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Predicting student mental wellbeing and loneliness and the importance of digital skills

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ABSTRACT

COVID-19 forced a rapid migration to online education and many institutions will continue with some online education post-pandemic. Here, we examined digital capabilities, measuring abilities and confidence, which are critical for online learning. We also examined social identity and connectedness which may be impacted by online study and considered whether these factors, along with digital capabilities, predict variance in student mental wellbeing and loneliness. Data were collected from 417 students at a large London university during the first UK lockdown. Students showed high digital abilities and confidence but there were individual differences in some digital domains determined, in part, by demographic and study factors. A significant proportion of variance in loneliness ratings could be explained by demographic factors, connection to the university and digital confidence. Significant predictors of wellbeing included loneliness, digital confidence, connectedness, social identity and a suitable study space. Based on these results we suggest that universities should consider how to improve digital confidence and ensure access to study spaces to support students in future online learning.

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Online education; remote learning; digital skills; mental wellbeing; loneliness; pandemic

Introduction

Prior to COVID-19, digital and online learning in Higher Education (HE) was not uncommon. Institutions routinely used virtual learning environments (VLEs) with tools such as lecture capture (Dommett 2019; Dommett, Gardner, and van Tilburg 2019). Despite this, the abrupt transition to all online learning when the first UK lockdown began in March 2020, was a substantive change. Engaging in online learning requires strong digital capabilities (Bowyer and Chambers 2017). Developing these takes time (Thorne 2013) and requires access to resources, including stable internet and adequate study space (Lemke 2002). Furthermore, research suggests that individual factors such as age, gender, education, experience and breadth of technology use can influence capabilities (Helsper and Eynon 2010), meaning that one student's experience could vary considerably from another student's. However, there has been limited research on the association of demographic factors, academic area, and study

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resources with digital capabilities in students. Given that HE was already on a trajectory towards increased online learning, it is essential that we establish how such individual factors impact digital capabilities.

Alongside this trajectory of increased digital and online education, another pattern has emerged recently; an increasing sense of crisis around student mental health and wellbeing (Macaskill 2013). Research supporting this is varied. For example, some studies show rates of specific mental health conditions, such as depression, rising (Haidt and Allen 2020; Ruhomaulu, Hafeez, and Karponis 2020). Others indicate that a high proportion of students meet criteria for mental health problems, without identifying specific conditions due to the use of general health metrics (Tabor, Patalay, and Bann 2021). Research also uses scales of mental wellbeing to show poorer outcomes in students (Çetin et al. 2021). Furthermore, studies show certain students are more likely to have poorer outcomes than others, irrespective of exact measures, including non-heterosexuals, students with low socio-economic status and females (McLafferty et al. 2017; Pedrelli et al. 2015). Whilst the terms mental health and mental wellbeing are often used interchangeably, the two can be distinguished. The World Health Organization defines mental health as a state in which an individual can realise their abilities, cope with normal life stresses, work productively and contribute to their community (World Health Organization (WHO) 2021). Although they argue mental health is more than the absence of a mental illness, in practice, much of the focus of health services is on preventing and managing mental illness rather than promoting mental health. Mental wellbeing is commonly defined in positive terms around constructs such as life satisfaction, self-fulfilment, and happiness (Westerhof and Keyes 2010). It is possible for an individual to experience distress, and thus poor mental wellbeing, in the absence of mental illness or with good mental health or for an individual with a mental illness to have good wellbeing. However, poor mental health is often associated with poor mental wellbeing, and good mental health with good mental wellbeing, supporting a 'two continua model', whereby mental health and mental wellbeing are distinct but related measures (Westerhof and Keyes 2010). In the present study, we focus on mental wellbeing, rather than mental health, but use both terms when discussing the work of others, including where no distinction has been made by the original authors.

The pandemic has exacerbated concerns about the mental health and mental wellbeing of students (Savage et al. 2020), with much attention placed on the lack of the campus experience and social contact caused by the switch to online education (Lyons et al. 2020). It is likely that the reduced social contact at university, alongside the mandated isolation during the lockdowns, impacted on the social connectedness of students, which is known to be important for wellbeing in general (Linders 2012) and is associated with mental health difficulties in students (AlShamlan et al. 2020). The unusual campus experience during the pandemic may also have resulted in increased loneliness, a factor found to exacerbate mental health concerns through the pandemic (Killgore et al. 2020). Social isolation and loneliness are separable constructs; and social connectedness does not preclude loneliness (Hawkey and Cacioppo 2010). The subjective feeling of loneliness arises when social connections are perceived to be inadequate or unfulfilling (de Jong Gierveld and Havens 2004). It is possible that students experiencing online learning had lower expectations of connectedness and therefore did not experience loneliness despite reduced connectivity. Furthermore, loneliness itself is not necessarily problematic although it can, in some cases, be associated with mental health concerns along with downward spirals in health behaviour, educational attainment and social mobility (Matthews et al. 2016). Therefore, it is helpful to understand if social connectedness relates to loneliness and mental wellbeing in the context of online learning during COVID.

