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Managing technostress in the STEM world

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Abstract

The rapid evolution of technological advancements in the science, technology, engineering, and mathematics (STEM) fields is enabling ever faster progress. However, the rapid pace of change can also lead to elevated stress for STEM workers. Here, we provide strategies for coping with and limiting technostress amongst researchers and other STEM professionals.

Introduction

The use of computer technology is an integral part of modern science and the increase in virtual communication in STEM fields during the coronavirus disease 2019 (COVID-19) pandemic has further increased reliance on technology. Scientists use computers to run simulations and build electronic models, such as when building artificial intelligence, programming a microscope, or segmenting a final graph with Python to quantify neuronal mitochondria. While these advances have opened new avenues, the need to engage in technological multitasking and the presence of ever-evolving new technologies contribute to technostress, a modern disease caused by inadequately coping with new technologies need to engage in technological multitasking and the presence of ever-evolving new technologies contribute to technostress, a modern disease caused by inadequately coping

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with new technologies [1]. Initially, there were five creators of technostress: techno-overload, techno-invasion, technocomplexity, techno-insecurity, and technouncertainty [2], but as recently as 2019, three other facets of technostress have been identified: techno-unreliability, information technology (IT)-based monitoring, and cyberbullying (Table 1) [3]. Technostress can be defined now as the stress created by technology-related demands and other stimuli. In addition, overuse and misuse of technology may result in technostress for a company and its employees. However, research has shown that prevention of technostress has a lasting effect on improving employee productivity and innovative thought, thus positively impacting their organizations and institutions [1,4]. We believe each era imposes a certain level of technostress associated with technology of the time and given the increased pace of change in modern times, keeping up presents increasing challenges. This paper will discuss how to identify technostress and be tech-savvy in a technology-reliant world and provide strategies to alleviate stress and modify behavior to create cyber balance in STEM workers.

What is technostress?

Technostress was defined in 1982, as a ‘disease of adaptation caused by an inability to cope with the new computer technologies in a healthy manner’ and it referred to computer anxiety [5]. More recently, the term ‘technostress’ has referred to increased stress associated with the digitization of modern jobs [6]. As shown in Table 1, technostress can be broken up into several key aspects, all of which are moderately correlated with each another and often occur simultaneously [3,5]. Together, these factors can add to workplace stressors already in place due to the demand and necessity of technology use (Figure 1). This can occur at workplace settings across the wide range of technologies and is not limited to the use of computers (Table 1). We believe that in totality, many STEM employees spend most of their waking day using and viewing screens, which exposes them to technostress and contributes to burn out, drop out, and associated harmful health effects.

In academic and professional settings, technostress can cause a lack of motivation and increased stress, which reduces productivity, performance, and causes individuals to leave STEM [2,6,7]. For example, there are levels of fear and anxiety around a person trained in biology suddenly needing to increase their computational skills to address problems related to computational modeling that could cause them to give up their goals. Computational biology-induced technostress as well as stress related to the demand to rapidly become proficient with new technologies may cause individuals to leave the pipeline. It has been shown that improper managing of technostress can lead to lower job satisfaction, increased worker anxiety, lower quality work, and more resistance to future technology [2,8], thus contributing to individuals leaving STEM careers. Further, avoiding technologies such as computational methods and technostress could be a reason for trainees choosing careers outside of STEM.

Beyond causing individuals to leave or avoid STEM careers, the effect of technostress on human health is an active area of investigation and there is growing evidence that technostress can damage ones holistic health [9–11]. Physical stress reactions that occur with technostress include increases in blood pressure, release of the stress hormone cortisol,

and heart rate [8]. Musculoskeletal issues, eye strain, and sleep disorders have all been associated with technostress [12]. Emotionally, technostress can cause exhaustion, fatigue, anxiety, and anger, which can lead to depressive thoughts [7,8]. Teaching individuals to reduce technostress would help retain workers and trainees in STEM as well as diminish detrimental health risks.

