Article

Learning, Student Digital Capabilities and Academic Performance over the COVID-19 Pandemic

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Abstract: During the time of COVID-19 lockdown over spring 2020, universities shifted teaching from on-campus blended learning to an emergency remote fully online approach. The aim of this study was to compare Psychology and Veterinary Science undergraduate students' academic performance with their responses on a self-reported questionnaire regarding their digital capabilities, individual's characteristics, and the role of environment on their independent learning process over the first COVID-19 lockdown period. Social-Cognitive Theory was adopted to conceptualise students' behaviour, individuals' characteristics, and learning environment with their academic performance to a learning framework. A total of 303 students from both disciplines (133 Psychology and 170 Veterinary Science undergraduate students) participated in this study by completing an online questionnaire after following the teaching shift from blended learning to full remote online approach at a UK University during the 2019–2020 academic year. Differences between students' responses were identified due to their discipline's curricular structure, students' study behaviours (i.e., being exposed to unrelated learning activities), and students' cognitive effort to think critically in the search, evaluation and managing of digital information. Students with high level of self-regulation and digital capabilities were able to keep focused and engaged during the lockdown. Although universities and teachers were "forced" to shift their teaching approach due to the unfortunate disruption of the COVID-19 pandemic, most students have coped with the changed teaching delivery mode relatively easy with minimum guidance. However, teachers should further consider how digital technologies could enhance students' learning flexibility promoting critical thinking.

Keywords: digital capabilities; academic performance; social-cognitive theory; independent learning; higher education; COVID-19

1. Introduction

The World Health Organization (WHO) declared COVID-19 as a global public health emergency on 30th January 2020 and as a pandemic on 11th March 2020 [1]. Countries' decisions for total lockdowns allowed little time for universities to shift their on-campus undergraduate programmes to fully online delivery [2]. Over the first COVID-19 pandemic lockdown period, universities have adopted an emergency remote online teaching approach in which web-conferencing tools, such as Zoom and Microsoft Teams, were used to facilitate online sessions that would, otherwise be delivered face-to-face via a blended learning approach, integrating digital technologies in a variety of ways into on-campus environment [3,4]. Researchers studied the effect of the disruptive changes on Higher Education in relation to curriculum challenges [5], student accessibility and affordability [6] and students' acceptance of the modified teaching process [7]. Tejedor, Cervi, Pérez-Escoda, and Jumbo (2020) [8] compared three countries' Higher Education Institutions in relation to digital literacy development proposing that communication, teaching, and teachers' digital competences influenced students' learning engagement and attitudes during a disruptive learning period due to the COVID-19 pandemic. This study also stated that the decision to

shift the on-campus to online activities was sudden and asserted that digital competencies, communication and teaching were key factors for enabling students to adapt to the new context.

Over the last two decades educational researchers and Higher Education institutions have explored how digital literacies could support teaching and learning allowing students to meet 21st century challenges [9,10]. Digital literacies could be defined as the knowledge, skills and dispositions needed for the use of technology in the context of a discipline or subject [11]. Professional bodies and consortiums have analysed and proposed frameworks to support student and teacher digital competences [12,13]. The European DigCompEdu framework [14] describes six digital literacy dimensions: 1. Professional engagement, integrating organisational communication, professional collaboration, reflective practice, and digital continuous professional development; 2. Digital Sources resources, including selecting, creating and modifying, and managing information, and protecting and sharing digital content; 3. Teaching and learning, teaching, guidance, collaborative learning, and self-regulated learning; 4. Assessment within assessment strategies, analysing evidence, and feedback and planning; 5. Empowering learners, embracing accessibility and inclusion, differentiation and personalisation, and actively engaging learners; and 6. Facilitating learners' digital competence including information and media literacy, communication, content creation, responsible use, and problem solving. The UK JISC (Joint Information System Committee) organisation has described digital literacies as those digital capabilities individuals need for living, learning, and working in a digital society [15] and it has introduced a framework known as JISC Digital Capability Framework (hereafter abbreviated as DigiCap) to describe the digital practices [16]. This framework includes six overlapping elements: 1. ICT proficiency—related to basic digital skills of adopting, adapting, and using digital devices, applications, and services; 2. Information, data and media literacies—related to the capacity to find, evaluate, manage and share digital information and data, critically reading in a range of digital media; 3. Digital creation, problem solving and innovation—related to creation, innovation, and problem-solving process with technologies and/or the development of new practices with digital technology; 4. Digital Communication and Collaboration—related to the capacity to communicate and collaborate effectively in a variety of digital media for different purposes and audiences; 5. Digital Learning and Development—related to the capacity to identify/participate in digital learning opportunities; and 6. Digital Identity and Wellbeing—related to the capacity to maintain a positive digital identity across platforms and look after one's work–life balance. The JISC DigiCap framework may explain how students and teachers benefit from learning and teaching opportunities through digitally rich resources and environments overlapping with digital communication and participation in digital teams building digital networks. The later processes allow students and teachers to develop themselves and support the development of others through collaborative learning interactions. Thus, for example, students' learning processes could be influenced by the integration of technology into a course and the support they receive regarding the digital resources, collaborative interactions among students or between students and teachers and the creation of digital learning resources [17,18]. The aforementioned frameworks mainly discuss the digital literacy concept in an "instrumental" way that provides information about the way individuals work and behave through the use technology to accomplish tasks and enhance their everyday lives [19].

