse, low levels of stress, and normal patterns of daily activity and sleep. Stress significantly climbs as the semester goes on and the workload grows, while good mood, sleep, conversation, and activity levels decline. Such data proved to be valuable in cases where the professor intervened and prevented the students who had skipped several weeks of lectures and failed to turn in numerous assignments from receiving failing grades. Instead, they received completed homework and incomplete grades during the summer.

The study by (Ann-Marie Houghton, 2017) places **curriculum** at the core of enhancing student mental health. Their study explores how curriculum content can support learning about mental health by presenting three approaches in order to achieve "interdisciplinary connections, adopting a curriculum-infusion approach, and/or drawing on a specific disciplinary knowledge base".

- Approach one, inter-disciplinary concern, given its prominence as a major societal concern, treats mental health as a curriculum area within curricula.
- Approach two, curriculum infusion, attempts to utilise discipline to help students engage with the classroom topic, and comprehend mental health and related concerns, where it draws on students' personal experiences (Harward, 2009).
- Approach three, discipline specific resources, integrates and embed mental health and wellbeing resources into the curriculum that are relevant to the discipline identifies "Five ways to wellbeing" (Aked et al, 2008).

Crucial to ensuring the population's well-being One, "Keep Learning," explicitly places higher education at the centre of national well-being goals. The other four - "Connect", "Be Active", "Take Notice", and "Give" - all underscore the idea that learning must be "engaged" in order to contribute to wellness. In essence, the idea of **engagement** overlaps with approach two presented in (Ann-Marie Houghton, 2017), (Harward, 2009). It is necessary to address the wider experience fragmentation brought on by modularization, the overall lack of academic assistance, and the poorly designed learning experiences. Approaches such as, tailoring work to individual student's needs resulted in "overwhelmingly positive" experiences. A study by (Tinklin et al, 2005) proposed model of support was well-received by the students and proven to be a successful strategy for helping them pass their courses.

Although it is generally acknowledged to provide **financial** aid to students who are in need, there is little knowledge and research on how to identify these individuals in an efficient manner. Traditional methods relying on advisers' subjective evaluations are ineffective and may not accurately represent the situation. Research by (Guan et al, 2015) developed a framework for determining whether students are eligible for financial aid through examining students' complicated behaviours on campus through "digital footprints" - digital footprints left behind while interacting in cyber-physical environments. The named framework, Dis-HARD, forecasts the portfolio of stipends that should be offered to a particular student.

The Computing: Ipsative Assessment (C:IA) tool developed by (Crosby et al, 2019) helps to address the problems that could be creating potential student unhappiness with **assessment** and feedback in UK higher

education. The web-based system focuses on goal-setting and progress monitoring for students. The system received a largely positive response, with particular praise for the personalised features. When students are inspired to participate in learning activities, they learn more effectively.

As (Jiao, 2015) explored the use of an e-assessment tool which provides students with a unique learning environment while also assisting university academics in managing the growing number of students with limited resources. The e-assessment tool provided students with several submission opportunities and response to their questions. Results showed an increase in pupils' interest in learning, as they were motivated to fix their mistakes and gain rewards. The academic performance of the students was enhanced by providing them with the opportunity to correct their mistakes. Focusing on the aspect of personalised learning environments (PLEs), through providing students with constructive criticism. Consequently, this led to the development of the Ontology-based Personalized Feedback Generator (OntoPeFeGe) by (Demaidi et al, 2018) which utilises a rule-based system that considers the features of both the assessment question and the student answer. The findings showed that students with little prior knowledge dramatically improved their performance after receiving tailored feedback.

MENTAL HEALTH IN WORKPLACE SETTING

People spend one-third of their life at work on average. As a result, the workplace is one of the primary locations that can influence one's quality of life, as well as their mental and physical well-being. (Hungerbuehler et al, 2021) presented a chatbot which assess employees' mental health in a cost-effective and engaging way and provide useful information for both the employee and the employer. Based on the results the system proved to be very engaging and successful in collecting anonymous mental health data from employees. Employees reported symptoms of anxiety, stress, depression and burnout, which are key factors that need be addressed in order to minimize the impacts they have on organizational **productivity**. Employee mental health and well-being outcomes must be measured in order to determine the effectiveness of organisational mental health initiatives. Success can be measured in terms of performance, engagement and **satisfaction**, as (Wu et al, 2021) identified, the eight categories of best practices for supporting mental health in the workplace.