The shift to online learning also forced students to become distance or remote learners, which may have impacted on their sense of social identity as a student, an issue which has previously been identified for remote working (Krug et al. 2021) and noted to be particularly important in adolescence (Koni et al. 2019). According to the Social Identity Approach to Health, the groups to which we belong provide us with a sense of belonging and meaning and these identity processes can impact

positively on health and wellbeing (Jetten et al. 2017). Furthermore, research has linked social identity to loneliness in the context of remote working (Krug et al. 2021) where stronger identity is associated with reduced loneliness.

Whilst these two trajectories – increasing digital and online education and increasing concerns about wellbeing – are distinct, there are reasons to connect the two beyond their temporal coincidence. For example, students with better digital capabilities may have experienced less impact on connectedness and identity through creating and maintaining virtual or remote networks. Certainly, research suggests that technical solutions to isolation can be beneficial to wellbeing, specifically by aiding participation, transparency, and social connectedness, providing access to health care and supporting education which can impact positively on wellbeing (Hassankhani et al. 2021). Based on previous research and the situation caused by COVID, we sought to better understand a) what determines digital capabilities in terms of abilities and confidence, and b) the role digital capabilities, along with social connectedness and social identity, play in predicting loneliness and mental wellbeing in students.

Methods

Design and procedure

Data were collected via an anonymous 25 minute online survey from undergraduate and taught postgraduate students at a large multi-campus London university between the 17 April and 18 May 2020. Data was collected during the initial national lockdown to capture the immediate impact. Recruitment was via institutional email circulars, and adverts on the VLE, via programme communications and social media. Multiple regression analyses were used to identify factors predicting digital capabilities, loneliness and mental wellbeing.

Participants

In total, 417 students completed the survey. Demographic factors are summarised in Table 1. Data collected by the Higher Education Statistics Agency (HESA 2021) can be used to establish how this sample compares to the wider student population at the host university or across the U.K. Our age categories do not map directly onto those used by HESA, however, data from HESA shows that the largest proportion of students would be expected to fall under 25, aligning with Table 1. The

Table 1. Sample characteristics.

Age/Years (18–21/21–25/over 26)	140/203/73
Gender (Female/Male)	333/72
Ethnicity (White British/White non-British/BAME [†])	119/144/146
Disability (non-MH) ^a	59
MH condition ^b	89
Fee status (Home/EU/International)	221/109/86
Level of study (UG/PG)	296/121
First-generation student	102
Discipline:	
Arts & Humanities	77
Social Sciences & Economics	126
Medicine & Allied Healthcare	182
Natural & Mathematical Sciences	24

[†]Including Black or Black British, Asian or Asian British, Chinese or Chinese British, and mixed background ethnicities.

^aDisability represents the number of students reporting one or more physical, sensory and learning disabilities.

^bMH condition represents the number of students reporting a long-term mental health condition (e.g. depression or anxiety).

N = 417. Some demographic questions were not answered by all respondents.

male: female ratio across the UK is 1:1.32 but for the specific university HESA report a ratio of 1:1.78. The present study has a higher proportion of females. Data on ethnicity within HESA also uses slightly different categories and only focuses on home students, however, these data indicate around 75% of students are white, compared to 25% belonging to other ethnic groups. In contrast, in the current study 64% reported a white ethnicity, indicating BAME groups may be over-represented in this present sample compared to the national data. However, the host university has 52% BAME so bucks the national trend. HESA disability data does not differentiate between types of disabilities but indicates that 17% of students at university will report a disability, which is lower than the amount reported here (35%). Level of study at a national level indicates 21% of students study at postgraduate level, compared to 29% of the current sample. Finally, approximately 46% of students nationally may not have a parent with university education. The current study asked a slightly different question and found that 24% of students were the first in their family to go to university. The differences may relate to the metric used but also could be indicative of the low widening participation (WP) rates at the host university.