Although these frameworks provide useful information to educational and industrial sectors regarding the level of individuals' digital skills, they do not consider individuals' personal characteristics (i.e., self-efficacy, self-regulation) in relation to their digital literacy. Thus, educational researchers have explored student digital capabilities in a Higher Education context in regard to their individual characteristics. For example, Ng (2012) [20] proposed a three-dimensional framework based on cognitive (i.e., choosing technology, searching information, and critically evaluate the information), technical (i.e., technical awareness of technology), and socioemotional (i.e., support through online communities
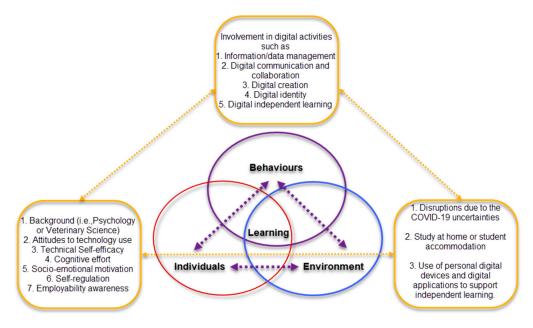
and protect oneself from harm in digitally environment) areas. These three dimensions overlapped providing information about individuals' digital literacy and their confidence to use unfamiliar technologies. This study revealed that Higher Education students could use unfamiliar technologies for learning purposes, when they became aware of what constitutes educational technologies and what were their use for learning purposes. Similarly, Bellini, Filho, de Moura Junior, and de Faria Pereira (2016) [21] divided technology use in three dimensions: access, cognition, and behaviour. Based on their proposed framework, access to technology was used in practice for a specific purpose to leverage the benefits from the technology use from students. The student levels of self-efficacy were not related to the presence of cognitive digital limitations or capabilities, as it referred to individuals' judgements about their own competence to perform the required tasks to achieve an expected performance [22]. Additionally, Greene, Yu, and Copeland (2014) [23] studied how self-regulation influenced students' learning in digital environment following data-driven approaches using the Internet. Students' ability to self-regulate their own learning mainly referred to their ability to define tasks, set goals, make plans, monitor their own learning progress, and make any necessary changes to their learning process in order to accomplish more efficiently and effectively their learning goals/tasks [24,25]. Self-regulation could be split into two main categories: social cognitive (e.g., self-efficacy and motivation) and behavioural dimensions (e.g., self-evaluation and effort management) [26]. Anthonysamy, Koo, and Hew (2020) [27] studied how self-regulation (metacognition knowledge, resource management, and motivational belief) and digital environment enhance student digital capabilities through the independent learning process.

Summarising the above discussion, educational professional bodies and researchers have mainly explored the wide area of digital literacy in Higher Education by studying how students behave in learning environments or how students develop the set of key skills in order to become digitally literate persons. Terminologies such as *digital natives* [28], *millennials* [29], *generation Y* [30], *i-generation* [31], or *net generation* [32] have been used to describe individuals with common characteristics in the level of technology use into their everyday lives, including learning purposes. However, many authors have, including Lai and Hong (2015) [33], refuted that the characteristic of belonging to the same age group would be a determining factor in students' use of digital technology for learning purposes. Being in the same age group was not a factor in students' learning characteristics. Thus, researchers have linked digital literacy to learners' individual characteristics through knowledge acquisition and either self-regulation to explain how students adapt their learning process accordingly [34], or academic performance to explore the effects of digital literacy on learning process [35].

The aim of this study was to explore how digital capabilities could influence students' independent learning and academic performance in two disciplines (Psychology and Veterinary Science) at a UK university during the time of COVID-19 lockdown over spring 2020. The study was underpinned by Social-Cognitive Theory (SCT) [36] allowing educational researchers to explore the reciprocal interactions between environment, behaviours, and individuals' characteristics in order to understand individuals' learning process. The social and cognitive interactions through the use of digital devices and applications over the first COVID-19 lockdown period allowed students to support digital independent learning. The initial assumption of this study was that student academic performance learning process might have been influenced by their individual characteristics, which might be related to digital literacy (i.e., technical self-efficacy, attitudes towards the use of technology) and/or their own personal beliefs/motivations (i.e., self-regulation and employability awareness) (Figure 1). The dynamic bonds between the interactions of individuals, behaviours, and environment [37] were applied to explore students' digital literacy development during the COVID-19 pandemic period which had disrupted the Higher Education delivery at a UK University and caused uncertainties to students. It was, therefore, important to gain an in-depth understanding of students' learning regarding their use of technology that they used to support their own independent study and, in turn, their supported their academic

performance. Thus, the objectives of this investigation were to explore whether there were any effects on students' academic performance from two disciplines (Psychology and Veterinary Sciences) in relation to:

1. Device usage, independent learning, and students' participation in a variety of digital activities;
2. Technical self-efficacy, self-regulation, cognitive effort, socio-emotional motivation, attitudes towards technology use and employability awareness.

