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Switching to Online Learning During COVID-19: Theorizing the Role of IT Mindfulness and Techno Eustress for Facilitating Productivity and Creativity in Student Learning

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Abstract

Online learning environments facilitate improved student learning by offering IT tools to enhance student productivity- and creativity-in-learning. COVID-19 impacted social-distancing measures forced an abrupt switch to online learning in most universities, putting immense pressure on the students to creatively adapt to new ways of online learning. Despite the purported positives of online learning, in the COVID-19 scenario, students reported mixed outcomes. While some students could adapt to the 'new normal', others struggled to adjust to the transformed IT-enabled learning scenario. Grounding our work in IT mindfulness literature, we posit that an IT-enabled learning environment may have differential impact on students' productivity- and creativity-in-learning, depending on the extent of their IT mindfulness. Besides leveraging the mindfulness-to-meaning theory, we hypothesize the mediating role of techno eustress in the relationship between student IT mindfulness and learning effectiveness. We test the theorized model through data collected via a two-wave survey in a university student population exclusively using IT-enabled learning environments during the pandemic lockdown period. Results indicate that IT mindfulness has significant positive relationships with both productivity- and creativity-in- learning. Moreover, these relationships are mediated by the students' techno eustress perceptions. Theoretical and practical implications arising from our study are also discussed.

Keywords: COVID-19, IT mindfulness, techno eustress, productivity, creativity, student learning

1. Introduction

Lockdowns and social distancing restrictions due to the COVID-19 pandemic have forced educational institutions to shift their emphasis from traditional face-to-face learning modes to online learning environments. While some institutions have resorted to piecemeal IT solutions to maintain their academic continuity, others have switched to more advanced holistic online classroom environments, depending on their budgetary and technical constraints (Marinoni et al., 2020; Sidpra et al., 2020). However, similar to pandemic induced digital disruptions in other sectors, the transition to online instruction has been rather abrupt, with minimum IT end-user training or user perception evaluations (Blackburn et al., 2020; Marr, 2020). A UN report states that about 87.6% of enrolled learners have been affected by this change (United Nations, 2020). The sudden shift to online learning mode resulted in enhanced IT demands that may not necessarily be coped well by all the learners (Di Pietro et al., 2020; Watermeyer et al., 2020). In fact, a recent meta-analysis shows that reliance on digital learning environments is not always successful (Mehta et al., 2021). Reports during the pandemic have highlighted issues such as learning loss, productivity loss, and emotional distress, often termed as ‘zoom fatigue’, among students all around the globe (Di Pietro et al., 2020; Fosslie & Duffy, 2020; Hvalshagen et al., 2021; Robinson, 2020; Upadhyaya & Vrinda, 2020). Such negative evidence goes against the strong narrative about the online learning environment as being an effective medium for teaching and learning (Hereward et al., 2020; Joosten et al., 2020; Srivastava et al., 2009; Toney et al., 2021). Although some prior research has reported mixed learning outcomes through IT-enabled tools (Ala-Mutka et al., 2008; Cladis, 2020; Gajda et al., 2017; Ngugi & Goosen, 2021; Sun et al., 2017; Swan, 2003; Toney et al., 2021; Zhang & Nunamaker, 2003), the current COVID-19 pandemic has precipitated the issue of online learning effectiveness. This certainly augments the

need for a deeper learner-centric enquiry to understand the mechanisms through which learners can perceive IT enabled learning environments in a positive manner for holistic learning outcomes (Rogers, 2003).

Calls for more concerted research efforts have galvanized IS researchers to focus on several key concerns engulfing online learning during the current pandemic. Recent research on online learning has examined issues from several vantage points. While some research has taken the perspective of the teacher, teaching structure and teaching effectiveness (Abcouwer et al., 2021; Alqabbani et al., 2020; Boor & Cornelisse, 2021; Carter Jr et al., 2020; Prinsloo & Singh, 2021), others have examined the institutional resources, policies, and IT tool adoption (Barnes, 2020; Favale et al., 2020; Hvalshagen et al., 2021; Iyer & Chapman, 2021; Li et al., 2021; Lumor et al., 2020; Mavengere et al., 2021; Xie & Siau, 2020). Notwithstanding the significance of such pandemic-related online learning issues, we recognize the need for individually-driven learnability as the key for effective online learning not only during the ongoing pandemic times but also during normal times (Hwang et al., 2000; Mehta et al., 2021). However, because of the enhanced use of online learning tools during the current pandemic period, there is no doubt that there is a greater need for more learner-centric responsibility for effective learning. All students may not uniformly perceive this increased responsibility of the learner as desirable. During the current pandemic, learners are experiencing a non-conducive emotional state to focus on learning, which can also impact their self-directed learning process (Carter Jr et al., 2020; Mosanya, 2020; Xie & Siau, 2020). A call for a deeper learner-centric enquiry based on the individual differences of the learners is expected to shed light on the mechanisms through which learners can perceive IT-enabled learning environments in a positive manner for holistic learning outcomes (Boor & Cornelisse, 2021; Carter Jr et al., 2020; Rogers, 2003).

We believe that research probing into IT-enabled learning is specifically meaningful during the current pandemic situation that has forced students to abruptly switch to digital means for continued learning (Favale et al., 2020; Pirson, 2020). IT-enabled learning outcomes during the COVID-19 pandemic closely relate to the *effective use* of online learning by students in the transformed academic environment, which in considerable measure depends on the learners' resilience to cope with this sudden technological shift (Barnes, 2020; Burton-Jones & Volkoff, 2017; Ivanišin, 2009). We posit that such resilience is shaped by the learners' perceptions about technology use, which are expected to influence their appraisals of technology-mediated learning (Boh et al., 2020; Wilkins, 2020). Taking a contextualized bottom-up approach to examine the individual-level factors impacting student online learning perceptions will address the calls for research in this direction (Boh et al., 2020; John & Gross, 2007). Hence, it becomes theoretically and practically interesting to examine the individual-level factors that can explain how students cope with the sudden increase in *IT demands* for learning during the COVID-19 lockdown period. A clearer understanding of such individual-level factors would help design pathways to encourage positive student appraisals of online learning environments, thereby contributing to the *effective use* of available IT tools for student learning (Panigrahi et al., 2018; Shirish, 2019).

Prior research on online learning has primarily taken a task-centered rather than an individual-centered perspective (Ivanišin, 2009). However, online learning lays the foundation for the learner's holistic development that encapsulates not only the competencies achieved through task-conscious directed learning, i.e. *productivity-in-learning* (PIL) but also the improvisations attained in the ensuing learning process termed as *creativity-in-learning* (Hereward et al., 2020; Van Laar et al., 2017; Voogt et al., 2013). Hence, we posit that besides task-conscious learning outcomes contributing to productivity in learning, IT-enabled

environments facilitate students to exercise their creativity by developing new and personally meaningful learning ideas and insights within the context of their specific academic constraints (Beghetto, 2007; Beghetto & Kaufman, 2007). Hence, in our study, we examine the two outcomes of learning effectiveness. First, *productivity-in-learning (PIL)* is the possibility of using IT to deliver efficient and better-quality academic output. Second, *creativity-in-learning* is the possibility of using available IT creatively for learning activities within the given academic constraints. We believe that both PIL and CIL are essential to understand the effectiveness of IT-enabled learning.

