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The Determinants of Study Progress in Postgraduate Students During the COVID-19 Pandemic

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Abstract

Aim/Purpose	The aim of this paper is to investigate the determinants of satisfaction with study progress during a period when COVID-19 restrictions were in place and after their removal.
Background	The pandemic instigated a period of rapid technological change in global higher education. Relatively little research has examined the combined effect of technological use and the pandemic on academic development. The current work sets out to examine the role of time management, technology use, and health and well-being on self-assessed academic progress.
Methodology	An opportunity sample of 494 doctoral students recruited predominantly from universities in the UK completed a survey with measures of technology use, attitudes to technology, self-reported health and well-being, satisfaction with study progress and aspects of time management. During the period of data collection, pandemic restrictions were removed, providing the opportunity for a limited, interrupted time series (ITS) analysis
Contribution	This paper presents a model of study progress, which is applied in two distinct periods over which data was collected – during the period of the pandemic when social restrictions were in place and in the period following, when restrictions were removed.
Findings	A majority of doctoral students reported being satisfied with their study progress. Several significant correlates of this were identified. A linear model utilising these variables statistically explained 29% of the variance in satisfaction with study progress. For the period when COVID restrictions were still in place, the model explained 47% of the variance, significantly greater than in the subsequent period when restrictions were removed. Effect sizes for happiness with

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	time management, finding software applications difficult to use or learn, currently reported general health, health compared to the previous year and the effects of the pandemic on study were significantly greater during the period of the pandemic.
Recommendations for Practitioners	A proportion of the sample reported finding software difficult to use/learn, with this impacting on reported study progress. This suggests a need for technology training for doctoral students. The relationship between time management and study progress also suggests a potential need for support in this area. It is important that technology training takes on board the 'emotional usability' of technology. Raising awareness amongst supervisors of doctoral students of both the psychological dimensions of technology use and the need for student support would be beneficial.
Recommendations for Researchers	Self-rated academic progress provides a useful measure of academic attainment. The role of doctoral students' health and well-being in relation to study progress warrants further investigation. To clarify the causal nature of relationships between time management, health and well-being and study progress further work using longitudinal studies is required.
Impact on Society	The study suggests the pandemic had a large influence on doctoral students' education and their health and well-being. With the increasing importance of international postgraduate recruitment for universities, the findings highlight the need for attention to be given for students' well-being and the support infrastructure which can contribute to this.
Future Research	Future work should seek to replicate the findings and examine how determinants of study progress may vary over time and in different populations of doctoral students. Structural equation modelling could be used to further explore the relationships which health, time management, technology use and appraisal have with study progress. More work is needed to assess the potential long-term effects of the pandemic on well-being and academic life.

Keywords	study progress, technology, health, time management, COVID-19

INTRODUCTION

To date, relatively little research has systematically examined the combined effect of technological use and the pandemic on academic development (see Cahusac de Caux, 2023). Several personal accounts have been given by doctoral students, which detail their experiences during the pandemic and how they have dealt with the cataclysmic changes impacting on them. These describe motivational strategies, management of work-life balance and future expectations and establishing academic identities (J. Li & Zhang, 2023; Mokbul, 2023; Patel, 2023; Rangarajan & Daneshfar, 2023; Utami, 2023). These accounts make clear the multidimensional nature of the change precipitated by the pandemic and the difficulties in evaluating its impact on PhD study. In any overall appraisal of this impact, assessments of productivity and efficiency during PhD study are limited by how any outcome is assessed. The principal goal of PhD study is judged only on its completion (pass/fail/refer), which renders this an inappropriate measure to assess impact during study. Another potential yardstick, publication output, is limited by two issues – the potential length of time awaiting the decision of journal editors and the fact that some students prefer to submit work for publication only on completion of the thesis.

In the absence of sensitive and practical, concrete benchmarks to evaluate students' progress prior to completion of a thesis, the present study will utilise a self-assessment of study progress, similar to the five point-scale measuring students' satisfaction with their PhD trajectory, which was employed by van Rooij et al. (2021) in their study of PhD students' success and attrition. Such self-assessments of academic progress have previously been employed in postgraduate populations, when researching the relationships which academic performance has with ethnicity (Woolf et al., 2011) and mental health (Grøtan et al., 2019).

The combined effects of technological practices and the rapid change instigated by the pandemic on academic practise and attainment is poorly understood. During the period of data collection, removal of pandemic restrictions provided the opportunity for a limited, interrupted time series (ITS) analysis – a method which is frequently employed in evaluations of public health interventions and unpredictable events such as disease outbreaks or natural disasters (Bernal et al., 2017). The present study aims to assess the determinants of doctoral students' self-assessed study progress during the period of the pandemic when restrictions were in place and in the period following their removal.

In particular, the study will examine the role of time management, the perception of and use of technology (including social media use), as well as health and well-being, on the perceived satisfaction with study progress. Several hypotheses are advanced.

1. The effect of the pandemic on study will be judged to be greater during the period when restrictions were in place.
2. Given the greater reliance on technology during the pandemic period, variables related to technology use will exert a greater effect on perceived study progress during the pandemic.
3. Given the threats to health during the pandemic, health assessed during this period will have a greater effect on perceived study progress.
4. Efficacy in time management will be positively related to study progress.
5. Social media use will be related to study progress.