Figure 1. Social-Cognitive Theory (SCT) applied to university students' digital independent learning disrupted by the COVID-19 pandemic.

2. Methods

2.1. Experimental Condition and Participants

This investigation was conducted in the Psychology and Veterinary Science Departments at a research-intensive University in the Northwest of England during the first COVID-19 lockdown period. An online questionnaire was distributed over the period of May 2020 to undergraduate students in all 3 years studying these two disciplines.

Both undergraduate courses (Veterinary Science and Psychology) were following the requirements of the Quality Assurance Agency (QAA) framework for Higher Education Qualifications and the QAA Benchmark Statements and had been accredited by professional bodies (Royal College of Veterinary Surgeons, and British Psychological Society, respectively). The Psychology curriculum included various research activities allowing students to act as researchers to develop subject-specific and generic skills (i.e., communication, problem solving, team working, independent learning, and research) [38]. Similarly, the Veterinary Science curriculum supported research opportunities for students following an integrated spiral approach, in which learning activities were linked to different disciplines and topics allowing students to apply their knowledge to different contexts [39]. Both programmes followed a similar blended learning approach before the COVID-19 pandemic period that exposed students to various educational technologies supporting learning activities such as collaboration, searching databases, and online self-assessment tests. Students could use their own digital devices (e.g., laptops and mobile phone) and a variety of applications (e.g., Microsoft packages, online voting systems, and statistical analysis packages) before, during, and after their lecture time [40]. During the COVID-19 pandemic period in spring 2020, both undergraduate programmes adopted the remote emergency teaching process, which included synchronous (i.e., using web conferencing tools) and asynchronous (i.e., pre-recorded videos and online discussion) activities between

teachers and students, and among students [4,41]. At the end of the semester, students from both disciplines completed an online, open-book final summative exam.

The undergraduate students from the three levels of study years were recruited on an opportunity sample basis by email distribution. Overall, 303 university undergraduate students fully completed the questionnaire allowing researchers to aggregate their academic performance. Figure 2 illustrates the distribution of participants per discipline and per year. The total percentage of female participants was 83.8% (Psychology: 87.9% and Veterinary Science: 80.5%). The ratio of the females who participate in this study was compatible with the whole Psychology and Veterinary Science undergraduate student cohort.
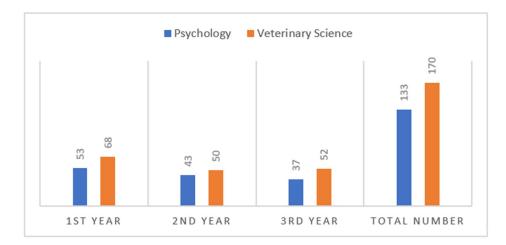

Figure 2. Participants per year and per discipline.

2.2. Questionnaire

Undergraduate Psychology and Veterinary Sciences students completed a 51-item questionnaire, which also included an open-ended question regarding the digital capabilities and study habits during the emergency remote online teaching period. The approximately 10–15 min-long questionnaire has been located at the ZENODO repository (http://doi.org/10.5281/zenodo.3900607 accessed on 18 June 2020). The first part of the questionnaire included 3 multiple-answer questions about the types of devices, applications/software that students used as well as their behaviours over their independent study period. The second part of the questionnaire included 19 single-answer items related to the extent of which students used their devices to support their learning, according to the elements of the JISC framework (2015) [15] (e.g., information literacy, communication, and collaboration, etc.). In the third part, 18 single-answer items followed including questions about student learning and study behaviour (e.g., student attitudes toward digital use for learning purposes, technical, cognitive, and emotional dimension) following Ng's (2012) framework [20], as discussed in the Introduction section. The fourth part of the questionnaire included 10 single-answer items related to students' self-regulation skills and employability awareness. The final item of the questionnaire was a free text box which allowed participants to provide more details about their remote online learning experience: "Do you feel that you have developed new digital skills or study habits in recent weeks, then please could you give us more details of how these have affected your learning?"

3. Results

By using a one-way ANOVA statistical analysis to compare the student academic performance (Table 1), no significant difference was found between the two disciplines ($F(1, 302) = 1.367$, $p = 0.243$, $\eta^2 = 0.101$). Thus, we could assume that although students had a different disciplinary background, both groups of students represented a similar level of academic ability and engagement with their undergraduate studies.