We integrate the aforementioned view on learning effectiveness with the need to incorporate individual-level factors that can contribute to effective IT use in the context of the ongoing pandemic and beyond. Specifically, we leverage the emerging concept of “IT mindfulness” that can help users extract value from their IT use (Roberts et al., 2007). IT mindfulness is an IT-specific individual-level trait, noticeable when IT users tend to focus on the present, pay attention to the operational details, and display interest to investigate IT features with an overall goal to improve their functioning (Thatcher et al., 2018). However, the role of IT mindfulness in the context of enhanced IT demands, both in the education and the business scenarios, is still not well understood (Hickman, 2020). Our study thus contributes to the literature that examines individual-level IT competencies, which can impact functioning in virtual learning environments (Mosanya, 2020; Panigrahi et al., 2018; Shirish, 2019; Wang & Haggerty, 2011). Recent research on the subject highlights the need to examine the role of IT mindfulness as an individual-level student trait for better understanding learner adaptation to technology-mediated learning environments by coping with the related technostress perceptions (Connolly & Rush, 2019). This leads us to our first research question:

RQ1 – Is there a relationship between the online learners’ IT mindfulness and IT-mediated learning effectiveness?

To unearth the mechanisms through which IT mindfulness influences IT-mediated learning effectiveness, we leverage recent research on “techno eustress” to examine the role of positive technology use appraisals (Califf et al., 2020; Chandra et al., 2019; Shirish, 2021). In contrast to technostress, techno eustress is the individual’s appraisal of IT demands as a “challenge” rather than as a “hindrance” for attaining the intended technology use objectives (Srivastava et al., 2015; Tarafdar et al., 2019; Zhao et al., 2009). Grounding our theorization in the “mindfulness to meaning theory” (MMT), we seek to explain the cognitive regulation process among students confronted with enhanced IT demands for learning during the COVID-19 pandemic (Garland et al., 2015, 2017). MMT explicates the cognitive processes through which the mindfulness trait (dynamic and secondary trait) among individuals faced with novel IT demands facilitates decentering and reappraisal leading to an improved well-being perception (eustress perceptions) through effective coping of the stressful situation (Garland et al., 2015). Prior research shows that traits are considered antecedents to appraisals and coping (Kim et al., 2016; Penley & Tomaka, 2002). Individual trait difference can influence eustress perceptions and their consequent evaluations (Saksvik & Hetland, 2011). Therefore, online learners’ IT mindfulness, a dynamic trait, is expected to regulate the learner’s appraisals causing them to evaluate IT demands as techno eustress, influencing their learning effectiveness. This leads us to our second research question:

RQ2 –Do positive appraisals of technology use mediate the relationship between the online learners’ IT mindfulness and their learning effectiveness?

To study the phenomenon of IT mindfulness and its influence on student learning in the context of a technology-mediated learning environment, we conducted a two-wave longitudinal survey amongst respondents in an educational setting during the COVID-19 pandemic induced lockdown. The responding students had to transition to online instruction rather abruptly at the start of the pandemic lockdown. The two-wave survey ensured a temporal separation between the independent and dependent variables, eliminating the possibility of method bias. Results indicate that IT mindfulness has a positive influence on both —productivity-in-learning and creativity-in-learning. Further, we also found that the positive appraisals of technology use (techno eustress) mediate these relationships, thereby providing a modest validation of the proposed IT mindfulness to meaning theory. The results from our research exhort educators to take into consideration the important individual-level trait of IT mindfulness in designing their technology-mediated instruction process. For students high on IT mindfulness trait, the switch to online learning seems to be relatively easy. Hence, directed efforts need to be made to identify and train the vulnerable students for enhancing their IT mindfulness to enhance their IT-enabled learning effectiveness.

2. Theory and hypotheses

Figure 1 presents the research model for our study. In the subsequent sections, we develop the indicated hypotheses based on IT mindfulness and MMT literature.

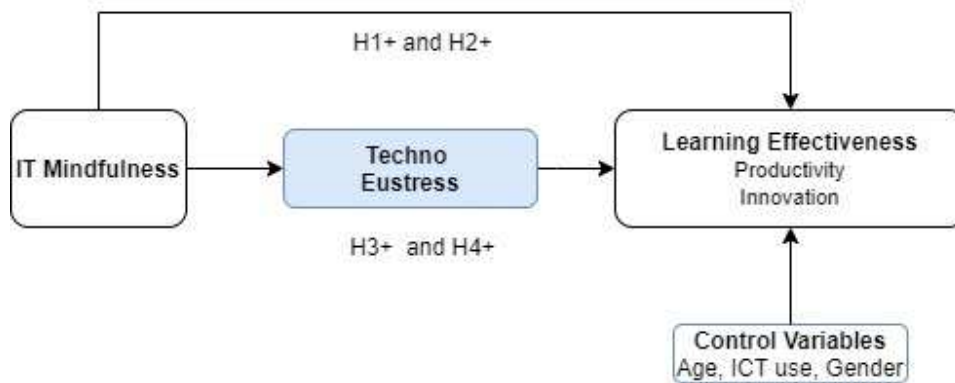


Fig. 1. Research model.

2.1 Technology-mediated learning effectiveness

As discussed in the previous section, prior literature has emphasized the need to examine mixed findings about the influence of technology-mediated learning environments on student learning effectiveness (Chang, 2016; Swan, 2003). In addition, scholars have underlined the need to investigate the role of online learning in enhancing task-conscious learning and improving the learning process itself by focusing on learner-conscious learning (Rogers, 2003). Such holistic learning is possible when IT learning tools are not completely automated, and rather they provide some room for learners to explore the functionalities of the available technological tools. Such an active online learning approach promotes learner creativity, which is expected to enhance their learning effectiveness (Ivanišin, 2009; Rogers, 2003).

The COVID-19 lockdown scenario provided a context where the students were not necessarily given formal training to use IT for learning (Fryling, 2020). Because of the sudden nature of the crisis, students in most situations were pushed to explore the different IT tools on their own to enrich their learning process (Carter Jr et al., 2020). Consequently, in our research, we investigate online learning effectiveness through two distinct and different productivity-in-learning (PIL) and creativity-in-learning (CIL) measures.

PIL implies productivity in achieving the intended learning goals through the use of IT. It relates to efficiency in both the quantity and quality of student online learning. IT can help achieve the PIL objectives by providing more information at a lower cognitive cost, easing out the limits of time and space for learning, and providing greater control to students over the learning process (Carpenter et al., 2014; Massy & Zemsky, 1995). In our study, PIL is described as the extent of help ICT provides to the students in the constrained COVID-19 environment to achieve intended learning in terms of quality and quantity.

CIL, on the other hand, implies the creative procedures that students adopt in their learning process with IT tools. It refers to using the provided IT creatively to enhance the learning process (Chandra et al., 2020; Harvey et al., 1993; Tarafdar et al., 2010; Torkzadeh & Doll, 1999). Online learning environments can allow students to use IT creatively to enhance their learning experience within the context of their idiosyncratic academic constraints (Beghetto, 2007; Beghetto & Kaufman, 2007). CIL is primarily discretionary and can be considered as a learner conscious effort directed at fulfilling the learners' specific goals (Rogers, 1995; Sia et al., 2004; Zaltman et al., 1973). CIL defines the learner enacted procedures for facilitating the learning experience (Fichman et al., 2014; Thatcher et al., 2018). In our study, CIL is described as the extent of help ICT tools provide to the students in the constrained COVID-19 environment to creatively enrich their learning process.