Measures

The survey collected details regarding demographics and student status as indicated in [Table 1](#). Additionally, students were asked two further questions about whether they have a safe space to study undisturbed and whether they had encountered additional financial costs to maintain access to technology or the internet (Y/N responses).

Social connectedness

The 8-item Social Connectedness scale (Lee and Robbins 1995) adapted for students (Summers et al. 2005) was used to measure students' connection with the university (e.g. 'I have no sense of togetherness with my peers at university'). These negatively worded items were rated on a Likert scale (1 = strongly agree, 6 = strongly disagree) and summed to give a total score (range 8–48, $\alpha = .91$) where higher scores indicate a weaker connection.

Social identity

The 11-item Social Identity Scale (Cameron and Lalonde 2001) was adapted for students (e.g. 'I often think about the fact that I am a university student'). Items were positively worded and were ranked on a Likert scale (1 = strongly disagree, 7 = strongly agree). A total score was calculated (range 11–77, $\alpha = .84$) with higher scores indicating a stronger student social identity.

Digital capabilities framework

This framework, developed by JISC, a digital solutions provider, asks students about their digital competencies across seven domains: data and media literacies ('Finding Info'), functional skills in using application, software and services ('Tools'), digital communication, collaboration and participation ('Comms'), digital learning and development ('Learn'), digital creation, problem solving and innovation ('Create'), managing their digital needs and preferences ('Prefer') and managing their digital identity and wellbeing ('Being online'). For each domain, participants check off their abilities from two pre-defined lists (subdomains). Each domain is composed of 10 items except for the 'Digital communication and collaboration' which has 9 items. Seven ability scores were calculated (range 1–10 and 1–9 for the 'Digital communication and collaboration') and a total ability score was computed by summing these scores and scaling to obtain a percentage from 1% to 98.6%, as advised by JISC. Digital confidence was assessed twice within each domain using a 0–100% scale. These two scores were averaged to give a digital confidence score for the domain. Total confidence levels were calculated as an average of the seven confidence domains.

Loneliness

The four-item UCLA Loneliness Scale (Russell 1996) was used where items were rated by frequency of feelings (0 = hardly ever, 1 = some of time, 2 = often) and summed to compute a total score (range 0–8, $\alpha = .88$). Higher scores indicate more loneliness.

Mental wellbeing

The 7-item Short Warwick-Edinburgh Mental Wellbeing Scale (SWEMWBS) (Stewart-Brown et al. 2009) was used. All items were positively worded and scored on a Likert scale (1 = none of the time, 5 = all of the time). Items were summed to compute total raw scores, which were converted to metric scores (range 7–35, $\alpha = .81$). Higher scores indicate better wellbeing.

Results

Here, we summarise the findings in terms of digital capabilities, loneliness and mental wellbeing and the links between them. In terms of sample characteristics, in our sample, one in five students said that they did not have a space for undisturbed study. One in four students reported that they had increased financial costs to maintain their access to technology. Social Connectedness ($M = 26.03$, $SD = 8.90$) and Social Identity scores ($M = 49.50$, $SD = 10.46$) indicated medium strength connection to the university and student social identity.

Digital capabilities

Figure 1 shows a breakdown of students' digital abilities and their corresponding levels of confidence as percentages. Overall, the average ability was 69% and confidence was 74%, indicating that abilities closely matched confidence. This is supported by significant moderate and strong positive correlations between digital ability domains and their corresponding confidence levels (see Table 2).

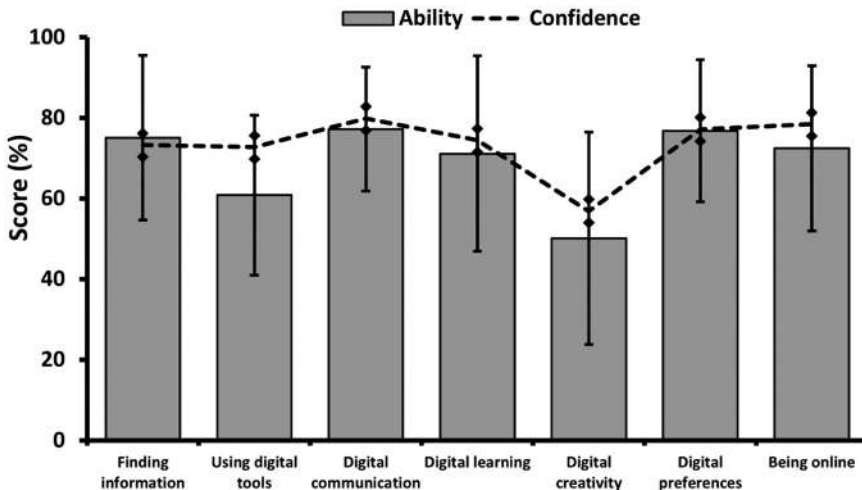


Figure 1. Students' digital abilities and confidence in using them. Error bars represent the standard deviation of the measure (line = ability; diamond = confidence).