Table 1. Participants' average grades per year per discipline (Mean (±SD)).

Year of Studies	Psychology	Veterinary Science
1st Year	65.9 (±7.15)	67.5 (±6.39)
2nd Year	63.4 (±6.61)	64.7 (±5.38)
3rd Year	64.7 (±7.01)	64.1 (±5.33)
Total number	64.7 (±6.96)	65.6 (±5.96)

The aim of the first part of the questionnaire was to explore the types of digital devices and applications that students usually used over their independent study time (Table 2). They have also been asked to respond to questions regarding their study habits. Most of the students for both groups used laptops to support their independent learning, whilst only a small percentage of them used additional smartphones. A chi-square analysis (α (0.05) is the limit of significance level, χ^2(a, b) is the variance between groups, p is significance level) on students' responses regarding the types of applications that they used revealed that there was a significant difference between the two disciplines only regarding the use of presentation software ($\chi^2(1, 303) = 11.752$, $p < 0.001$), statistics packages ($\chi^2(1, 303) = 178.823$, $p < 0.001$), email packages ($\chi^2(1, 330) = 16.220$, $p < 0.001$), and web conferencing applications ($\chi^2(1, 303) = 4.787$, $p < 0.001$). Further significant differences for students' learning habits over their independent learning between the two groups of students were found only in searching the University Library to support your reading ($\chi^2(1, 303) = 57.871$, $p < 0.001$), searching the Internet for reading around the lecture topic but beyond the level of the lecture ($\chi^2(1, 303) = 57.871$, $p < 0.001$), checking their social media ($\chi^2(1, 303) = 11.043$, $p < 0.001$), receiving and sending messages to their friends and family ($\chi^2(1, 303) = 8.952$, $p < 0.001$), and browsing the Internet for unrelated to lecture topic material ($\chi^2(1, 303) = 11.405$, $p < 0.001$).

Table 2. Students' responses on questions related to the types of devices, used applications and their behaviour during their study time.

	Psychology (%)	Veterinary Science (%)
Devices Were Mostly Used for Studying Purposes		
Smartphone	18.8%	26.5%
Laptop	99.2%	98.8%
Applications/Software Were Mostly Used for Studying Purposes		
Word processing software	94.7%	92.9%
Presentation software	85.7%	68.8%
E-mail packages	57.9%	34.7%
Statistics packages	79.7%	4.7%
Spreadsheet software	35.3%	34.1%
Virtual Learning Environment	92.5%	98.2%
Web conferencing applications	57.9%	70.0%
Video sharing applications	34.6%	27.6%
Habits Mostly Exhibited Over Independent Study Time		
Reading learning material on a digital device	82.0%	77.6%
Accessing the lecture capture videos	78.9%	69.4%
Reading your personal notes on a digital device	59.4%	65.3%
Receiving and sending messages to your friends and family	57.9%	40.6%
Checking your social media	51.9%	32.9%
Searching the Internet for reading around the lecture topic but beyond the level of the lecture	48.9%	14.1%
Searching the University Library to support your reading	44.4%	7.1%
Browsing the Internet for unrelated to lecture topic material	30.1%	14.1%

A two-way ANOVA statistical analysis further explored the differences in students' responses on their study habits regarding their academic performance (Table 3). There were significant differences between students' grades when they checked their social media profiles and searched the Internet to discover material beyond the level of the lecture, with the Veterinary Science students presenting better academic performance compared to Psychology students.

Table 3. Students' academic performance (Grades) per disciplines on questions related to their study habits during their independent learning.

	Psychology (M, SD)	Veterinary Science (M, SD)	ANOVA between Disciplines ($\alpha = 0.05$)
Receiving and sending messages to your friends and family	65.5 ($\pm$6.11)	66.3 ($\pm$5.19)	$F(3, 299) = 1.794$, $p = 0.148$, $n^2 = 0.018$
Checking your social media	65.4 ($\pm$6.17)	67.9 ($\pm$5.59)	$F(3, 299) = 4.846$, $p = 0.003$, $n^2 = 0.046$
Searching the Internet for reading around the lecture topic but beyond the level of the lecture	63.1 ($\pm$7.21)	66.2 ($\pm$6.59)	$F(3, 299) = 3.448$, $p = 0.017$, $n^2 = 0.033$
Browsing the Internet for unrelated to lecture topic material	64.5 ($\pm$7.55)	66.3 ($\pm$2.73)	$F(3, 299) = 0.604$, $p = 0.613$, $n^2 = 0.006$

α: the limit of the significant level, M: Mean, SD: Standard Deviation, F(a, b) is the variance value, *p*: significant value, n^2: size effect.