LITERATURE REVIEW

In a 21st century environment of accelerating technological innovation (Ellis & Goodyear, 2010), competence in information and communication technology (ICT) has come to play an increasing role in education, both for students and academic staff (Costa et al., 2019; Elzarka, 2012), bringing in its wake a shift, in the nature of postgraduate study (Haleem et al., 2022). As universities seek to revolutionise methods of teaching, learning and research, aptitude in ICT is now regarded as essential for anyone wishing to enter higher education (HE) (Aspden & Thorpe, 2009; Henderson et al., 2016).

To date, research examining the role of technology in tertiary education has concerned the accessibility and delivery of both conventional (Haleem et al., 2022) and distance learning (Sidikova, 2021), the social organisation and nature of communication within the academic community (Zhu & Procter, 2015), the provision of student feedback (Murphy Odo & Yi, 2014), the personal intellectual development of students (Stephen & Rockinson-Szapkiw, 2021), as well as the efficacy and efficiency of learning (Studebaker & Curtis, 2021). In considering the role of technology in aiding learning, consideration must be given to the differing levels of prior technological experience and training students may have (VanDer Schaaf & Shifrer, 2019), their perceptions of and attitudes toward technology (Al-Rahmi et al., 2021; Kemp et al., 2019; Park, 2009), their efficacy in time management (Chase et al., 2013; Wahid et al., 2022), the social bonds and relationships between staff and students (Hradsky et al., 2022), as well as students' health and well-being (F. Li et al., 2022; Mahdavi et al., 2023). Many of these factors are known to affect academic success, either directly or indirectly through effects on academic motivation.

The work conducted to date highlights a range of benefits which technology may bring to the academic community. However, concerns have been raised regarding the levels of attrition in doctoral programs (Artiles & Matusovich, 2020) and the acknowledged higher drop-out rates observed for online compared to residential programs. It has been estimated that those attending online programs are 10-20% more likely to quit their programs (Bawa, 2016; Graham & Massyn, 2019). Other authors have reported comparable or even higher figures (Cassuto, 2013; Lee et al., 2020; Miller, 2013; Studebaker & Curtis, 2021).

Understanding the factors which drive attrition has been the subject of a growing body of research. This suggests the problems appear to be more prevalent in social science and humanities programmes (Mestan, 2016). There are also indications that first generation college students, those whose family have no background in higher education, and who are less comfortable with technology, may be more susceptible to attrition from online courses (Aldowah et al., 2020; Cataldi et al., 2018; Musingafi et al., 2015; Pratt et al., 2019). A recent review of student attrition in tertiary education indicates that it is determined by a range of individual, institutional, and economic factors, with these mediated by a student's ability to integrate into the academic system (Aina et al., 2022). In line with this, Storrie et al. (2010) found that the ability to manage emotional distress was a factor preventing academic dropout. The importance given to students' social integration suggests that relationships with peers and academic staff may also be an important factor, with the different social environments associated with both online provision and part-time study also being relevant. This has led researchers to consider whether technology can overcome the social differences between online and face-to-face provision. With this aim, Maul et al. (2018) explored the use of videoconferencing in reducing social isolation and increasing motivation during doctoral students' dissertation writing period. They found that students who were coached via videoconferencing demonstrated increased self-efficacy and efficiency and were less likely to drop out of their doctoral course.

The Effect of the COVID-19 Pandemic

The onset of the COVID-19 pandemic led to rapid changes in technological practice in both education and work life throughout the world (OECD, 2021), with many universities switching to an online education model (Lemay et al., 2021). In an extensive review of digital technology use during the pandemic, Vargo et al. (2021) noted that this transition from the face-to-face delivery of teaching, learning and communication to an online model presented severe challenges. At the same time, some took the view that it also presented an opportunity to make learning more flexible, personalised, and effective (Shtykhno et al., 2020). Evidence to date, however, suggests that students have not been entirely convinced that teaching objectives were maintained, with many finding the transition to online education stressful, with deleterious effects reported in both physical and mental health and social life (Chakraborty et al., 2021; Chirikov et al., 2020; Wasil et al., 2021). For doctoral students, the change to remote learning and videoconferencing for supervision precipitated increased anxiety and frustration, consequent to the reduced level of immersion and cultural affinity experienced compared to face-to-face learning (Cahusac de Caux, 2023). Gender differences in academic output have also been reported, with academics who are mothers less likely to submit work for publication (Shalaby et al., 2021) and reporting fewer hours devoted to research compared to fathers (Deryugina et al., 2021); both are a likely consequence of differing family commitments. Over the course of the pandemic Cahusac de Caux (2023) reports shifts in the proportion of doctoral candidates reporting the pandemic had had a negative impact on their academic writing. This ranged from 50% in April 2020 during the early stages of the pandemic to 25% by February 2022. By this latter point, positive outcomes were reported by 37%. These findings reflect changes in both the course of the pandemic and in adaptation to it.

The following sections present the study design and methodology, after which the findings will be presented, together with a discussion of the significance of the results and limitations of the study.

METHODS

DESIGN

A survey design was employed. The survey investigated doctoral students' use and appraisal of technological tools, health, well-being, time management and satisfaction with study progress. This method has advantages in terms of questionnaire delivery and data collection (Nayak & Narayan, 2019). The survey was hosted on the Online Survey platform (formerly BOS) with a mixture of closed and open questions amenable to quantitative and qualitative analysis (Lupu & Michelitch, 2018). Data collection began in November 2021, 18 months after the onset of the pandemic. Removal of pandemic restrictions during the data collection period enabled the opportunity to conduct a limited, interrupted time series (ITS) analysis. The present study aims to assess the determinants of doctoral students' self-assessed study progress during the period of the pandemic when restrictions were in place and in the period following their removal. Data collected in these two distinct time periods is therefore examined. The first covering the period up until mid-July 2022 before COVID-19 restrictions ended on university campuses and the second period, from Mid-July to the beginning of September 2023. Variables are described below.