How to deal with technostress

To remedy technostress, it must first be properly recognized and diagnosed. Scholars have proposed measuring technostress with questionnaires and indices that allow a better understanding of which dimension(s) of technostress an individual is experiencing [6,8]. In the past, technostress was considered from two separate perspectives: what the individual can do; and steps the organization can employ to reduce technostress [1,13]. Mitigating technostress may include venting, distancing, creating a positive outlook, increasing technological knowledge, improving time management of technology use, and improving work–life balance to find time to ‘unplug’ [13]. One method of dealing with technostress, proposed by Lazarus, is to tackle the problem head-on by removing the stressor(s) [14]. Seeking new routines that omit technology wherever possible and working towards stressavoidant behavior can be helpful. For example, if a job utilizes imaging and emailing all day, setting up an environment free of work screens at home is beneficial. Prioritizing self-care is important, as is finding an outlet free of technostress that promotes it. Practicing relaxation, breathing, and mediation techniques, especially when getting frustrated with technology, can be invaluable. For example, mindfulness, the art of focusing on the moment, may be critical in allowing individuals to improve job performance and satisfaction [15]. Further, focusing on developing a more positive outlook and embracing new technology can reduce techno-overload. Recontextualizing one’s relationship with technology can result in its greater use in saving energy, time, and decreasing frustration, while gaining greater productivity, task completion and job satisfaction (e.g., working smarter not harder). An example of recontextualizing relationships with technology is the use of an app to program one’s daily activities to expedite screen time usage and retain important reminders (and in the future using artificial intelligence methods to complete tasks).

On an organizational level, technostress strategies include better education around individual techniques, encouraging sharing and discussion of coping behaviors, adjusting inefficient roles, and offering employees ways to adjust their usage of technology to a frequency and method they would prefer [13]. In general, a consistent link between these is greater social support during times of technostress. Reducing isolation in dealing with technostress, by destigmatizing it as an issue to discuss, may be important. Institutions must practice positive technology by having user-friendly technology and should offer proper training to employees in new technologies to reduce technostress [2]. This is especially true of institutions in the STEM workplaces, which impose the most technostress on employees. Institutions must also encourage healthy work–life balance. We believe, for difficult-to-operate machinery such as imaging units, there should be dedicated teams of individuals to alleviate pressure on a single individual, thus avoiding technostress. Therefore, importantly, increasing literacy facilitation and offering employees dedicated chances to gain familiarity with new technologies, supplemented with technical support, can be helpful for mitigation

[15]. Additionally, students now need to deal with increased virtual learning and a plethora of computational methods that previously have not existed [6]. Given this, mentors need to be more flexible and ensure that their students are not having techno-overload. We believe mentors should consider establishing computational programs that host courses in coding and bioinformatics to develop skillsets to reduce technostress. Ultimately, in the technologically driven future, we believe coding courses should be standard skills taught to all STEM students to reduce overall technostress.

Mentors may consider creating programs to facilitate training to keep up with technological advancements. Similarly, we believe mentors may consider creating summer enrichment opportunities around computational biology to foster skills, build confidence, and support the mentor–mentee relationship. Forging networks to address technostress creates places for individuals to rise. Finally, we believe institutions often do not consider the technostress associated with the workload given to students. We believe mentors should participate in assigned skillsets to better understand and appreciate the student's workload. In combination, these strategies will help to mitigate technostress.