2.2 Linking IT mindfulness trait to learning effectiveness

IT mindfulness is an IT-specific individual-level trait. It is noticeable when IT users focus on the present, pay attention to distinctive operational details, and display an interest to investigate new IT features, with an overall goal to get better insights and improve their functioning (Thatcher et al., 2018). However, in contrast to other IT-specific individual-level

traits such as computer self-efficacy and computer anxiety, it is dynamic and malleable. This implies that IT mindfulness can be learned by individuals through managerial interventions and activities such as training and role modelling (Thatcher et al., 2018).

IT mindfulness is a superordinate, second-order construct comprising four reflective, first-order dimensions described as alertness to distinction, awareness of multiple perspectives, openness to novelty, and orientation in the present (Langer, 2014; Thatcher & Perrewé, 2002). *Alertness to distinction* is the capacity in the IT users to recognize the differences between the capabilities of old and new features of an IT system (Langer, 1989; Thatcher et al., 2018). *Awareness of multiple perspectives* is the ability of the IT users to observe different potential applications of feature sets that go beyond the intentions of the designers or managers (Thatcher et al., 2018). *Openness to novelty* is the capability in the IT users to go beyond the standard features such as voice and text in IT and experiment with less familiar features such as virtual reality and screen sharing to increase organizational productivity (Dennis et al., 2008). Lastly, *orientation in the present* is the competence of the IT users to stay focused on the present and understand that their IT system use needs to vary in response to different contexts (Thatcher et al., 2018).

Prior research suggests that mindful IT users are more likely to identify the changes in their environment and the corresponding opportunities for action (Hickman, 2020; Langer & Moldoveanu, 2000). They understand the present and future implications of their efforts better, resulting in enhanced productivity and innovation (Thatcher et al., 2018). For example, individuals with an 'orientation in the present' will be able to conduct effective upward social comparisons when using different features of technology-mediated learning tools. This will

contribute to their learning productivity and creativity in the learning process (Michinov & Primois, 2005).

Past research has also shown that mindful individuals are more likely to have a systemic action repertoire, which allows them to use the technology in innovative ways, even in academic settings (Wei et al., 2021). Because of their alertness to distinctions and openness to novelty, mindful learners are easily acculturated to novel ICT features that can facilitate better learning. Moreover, individuals who are alert to differences are expected to relate their novel IT experience with their accumulated learning which further enhances their competence in the online learning environment (Panigrahi et al., 2018; Wan et al., 2008; Wang & Nickerson, 2017). Thus, IT mindfulness can reduce inefficiencies and positively contribute to productivity-in-learning by triggering self-regulatory mechanisms. Each mindful act of the online learner, such as experimenting with a new feature in the Moodle or Blackboard collaborative platform or using the discussion forum to post questions instead of emailing the professors directly, would signify an effective IT use event. Cumulatively, such effective IT use events contribute towards productivity-in-learning. Similarly, high alertness to distinctions would make mindful students capable of detecting changes in ICT use, thereby enabling productivity in learning outcomes and creativity in the learning process by facilitating agile changes in their plans and actions (Khan et al., 2013). Such agility will keep the mindful learners motivated and engaged in IT mediated learning, thereby influencing their learning effectiveness positively (Panigrahi et al., 2018).

Prior studies have also shown that IT mindful individuals are adept at using former cognitive schemas in novel situations, which helps them innovate with IT (Thatcher et al., 2018). Hence, mindful learners can improvise on their prior knowledge structures and look for alternative solutions in the new IT mediated learning context. This possibility to use ICT for

knowledge search, retention, reuse can help such mindful learners to innovate with ICTs for their learning (Bawack & Kamdjoug, 2020; Henriksen et al., 2020). Thus, in the online learning context, if the students are cognitively involved and continuously explore new ways to use the available IT, they can complete the assigned learning tasks efficiently using creative ways.

Hence, we hypothesize:

H1: In the context of IT-mediated learning during the COVID-19 mandated lockdown, learner's IT mindfulness is directly associated with the learner's productivity-in-learning.

H2: In the context of IT-mediated learning during the COVID-19 mandated lockdown, learner's IT mindfulness is directly associated with the learner's creativity-in-learning.

2.3 The mediating role of the positive technology appraisals– Techno eustress

2.3.1 Techno eustress: cognitive state

Traditional coping theories suggest that individual differences influence cognitive appraisals of stressful demands, triggering different responses (Fevre et al., 2003; Lazarus & Folkman, 1984). Negative appraisals are made when demands are perceived to thwart personal development, growth and well-being. Such evaluation of loss, fear, or harm is akin to distress. Positive appraisals, on the contrary, are made when demands are perceived to promote personal development, growth, and well-being and signifies psychological well-being. Though most appraisals of stressful situations are negative, resulting in unproductive behavior, specific individuals may appraise similar situations positively as eustress (Öhman et al., 2007). In technology-related situations, techno eustress comprises positive appraisals as a response to enhanced IT demands. In the event of positive appraisals as techno eustress, the IT demands are viewed by the individual as a challenge rather than as a hindrance, allowing for the individual's well-being (LePine et al., 2005; LePine et al., 2016; Tarafdar et al., 2019). Besides, it provides the potential to promote personal growth and gains (Cavanaugh et al., 2000; Crawford et al.,

2010; Fay et al., 1998; Fevre et al., 2003). Techno eustress also occurs when individuals' IT demands push individuals to upgrade their skills and improve their flexibility across different contexts (Diaz et al., 2012; Leung & Zhang, 2017; Ohly & Latour, 2014). However, the appraisal of technostress as positive (techno eustress) or negative (techno distress) depends on the individual-level traits of the appraiser, which in this study are the online students. Prior technostress research has shown the salience of individual differences in determining task outcomes (Srivastava et al., 2015). Building on this stream of research, we posit that the individual-level trait of IT mindfulness will influence appraisals of enhanced COVID-19 impacted IT demands by the student learners, which will influence their learning effectiveness.

Individuals describe techno eustress as a mindful state of challenge, a healthy state of aroused attention on the IT task, exhilaration, and being fully present when using IT tools (Hargrove, 2013; Nelson & Simmons, 2011; Selye, 1975). Through the eustress pathway, individuals trust their coping ability to overcome the stressful demands using appropriate resources, which help them develop the needed efficacy and positive affect (Fevre et al., 2003; Folkman & Lazarus, 1984; Kozusznik et al., 2015). Reappraisal is one such strategy that individuals use to extract positive experiences of techno eustress in the face of encountered IT stressors leading to productivity and creativity in the task, e.g., (John & Gross, 2007; Quinones et al., 2017). Positive appraisals of stressful situations have been shown to be positively related to job satisfaction and low attrition rates in different work contexts, e.g. nurses (Califf et al., 2020). Because the positive appraisals are contingent largely on the individuals' cognitive capabilities, we argue that the IT mindfulness trait in learners will foster their techno eustress perceptions, which will influence their online learning effectiveness (Quinones et al., 2017). The mediating role of eustress has also been examined in general stress literature to better understand the

mechanisms that influence the relationships between different organizational and academic stressors and individual performance (LePine et al., 2004; LePine et al., 2016).