A two-way ANOVA statistical analysis was conducted to compare students' responses regarding their engagement in a variety of digital activities during the study period following the JICS DigCap framework (Table 4). The analysis reveals that there was a significant difference between the groups of students regarding their participation in information/data management, digital material creation and digital independent learning. The Psychology students were more active in searching and managing information through the Internet compared to Veterinary Science students. This finding is consistent with students' responses with the previous section, as Psychology students used the library facilities more frequently together with the Internet to support their reading. On the contrary, Veterinary Science students were involved more in digital creation (i.e., blog, e-portfolios, wikis) activities than Psychology students. A progressive and reflective learning portfolio allowed Veterinary Science students to support their digital independent learning.

Table 4. The differences between students' engagement in digital activities following the JISC's Digital Capability Framework.

JISC's Digital Capability Framework Elements	Psychology	Veterinary Science	ANOVA Analysis between the Disciplines ($\alpha = 0.05$)
	(M, SD)	(M, SD)	
Digital independent learning (5-items, a = 0.612)	5.5 ($\pm$0.89)	5.8 ($\pm$0.82)	$F(1, 302) = 10.283$, $p < 0.001$, $n^2 = 0.033$
Digital information/data management (4-items, a = 0.754)	4.9 ($\pm$1.09)	3.9 ($\pm$1.29)	$F(1, 302) = 50.071$, $p < 0.001$, $n^2 = 0.143$
Digital communication and collaboration (6-items, a = 0.789)	3.3 ($\pm$1.11)	3.5 ($\pm$1.19)	$F(1, 302) = 2.253$, $p = 0.134$, $n^2 = 0.007$
Digital creation (2-items, a = 0.626)	3.3 ($\pm$1.11)	3.5 ($\pm$1.19)	$F(1, 302) = 32.252$, $p < 0.001$, $n^2 = 0.097$
Digital Identity (2-items, a = 0.738)	2.5 ($\pm$1.52)	2.8 ($\pm$1.48)	$F(1, 302) = 2.537$, $p = 0.112$, $n^2 = 0.008$

a = Cronbach's Alpha, α: the limit of the significant level, M: Mean, SD: Standard Deviation, F(a, b) is the variance value, *p*: significant value, n^2: size effect, 7-point Likert scale (1: not at all, to 7: to very great extent).

Multiple regression analysis was conducted to explore whether students' academic performance (grades) for each discipline was associated with the year of studies, information/data management, communication and collaboration, creation, identity, and independent learning following the JISC DigCap framework. The regression model predicted 12.2% of the overall variance in total Psychology student performance (grades), adjusted $R^2 = 0.122$, $F(5, 132) = 4.662$, $p < 0.05$. For all the variables, information/data management ($\beta = -1.765$, $p < 0.05$) and digital creation ($\beta = -1.542$, $p < 0.05$) were negative significant predictors, while digital independent learning ($\beta = 2.857$, $p < 0.05$) was a positive significant predictor on student academic performance. The regression model predicted 1.6% of the overall variance in total Veterinary Science student academic performance, adjusted $R^2 = 0.016$, $F(5, 169) = 1.555$, $p = 0.176$. For all the variables, only information/data management ($\beta = -940$, $p < 0.05$) were negative significant predictors on student academic performance, while all the other JISC's digital capability elements did not significantly contribute to the academic performance of the Veterinary Science students.

A two-way ANOVA statistical analysis was conducted to compare students' responses regarding their individual characteristics following Ng's framework [20] along with self-regulation and employability awareness (Table 5). The analysis revealed that there was a significant difference between the groups of students regarding the required cognitive effort to use digital technologies for learning purposes and how students appreciated the connection between digital capabilities and employability awareness. The Psychology students perceived a better connection between digital literacy with employability compared to Veterinary Science students, potentially due to a better link to the Psychology curriculum. On the contrary, Veterinary Science students perceived that the use of technology expected from them less cognitive effort compared to Psychology students, who mentioned that they needed support to use technology for learning purposes.

Table 5. The differences between students' engagement in digital activities following Ng's framework (2012).

Individual Learning Variable	Psychology	Veterinary Science	ANOVA Analysis between the Disciplines ($\alpha = 0.05$)
	M (SD)	M (SD)	
Attitudes (10-items, a = 0.901)	5.3 ($\pm$1.19)	5.3 ($\pm$0.92)	$F(1, 301) = 0.053$, $p = 0.818$, $n^2 = 0.000$
Cognitive dimension (2-items, a = 0.733)	5.5 ($\pm$1.06)	5.2 ($\pm$1.12)	$F(1, 302) = 5.632$, $p = 0.018$, $n^2 = 0.018$
Technical dimension (5-items, a = 0.922)	4.8 ($\pm$1.40)	4.8 ($\pm$1.29)	$F(1, 302) = 0.022$, $p = 0.882$, $n^2 = 0.000$
Socio-emotional dimension (2-items, a = 0.637)	4.6 ($\pm$1.6)	4.8 ($\pm$1.33)	$F(1, 302) = 0.687$, $p = 0.408$, $n^2 = 0.002$
Self-regulation (7-items, a = 0.808)	3.2 ($\pm$1.11)	3.4 ($\pm$1.10)	$F(1,302) = 1.554$, $p = 0.213$, $n^2 = 0.005$
Employability awareness (3-items, a = 0.931)	2.8 ($\pm$1.59)	2.3 ($\pm$1.27)	$F(1, 301) = 7.773$, $p = 0.006$, $n^2 = 0.025$

a = Cronbach's Alpha, α: the limit of the significant level, M: Mean, SD: Standard Deviation, F(a,b) is the variance value, p: significant value, n^2: size effect, 7-point Likert scale (1: not at all to 7: to very great extent).