PARTICIPANTS

With regression utilised as a major analytic tool, calculations in GPower3.1 (Verma & Verma, 2020) suggested a minimum sample size of 434 as sufficient for detecting small effect sizes (f=0.03) in a regression analysis with five predictors, at a statistically significant level (alpha=0.05) with 80% power. An opportunity sample of doctoral students was recruited by sending emails to several sources: the Postgraduate Student Association in the Education Department of Glasgow University, supervisors of doctoral students and Heads of Department in departments of Education and Psychology throughout the UK. These letters informed recipients of the nature of the study and, where appropriate, requested them to forward the email to PhD candidates. Each letter contained a live link to the survey. Notices were also posted on Facebook, Twitter, and Instagram.

MATERIALS AND VARIABLES

Demographic variables

In the first part of the survey demographic information was collected. This included field of study - coded into science and non-science subjects, a distinction following Rockinson-Szapkiw et al.'s (2019) demarcation between STEM and Non-STEM subjects. Following UK census guidelines (UK Government, 2021), ethnicity was coded into five categories (1=Asian, Asian British, 2=Black, Black British, Caribbean, or African, 3=Mixed or multiple ethnic groups, 4=White, 5=Any other Ethnic group).

Time management

Several questions concerning time management were presented. These were presented as a series of statements to which participants gave their level of agreement (from 1=strongly disagree to 5=strongly agree). Four statements on potential problems arising from spending time online were given. These were '*Spending time online with study affects how much exercise I take*', '*Spending time online with study affects my social life*', '*Spending time online interferes with the quality of my sleep*', '*Spending time online with study affects my family life*'. A scale, '*Problems caused by spending time online*' was computed by summing scores from these items. Total possible scores ranged from 5 to 20. Cronbach's alpha for the summed variable was good (alpha=0.79). wo further statements on time management were given '*I am happy with how I spend my time*' and '*I tend to spend more time on the internet than I had intended*.'

Social media use

One question enquired into participants' use of social media. They were asked to indicate which of the following they used: Snapchat, Twitter, YouTube, LinkedIn, Facebook, and Instagram. A variable

'Social media usage' was computed from the sum total of these which were used. Possible scores ranged from 0 to 6.

Helpfulness of technology

Helpfulness of a range of technologies (quantitative analysis, qualitative analysis, word processing, presentations, videoconferencing, email, messaging) was assessed by asking respondents to indicate their level of agreement (from 1=strongly disagree to 5=strongly agree). with a given statement. For example, "*Overall I find using email helpful in my studies.*"

Orientation to technology use

A single question enquired into respondents' preference for digital or physical copies of academic material. '*When reading, I prefer to have Physical Copies of the articles/books I access.*' Possible answers ranged from 1=strongly disagree to 5=strongly agree.

Training

The issue of training was addressed by giving respondents the option of answering yes or no to the question '*Have you ever received training in the use of technology*?' In addition, they were asked to indicate whether they had received training in the following areas: Literature searching, Data analysis software – quantitative, Data analysis software – qualitative, Spreadsheets (E.g. Excel), Presentation software, Messaging software, Video conferencing, Subject Specific software, and End Note/referencing software.

Emotions when using information sources

This section describes the main variables used in the present study. Participants were asked to state how they feel overall about using electronic information sources. For each emotion (frustration, interest, engagement, boredom, anxiety, and relaxation) they were asked to indicate their level of agreement on a 5-point scale (from 1=strongly disagree to 5=strongly agree) with a statement. An example statement was "*I feel angry.*" A total score for negative emotions felt was computed from the summed scores for feeling frustrated, bored, and anxious. Similarly, a total score for positive emotions was computed from the summed scores for feeling interested, engaged, and relaxed. Possible scores for the summed variables thus ranged from 5 to 15.

Health and well-being

A section on health and well-being contained previously validated items on the self-evaluation of health status, and perceived stress (Marmot, 2020; Marmot et al., 1991). Current health was rated on a 5-point scale (1=poor, 2=fair, 3=good, 4=very good, 5-excellent) and health compared to one year ago was also rated on a 5-point scale (1=much worse than 1 year ago, 2=somewhat worse than 1 year ago, 3=about the same as 1 year ago, 4=somewhat better than 1 year ago, 5=much better than 1 year ago). Perceived stress, defined as "a situation where a person feels tense, restless, nervous, or anxious, or is unable to sleep at night because his/her mind is troubled all the time" was also measured on a 5-point scale. Possible answers were, 1=not at all, 2=only a little, 3=to some extent, 4=rather much, 5=very much. Respondents were asked to indicate how the COVID pandemic had affected their studies. They could select from a range of options, varying from very positively to very negatively (1=very positively, 2=positively, 3=not at all, 4= negatively and 5=very negatively).

Study progress

Satisfaction with study progress was measured on a 5-point scale in answer to the statement "*I am satisfied with the progress of my studies.*" Possible answers ranged from 1=strongly disagree to 5=strongly agree.

Two open ended questions were presented: These were 'My greatest satisfaction in using technology is....' and 'My greatest problem in using technology is....'

Communication with students and academic staff

Four questions assessed communication with students and academic staff. Frequency of communicating with lecturers/tutors or supervisors through videoconferencing was answered on a 4-point scale (never, rarely, occasionally, frequently) as was frequency of communicating with fellow students. Frequency of communicating via instant messaging was assessed with two similar questions.