Table 2. Correlations between JISC abilities and confidence levels.

Variable	Finding Info (C)	Tools (C)	Comms (C)	Create (C)	Learn (C)	Prefer (C)	Being online (C)	Overall (C)
Finding Info (A)	.603**	.363**	.308**	.452**	.388**	.410**	.289**	.499**
Tools (A)	.324**	.438**	.370**	.433**	.425**	.410**	.174**	.454**
Comms (A)	.386**	.392**	.563**	.400**	.406**	.365**	.076	.493**
Create (A)	.490**	.469**	.379**	.774**	.503**	.513**	.273**	.626**
Learn (A)	.369**	.433**	.423**	.447**	.687**	.498**	.278**	.563**
Prefer (A)	.270**	.329**	.354**	.320**	.449**	.541**	.257**	.462**
Being online (A)	.173**	.159**	.164**	.172**	.247**	.207**	.513**	.293**
Overall (A)	.560**	.552**	.530**	.663**	.674**	.625**	.400**	.734**

Highlighted cells indicate the correlation between a specific digital ability (A) and confidence (C) for that ability. ** $p < .01$

Table 3. Predicting overall digital ability and subdomains (finding info, tools, comms).

IV	Overall		Finding Info		Tools		Comms	
	b	95% CI	b	95% CI	b	95% CI	b	95% CI
Constant	68.55	60.1, 77.01	7.06	5.8, 8.33	6.21	5.08, 7.35	7.52	6.64, 8.4
Demographics								
Age	-2.09	-4.83, 0.64	0.05	-0.36, 0.46	-0.42	-0.78, -0.05	0	-0.29, 0.28
Female	-3.72	-7.55, 0.11	-0.67*	-1.25, -0.1	-0.65*	-1.17, -0.13	-0.46*	-0.85, -0.06
White Non-British ^a	2.1	-2.86, 7.06	0.34	-0.4, 1.09	0.32	-0.35, 0.99	0.08	-0.44, 0.6
BAME ^a	1.98	-2.21, 6.18	0.14	-0.49, 0.76	0.53	-0.04, 1.09	0.12	-0.32, 0.56
Home student	-1.3	-5.46, 2.85	-0.13	-0.75, 0.49	0.14	-0.42, 0.7	-0.24	-0.68, 0.19
Disability	-0.88	-4.88, 3.12	0.23	-0.37, 0.82	-0.05	-0.58, 0.49	-0.24	-0.66, 0.17
MH condition	1.1	-2.7, 4.9	0.09	-0.48, 0.65	0.15	-0.36, 0.66	0.28	-0.12, 0.67
First generation	-1.15	-4.88, 2.59	0.07	-0.49, 0.63	-0.48	-0.98, 0.03	-0.26	-0.64, 0.13
Level of study	4.44*	0.07, 8.82	0.35	-0.31, 1	0.64*	0.05, 1.23	0.27	-0.19, 0.72
Academic Area								
Social Sci. & econ ^b	-1.22	-5.2, 2.75	-0.34	-0.93, 0.26	-0.09	-0.63, 0.44	0.06	-0.35, 0.48
Arts & Humanities ^b	1.83	-2.38, 6.04	0.36	-0.27, 0.99	0.06	-0.51, 0.63	0.34	-0.1, 0.78
Natural & Maths Sci. ^b	-5.66	-12.1, 0.78	-0.68	-1.65, 0.28	-0.34	-1.21, 0.53	-0.26	-0.93, 0.41
Study resources								
Safe study space	3.28	-0.32, 6.87	0.59*	0.06, 1.13	0.36	-0.13, 0.84	0.4*	0.03, 0.77
Financial costs	-2.06	-5.65, 1.53	-0.34	-0.88, 0.2	-0.33	-0.81, 0.15	-0.11	-0.48, 0.27

Overall Ability, $R^2 = 0.08$, $F(14,313) = 1.85$, $p = .031$; Finding Info, $R^2 = 0.07$, $F(14,313) = 1.74$, $p = .047$; Tools, $R^2 = 0.08$, $F(14,313) = 2.15$, $p = .010$; Comms, $R^2 = 0.09$, $F(14,313) = 2.12$, $p = .011$

* = $p < 0.05$. ^aWhite British, ^bMedicine & Allied Healthcare Subjects were used as reference values.