2.3.2 *Mediating role of techno eustress using mindfulness to meaning theory*

The mediating role of techno eustress in our specific study context can also be explained through the ‘Mindfulness to Meaning Theory’ (MMT). MMT is a conceptual model describing the cognitive, emotional, and neurobiological processes through which mindfulness in individuals can trigger positive psychological states that provide a sense of meaning even in the face of adversity (Garland et al., 2015). Mindfulness allows individuals to distance themselves from stress appraisals and use their metacognitive state of awareness with broadened attention. This permits them to include any previously unattended contextual elements, data, or inputs to life, in their appraisals. Such mindful individuals accommodate the *reappraisal* of adverse circumstances, which has been shown to promote positive emotions (Garland et al., 2017). Further, this positive reappraisal is deepened and enriched by the individual when the reappraiser starts to *savor* what is pleasant, growth-promoting, or meaningful in life.

Savoring is a process known to motivate value-driven behavior by providing a more profound sense of purpose (Hargrove, 2013). In the context of our study, because online learning during COVID-19 related lockdown was a continuous exercise for several months, the concept of savoring further reinforces the positive appraisals. Thus, the previously discussed *learner’s cognitive abilities* argument for describing the mediating role of eustress is further reinforced by MMT. It proposes the two mechanisms of *mindful reappraisal* and *mindful savoring* through which mindfulness can foster eustress, which can positively influence learning effectiveness.

Using the mechanisms mentioned above, we believe that students high on IT mindfulness trait should reappraise the newly mandated IT demands in the COVID-19 impacted academic

settings as a challenge. This reappraisal of the abrupt IT demands by mindful students would be goal-directed and hence positive (Wei et al., 2021). This positive reappraisal of the situation by mindful learners would propel them to look for innovative ways to enhance their learning experience. Such an effort would, in turn, impact the students' learning effectiveness in terms of their PIL and CIL (Gajda et al., 2017; Ngugi & Goosen, 2021; Sullivan, 2020). Hence, we hypothesize:

H3: In the context of IT-mediated learning during the COVID-19 mandated lockdown, learner's techno eustress perceptions mediate the relationship between the learner's IT mindfulness and the learner's productivity-in-learning.

H4: In the context of IT-mediated learning during the COVID-19 mandated lockdown, learner's techno eustress perceptions mediate the relationship between the learner's IT mindfulness and learner's creativity-in-learning.

3. Method

3.1 Data collection

We employed a two-wave survey method for collecting the data and testing the research hypotheses. The respondents were graduate students from an institution of higher learning in France. The survey requests were sent to all the students enrolled for the 2019-2020 academic year. Participation in the study was purely voluntary. No credits or rewards were provided for the responses. The first survey was sent to the potential respondents at the beginning of the COVID-19 lockdown in March 2020. Because our study comprised two waves, the second survey conducted two months later in May 2020 was sent only to the respondents who had participated in the earlier survey. Two reminders were sent for both surveys before closing the response collection. During the period of our study, all the students were receiving academic instruction *exclusively* through ICT tools. The students relied on different remote learning technological

solutions for their classes and their individual and group assignments. All students were undertaking their final semester and had to be graded on their courses. They were all enrolled in business management and innovation related subjects during this period. Access to campus and its facilities for both the teachers and the students were highly restricted during this lockdown period in France (March to May 2020). Most lessons were delivered synchronously using video conferencing tools such as Zoom, the big blue button and Microsoft Teams. Some instructors also used asynchronous video recordings posted on Moodle's learning platform accompanied by synchronous activities and online interactions. Students were free to use any digital tools at their disposal to undertake their group projects and assignment, including their personal IT tools. Exams were also conducted using a mix of different digital tools. In many cases, synchronous group presentations were also used for evaluating teamwork. Student assignments were submitted to the instructors either through emails or through the learning platform.

We collected data on IT mindfulness, control variables, and demographic variables during the first wave of the survey which was conducted at the start of the lockdown in March 2020. During the second wave of survey in May 2020, we collected data on the experienced techno eustress and learning effectiveness in terms of productivity-in-learning and creativity-in-learning during the entire lockdown period in France from March to May 2020. Because during this period, the teaching was conducted exclusively through online means with no face-to-face interaction, it provided us with a unique natural context where the influence of non-online interaction between the instructor and the students was completely controlled for. In addition, a two-wave survey design helped us alleviate the possibility of method and recall bias confounding our results.

3.2 Demographics and study variables

After the extensive data collection exercise, we had 82 matched two-phase responses for final analysis. 75% of the respondents were female, and 25% were male. The age of the respondents ranged from 18 to 31 years, with an average of 22 years. 49% were from the first to the third year, 22% were fourth-year students, and 29% were fifth-year specialization students. 25% of the respondents were working students with apprenticeship contracts. All students were undertaking their spring semester. They went through a graded curriculum in management that included innovation, and it involved presentations, written assignments, group work, debates, and class participation. Thus, interactions through skillful use of online tools were needed to be productive and creative at learning. Further, all surveyed students had a one-week official vacation period between 13-17 April 2020 in which no online classes were conducted. On average, respondents had three years of experience using ICT tools for their studies, and they used ICT tools for an average of 6 to 8 hours a day during the school period.

As the sample size for our study was 82, we checked for the acceptable smallest sample size to detect the effect of regression analysis at $p < 0.05$ using G*Power (Faul et al., 2009). Although the recommended power level for valid analysis is 0.80, the researcher performing power analysis can specify a higher level to be more confident about the results. Our analysis for a conservative power level of 0.95 revealed that the smallest acceptable sample size of 74. Because our sample size was larger than 74, we can be reasonably sure with a 95% probability of not committing a type II error in our research with the given sample size. As seen in Figure 2, the G power plot provides us with the confidence that our sample size is sufficient to offer significant results.

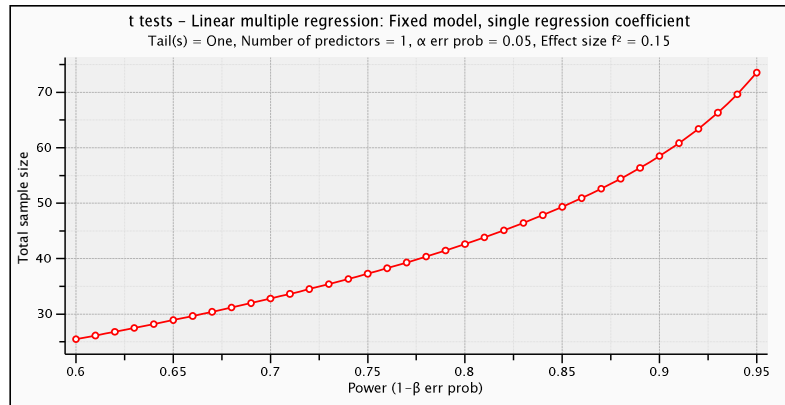


Fig. 2. G*Power plot.