Multiple regression analysis was conducted to explore whether students' academic performance (grades) for each discipline was associated with attitudes towards learning technology, technical self-efficacy, cognitive effort, socio-emotional motivation, self-regulation and employability awareness. The regression model predicted -4.2% of the overall variance in total Psychology student performance (grades), adjusted $R^2 = -0.042$, $F (6, 131) = 0.125$, $p = 0.993$. None of the variables were significant to student academic performance. Similarly for the School of Veterinary Science, the regression model predicted approximately 0% of the overall variance in total Veterinary Science student academic performance, adjusted $R^2 = 0.008$, $F (6, 168) = 1.223$, $p = 0.297$, but none of the variables significantly contribute to student academic performance.

Finally, a thematic analysis was run to analyse students' responses on the open-ended question regarding the potential new digital skills development or study habits which might have affected students' learning. Overall, 103 out of 303 students from both disciplines left responses to the open-ended question, with two students simply answering "No" and one answering "Not Applicable", therefore, 100 qualitative comments were used

in the qualitative analysis. Table 6 provides a breakdown of the number of students who left a qualitative reply to the last question per discipline and per year. The majority of those leaving comments (72) received grades at a 2:1 level (60–70%), with 16 gaining 1st class (70% and above), 8 gaining a 2:2 level (50–60%), and 3 a 3rd class grade 40–50%), while only one student received a failing grade (less than 40%). Interestingly those with the lower grades (failing, 3rd, and 2:2 grade) were slightly more likely to suggest that they had coped well with the teaching and learning transition due to the COVID-19 isolation restrictions having difficulties regarding their metacognitive awareness, while they present a range of self-regulation skills. However, the number of students who belonged to the group with low academic performance was very small (only 12 students), so these findings need to be taken with caution.

Table 6. Breakdown of participant characteristics (discipline and year) leaving comments on the open-ended question.

Discipline	1st Year	2nd Year	3rd Year	Total Number
School of Psychology	16	13	13	42
Veterinary Science	24	16	18	58
Both disciplines	40	29	31	100

Overall, the students' qualitative responses split into two broad themes which influenced their independent learning over the first COVID-19 lockdown period: 1. structural and environmental factors and 2. digital skills and adaptation to situation. For example, comments regarding the structure involved difficulty with time management, motivation, and self-regulation. For example, students struggled to work consistently, "Since lock down I have less of a working schedule and get more easily distracted at home" (1st year Psychology Student). Structure also referred to the infrastructure in place to allow students to access their learning. Poor Wi-Fi, changing work habits, and lack of access to reliable technology impeded students' ability to study. For example, several students compared their current with the previous year experience making a comment about a potential negative impact on their academic performance: "Study habits massively affected-do not have access to a good laptop at home; studying is becoming almost impossible. It's stressful and the university are not understanding at all" (3rd year Psychology student). Students offered a range of views on increasing digital skills development feeling it helped them to access their learning through new technology such as Zoom and Microsoft Teams applications. For instance, those who tended to show higher self-regulation and were more likely to have first-class grades: "I have learned how to use Microsoft Teams and to join meetings with class groups and I feel this has been very useful in aiding my learning, such as still being able to meet with my academic adviser to discuss coursework" (2nd year psychology student). Other students felt they preferred the face-to-face teaching delivery process, as they missed the social interaction of face-to-face lectures, meeting their friends/peers, and taking notes by hand. These students were predominantly from Veterinary science, "personally I miss lectures. I find it takes so much longer listening to stream captures as there is the temptation to pause it every 10 s to make sure you write down every single thing the lecturer is saying-an hour lecture can take me 2 hrs! Also, I feel that I can get bored easily whereas lectures are dynamic and more tactile than stream captures" (3rd year Veterinary Science student). On the contrary, there are many other students for whom technology usage did not change, as they had already used digital solutions such as: the Virtual Learning Environment (VLE), lecture capture, and online notetaking so they easily adapted their learning process to the new circumstances that the COVID-19 pandemic brought. "I have found the uni has coped very well with the transition to online learning. I feel I have not needed to learn new digital skills after this change as the Vet School has made all the material easy to access and minimised disruption" (2nd year Veterinary Science student).