Abbreviations: MH Condition – mental health condition; Social Sci. & econ – social sciences and economics; Natural & Maths Sci; natural and mathematical sciences

Predicting digital capabilities and confidence

Table 3 shows that digital ability varied between individuals, with the individual difference factors in combination explaining 7% of the variance in digital ability. The influence of individual differences differed between the specific digital ability domains, with the factors considered explaining a significant proportion of variance in data and media literacies (Finding Info), functional skills in using applications, software and services (Tools) and digital communication, collaboration and participation (Comms). Considering these areas of ability, women identified having a lower ability than men. Individuals who had a suitable space to study at home had higher levels of ability in data and media literacies and digital communication, collaboration, and participation. Postgraduate students identified higher functional skills using applications, software, and services. Our model did not explain a significant proportion of the variance in scores for digital learning and development (Learn; $R^2 = 0.06$, $F(14,313) = 1.51$, $p = .104$), digital creation, problem solving, and innovation (Create; $R^2 = 0.07$, $F(14,313) = 1.66$, $p = .062$), managing digital needs and preferences (Prefer; $R^2 = 0.06$, $F(14,313) = 1.51$, $p = .106$) or managing digital identity and wellbeing (Being online; $R^2 = 0.05$, $F(14,313) = 1.08$, $p = .374$).

The regression model used to predict digital ability, containing the variables shown in Table 3, did not explain a significant proportion of the variance in digital confidence, $R^2 = .04$, $F(14,304) = 1.00$, $p = 0.457$. However, adding digital ability into this model, significantly increases the proportion of the

variance explained, $R^2_{\text{change}} = 0.52$, $F(1,303) = 362.10$, $p < 0.001$, such that the combined model, i.e. the variables within [Table 3](#) and digital ability, explains 56% of the variance in digital confidence, $F(15,303) = 26.17$, $p < 0.001$, illustrating that digital ability is a strong significant predictor of confidence, over and above the individual difference factors in [Table 3](#).

Predicting loneliness and mental wellbeing

Average scores for loneliness and mental wellbeing were 4.19 (SD = 2.59) and 19.52 (SD = 3.23) respectively. Multiple hierarchical regression analysis ([Table 4](#)) showed that several factors impact on these constructs. Demographic factors and area of study combined explained a significant proportion of the variance in loneliness, $R^2 = .07$, $F(12,303) = 1.85$, $p = .041$. Adding successive clusters of factors resulted in significant increases in the proportion of variance explained; social identity and connectedness, $R^2 = .14$, $R^2_{\text{change}} = .08$, $F_{\text{change}}(2,301) = 13.34$, $p < .001$; suitable and safe place to study and costs to maintain access, $R^2 = .16$, $R^2_{\text{change}} = .02$, $F_{\text{change}}(2,299) = 3.19$, $p = .043$; digital abilities and confidence, $R^2 = .16$, $R^2_{\text{change}} = .04$, $F_{\text{change}}(2,297) = 8.02$, $p = .001$. The final model indicates that individuals who felt a *weaker* connection with the university and those with greater digital confidence reported less loneliness. Further, younger students and those studying arts and humanities were more likely to be lonely.

While demographic factors and area of study did not explain a significant proportion of the variance in mental wellbeing, $R^2 = .06$, $F(12,302) = 1.60$, $p = .091$, adding successive clusters of factors resulted in significant increases in the proportion of variance explained; social identity, connectedness and loneliness, $R^2 = .29$, $R^2_{\text{change}} = .23$, $F_{\text{change}}(3,299) = 31.57$, $p < .001$; suitable and safe place to study and costs to maintain access, $R^2 = .34$, $R^2_{\text{change}} = .05$, $F_{\text{change}}(2,297) = 11.01$, $p < .001$; digital skills and confidence, $R^2 = .37$, $R^2_{\text{change}} = .03$, $F_{\text{change}}(2,295) = 7.14$, $p = .001$. After considering

Table 4. Regression coefficients for the final model predicting mental wellbeing and loneliness.