Validated constructs from prior studies where the psychometric properties have already been established were adapted and used for this study (see Appendix A for further details). A five-point Likert scale was used to measure all the latent constructs in our study—a value of 5 denoting *strongly agree*, and 1 representing *strongly disagree*. Because the dependent variable may be influenced by factors other than those in the hypothesized model, we incorporated suitable control variables in the research model to better understand the variance explained by the predictor variables. Similar to previous similar studies—*gender*, *age*, and *ICT use during schoolwork* were used as controls in our analysis (Ayyagari et al., 2011). The field survey relied on a naturally occurring COVID-19 impacted strict lockdown (March to May 2020 in France) that mandated an exclusive IT-enabled work setting. Hence, we could safely discount the impact of other extraneous factors that may apply to a pure face-to-face work or a hybrid context and may affect our dependent variables.

4. Analysis and results

For the data analysis, we used Partial Least Squares (PLS), a latent structural equation modelling technique, as implemented in Smart PLS 3.0, which utilizes a component-based path

modelling application (Ringle et al., 2005). PLS avoids the two major problems of inadmissible solutions and factor indeterminacy. It is thus appropriate for analyzing complex models with latent variables and small sample sizes (Fornell & Bookstein, 1982; Pavlou & Gefen, 2005). Various prior IS studies have employed PLS and found it an effective method for data analysis, e.g. (Srivastava & Chandra, 2018; Teo et al., 2008). Following the recommended two-stage analytical procedure (Anderson & Gerbing, 1988; Hair et al., 1998), we first evaluated the measurement model. In the second stage, we examined the structural relationships.

4.1 Measurement model

We tested three types of validity: content validity, convergent validity, and discriminant validity. Content validity assesses whether the chosen measures appropriately capture the full domain of the construct (Straub et al., 2004). We examined content validity by checking for consistency between the measurement items and the existing literature. This was done at the stage of designing the questionnaire. Convergent validity checks that the indicators for a construct are more correlated with one another than with the indicators of another construct (Petter et al., 2007). We tested the measurement model with PIL and CIL as the two dependent variables. Factor analysis shows a strong correlation between each item and its corresponding construct (Appendix B). This demonstrates convergent validity. We also tested for convergent validity by examining the composite reliability (CR) and average variance extracted (AVE: the ratio of the construct variance to the total variance among indicators) for the indicators (Hair et al., 1998). 0.70 is the suggested CR threshold for reliable measurement (Chin, 1998). As seen in Table 1, the CR values ranged from 0.88 to 0.93. AVE was satisfactory with values ranging from 0.50 to 0.81, thus fulfilling the threshold criterion of 0.50 (Fornell & Larcker, 1981). The high

Cronbach's alpha values, ranging from 0.83 to 0.88, confirm the reliability of the scales for all the constructs.

Table 1
Reliability and average variance extracted.

| | Cronbach's Alpha (CA) | Composite Reliability (CR) | Average Variance Extracted (AVE) |
|----------------------------------|-----------------------|----------------------------|----------------------------------|
| Age | 1 | 1 | 1 |
| Techno eustress | 0.84 | 0.90 | 0.76 |
| Gender | 1 | 1 | 1 |
| ICT use for school-related tasks | 1 | 1 | 1 |
| IT mindfulness | 0.84 | 0.88 | 0.50 |
| Productivity-in-learning | 0.83 | 0.88 | 0.66 |
| Creativity-in-learning | 0.88 | 0.93 | 0.81 |

We verified the discriminant validity of the constructs by checking the square root of the AVE, as recommended by (Fornell & Larcker, 1981). The values of the square root of the AVEs (shown on the diagonal in the shaded cells of Table 2) are all greater than the corresponding inter construct correlations (the off-diagonal entries in Table 2), exhibiting satisfactory discriminant validity.

Table 2
Correlations and Fornell-Larcker criterion.

| | Age | EUT | GEN | ICTS | ITMF | CIL | PIL |
|------|--------|-------|--------|-------|-------|-------|-------|
| Age | 1.000 | | | | | | |
| EUT | 0.203 | 0.876 | | | | | |
| GEN | -0.041 | 0.108 | 1.000 | | | | |
| ICTS | 0.085 | 0.139 | -0.012 | 1.000 | | | |
| ITMF | 0.065 | 0.258 | -0.192 | 0.122 | 0.706 | | |
| CIL | -0.068 | 0.622 | 0.010 | 0.262 | 0.472 | 0.904 | |
| PIL | 0.090 | 0.631 | 0.028 | 0.227 | 0.364 | 0.572 | 0.817 |

Notes: EUT: Techno eustress; GEN: Gender; ICTS: No of average hours of ICT used by students in a day for school-related tasks; ITMF: IT mindfulness; PIL: productivity in learning; CIL: creativity-in-learning. Grey shaded cells represent the square root of AVE.

We also examined the cross-loadings of the items on other constructs, which were relatively low, indicating discriminant validity (Appendix B). Further, we also checked for the

heterotrait-monotrait (HTMT) ratio criterion recommended for variance-based SEM models to establish discriminant validity (Hair et al., 2019; Henseler et al., 2015). HTMT is the average of the Heterotrait-Heteromethod correlations (i.e., the correlations of indicators across constructs measuring different phenomena) relative to the average of the Monotrait-Heteromethod correlations (i.e., the correlations of indicators within the same construct) (Ashrafi et al., 2019). The HTMT should be significantly lesser than one (ideally less than 0.85) to discriminate between two factors (Henseler et al., 2015). In this study, HTMT ratios for all pairs were less than 0.85 (see Appendix C), thus fulfilling the HTMT criterion for discriminant validity. Together, our results indicate a satisfactory measurement model paving the way for subsequent structural model analysis.

4.2 Structural model

Tables 3 and 4 present the results of the structural models. The presentation of results follows a format similar to prior studies (Chandra et al., 2020; Medappa & Srivastava, 2020; Srivastava & Chandra, 2018). Models 1a and 1b represent the control variables only model. Among the control variables, *age* and *gender* were not significantly associated with the two dependent variables. However, *ICT use for schoolwork* has a significant association with both PIL ($\beta=0.25$, $p<0.01$) and CIL ($\beta=0.27$, $p<0.01$). The results reiterate the significant role of ICT use for schoolwork in influencing the productivity- and creativity-in-learning among students, which perhaps was more pronounced because of the pandemic induced lockdown during the data collection period. Models 2a and 2b depict the results from the direct path model linking IT mindfulness to PIL and CIL. We note that *IT mindfulness* is significantly associated with both PIL ($\beta=0.36$, $p<0.01$) and CIL ($\beta=0.47$, $p<0.01$), thereby supporting H1 and H2.