Concluding remarks

Every technological change or problem that scientists encounter is an opportunity to learn and balance positive and negative thoughts while tackling the issues of technostress. For those in STEM fields, avoiding technology altogether is not an option. Most communication with colleagues is virtual and many data analyses, data collection, and imaging techniques rely on virtual technologies. Mitigating technostress is not merely about reducing the technical annoyances of a workday. Mitigation must be performed at an institutional and individual level. Stress negatively influences human behavior through physical, mental, and social health. Simply, stress is the body's nonspecific response to a demand placed on it. Technostress can cause physical, psychological, and emotional issues such as insomnia, uncertainty about performance, and, ultimately, students leaving STEM. Mental health issues associated with technostress include burnout, awfulizing, and chronic stress [8]. Furthermore, technostress can reduce productivity [2]. Therefore, both individuals and institutions need to identify, measure, and ultimately reduce technostress. Prioritizing self-care, being technologically mindful, practicing mindfulness, increasing distancing, and changing outlook may be positive for individuals, while institutions and mentors should implement socialbased programs to reduce technostress.

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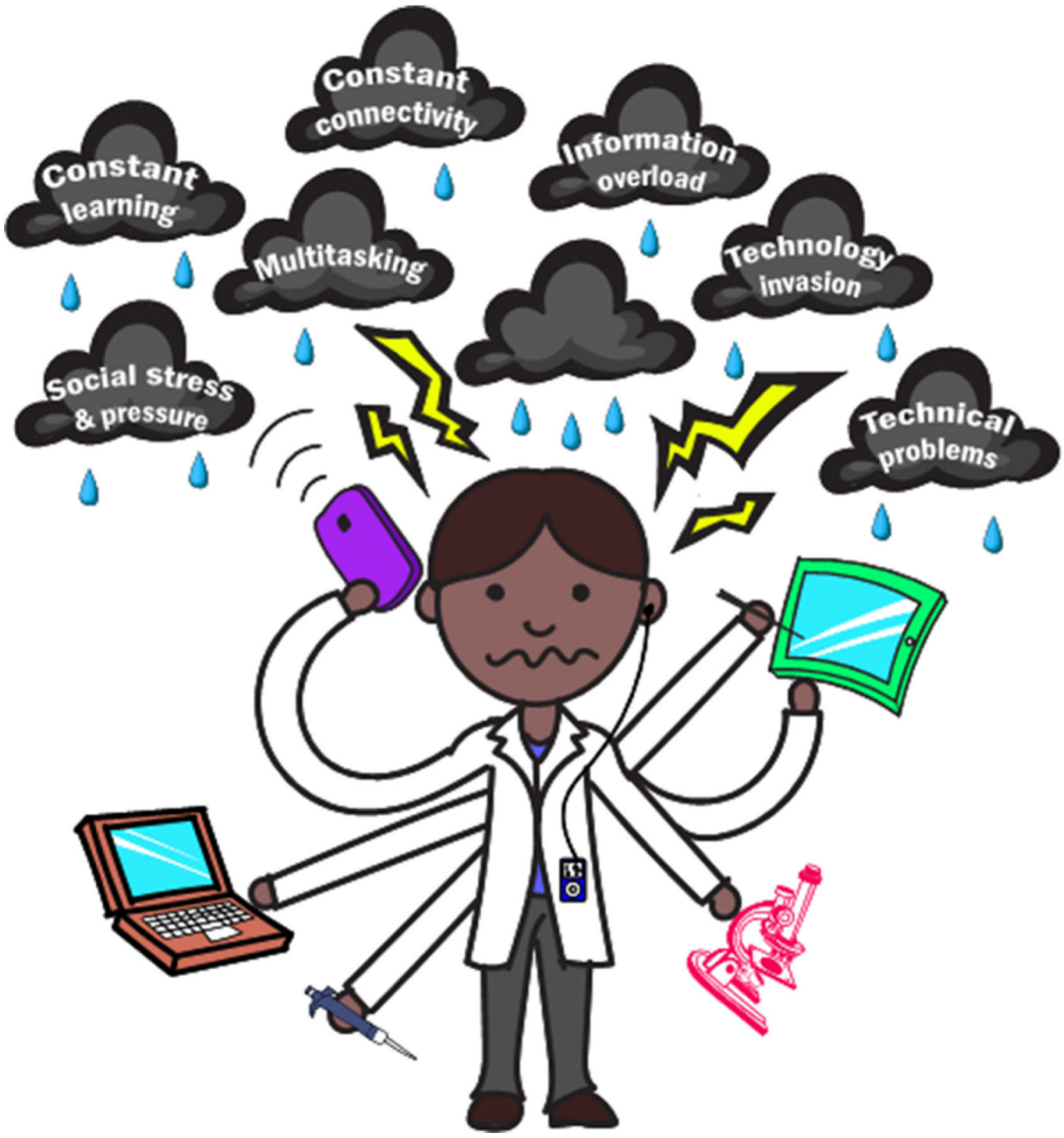