IVs	Mental Wellbeing		Loneliness	
	b	95% CI	b	95% CI
Constant	15.62	12.12, 19.13	5.71	2.51, 8.92
Demographics				
Age	0.11	-0.43, 0.65	-0.55*	-1.05, -0.05
Female	-0.75	-1.5, 0	-0.41	-1.11, 0.29
White Non-British ^a	0.15	-0.81, 1.11	-0.26	-1.15, 0.64
BAME ^a	-0.22	-1.05, 0.6	-0.04	-0.8, 0.73
Home student	-0.09	-0.9, 0.71	-0.61	-1.36, 0.14
Disability	0.24	-0.53, 1.01	-0.06	-0.78, 0.66
MH condition	-0.77*	-1.53, -0.01	0.61	-0.1, 1.32
First generation	0.59	-0.13, 1.3	-0.15	-0.82, 0.52
Level of study	0.02	-0.83, 0.86	0.32	-0.47, 1.11
Academic area				
Social Sci. & econ ^b	-0.17	-0.94, 0.6	0.05	-0.67, 0.76
Arts & Humanities ^b	0.27	-0.55, 1.09	0.92*	0.16, 1.67
Natural & Maths Sci. ^b	-0.5	-1.81, 0.81	0.39	-0.83, 1.61
Connection				
Social identity	0.04*	0, 0.07	0.02	-0.02, 0.05
Connectedness	0.05*	0, 0.09	0.07***	0.03, 0.11
Loneliness (UCLA)	-0.49***	-0.61, -0.37		
Study resources				
Safe study space	0.92**	0.21, 1.63	-0.58	-1.23, 0.07
Extra technology costs	-1.13	-1.83, -0.42	0.32	-0.34, 0.98
Digital skills and ability				
JISC overall ability	0	-0.03, 0.04	0	-0.03, 0.03
JISC overall confidence	0.04*	0.01, 0.06	-0.04**	-0.06, -0.01

Mental wellbeing: $R^2 = .37$, $F(19,295) = 8.96$, $p < .001$; UCLA: $R^2 = .21$, $F(18, 297) = 4.25$, $p < .001$. * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$. ^aWhite British, ^bMedicine & Allied Healthcare Subjects were used as reference values.

Abbreviations: MH Condition – mental health condition; Social Sci. & econ – social sciences and economics; Natural & Maths Sci; natural and mathematical sciences.

demographic factors, including presence of a mental health condition, multiple factors predicted variance in mental wellbeing. Students with lower levels of loneliness and those identifying having a suitable place to study reported better mental wellbeing. Students identifying more strongly with the identity of a student and those reporting a *weaker* connection to the university had better mental wellbeing. Finally, students with greater digital confidence reported better mental wellbeing.

Discussion

The abrupt transition to online education during COVID-19 affected students in multiple ways. This study focused on understanding what factors influence digital abilities and confidence, which are critical for online learning. We also measured connectedness and social identity, which might reasonably be affected by remote study. Finally, we considered how these factors might influence mental wellbeing and loneliness, giving the rising concern about student mental health in the sector.

The current study identified good levels of digital ability and confidence in students, with higher capabilities in finding information, communicating, and digital preferences. However, despite most students reporting adequate capabilities, some were better equipped than others. Postgraduates had higher overall ability than undergraduates, as might be expected. Compared to males, females reported lower abilities in data and media literacies, functional skills in using applications, software and services, and digital communication, collaboration and participation. To our knowledge, this is the first study to indicate a gender difference in these digital capabilities in university students, but the findings align with previous work in the general population which indicates gender and educational level are frequently found to be significant determinants of digital skills (van Laar et al. 2020). However, other work in secondary pupils suggests females may have less confidence in their abilities rather than lower abilities (Hatlevik and Christophersen 2013; Umar and Afidah Jalil 2012). This explanation seems unlikely given the nature of the questions (e.g. 'Which of the following can you do?') and the fact that a model containing gender but not ability did not predict confidence. In addition to level of study and gender, students lacking access to a suitable study space reported lower abilities in data and media literacies and digital communication, collaboration and participation. Lack of access to suitable space has been identified elsewhere with the Sutton Trust identifying that around 25% of university students lack adequate study space (Montacute and Holt-White 2021), suggesting this is not specific to the institution sampled here. Given the binary nature of our questioning, the exact reason for these students having lower digital abilities this is unclear. However, we can speculate these students might be from a lower socioeconomic group, which is likely to mean less exposure to digital tools at home and in school, reducing development of digital skills, a pattern that has been found elsewhere (van Laar et al. 2020; Zhou and Wolstencroft 2020). As universities continue to move towards supporting online learning beyond the pandemic, they must consider issues of equity and recognise that in shifting learning online, inequalities in students' educational experience may be accentuated unless all students have equal access to appropriate study spaces. One way to ensure this is to provide study spaces on campus. In the context of the current study, such facilities could not be accessed due to lockdown and COVID restrictions. It may be that under normal circumstances, the typical universities provision, e.g. library access and computing rooms is sufficient, but this should be further investigated to be clear on the needs of students. Exactly what form any additional study spaces should take is likely to vary according to programme requirements and university facilities, but research suggests that students prefer access to individual rather than group spaces (Oliveira 2016) and that where spaces will have high levels of digital device use, noise prevention strategies will be necessary (Chaputula 2021).