If mental illness is not effectively treated, it can lead to increased medical costs, a higher risk of suicide, decreased work **performance**, etc. The study by (Fattah et al, 2021) explored the development of classification methods for assessing whether or not an employee needs mental health care. The importance of mental health issues in the workplace is rising. Such factors influence employee **productivity**, which in turn affects the productivity of the company. Three proposals are made by to improve the **productivity** of the employee. They asserted that people employees can boost their sense of purpose at work by utilising their abilities and working in ways that are consistent with their life objectives(Dik et al, 2013). A study by (Mohan and Panuganti, 2022) used the Perceived Stress Scale (PSS) technique for **stress** prediction, along with an assortment of machine learning algorithms to anticipate whether or not a person is stressed. With an accuracy of 99%, precision of 0.98, and sensitivity of 1, they were able to identify that amongst data captured from 251 employees only 9.6% were stress free.

Many employees are not aware that they are "burned out," therefore the symptoms go untreated, which can be problematic in the long term. Another study by (Jain et al, 2021) made use of machine learning to predict the **burnout** rate of employees using a curated set of criteria (factors).

Stress disorders are a common issue among employees, with an increased risk of stress among the employees. The authors (Reddy et al, 2018) identified factors that lead to mental **stress** using Machine Learning (ML) algorithms to identify stress in working employees. The study discovered that random forest has the highest precision and accuracy (75.13%).

Another study by(Katarya and Maan, 2020) also used machine learning to predict mental health disorders using a range of attributes. Based on the findings it was concluded that personal history of mental health disorder contributes most during disorder prediction followed by family history.

TECHNOSTRESS IN EDUCATIONAL SETTING

To the best of our knowledge, upon searching, technostress in the education setting has been explored (as presented in Section 4.3) but the problem of managing technostress in an education setting has not been technically solved, as no results of literature/research on this topic were found. There is therefore a research gap in this sub-section that we're going to address in the in the future to optimize for student performance, productivity, and satisfaction.

TECHNOSTRESS IN WORKPLACE SETTING

The authors (Salah-Eddine et al, 2018) proposed a semi-automatic process to cope with the technostress experienced by employees, in order to have a positive impact on job **satisfaction**. The first part of the process consists of employees filling in a survey-based questionnaire, once filled in the technostress detection operation begins, and concludes by the detection of one or more items of technostress creators. The second part of the operation deals with the coping element. This phase makes use of human factor involvement, represented in this instance by the mental health specialists in charge of employee monitoring and diagnosis, thus making it semi-automatic process.

Another study by (Salah-Eddine and Belaissaoui, 2016) again made use of the questionnaire developed by (Ragu-Nathan et al, 2008). This approach the employees are required to fill in the technostress-based questionnaire. Once completed the data will get passed through a Knowledge Management Server (KMS) where from there adequate coping strategies are applied. Coping strategies that work will lead to increased employee **satisfaction**, whereas coping strategies that do not work are re-evaluated by cycling through the process again.

The authors (Wang et al, 2005) provide a conceptual framework of the impact of coping strategies on computer-related technostress among employees. Their study also provides several validated coping strategies of computer related technostress to employees. By effectively utilising the coping mechanisms, it is hoped that the adoption of computer-related applications would be more productive, and that both employee and corporate **productivity** will increase.

ASSISTIVE TECHNOLOGY IN EDUCATIONAL SETTING

KidKanit a calculating aid tool by (Poobrasert and Gestubtim, 2013) proposed a brand-new approach to math education and comprehension for dyscalculic students through the aid of AT. Their results indicated an improvement in **performance** between the pre-test and the post-test scores. The tool increased dyscalculic students chance of succeeding whilst also providing the same opportunities as their learning peers. The Word Prediction software also designed by (Poobrasert et al, 2011) helps students who have learning difficulties (LD), by anticipating what terms the student wants to type into the computer. The programme was designed to enhance the writing skills of LD students.

Research carried out by (Vinumol et al, 2013) made use of Augmented Reality (AR) to assist the education of LD of students. Their proposed prototype, called Interactive Textbook, will assist students with learning disability. Without any unique markings and identifiers, the book will be exactly like a standard textbook. When the student focus on a text, 3D visuals, sounds, and videos that graphically explain the text will be augmented on that page.

A fast-paced class, especially in more advanced classes, might make it challenging for a student with visual impairments to keep up with the lectures. The authors (Black and Hayden, 2010) developed a portable

Tablet-PC-based Note-Taker, which enables students to carry it from class to class without the need for lecturers to modify their presentations in any way. This approach actively **engages** the students in notetaking during lectures, instead of audio or video recordings.