PROCEDURE

Once directed to the website hosting the survey (https://glasgow-research.onlinesurveys.ac.uk/students-perceptions-of-the-benefits-and-drawbacks-of-tec-3), respondents were presented with a participation information sheet detailing the nature of the study, estimated time to complete it, a statement explaining participation was voluntary, that respondents could withdraw at any time and that all personal details would be kept confidential. Contact details were provided for the principal researcher and supervisor and a consent form for participants to confirm they had read and understood the information provided and agreed to take part. On informed consent being given, participants were directed to the beginning of the survey. It was possible to move back and forth through the survey with the option of answering missed questions later if desired.

DATA ANALYSIS

Descriptive analysis

Prior to detailed analysis, the main descriptive features of the sample are presented, with participants described in terms of age, gender, full-time/part-time status, length of time studying, discipline studied (science/non-science), nationality (UK, European, Middle Eastern, Asian, Americas/Caribbean, Africa, Australasia) and ethnicity.

A summary of how satisfied participants were with their study progress is given in Figure.1.

Inferential analysis: Perceived study progress

Correlational analysis. Using correlational analysis, several distinct issues were examined in relation to satisfaction with study progress. These were (A) time management, (B) social media use, (C) helpfulness of technology, (D) Orientation to technology use – this had two aspects; preferences for accessing information in digital/physical form, and whether participants found software difficult to use, (E) training, (F) emotions felt when using information sources, (G) stress, health and well-being, (H) communication with other students and lecturers, and (I) demographic factors (e.g., gender, ethnicity, age, country of study, field of study, nationality). As variables were assessed on an ordinal scale initial analyses are conducted using Sperman's rank correlation.

Tests for differences and association. Differences in study progress by demographic characteristics were examined by Mann-Whitney (gender, and full/part-time status, field of study) and Kruskal Wallis tests (ethnicity, nationality, country of study).

With data collection undertaken over two periods, a duration prior to the removal of COVID-19 restrictions and subsequent to this, it can be expected that during the earlier period students were more reliant on technology, and more affected by the pandemic. A Mann-Whitney t-test and chi-square analysis were used to examine whether students reported differences in how their study was affected by the pandemic in these two periods.

General linear modelling. Based on the variables which were significantly related to satisfaction with study progress, a general linear model to predict satisfaction with study progress was constructed. Schmidt and Finan (2018) have demonstrated that linear models yield unbiased estimates even when normality is violated, once sample sizes exceed 25.

It is predicted that the model applied during the pandemic period would have greater predictive power. Fisher Z-transforms of the multiple correlation coefficient R were computed to assess whether the predictive capacity of the model differed across the two periods of data collection. Differences in the effect size of predictors between the two models were examined by general linear models composed of interaction terms between a predictor and the data collection period. All quantitative analyses were conducted in SPSS v27.

RESULTS

DESCRIPTIVE ANALYSIS

Characteristics of respondents

In total, 494 people responded. Of these 175 were males, (35.4%; mean age = 30.01 years, SD=7.22) and 309 females (62.6%; mean age=30.23 years, SD=7.36); seven participants identified as non-binary, mean age=26.86 years, SD=2.41. Full participant characteristics are provided in Table 1.

Table 1. Characteristics of Sample

Gender	N
Male	175 (35.4%)
Female	309 (62.6%)
Non-Binary	7
Missing data	3
Nationality	
British	204 (41.3%)
European	110 (22.3%)
Asian	87 (17.6%)
Middle Eastern	32 (6.5%)
American/Caribbean	28 (5.7%)
African	20 (4.0%)
Australasian	3 (0.6%)
Ethnicity	
White	253 (51.2%)
Asian	106 (21.5%)
Black	29 (5.9%)
Mixed	21 (4.3%)
Other	28 (5.7%)
Missing data	57 (11.5%
Country of Study	
United Kingdom	
England	323 (65.4%)
Scotland	75 (15.2%)
Northern Ireland	14 (2.8%)
Wales	11 (2.2%)
Europe	20 (4.0%)
Americas	16 (3.2%)
Asia	9 (1.8%)
Other	19 (3.8%)
Missing Data	16 (3.2%)
Study Discipline	
Science/Engineering	347 (70.2%)
Non-Science	129 (26.1%)

As can be seen from the table, the sample contains students with a range of nationalities. The majority (85.6%) were studying at UK universities and dawn from both scientific (70.2%) and non-scientific fields (26.1%). During the first period of data collection, 152 participants responded to the survey and in the post-COVID period from mid-July 2022 onwards 336 responded.

Participants' responses to the item on perceived study progress is shown in Figure 1.