4. Discussion

The aim of this study was to explore how digital capabilities of Psychology and Veterinary Science undergraduate students influenced their academic performance and their independent learning during spring 2020 lockdown of the COVID-19 pandemic period. The teaching–learning processes in Higher Education shifted from on-campus blended learning to an emergency remote fully online approach where web-conferencing tools (i.e., Zoom and Microsoft Teams) were adopted by teachers and students to overcome the COVID-19 pandemic restrictions [42]. Many educational researchers had already started exploring the effects of the COVID-19 outbreak on student experiences and expectations [43,44] as well as online teaching-learning modes [2,45]. However, this study adopted Social-Cognitive Theory (SCT) to investigate how student individual characteristics, behaviours, and digital capabilities were employed to cope the learning environment change due to the COVID-19 pandemic. The framework of the applied SCT in student independent learning was premised on the three dimensions: environment (disruptions from the COVID-19 pandemic), behaviours (interaction with technology to support learning), and individual (personal characteristics which may influence learning).

By analysing the questionnaire responses, it was found that students from both disciplines had the required digital technical capabilities to be comfortable with technology and the level of ability to adopt new technologies for learning purposes. Specifically, students mainly worked online using laptops and a variety of applications to support their learning (i.e., word processing packages and Virtual Learning Environment) and their personal communication needs (i.e., social media and messaging application). The difference that was identified between students from the two disciplines (Psychology and Veterinary Science) regarding several applications were highly related to the curriculum structure. For example, statistical analysis software was more frequently used by Psychology undergraduate students, promoted by their research-intensive curricular activities. The nature of the curriculum also explained the reason why Psychology students had been more exposed to digital searching processes (i.e., searching the Internet and University Library to read material beyond the lecture material) than Veterinary Science undergraduate students were. The Veterinary Science course had emphasis on clinical laboratory and small classes where the learning material was mainly provided from teachers; therefore, there was no need for those students to search additional material beyond the level of the lecture to support their studies. Additionally, it was found that there was a significant difference in students' study habits regarding searching materials. Psychology students presented lower performance compared to Veterinary Science students with the JISC's digital information/data management element, which was found to be a negative predictor to their academic performance. The implication of this finding was that it is not sufficient for teachers to expose students to information and data management activities, but they also need to provide students with the necessary support in developing effective information management strategies.

Another interesting finding was that Psychology undergraduate students who had been more exposed to activities unrelated to learning (i.e., checking social media and exchanging messages with friends and family) presented low academic performance. This finding was in alignment with a previous study which was conducted to explore learning process when Psychology and Veterinary Science students brought their own personal digital devices into lecture theatre [40] and therefore this finding has been considered unrelated to the COVID-19 teaching shift to a remote online approach. According to Lai and Hong (2015) [33] it is not likely for students belonging to the same age group to present the same homogeneous behaviour despite their likely familiarity with social uses of technology, and this might explain the difference in the use of social media between Psychology and Veterinary Science students. A potential implication of this finding was related to the challenge that teachers might have when taking decisions of the learning tools and the way that they would integrate them into their teaching approaches. The difference between the two disciplines in the use of variety of applications might link to either the curriculum structure or students' learning behaviour and/or individual characteristics.

SCT, which was adopted to conceptualise students' independent learning process over the COVID-19 pandemic period in relation to digital capabilities, further supports this implication revealing differences in students' performance and behaviours in regard to digital creation and digital independent learning. Although neither of the two disciplines' curricula expected from students to create their own digital material (i.e., video, photos, blogs, and wikis for learning purposes), Veterinary Science students were involved in building a progressive and reflective portfolio during their studies presenting evidence for a better performance compared to Psychology students. However, digital independent learning was a significant positive predictor only to Psychology student academic performance as those students might benefit from digitally rich settings more than the others. Although Veterinary Science students had been encouraged to create their own digital resources to cover the learning needs of (pre)clinical sessions, their digital learning opportunities were highly related to the class/seminar/laboratory environment. This is a common practice to Veterinary Science University programmes due to the nature of this cognitive subject [46]. Thus, Veterinary Science students did not have enough opportunities to support their independent learning with digital stimulus as the Psychology students had. The implication of this finding was mainly for Veterinary Science teachers who could provide more digital resources and/or encourage Veterinary students to work online during their independent learning.

However, promoting an even more digital learning experience would not create a dissatisfaction to students, as there were not significant differences between the Psychology and Veterinary Science students regarding technical and socio-emotional aspects of technology adoption. These aspects of students' familiarity with technology were not of their foremost concern, as they had enough capabilities to manage data, communicate and collaborate with others and to build as well as maintaining their social network for learning purposes. This last evidence is previously supported by Ng's work (2012) [20]. However, a significant difference was found in the cognitive aspects of the use of technology, which seemed to be related to student ability and cognitive effort to think critically in searching, evaluating, and managing digital information. The implication of these findings was that teachers could provide students minimum guidance on the use of technologies, but they would be more focused on the transformation of teaching and learning with digital technologies involving either redesign of learning experience or creation of new learning experiences promoting critical thinking [47]. The findings regarding the attitudes to digital learning further support the pedagogical transformation implication, as the students from both disciplines had no issue to follow the curriculum shift process from their previous blended learning experience. Kalloo et al. (2020) [48] found that technological, content, and pedagogical readiness counted as successful factors for transitioning teaching delivery mode from on-campus to a fully distance. This was also the case with more content-based sessions, even though students had no or little experience with web-conferencing tools prior the pandemic.