ASSISTIVE TECHNOLOGY IN WORKPLACE SETTING

With the aims to improve **efficiency** and support in production processes based on motion detection and projection, research carried out by (Funk and Schmidt, 2015) proposed the motionEAP system. A top-mounted projector that displays feedback on whether a worker chose the correct parts and assembled them using the proper tools. Such system can be used in environments where employees are configuring a product in a specific specification.

Breakbot proposed by (Reeder et al, 2010) is an emotionally expressive companion robot to encourage employees to take more regular **breaks** and **socialise**. This help office employees pace their work and manage break cycles throughout the day.

SUMMARY

Once again, the least studied field across the three themes is technostress. Therefore, there is space for studying and solving the technostress problem in a systematic manner. Moreover, in the technostress theme, no contributions in the educational (0) vs. the workplace setting (4). Although marginal, this difference can be promising since it provides a bigger pool of contributions to the educational setting. Therefore, this can be a positive preliminary sign for further research focus on mental health issues in the STEM educational setting.

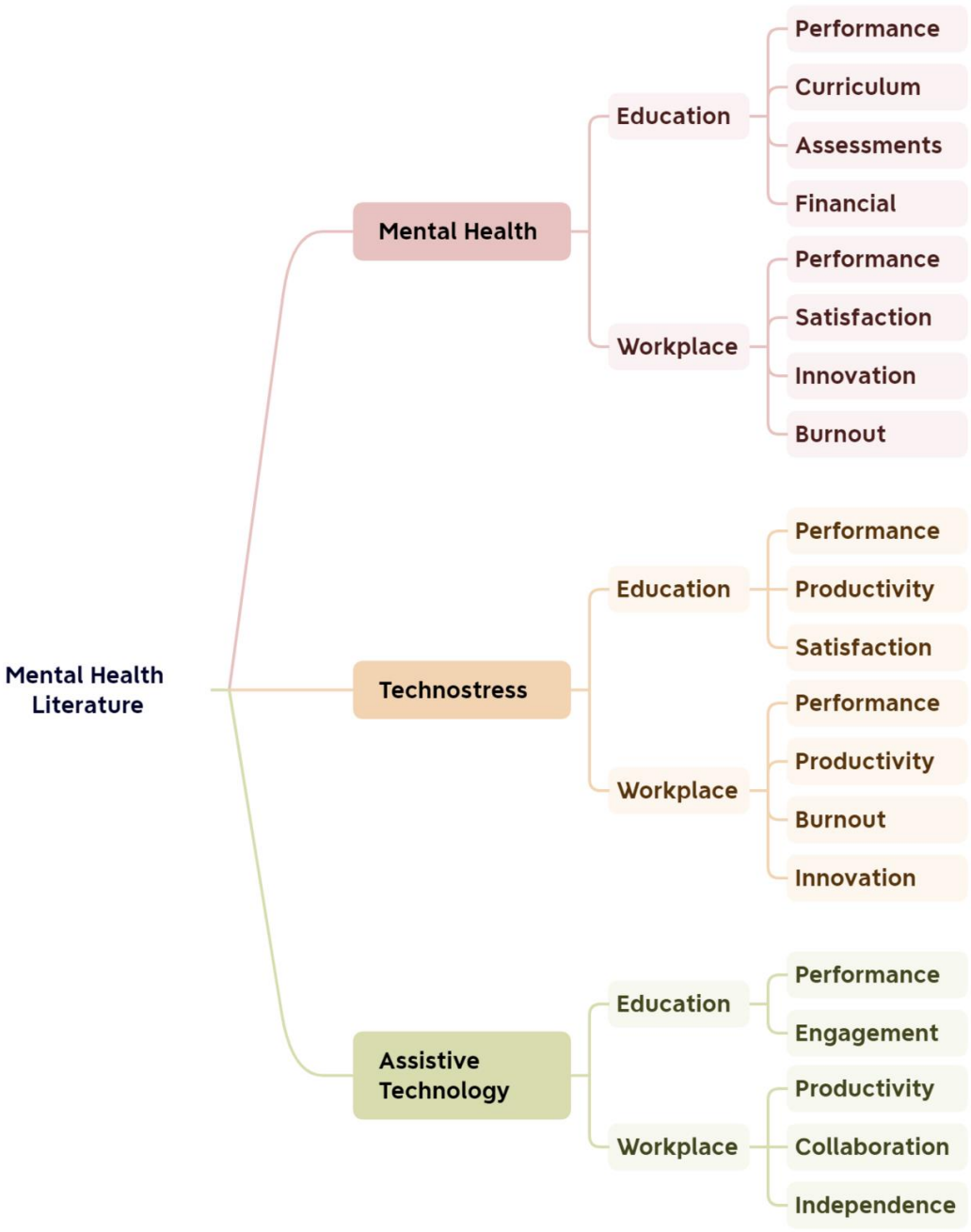

Fig. 1 Mental Health Literature Taxonomy

DISCUSSION

The most common factors linked to mental health an educational setting according to results are: The study found that mental health has a significant impact on education and career outcomes. It negatively affects student academic performance and leads to decreased job satisfaction, absenteeism, burnout, and increased likelihood of unemployment, early retirement, and disability. Technostress in education and the workplace can negatively impact performance, productivity, and lead to symptoms of stress, anxiety, depression, burnout, and pressure. However, effective use of technology can increase satisfaction and improve outcomes. The use of assistive technology in education and the workplace can reduce barriers and improve performance, engagement, motivation, independence, and productivity.

There is a clear research gap for technostress in the education setting based on the results. The problem has been acknowledged (as presented in Section 4.3) but it has not been solved. In fact, this chapter builds on the exploration of the problem, by using it to identify the three main factors affected by technostress among students: performance, productivity and satisfaction. This chapter includes these factors in that branch of the taxonomy (Fig. 1).

This gap opens venues for future software-based research to manage technostress in an education setting. More specifically, envisioning a framework as a solution to this problem. This framework would include a) a modelling approach to map technostress to software design and b) guidelines to design software in a technostress-aware manner. In essence, this framework would be a flexible way to transform any piece of educational software into a potential assistive technology.

Based on the results section, the following are considered to be the definitions of performance, productivity and satisfaction in the context of technostress among students:

- Performance: Extent to which student has achieved academic success, measured by their attained score or grades during their studies (IGI, 2023).
- Productivity: Refers to students' efforts and ability to perform efficiently in their studies (Lastirihere, 2022).