Figure 1.
Scientists experiencing technostress and the various factors that may lead to increased technostress.

Table 1.

Creators of technostress

Type	Cause	Example	Other considerations
Techno-overload	Being overwhelmed with tasks associated with technology.	Needing to utilize many new technologies such as Zoom during the pandemic.	Techno-overload has become more likely as technology has become increasingly needed for modern STEM workflows. For example, data and chemical analyses are performed almost exclusively via computers. Technostress may be accentuated if breaks are not taken during computational analyses.
Techno-invasion	The feeling that technology has become too prominent and causes too much change in one's workplace and/or personal life.	Constantly needing to answer emails during days off.	These challenges may be further exacerbated in the home setting. In particular, the increased usage of virtual technologies for teaching, working, and mentoring can cause techno-invasion [9]. While virtual platforms used for working from home have allowed new cross-cultural opportunities, they have also weakened the divide between the home and the workplace [7,9].
Techno-complexity	Not receiving the resources needed to properly understand and operate new technology.	Needing to operate a complex microscopy that is new in the field.	Techno-complexity may be especially common in STEM fields. For example, many solutions for 3D reconstruction require knowledge of complex coding languages such as Python. Given that the scientific field increasingly seeks novel methods, scientists may need to develop their own techniques. A lack of guidance during the process of developing a technique, which are prone to errors, can cause technostress, which can eat away at an individual's productivity. This is especially true for older workers, since increased age is associated with technostress, as there is less familiarity with the newest technologies [1].
Techno-insecurity	Fear of losing one's current position if one lacks knowledge of technology	Not being efficient at programs that are essential for data presentation	While new technological methods such as machine learning exist and may help reduce the burdens of data analysis, they may also cause techno-insecurity if users lack the knowledge to use them. Investigators may fear they will not be proficient in performing their duties as technology continues to advance.
Techno-uncertainty	Uncertainty arising from the speed of technology evolution surpassing the speed needed to learn new technologies.	Having to download new computer operating systems every time familiarity is gained with the older operating system.	Not learning new technologies is unfeasible, as many important tools for data collection, such as organelle analysis, requires computational methods [6]. Given the need to constantly update software and the compatibility issues with older software, one needs to learn new methods.
Techno-unreliability	The feeling of frustration resulting from errors in essential technology.	Not being able to send an important email due to a technical error.	As technologies get more complex, troubleshooting has typically become more robust but also more complex. This can make it difficult to remedy issues in complex machinery and mistakes can result in loss of valuable data or monetary penalties, should the issues be unresolved.
IT-based monitoring	Comfortability regarding the increasing monitoring and lessening of individual privacy that arises from technology.	Dislike all work searches being monitored on institution's Wi-Fi network.	Today, most employees cannot avoid technology, especially in laboratory settings that use virtual technology for image analysis, video interacting with colleagues, and collaborative grant writing. It can feel as though one does not get a choice but to use these programs, even if they disagree with the Terms of Service and/or institutional/federal monitoring.
Cyberbullying	Negative interactions from another individual facilitated by the use of technology.	A coworker sending harmful emails about a colleague.	Continued use of technology such as computers or phones after work further fuels technostress. It can potentially allow for purposefully, or inadvertently, mental health harm both at and outside of work.