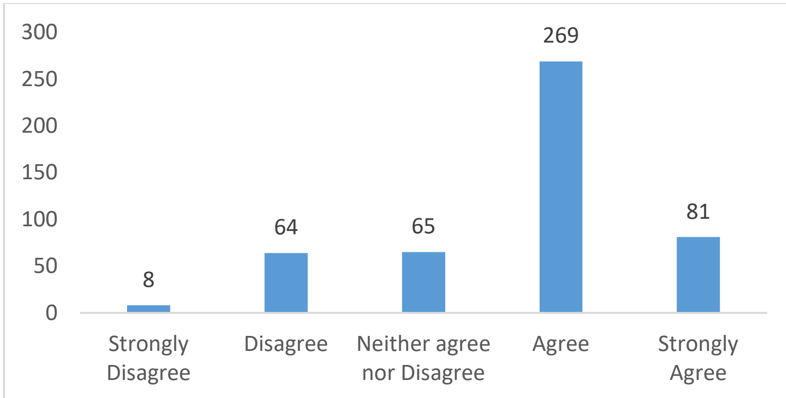

Figure 1. Distribution of responses to 'I am satisfied with the progress of my studies'

Inferential Analysis

A. Time Management

Over half the respondents reported being happy with how they managed their time (N=251, 50.8%). Satisfaction with study progress was significantly positively correlated with happiness with time management (rho (470)=.36, p<.001) and negatively correlated with; spending more time on the Internet than intended (rho (473)=-.15, p=.001), spending time online interferes with my social life (rho (474)=-.10, p=.04), spending time online affects my family life (rho (472)=-.12, p=.012), spending time online affects my sleep (rho (481)=-.09, p=.05) and the sum of problems caused by spending time online (rho (299)=-.10, p=.039). Satisfaction with study progress was significantly negatively correlated with the number of hours spent on a computing device on a typical day (rho (460) =-.090, p=.049).

B. Social Media Use

The number of social media platforms used varied markedly, with a large proportion of the sample using three or more (N=401, 81.2%). Satisfaction with study progress was unrelated to the number of social media platforms used (rho (481) =.04, p=.94) and to use of Twitter, YouTube, LinkedIn, Facebook, Snapchat and Instagram (p>.05 in all cases).

C. Helpfulness of Technologies

Respondents judged the most helpful software packages were word processing (N=454, 91.9%), presentations (N=452, 91.3%), quantitative analysis (N=449, 90.9%), email (N=447, 90.5%), and videoconferencing (N=440, 89.1%). Other software (for qualitative analysis, instant messaging, receiving information, and online data collection) were judged as helpful by more than 50% of those responding. Satisfaction with study progress was significantly positively correlated with helpfulness of software for quantitative analysis (rho (467) =.14, p=.002), videoconferencing (rho (474) =.16, p<.001), technology used for receiving information (rho (448) =.13, p=.021), using email in studies (rho (477) =.09, p=.05), and software for presentations (rho (477) =.11, p=.018).

D. Orientation to technology use

Preferences for using physical (N=178, 35.8%) or digital copies of articles and books (N=163, 33.0%) were evenly divided, whilst just over one in ten (N=55, 11.1%) indicated they found software applications difficult to use/learn. A substantial number (N=155, 31.5%) were undecided. Satisfaction with study progress was significantly positively correlated with a preference for digital over physical copies of articles/books (rho (480) =-.15, p=.002) and significantly negatively correlated with finding software applications difficult to use/learn (rho (468) = -.15, p=.002).

E. Training

Over three-quarters of the sample (N=387, 78.3%) reported having received some form of training in technology use, though this was not related to satisfaction with study progress (rho (480) =.05, p=.28). Only 61 individuals (12.3%) reported that they had received training in the use of videoconferencing (12.3%). There was no difference in satisfaction with study progress between those who had or had not received this training (3.68 cf. 3.72, t(479)=-.25, p=.80).

F. Emotions felt when using information sources

Positive emotions were more frequently reported than negative ones. The most widely reported emotion was feeling interested (N=403, 81.5%), followed by engaged (N=356, 72.0%) and relaxed (N=226, 45.7%). More negative emotions: feeling bored (N=84, 17.0%), anxious (N=80, 16.2%) or frustrated (N=68, 13.7%) were reported by fewer than one-in-five.

Satisfaction with study progress was related to emotions felt when using information sources. There were significant negative correlations with feeling frustrated (rho (478) =-.15, p<.001), bored (rho (480) =-.14, p=.003) and anxious (rho (476) =-.26, p<.001) and positive correlations with feeling interested (rho (478) =.12, p=.012), engaged (rho (476) =.15, p=.001) and relaxed (rho (481) =.20, p<.001). Overall positive emotions were significantly positively correlated with study progress (rho (474) =.23, p<.001), whilst overall negative emotions were significantly negatively correlated with it (rho (472) =-.49, p<.001).

G. Stress, Health, and Well-Being

A minority of participants (N=88, 17.8%) reported that the pandemic had affected their studies positively. In contrast, over half (N=266, 53.8%) reported the effects had been negative. Whilst a large majority (N=409, 82.8%), reported their current health was good to excellent, almost a quarter (N=118, 23.9%) reported that it had worsened compared to the previous year. Moderate to high levels of stress (from to some extent to very much) were also reported by a large majority (N=344, 69.6%).

Satisfaction with study progress was significantly correlated with the COVID pandemic affecting studies positively (rho (478) =0.27, p<.001), current general health (rho (480) =0.29, p<.001), better health compared to one year ago (rho (479) =.12, p=0.009), and perceived stress (rho (477) =-.28, p<.001).

H. Communication with other students and lecturers

Frequency of communicating with lecturers through videoconferencing (rho (475) =.11, p=.018) was weakly related to study progress, whilst use of videoconferencing to communicate with other students was moderately correlated with study progress (rho (477) =.22, p<.001). Use of instant messaging software with both lecturers (rho (476) =.00, p=.99) and other students (rho (470) =.01, p=.82) was not related to study progress.

I. Demographic factors

Table 2 summarises the findings regarding whether satisfaction with study progress varied by gender, ethnicity, nationality, country of study, full-time/part-time status, and field of study.