Table 3
Structural model.

| Dependent Variable | Learning Effectiveness: Productivity-in-learning (PIL) | | | Learning Effectiveness: Creativity-in-learning (CIL) | | |
|----------------------|--|---------------------|---------------------|--|---------------------|---------------------|
| | Model 1a β | Model 2a β | Model 3a β | Model 1b β | Model 2b β | Model 3b β |
| Control variables | | | | | | |
| Age | 0.046 | 0.053 | -0.051 | -0.091 | -0.113 | -0.216** |
| GEN | 0.049 | 0.104 | 0.007 | 0.014 | 0.098 | 0.005 |
| ICTS | 0.248** | 0.186 | 0.128 | 0.274** | 0.214** | 0.163** |
| Direct Path | | | | | | |
| ITMF | | 0.356** | 0.205** | | 0.473** | 0.323** |
| Indirect Path | | | | | | |
| EUT | | | 0.570** | | | 0.559** |
| R ² | 0.030 | 0.138 | 0.423 | 0.044 | 0.251 | 0.528 |
| ΔR^2 | | 0.108 | 0.285 | | 0.207 | 0.277 |
| Q ² | 0.029 | 0.093 | 0.272 | 0.035 | 0.206 | 0.431 |

Notes: GEN: Gender; ICTS: No of average hours of ICT used by students in a day for school-related tasks; ITMF: IT mindfulness; EUT: Techno eustress
Significance * $p < 0.05$, ** $p < 0.01$

As a robustness test, we performed the Stone and Geisser Q² test using the blindfolding procedure to evaluate the predictive relevance of the structural model (Geisser, 1974; Stone, 1974). The blindfolding test, which was conducted with omission distance equals 7 (the recommended number), revealed that all Q² values of the endogenous variables were greater than zero for models 1, 2, and 3 with the two dependent variables (see Table 3). Positive Q² values provide evidence for the *predictive relevance* of our theorized research model.

Prior to testing the mediation hypotheses (H3 and H4), we examined Model 3, which presents an indirect path model, after including techno eustress as a mediator for both PIL and CIL. We observe that *techno eustress* is positively related to both PIL ($\beta=0.570$, $p < 0.01$) and CIL ($\beta=0.557$, $p < 0.01$). We also observe that upon introducing the techno eustress in Models 3a and 3b, the β values for *IT mindfulness* drop compared to Models 2a and 2b, but are still significant for both PIL ($\beta=0.205$, $p < 0.01$) and CIL ($\beta=0.323$, $p < 0.01$) hinting at a partial mediation effect.

We undertook three tests to confirm the mediating role of techno eustress on the relationship between IT mindfulness and learning effectiveness (PIL and CIL). First, the partial mediation effect was confirmed by the mediation analysis in SmartPLS, as shown in Table 4.

The specific indirect effect results of techno eustress in Table 4 with PIL ($\beta=0.147$, $p<0.05$) and CIL ($\beta=0.144$, $p<0.05$) as dependent variables clearly show the positive and significant partial mediation effect of techno eustress in the relationship between IT mindfulness and learning effectiveness outcomes.

Table 4
Mediation results.

| Target construct: Productivity-in-learning | | |
|--|--------------------------|-------------------------|
| Mediator: Techno eustress | | |
| Independent variable: IT mindfulness | | |
| Direct effect | Specific indirect effect | Total effect + controls |
| .205** | .147* | .354* |
| Target construct: Creativity-in-learning | | |
| Mediator: Techno eustress | | |
| Independent variable: IT mindfulness | | |
| Direct Effect | Specific indirect effect | Total effect + controls |
| .323** | .144* | .467* |

Next, we conducted the mediation analysis using the product of coefficients —“Sobel test” and bootstrap confidence intervals — “Preachers and Hayes test” (Preacher & Hayes, 2004, 2008). For conducting these tests, we used the SPSS process plug-in. These mediation test results are summarized in Tables 5 and 6 for the two dependent variables PIL and CIL.

Table 5
Mediation results for PIL-Sobel test and Preacher and Hayes test.

| Test of the indirect effect of Techno eustress | | |
|--|---------|-------------------------------------|
| Productivity-in-learning (PIL) | | |
| Product of coefficients | | |
| | Z-test | Significance |
| IT mindfulness | 2.158 | 0.000 |
| Bootstrap confidence interval | | |
| | β | Bias-corrected confidence intervals |

| | | |
|----------------|-------|----------------|
| IT mindfulness | 0.148 | 0.003 to 0.317 |
|----------------|-------|----------------|

Table 6

Mediation results for CIL-Sobel test and Preacher and Hayes test.

| Test of the indirect effect of Techno eustress | | |
|--|---------|-------------------------------------|
| Creativity-in-learning (CIL) | | |
| Product of coefficients | | |
| | Z-test | Significance |
| IT mindfulness | 2.159 | 0.030 |
| Bootstrap confidence interval | | |
| | β | Bias-corrected confidence intervals |
| IT mindfulness | 0.244 | 0.062 to 0.293 |

The Sobel test (Tables 5 and 6, Upper Panel) results confirmed the significant mediating influence of techno eustress between PIL ($Z = 2.158$, $p = 0.00$) and CIL ($Z = 2.159$, $p = 0.030$). Next, the bootstrapped unstandardized indirect effect of techno eustress between the IT mindfulness and PIL was 0.148, and the 95% confidence interval ranged from 0.003 to 0.317. Thus, the indirect effect was statistically significant, offering support for H3. The bootstrapped unstandardized indirect effect of techno eustress between the IT mindfulness and CIL was 0.244, and the 95% confidence interval ranged from 0.062 to 0.293. Thus, the indirect effect was statistically significant, offering support for H4. Together, through these tests, we confirm the partial mediation effect of techno eustress on the relationship between IT mindfulness and learning effectiveness described by productivity-in-learning and creativity-in-learning. Hence, both H3 and H4 are supported for partial mediation.

5. Discussion

IT tools are becoming indispensable for student learning during the current COVID-19 crisis. In this research, we sought to examine the key role of “IT mindfulness” as an individual-level trait that enhances student learning effectiveness by providing a self-regulatory coping

mechanism in the face of enhanced IT demands for learning. We found good support for the proposed theoretical model. *IT mindfulness* has a significant direct relationship with the students' learning effectiveness in *productivity-in-learning* and *creativity-in-learning*. Furthermore, we found the significant mediating effect of *techno eustress* on the relationship between IT mindfulness and the two learning effectiveness outcomes. Incorporating *techno eustress* as a mediator in the model increases the variance explained by the IT mindfulness to PIL and CIL paths by 27 % and 28% respectively. We observed these significant effects even after controlling for the students' 'ICT use for schoolwork' and their demographic characteristics of 'age' and 'gender'. The high R² values explained together by IT mindfulness and techno eustress along with our chosen control variables (42 % for PIL and 52 % for CIL) confirm the relevance and robustness of our research model. In the subsequent sections, we discuss the theoretical and practical implications followed by the limitations of our study.

5.1 Theoretical implications

Our study offers several theoretical implications. *First*, our study addresses the calls to understand the role of individual differences in fostering productivity and creativity in technology-mediated learning settings (Michinov & Primois, 2005; Wang & Nickerson, 2017). Though prior research has shown the salience of specific technological and course design elements on technology-mediated learning effectiveness (Jahnke & Liebscher, 2020), such studies have not emphasized the role of individual differences among students on students' learning effectiveness. The specific characteristics of the students are of a much higher relevance during the current pandemic when the IT demands related to learning have suddenly escalated, and the students are being coerced to adapt to new IT-enabled learning environments swiftly. Our work sheds light on this salient research agenda. The findings can be generalized and

applied to other sectors to elicit broader implications for all kinds of remote work environments in different sectors (Califf et al., 2020). *Second*, our research is one of the few IS studies to theorize the role of IT mindfulness in alleviating the proven negative stress responses among students using ICTs for schoolwork (Di Pietro et al., 2020; Tarafdar et al., 2010). Our findings demonstrate that students with higher IT mindfulness are better prepared to understand and adapt to stressful situations arising due to enhanced IT demands. Our research paves the way for future IT mindfulness research in different IT impregnated contexts.