The digital "Visitors and Residents" (V&R) model [49] could further explain why students' attitude towards digital learning seemed largely unaffected by the COVID-19 lockdown period. Based on this model, a digital "Visitor" is defined as a goal-oriented user who does not use digital tools if there are not any yielding any concrete benefits. Digital technologies for visitors are other ways for them to achieve certain goals, such as to gain good marks or enhance their employability skills. Whereas "Residents" are those who present a strong online identity by sharing information about their personal life and work within an online community. They use digital technologies to maintain virtual communities and spend time living online. The findings of this study supported the argument that the students exhibited digital "Visitor" behaviours regarding their own learning, whereas in their personal life they might exhibit more of a digital "Resident" behaviour due to their familiarity with technology. Students made a distinction between university and personal life, as their academic performance and attitudes to digital learning were unaffected by their previous exposure to all different types of technological tools [50].

Therefore, an implication of this finding is that teachers could prepare goal-oriented digital learning activities for students encouraging them to use and develop digital capabilities to support their professional career. For example, a goal-oriented activity could be related to employability. Psychology students who gained employability awareness and how this was associated with digital literacy through the curriculum structure, paid more attention to the development of their digital capabilities as well as their skill repertoire to support their professional life than Veterinary students might do. Veterinary Science students, on the other hand, paid more attention to develop practical skills and knowledge which are considering essential for their career. Specifically, Veterinary Science teachers should overcome the difficulties in online remote education providing virtual resources to mimic the laboratory work and enhance practical classes with videos and 3D animations. Thus, practical classes for Veterinary Science during the COVID-19 pandemic were more focused on the student development practical rather than employability skills.

Finally, there was no difference between students' academic performance from the two disciplines in the self-regulation quantitative items. However, analysing students' qualitative responses regarding the influence of the use of technology and their digital capabilities during their independent learning within the COVID-19 first lockdown period, two categories were identified. The first one was highly related to the effect of structural and environmental factors on independent learning, as students felt disrupted by the speed and the uncertainty that the COVID-19 pandemic brought to their university and personal life. These students struggled to continue their studies and presented difficulties in establishing a new "normality" due to lack of the face-to-face interactions and self-regulation skills. Students, however, with high level of self-regulation and digital capabilities were able to keep focused and engaged during the lockdown. Students who were well-adapted to the new emergency online teaching approach presented a combination of high-self regulation, technology use, and a positive attitude to digital study practices. This was also advocated by Broadbent and Poon (2015) [51] who discussed about the importance of time management and perseverance for higher academic performance in an online context. The implication of this finding was that teachers should not only be focused on self-regulation strategies and supporting students to develop them [52], but also, teachers should consider that students need time to accept a situation and adapt their learning accordingly.

Whilst findings and implications of this study gave insight into how digital capabilities linked to independent learning over the COVID-19 first lockdown period, the current study had several limitations. For example, the sample was restricted to students studying only at one UK University where an online questionnaire was the sole data collection method. It was not possible to study the longer-term effects of the pandemic on student learning within the study. In order to perceive more concrete findings in the future from other Universities and different disciplines around the world, this study questionnaire has been uploaded into the Zenodo open-access repository. Educational researchers can download the questionnaire and conduct a similar study comparing their findings with the outcomes of this study. Although the main part of the questionnaire includes quantitative items, it also allows students to leave their qualitative responses supporting an in-depth understanding of the student digital capabilities in independent learning. Additionally, a future longitudinal research could explore this area providing more accurate findings over the years providing evidence regarding the digital learning transformation. Finally, digital divide was not examined in this investigation. This could be a future research dimension to contribute to the dialogue of equity in higher education [53].

In conclusion, this study explored the role of digital capabilities over the COVID-19 spring 2020 lockdown period on student independent learning. There has not been a similar research study—that the authors are aware of—that splits the independent learning process into environment, behaviour, and student individual characteristics. After discussing each of the findings, relevant implications for teachers were provided. Overall, students did not have any issue to follow any digital transformation due to their engagement with technologies in their university and personal life. However, the COVID-19 pandemic

"forces" everyone to change habits and build on prior experience elaborating approaches and self-regulation strategies which may affect teaching and learning. Transformative use of digital learning technologies (from on-campus to online) is a challenge for a teacher who should redesign and reconsider their teaching approaches taking into their account student capabilities and student study habits. Future work on this area, as discussed above, could assist universities and teachers to reconsider the digital learning transformation.

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