Table 2. Study Progress by Demographic variables

Variable	Satisfaction with Study Progress
Gender	There was no significant difference between males and females (3.66 cf. 3.79; Z (473) =-1.66 p=0.09).
Ethnicity	There was no significant difference by ethnicity (H (4) =4.67, N=451, p=.32).
Nationality	There was no significant variation by nationality (H (5) =3.71, N=470, p=.59).
Country of Study	There was no significant variation by country of study (H (5) =3.0, N=449, p=.65).
Full-Time/Part-Time status	There was no significant difference between full and part-timers (3.73 v 3.61; Z (474) =.72, p=.47).
Field of Study	There was no significant difference between science and non-science students (3.72 cf. 3.70; Z (472) =.45, p=.65).

As can be seen, no significant differences were found.

Participants reported, as expected, that the COVID-Pandemic had affected their studies significantly more negatively during the period when COVID restrictions were still in place (3.61 cf. 3.38; Z (482) =2.20, p=.03). In the first study period, 94 participants (62.7%) reported that the pandemic had negatively affected their studies, compared to 22 (14.7%) who reported it had had a positive effect. In the second period of data collection the proportion of participants who reported the pandemic had had a negative effect dropped to 51.9% (N=266), with the proportion stating it had had a positive effect was greater than during the first period (N=88, 19.9%). These changes were significant ($\chi 2$ (1, N= 482) = 4.59, p=.032).

MODELLING STUDY PROGRESS

Based on the above analyses, a general linear model of satisfaction with study progress was constructed. This included variables that were related to time management, technology use, and variables concerned with psychological health and well-being. Time management variables were the sum of problems arising from time online, and happiness with time management. Technology use related variables entered were as follows: preference for physical/digital copies of work, hours spent on a typical day on a computing device, difficulty of using/learning software applications, use of videoconferencing to communicate with lecturers, use of videoconferencing to communicate with other students, the helpfulness of software for - quantitative analysis, videoconferencing, presentations, receiving information, and using email in studies. The health/well-being variables were as follows: current general health, health compared to previous year, the effect of the COVID-pandemic on study, perceived stress, sum of positive emotions and sum of negative emotions. All variables were entered as fixed factors except for sum of positive emotions, sum of negative emotions, sum of problems arising from time online and hours spent on a computing device, which were entered as covariates.

Table 3. General Linear Model of Satisfaction with Study Progress

	Partial eta^2	p
Time Management		
*Sum of problems arising from time online**	.016	.023
*Happiness with time management***	.049	.003
Technology Use-Related Variables		
Prefer digital to physical copies when reading	.027	.06
Hours in total spent on computing devices on a typical day	.006	.148
Find software applications difficult to use/learn	.005	.789
use of videoconferencing to communicate with lecturers	.003	.781
use of videoconferencing to communicate with other students*	.033	.012
Helpfulness of software		
For quantitative analysis	.021	.147
For videoconferencing	.026	.073
For presentations	.007	.656
For receiving information*	.032	.033
Using email in studies	.016	.266
Well-Being Variables		
General Health	.026	.076
Health compared to previous year	.012	.401
Effect of Pandemic on Study**	.045	.005
Perceived Stress**	.042	.008
Sum of Positive Emotions	.004	.27
Sum of Negative Emotions	.121	.12

* $p \leq .05$ ** $p \leq .01$

The final model explained 28.6% of the variance in satisfaction with study progress ($F_{58,323}=3.63$, $p<.001$; Partial eta^2=.40, adjusted R^2=.29). The test for heteroskedasticity was non-significant ($F_{58,323}=1.0095$, $p=.31$) indicating the model had a consistent fit across all values of study progress. Results of the analysis are shown in Table 3.

Greater study progress was significantly related to fewer problems arising from time spent online, greater satisfaction with time management, the helpfulness of technologies for receiving information, increased frequency of using videoconferencing to communicate with other students, less stress, and the pandemic having a negative effect on study. Of these, happiness with time management, the effect of the pandemic on study and perceived stress had the largest effect sizes.

As indicated, the model was applied in two distinct time periods. The first covering the time up until mid-July 2022 before COVID restrictions ended on university campuses and the second from Mid-July to September 2023. Results of the model applied in the two periods are shown in Table 4 below.

The predictive capacity of the model during the first period was substantially greater than during the second. Treating the multiple correlation coefficient 'R' for these two samples as a simple correlation coefficient (for Period 1, R=.68; for Period 2, R=.48), permits Fisher-Z transformations to be applied to assess whether they differ significantly. This found the model's predictive power in Period 1 was significantly greater than in Period 2 (z=2.80, p=.005).

Table 4. General Linear Model of Satisfaction with Study Progress in Two Time Periods

.	Period 1	R^2	Period 2	R^2
		0.47		0.23
	Partial eta²	**p**	**Partial eta²**	**p**
Time Management				
Sum of problems arising from time online	.002	.750	.017	.066
Happiness with time management	.086	.189	.042	.067
Technology Use-Related Variables				
Prefer digital to physical copies when reading	.057	.405	.032	.154
Hours in total spent on computing devices on a typical day	.032	.142	.000	.903
Find software applications difficult to use/learn	.142	.034	.010	.721
use of videoconferencing to communicate with lecturers	.030	.362	.006	.758
use of videoconferencing to communicate with other students	.016	.784	.051	.013
Helpfulness of software				
For quantitative analysis	.006	.934	.051	.013
For videoconferencing	.061	.239	.016	.504
For presentations	.027	.761	.008	.802
For receiving information	.021	.488	.054	.024
Using email in studies	.056	.143	.012	.664
Well-Being Variables				
General Health	.082	.212	.024	.285
Health compared to previous year	.077	.244	.018	.442
Effect of Pandemic on Study	.136	.041	.041	.073
Perceived Stress	.071	.290	.036	.113
Sum of Positive Emotions	.037	.115	.019	.050
Sum of Negative Emotions	.001	.809	.009	.188