Third, a recent review paper on technostress has highlighted that IS literature is essentially skewed towards examining distress perceptions with a limited focus on appraising the demands from the technology environment as challenging or motivating (Tarafdar et al., 2019). Interestingly, very few IS papers discuss the positive side of IT stressors (Califf et al., 2020; Chandra et al., 2019; Srivastava et al., 2015; Zhao et al., 2020). Our research adds to this noteworthy stream of research by unravelling the role of one IT-specific individual-level trait, namely IT mindfulness, in generating techno eustress and facilitating better learning effectiveness. The results indicate that IT mindful students will experience techno eustress, which allows them to positively reframe their cognitions for self-accomplishment, leading to effective use of IT tools to enhance their productivity and creativity in learning. These findings can be examined in the context of other individual-level traits such as cognitive absorption and self-efficacy in fostering positive stress perceptions while using technology for learning and work (Chandra et al., 2012).

Fourth, our study addresses the calls to delve deeper into the techno eustress pathway to understand why individuals may experience mixed responses (positive and negative) when faced with enhanced IT demands (Chandra et al., 2019; Shirish, 2021; Srivastava et al., 2015). The

study offers a fresh perspective to study stress-coping response from a positive lens instead of viewing all IT demands and environmental situations due to remote work/learning resulting in adverse outcomes. Our study theorizes how IT mindfulness leads to positive impacts by explaining the mechanisms through which IT mindfulness influences stress responses (Thatcher et al., 2018), which we term as “IT mindfulness to meaning”. We theorize and demonstrate how, in the times of compulsory technology usage context (such as the examined pandemic lockdown), students with higher IT mindfulness thrive in digital environments by deriving positive personal meaning (techno eustress), which helps improve their PIL and CIL. The new theoretical perspective that we term as “IT mindfulness to meaning” offers additional avenues for research on the phenomenon of positive stress.

5.2 Practical implications

In addition to the aforementioned theoretical implications, our study offers several practical implications. *First*, the pre-COVID-19 period began witnessing high growth and adoption in education technology, with global EdTech investments reaching US\$18.66 billion in 2019 (Business Insider, 2020). The onset of the COVID-19 pandemic has accelerated the use of IT tools for student learning underlining the need to augment the research efforts for examining the role of technology in education. Our study is a modest attempt in this direction. The results from our study provide clear directions to educational institutions to sharpen not just their technological infrastructure but also plan to enhance the IT mindfulness of their students. We believe that these findings have implications for all businesses and organizations undergoing rapid digital transformation due to the coronavirus pandemic. Appropriate multi-pronged efforts are required to enhance the IT mindfulness of employees, partners, and users who are experiencing a sudden step-up in their IT demands to reappraise the enhanced IT demands as

techno eustress than succumb to the techno distress. Such features are expected to calibrate the IT mindfulness of the students so that they may develop the required sensitivity to assess the value of new technologies before using them.

Second, we recommend that educational institutions actively teach and undertake training on IT mindfulness to reduce any negative impact of online learning on student well-being, creativity, and productivity. Such training programs to refine the IT mindfulness trait in the students would bring about a permanent change, helping them in the ‘new normal’, which may see a significant rise in regular online educational tools even after the pandemic is over. Although we have not tested our model in other contexts, we believe that IT mindfulness training might be helpful for employees from other sectors as well, who are using IT for prolonged periods (Hickman, 2020) in the context of digital workplace programs.

Third, the mediating role of techno eustress highlights that if collaborative and organizational technologies are amenable to positive appraisals, they can increase productivity and creativity in student learning. To evoke sufficient techno eustress among potential users, educational institutions should attempt to concentrate their efforts in redesigning their instructional methods to use collaborative IT features, and different IT enabled engagement methods. Such a method of personalization would facilitate better student inclusion compared to just delivering a physical class/lecture through video (Loeb, 2020). Infusing such new learning methods that invoke IT mindfulness among students would make technology-driven learning enjoyable and enhance students’ learning effectiveness.

5.3 Limitations and future research directions

We acknowledge that our study has a few limitations. However, we believe that these limitations can provide interesting avenues for future research. *First*, the COVID-19 pandemic

has precipitated the relevance of IT and digital transformation in all areas of business and personal lives. However, our study focuses only on the education sector, where there is an ongoing debate in the field on how to increase 21st-century students' productivity- and creativity-in-learning through IT (Massy & Zemsky, 1995; Powell & Wimmer, 2015; Van Laar et al., 2017; Zhao et al., 2009). Future research can theorize and examine other contexts undertaking massive digital transformation efforts because of COVID-19 induced changes. Replication and extension of the IT mindfulness model in non-academic settings that involve digital workforce transformations can help increase the generalizability of our research findings.

Second, our study uses a two-wave survey method to examine the relevance of IT mindfulness and techno eustress in facilitating online learning effectiveness. Though collecting the data in two phases mitigates methodological biases, future studies can consider using an experimental method to have conclusive evidence for the causal impact of IT mindfulness. In a similar vein, qualitative studies on the subject can help better understand the nuanced processes through which IT mindfulness influences online learning effectiveness. Future studies can also evaluate to what extent IT mindfulness trait perceptions could increase over time when participants continue to exhibit high techno eustress perceptions in online learning or other settings.

Third, we tested the theorized model through a unique data set collected during the first pandemic driven lockdown period (from March to May 2020) in France. However, our sample size was relatively small. This was primarily because the study was designed as a two-wave matched pair survey conducted during the COVID-19 induced strict lockdown period in France. Many students had to make an abrupt first-time switch to different online learning modes. However, we conducted the G Power plot analysis, which shows that our study had sufficient

power to establish conclusive results. Future research can conduct similar studies with a larger number of respondents, perhaps from different cultures and countries. In addition, our study did not include the term pandemic in the survey instrument as it was a nationwide publicized phenomenon when the survey was rolled out. However, future research can use more contextualized survey instruments.

Fourth, in this study, we have examined one individual-level trait, namely, IT mindfulness, which influences techno eustress and students' online learning effectiveness. Though our theorized mindfulness model has good explanatory power, other individual-level traits such as personality, growth mindset, goal orientation, affect towards ICT use, and coping flexibility can also act as individual coping resources for online learners (Srivastava et al., 2015; Shirish, 2021). Examining the influence of these traits on IT-mediated learning effectiveness are fertile avenues for future research. In addition, issues related to student engagement, mental health conditions (such as depression) and other academic performance outcomes have gained salience, especially among college students (Yang et al., 2021). Examining these novel outcome variables can provide interesting directions for future work. The results of our study can be further contextualized to effective IT use contexts with specific challenge stressors and other organizational factors as conditions to tease out the mechanisms through which IT mindfulness positively influences performance outcomes via techno eustress (Burton-Jones & Volkoff, 2017; Chandra et al., 2019). Although we have examined only the impact of individual characteristics on learning effectiveness, task characteristics¹ could also influence the learning outcomes. Future research can investigate the role of task characteristics along with the individual-level traits in determining the online learning outcomes.

¹ We sincerely thank one of the anonymous reviewers for highlighting this important future research direction.