Our regression analysis investigating which factors predict loneliness found that a significant proportion of the variance explained by demographic factors and level of study, with younger students and those studying arts and humanities more likely to be lonely. This is in line with other data showing that young adults are most likely to experience loneliness (Barreto et al. 2021). Younger adults can be more vulnerable to loneliness due to volatile social networks, changes in their roles and

identity exploration (Matthews et al. 2016; Qualter et al. 2015). The reason behind arts and humanities students being lonelier is unclear and no previous research has identified this group as particularly at risk of loneliness. However, a previous study has shown faculty-based differences in psychological status of students. For example, Arts students have shown higher psychiatric morbidity than students of other faculties (Springett and Lekarz 1986). Although the current study did not find the presence of a mental health condition was a predictor of loneliness, this could indicate more subtle variation in psychological status of students studying different disciplines exists. Furthermore, one study focused specifically on the performing arts, showed high loneliness, which the authors attributed to the lack of performance opportunities which students view as a necessity (Stubbe et al. 2021). It is also possible that teaching in these disciplines incorporates more discursive approaches, meaning the lack of these, was more acutely felt. Therefore, the finding reported here could be due to the different status given to social activities within these disciplines. In addition to age and study area, connectedness was also a predictor of loneliness, where weaker connectedness to the university predicted greater loneliness. This is unsurprising given that loneliness arises when individuals consider their social connectedness to be inadequate or unfulfilling, as was likely the case during the pandemic (de Jong Gierveld and Havens 2004).

The only other significant predictor of loneliness in our model was digital confidence, with reduced confidence predicting greater loneliness. To our knowledge this is the first study demonstrating a relationship between digital confidence, which is highly dependent on digital abilities, and loneliness. However, this does align with other research prior to, and during the pandemic, showing that people who can connect with social networks via digital tools are less isolated and lonely (Cotten, Anderson, and McCullough 2013; Shah et al. 2020). A recent systematic review about remote learning during the pandemic also found that digital activities and resources can provide a means of connecting students to each other and their university, which the authors suggest decreases loneliness (Hehir et al. 2021). Therefore, it is possible that those with lower confidence were less able to engage with digital networks, increasing feelings of loneliness. Proposals to increase digital skills to support better social connectivity and reduce loneliness have been made previously for other groups susceptible to loneliness (Barbosa Neves et al. 2019; Frantál, Klapka, and Nováková 2020), indicating that the findings here are not without precedent. However, it is important to recognise that the picture is likely to be complex; for example, research has found increased social media connections may be detrimental if they replace in-person connections (Valkenburg and Peter 2007). There is no evidence to suggest that students forming online connections with each other do so at the cost of in-person connections under normal circumstances, but this should be further investigated. Although the current study was not focused on social media, it is possible that online connections could be detrimental. It is also important to recognise that the present study used a relatively crude measure of loneliness, not differentiating between emotional and social components, which may be predicted by different factors (Cramer and Barry 1999). For example, high levels of internet use, which might be associated with greater digital confidence, predicts reduced social loneliness but greater emotional loneliness (Moody 2001). Additionally, it is possible that digital confidence, and digital ability, are underpinned by other factors, not measured in the current study, which have resulted in a link to loneliness. For example, digital skills may also relate to personality, motivation and culture, which were not assessed here (van Laar et al. 2020) but could logically impact on loneliness.