Table 4 suggests five variables (happiness with time management, finding software applications difficult to use/learn, general health, health compared to the previous year and the effect of the pandemic on study) had substantially greater effect sizes during Period 1. Finding software applications difficult to use yielded the largest effect size, closely followed by the effect of the pandemic on study. To test whether each of these differed in their effect on study progress across the two periods, five further general linear models were computed. Each of these models included an interaction term with study period for the relevant variable. Results are given in Table 5 and suggest that the five variables exerted a significantly greater effect during the first period of data collection.

Table 5. Results for General Linear Model, change in effect size over time.

Interaction term with Time Period	Partial eta^2	p
Happiness with time management	.136	<.001
Find software applications difficult to use/learn	.036	.05
General Health	.086	<.001
Health compared to previous year	.041	.019
Effect of Pandemic on Study	.101	<.001

DISCUSSION

The findings in the presents study provide further evidence of the importance of technology in education which has been noted by other researchers (Chase et al., 2013; Costa et al., 2019; Elzarka, 2012;) and adds to what little research is available on the combined effects of technology use and the pandemic on academic development (Cahusac de Caux, 2023). The hypothesis that the effect of the pandemic on study will be judged to be greater in the period when restrictions were in place was supported, as was the hypothesis that variables related to technology use would exert a greater effect on study progress during the pandemic. Similarly, there was support for the hypothesis that the effects of health and well-being on study progress would be greater during the pandemic and for the hypothesis that time management would be positively related to study progress. The one hypothesis not supported concerned the use of social media use. The main findings are discussed below.

Approximately seven in every ten postgraduates in the sample reported being satisfied with the progress of their studies, with several significant correlates of this identified. These were related to time management, the perceived helpfulness of technology (notably for video-conferencing, quantitative data analysis and the receipt of information), the orientation toward technology (preferences for digital over physical copies of information and not finding software difficult to use or learn) emotional reactions when accessing information sources (positive emotional reactions were positively related to satisfaction and negative emotional reactions, negatively related), stress, health and well-being and use of video-conferencing software to communicate with lecturers and other students. For the most part, these individual relationships were weakly or moderately related to study progress. These support previous evidence for the importance of technology use, efficacy of learning, attitudes toward technology, time management and health, in doctoral study (Al-Rahmi et al., 2021; Grøtan et al., 2019; Mahdavi et al., 2023; Studebaker & Curtis, 2021; Wahid et al., 2022).

A linear model utilising these variables accounted for approximately 29% of the variance in satisfaction with study progress. In this model six variables were significantly predictive. These concerned time management (overall happiness with time management and the total number of problems arising from spending time online), technology use (use of videoconferencing to communicate with other students, and the helpfulness of technology for receiving information) and well-being (the effects of the pandemic on study and level of perceived stress). For the data collection period when pandemic restrictions were still in place, the model explained 47% of the variance, significantly greater than for the period succeeding it (23%). Examination of the effects sizes of all variables in the model during the two periods suggested five variables exhibited markedly greater effects during the period when pandemic restrictions were in place. Subsequent analysis confirmed that the effect sizes for these (happiness with time management, finding software applications difficult to use or learn, currently reported general health, health compared to the previous year and the effects of the pandemic on study) were significantly greater during this time.

Cahusac de Caux's (2023) findings of shifts in the proportion of doctoral candidates reporting the pandemic had impacted negatively on their work are echoed in the present study, with the reported influence decreasing over time – suggesting, in line with de Caux, adaptation to the changes caused by the pandemic and a decline in the disruptive effects, as its severity waned. These analyses serve as a reminder that factors influencing satisfaction with study progress may not be constant and may be external to the function of the university. The variables which predicted satisfaction with study progress over the study period, concerning time management, use of technology and health and well-being are of particular significance given the pandemic induced disruptions. The predictive role of time management on perceived study progress suggests that practical benefits for doctoral students may result from support and training provided to improve time management. This concurs with Chase et al.'s (2013) work linking time management strategies to research productivity and lends further weight to suggestions that time management skills should be actively encouraged and developed in higher education settings.

Several authors (e.g., Gurung & Stone, 2023; Karademas & Thomadakis, 2023) have also pointed to the importance of time management skills in relation to the pandemic. It is evident that pandemic disruption made new demands on the organisation of respondents' time and the above results are consistent with students' greater reliance on technology during this period, with some perhaps finding difficulty in balancing study and private time at home. That happiness with time management exerted a significantly greater effect on satisfaction with study progress during the pandemic is consistent with this work.

For those who have difficulty in using/learning to use software, the greater dependence on technology during the pandemic, for both social communication and academic work, had a more negative effect on their perceived study progress. This is consistent with Shih and Liu's (2007) contention that the 'emotional useability' of technology is as important as its practical ease of use. Postgraduates engage with it, not as unemotional, dispassionate users, but as embodied, emotionally aware agents who bring their own affective histories to their interactions with technological systems. Saariluoma and Jokinen (2014) have described this emotional landscape in terms of an opposition between frustration and competence. That a notable minority reported finding software applications difficult to use or learn adds to evidence that some postgraduates have difficulty in utilising information and communication technology and may require additional help and support to overcome this (Henderson et al., 2016; Nair & Pillay, 2004). Such support is likely to be an important factor in reducing drop-out rates, recognised as an issue of importance in doctoral education (Artiles & Matusovich, 2020).