6. Conclusion

The quest to enhance online student learning effectiveness has prompted several research efforts. However, recently the ongoing COVID-19 pandemic has further accelerated the momentum in this area. Mandatory lockdowns and social distancing measures have led to extreme dependence on IT-mediated learning tools. Academic institutions have been trying to adopt, adapt, and implement different technological tools to facilitate continued student learning. But because of the abrupt transition to online learning environments, there is an increased onus of learning on the learners themselves. Anecdotal evidence shows that while some students can cope with the increased IT demands and transition smoothly to online learning environments, many others have serious issues which hamper their learning effectiveness. Thus, from a theoretical and practical standpoint, it is interesting to understand how online learners cope with this sudden increase in IT demands to stay productive and creative during the learning process. Through our study, we theorize and empirically demonstrate the salient role of *IT mindfulness* in helping students cope with the increased COVID-19 impacted IT demands by positively influencing their productivity- and creativity-in-learning. Further, leveraging mindfulness-to-meaning theory, we show that students' techno-eustress perceptions mediate the relationship between IT mindfulness and learning effectiveness outcomes. Our research provides actionable novel insights into the trainable individual-level competencies that can enhance online student learning effectiveness. The results from our study can assist educational institutions in implementing online learning environments that offer holistic learning opportunities to the students and ensure their personal growth and well-being.

7. References

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8. Appendices

Appendix A

Items of key variables.

| |
|--|
| First Wave Survey |
| IT mindfulness (Thatcher, et al., 2018) |
| <i>Alertness to Distinction</i> |
| 1. I find it easy to create new and effective ways of using new technologies. * |
| 2. I am very creative when using new technologies. |
| 3. I make many novel contributions to my work-related tasks through the use of new technologies. |
| <i>Awareness of Multiple Perspectives</i> |
| 1. I am often open to learning new ways of using technology. |
| 2. I have an open mind about new ways of using technology. |
| <i>Openness to Novelty</i> |
| 1. I like to investigate different ways of using new technologies. |
| 2. I am very curious about different ways of using new technologies |
| 3. I like to figure out different ways of using new technologies |
| <i>Orientation in the Present</i> |
| 1. I often notice how other people are using new technologies |
| 2. I attend to the 'big picture' of a project when using technology* |
| 3. I 'get involved' when using technology* |
| Second Wave Survey |
| Techno eustress (Adapted from LePine, et al., 2016) |
| 1. ICTs use help me to fulfill the demands of my schoolwork so I can improve my personal growth and well-being. |
| 2. I feel the ICTs use help me to address the demands of my school challenges so I can achieve personal goals and accomplishments. |
| 3. In general, I feel that ICT use for my schoolwork promotes my personal accomplishment. |
| Productivity-in-learning (Tarafdar, et al., 2010) |
| The ICTs I use for school-related work help me to... |
| 1. improve the quality of my work. |
| 2. improve my productivity. |
| 3. accomplish more work than would otherwise be possible. |
| 4. to perform my job better. |
| Creativity-in-learning (Tarafdar, et al., 2010) |
| The ICTs I use for school-related work help me to... |
| 1. identify innovative ways of doing my schoolwork. |
| 2. come up with new ideas relating to my schoolwork. |
| 3. try out innovative ideas |
| Notes: * deleted during data analysis due to poor factor loading at the measurement model stage. |

Appendix B

Cross loadings.

| | Age | EUT | GEN | ICTS | ITMF | CIL | PIL |
|-------|-------|------|-------|-------|-------|-------|------|
| AGE | 1.00 | 0.20 | -0.04 | 0.09 | 0.06 | -0.07 | 0.09 |
| EUT1 | 0.19 | 0.89 | 0.11 | 0.05 | 0.21 | 0.53 | 0.47 |
| EUT2 | 0.08 | 0.89 | 0.11 | 0.17 | 0.23 | 0.55 | 0.55 |
| EUT3 | 0.27 | 0.86 | 0.06 | 0.14 | 0.23 | 0.55 | 0.63 |
| ICTS | 0.09 | 0.14 | -0.01 | 1.00 | 0.12 | 0.26 | 0.23 |
| ITMF1 | 0.04 | 0.18 | -0.16 | 0.05 | 0.82 | 0.33 | 0.39 |
| ITMF2 | 0.13 | 0.25 | -0.12 | 0.13 | 0.76 | 0.36 | 0.35 |
| ITMF3 | 0.05 | 0.14 | -0.18 | 0.13 | 0.89 | 0.39 | 0.25 |
| ITMF4 | 0.05 | 0.22 | -0.13 | 0.14 | 0.85 | 0.50 | 0.23 |
| ITMF5 | 0.06 | 0.12 | -0.16 | 0.05 | 0.73 | 0.32 | 0.18 |
| ITMF6 | 0.01 | 0.15 | -0.17 | -0.07 | 0.50 | 0.15 | 0.14 |
| ITMF7 | -0.01 | 0.24 | -0.07 | 0.13 | 0.59 | 0.33 | 0.28 |
| ITMF8 | 0.02 | 0.10 | -0.28 | 0.05 | 0.40 | 0.08 | 0.07 |
| PIL1 | -0.01 | 0.53 | 0.12 | 0.20 | 0.25 | 0.55 | 0.82 |
| PIL2 | 0.07 | 0.51 | -0.06 | 0.15 | 0.27 | 0.41 | 0.83 |
| PIL3 | 0.00 | 0.40 | 0.05 | 0.27 | 0.25 | 0.46 | 0.80 |
| PIL4 | 0.20 | 0.59 | -0.01 | 0.14 | 0.38 | 0.45 | 0.82 |
| CIL1 | -0.06 | 0.55 | 0.00 | 0.22 | 0.47 | 0.91 | 0.51 |
| CIL2 | -0.06 | 0.55 | 0.05 | 0.27 | 0.36 | 0.88 | 0.50 |
| CIL3 | -0.06 | 0.58 | -0.02 | 0.22 | 0.44 | 0.91 | 0.52 |
| GEN | -0.04 | 0.11 | 1.00 | -0.01 | -0.19 | 0.01 | 0.03 |

Notes: EUT: Techno Eustress; ICTS: No of average hours of ICT used by students in a day for school-related tasks. ITMF: IT mindfulness; PIL: productivity-in-learning; CIL: creativity-in-learning; GEN: Gender.

Appendix C.

Hetrotrait-Monotrait (HTMT) ratio criterion test

| | Age | EUT | GEN | ICTS | ITMF | CIL | PIL |
|------|--------|-------|--------|-------|-------|-------|-------|
| Age | 1.000 | | | | | | |
| EUT | 0.203 | 0.876 | | | | | |
| GEN | -0.041 | 0.108 | 1.000 | | | | |
| ICTS | 0.085 | 0.139 | -0.012 | 1.000 | | | |
| ITMF | 0.065 | 0.258 | -0.192 | 0.122 | 0.706 | | |
| CIL | -0.068 | 0.622 | 0.010 | 0.262 | 0.472 | 0.904 | |
| PIL | 0.090 | 0.631 | 0.028 | 0.227 | 0.364 | 0.572 | 0.817 |

Notes: EUT: Techno eustress; GEN: Gender; ICTS: No of average hours of ICT used by students in a day for school-related tasks; ITMF: IT mindfulness; PIL: productivity in learning; CIL: creativity-in-learning.