Our regression showed that several factors predicted mental wellbeing. Students with a pre-existing mental health condition were more likely to have poorer wellbeing, aligning with previous research (Slade et al. 2014). Social identity was a positive predictor of wellbeing, whilst loneliness was a significant negative predictor as might be expected from the previous research (Hawkey and Cacioppo 2010; Killgore et al. 2020). However, weaker connectedness to the university predicted stronger wellbeing, in contrast to previous research where greater connectedness associates with better wellbeing (Lamblin et al. 2017; McIntyre et al. 2018; Postmes et al. 2019). One explanation is that the lockdown disrupted university connectedness and therefore students who felt less connection initially were better off when this connection was damaged. Access to a suitable study space was

also a significant predictor of mental wellbeing. The exact reasoning for this is unclear. It could relate to socioeconomic status, with previous studies indicating those with a lower SES within the hierarchy of an educational setting have poorer wellbeing (Moore et al. 2020). Alternatively, it may relate to the ease with which students can study, because a student lacking suitable space may encounter higher levels of stress, resulting in lower wellbeing. Future research should consider qualitative work to unpick the role of study space in wellbeing. The final significant predictor of wellbeing was digital confidence where greater confidence predicted better wellbeing. The exact reasons behind this are unclear from the current study. As in the discussion of loneliness, digital confidence may result in better connectedness, in turn improving wellbeing but then we might expect this to show in connectedness measures, although our measures were about university connectedness and students may have connected to others outside of the university. Alternatively, digital confidence could have created stronger social support. For example, research shows that the size of social media networks and the frequency of use, which may associate with digital confidence, is linked to perceived social support (Lu and Hampton 2017) and almost 70% of students say that they have received social support via social media (Drouin et al. 2018). Therefore, the effects of digital confidence could stem from access to support. Additionally, as indicated above, it could relate to other factors such as personality.

Irrespective of exactly how and why digital confidence impacts on mental wellbeing and loneliness, this study suggests there is a relationship between these factors. As such, institutions looking for ways to promote better mental wellbeing should consider ways to enhance students' digital abilities and, in turn, confidence. When developing skills training for students there are several approaches that can be taken. For example, training could be part of induction or a continuous process. It can be embedded into the curriculum or separated from it. Such training may be delivered at the level of the degree programme, department or even university-wide with the approach dependent on the location of expertise within individual universities and resource available. Evidence suggests that digital competencies take time to develop (Thorne 2013), meaning induction activities alone are unlikely to be successful. It has been argued that an embedded approach is preferable because the skills are integrated into the wider experience (Orr, Appleton, and Wallin 2001; Snaveley and Cooper 1997). Conversely, it has been suggested that where something is fundamental or mandatory, as digital capability training may be, it is better delivered at a university-wide level, because this is cost-effective and the need spans disciplines (Benson 2019). Our data show that students had higher abilities in finding information, digital communication and digital preferences, suggesting focusing on other domains may be most beneficial.

Although the present study identified interesting relationships, it is important to acknowledge limitations of the work. Firstly, this was conducted at a single university, and the sample was not always representative of the UK student population, for example, whilst age was comparable, our sample over-represented women, and possibly BAME and widening participation (WP) students compared to national data, although less so for the specific institution. Whilst, the strong representation of BAME and WP students could be considered a strength, because these groups are often not well-represented in research, further investigation in a larger, more representative sample is needed. Secondly, data was collected remotely. Whilst this was necessary, given the pandemic, this may mean that only those who were more digitally able participated, which could have inflated digital ability and confidence scores. Thirdly, the sample size, whilst large for a case study, is too small to make conclusions about intersectionality and how this relates to digital capabilities, loneliness and mental wellbeing. Fourthly, the data is quantitative and does not capture the lived experience of students in the way that qualitative methods might. As such, further research into digital capabilities and student experience, including mental wellbeing, should incorporate qualitative methods. These would allow some of the unanswered questions in the current study to be addressed, for example, around the role of study space. Finally, the present study focused on a limited number of predictors of digital ability, confidence, loneliness, and wellbeing, with selection driven by those that may have

been disrupted during the rapid transition to online learning. Therefore, whilst the statistical models presented provide an insight into key determinants in our regression models, they cannot provide a comprehensive model for the complex behaviours and experiences considered.

In conclusion, the current study has demonstrated that several demographic and study-related factors impact on digital abilities and confidence and that, in turn, digital confidence is one of several predictors of loneliness and mental wellbeing. If universities are to continue with online learning post-pandemic, it is important that they support students to develop digital abilities and confidence and ensure equity in students' access to study spaces.

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Availability of data and material

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Disclosure statement

No potential conflict of interest was reported by the authors.

Ethics approval

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