That several measures of health and well-being were predictive of reported satisfaction with study progress is consistent with work linking well-being to academic attainment (Chakraborty et al., 2021; Chirikov et al., 2020; Wasil et al., 2021). In addition, that the effect sizes for several of these measures were significantly greater during the pandemic, both supports the hypotheses made and provides additional evidence supporting the validity of the measures. The overall negative effect of problems arising from time spent online is also consistent with too much time being spent online leading to disruptive effects on sleep, family life and social life. These effects are likely to impair the efficacy with which work is conducted and raise questions about the utility and availability of student support which could have wide ranging beneficial effects.

LIMITATIONS

In considering the findings, several issues should be remembered. The first of these concerns the nature of the data, with each participant providing data at one moment of time. This means that caution is urged in interpreting correlational data in terms of causal relationships. For example, the observed relationships between satisfaction with study progress and both stress and well-being may plausibly be interpreted in either direction, and bi-directional effects are likely to be present. The data is thus consistent both with reduced stress facilitating study progress and poorer study progress functioning as a significant source of stress (Chawla & Sachdeva, 2018) or finding satisfaction with academic performance functioning as a protective factor against the stress of anxiety and depression (Pokhrel et al., 2020).

Secondly, the nature of the analysis over time would ideally require sampling data at different intervals of time, rather than the before and after comparison conducted here. Given the unpredictable removal of restrictions the present study was opportune and did not permit a different design. With the data collected over a period of time which included the presence and removal of pandemic restrictions, comparison of data between these two periods rests on an assumption that the participants who provided data in each period are well-matched. Post-hoc analysis supported this assumption with no significant differences found in age, gender, or study discipline between the participants. An alternative means of testing the hypothesis would have required each person to act as their own control, though given the unique nature of the pandemic and the considerable uncertainty that existed as to when it would end, this was not practically possible. A further assumption concerns the consistency of measuring instruments across time. Where this could be directly tested - for the composite variable *Problems caused by spending time online* - the data show comparable levels of internal consistency over the two time periods (.78 for the first period and .80 for the second).

What must be stressed in comparing the determinants of study progress across these periods is that the end of restrictions did not signify the end of the pandemic, though it is reasonable to infer that the two periods denote in general two periods in which the pandemic was of different levels of severity, both in terms of threats to health and in terms of its social policing. Nevertheless, it is undoubtedly true that the unique nature of the pandemic poses difficulties for the replication of these findings, though they point to potential effects in any future pandemic.

Thirdly, technology use and well-being may not be entirely independent. For example, the pandemic has had detrimental effects on well-being, through several channels; direct infection, the perceived risk of infection and imposed social restrictions (Coelho et al., 2020; Kurcer et al., 2022; Nabe-Nielsen et al., 2022). In turn, these direct effects on well-being have likely influenced how participants perceived and interacted with technology. Undoubtedly the pandemic's disruptive effects on social, occupational, and academic life have meant that specific forms of technology use came to acquire new meanings, as it functioned both as an aid to social connection, and a means to continue academic work. It is likely that both these channels contributed to the maintenance of health and well-being. Canale et al. (2022) have argued that digital technologies contributed positively to mental health during the pandemic, emphasising its role in facilitating the online expression of emotions and in enabling social connection and support. The extent to which positive emotions are contingent upon the specific actors involved, as in psychotherapy, cannot presently be ascertained. Nevertheless, how much different software functions facilitate virtual contact and communication with others, and the importance which is attached to this human connectedness remains of great interest. Further work with the current data is required to explore in more detail the relationships between technological use and health.

Finally, as discussed earlier, satisfaction with study progress is a subjective measure, employed in the absence of pragmatic, externally verifiable indicators of attainment. Its use in the present study and in previous work (e.g., van Rooij et al., 2021) nevertheless attests to its utility and validity as a form of assessment. Measures of health and well-being are similarly based on self-reports; however, such self-reports have well-established empirical foundations in predicting objective indictors of health (e.g., Marmot, 2020; Marmot et al., 1991).

CONCLUSIONS

A majority of respondents reported being satisfied with their study progress. It is to be noted that a proportion of the sample reported finding software difficult to use/learn, and that this impacted on study progress. This strongly suggests a need for technology training for doctoral students and for the provision of support to those students who experience difficulty. The relationship between time management and study progress also suggests a potential avenue for support to assist students with time management skills. Together, these findings point to a need for technology training to consider the 'emotional usability' of technology. In addition, evidence highlighting the potential role of health and well-being in relation to study progress suggests the importance of the availability of health care. This relationship warrants further investigation.

Overall, the present research provided evidence that study progress during the period when pandemic restrictions were still in place was more strongly influenced by efficacy of time management, technology use, and health and well-being. The comparisons undertaken were between two broad time periods.

It is possible that the strength of the observed effects here underestimates their actual magnitude in the early periods of the pandemic, prior to the onset of data collection, when disruption was at its height. The work here nevertheless builds on previous research into the factors affecting performance of doctoral students and provides new insights into the effects of the pandemic on academic attainment and study progress. More work is needed to assess the potential long-term effects of the pandemic on well-being, academic progress, and academic life. This could be undertaken by work following up the health and health and well-being and career progress of the cohort of doctoral students who undertook their study during the pandemic.

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