- Satisfaction: (Elliott and Shin, 2022) defines student satisfaction as students' disposition by subjective evaluation of educational outcomes and experience.

It is worth noting that these definitions differ when studied in workplace setting. For example, performance in the workplace setting is considered to mean how an employee's fulfil their job duties and executes their required tasks(Ratnasari et al, 2019).

THREATS TO VALIDITY

Internal - Naturally more papers will come up in this field, not every aspect will have been covered even though a systematic approach was taken. It is acknowledged that this field is going to emerge. To minimise this internal threat, a systematic approach to the study was taken, in which clear exclusion and inclusion criteria were identified and snowballing was applied to increase the coverage of the literature.

Best effort was made to ensure these themes: (a) do not pre-determine the factors affecting mental health in STEM nor the systematic efforts to address them and (b) provide good coverage of the literature needed to address the target problem of the paper.

External - This taxonomy only covers the education and workplace setting; it does not cover every field in which Technostress can appear or every possible workplace setting. To minimise this threat, the focus was set on the research gap in the education setting as presented at the end of Section 6. Thus, only being

concerned about the comparison between education and workplace setting, not really about the details of the workplace setting.

Conclusion

This chapter provides a systematic review and analysis of the concepts and terminologies related to mental health, technostress, and assistive technology in STEM.

The chapter presents (a) a working taxonomy of the most commonly reported factors affecting mental health in STEM along with the systematic efforts done to improve these factors (b) research gaps in systematic efforts which improve the factors identified in the taxonomy, paving the way for future research to fill these gaps. The significance of the chapter's contributions lies in providing clarity and identifying research gaps related to mental health, technostress, and assistive technology in STEM. The chapter also outlines the threats to validity related to these contributions, which is important for building on the taxonomy in the future as more research emerges in the themes of this chapter.

Overall, this chapter is a valuable resource for researchers and practitioners in the field of mental health and software design, providing a deeper understanding of the presented themes and identifying areas for further research.

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KEY TERMS AND DEFINITIONS

Higher Education: A term used to describe the institutional providers of undergraduate level education.

Mental Health: Described as a person’s level of mental and emotional health

Assistive technology: Devices or systems that support people with disabilities, limited mobility, or other impairments to carry out tasks that would otherwise be challenging or impossible.

Technostress: Inability to cope with technology in a healthy manner.

Student: A learner enrolled in an educational institution, actively acquiring knowledge and skills in various subjects through instruction and assessments

Employee: An individual who works for an organization or employer in exchange for compensation.

Workplace: A physical or virtual location where employees or individuals carry out their professional activities, tasks, and responsibilities