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A cross-sectional study of discipline-based self-perceived digital literacy competencies of nursing students

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Abstract

Aims

This study offers an empirical exploration of self-assessed digital competencies of students, most of whom studied in nursing courses, using a discipline-based self-assessment survey tool. A range of digital competences were explored: information and communication technology proficiency and productivity, information literacy, digital creation, digital research, digital communication, digital learning and development, digital innovation, digital identity management and digital wellbeing.

Design

A cross-sectional empirical study.

Methods

Quantitative data was collected from November to December 2021 via a questionnaire survey administered to students. Quantitative results were reported through descriptive statistical analysis. Mann-Whitney (U-test), and Kruskal-Wallis non-parametric statistical tests were used to identify statistically significant differences based on age demographics and pre or post registration course. Thematic analysis was utilized for survey open-ended questions data.

Results

Students reported low competencies in the following digital literacy dimensions, all of which were imperative for their studies and for their future professional careers: information literacy, digital research, digital innovation. Significant statistical subgroup differences were found between age demographics and pre/post registration within most of the digital competence dimensions. The survey open-ended comments revealed that students encountered challenges around digital skills they had mostly developed via everyday life experiences and trial and error approaches.

Conclusion

Increasing awareness of existing digital gaps and offering tailored digital skills enhancement can empower students as future-proof evidence-based practitioners in an evolving digital healthcare landscape.

Implications for the profession and/or patient care

Highlights the importance of embedding digital literacy within nursing study programmes, as preparation for comprehensive patient health care.

Impact

- Offers insights into digital competences gaps of nursing students.
- Proposes targeted educational digital skills training interventions.
- Stresses the value of academic staff supporting nursing students to develop digital skills in important areas of professional practice.

Reporting method

JBI critical appraisal checklist.

No patient or public contribution.

Keywords: assessment; attitudes, curriculum planning; evidence-based practice; nurse education; nursing students; professional development; quantitative approaches; social media; clinical decision-making

1. INTRODUCTION

In 2016, the Royal College of Nursing (RCN) Congress concluded that the use of data, information, and technology were no longer specialist issues; rather, every nurse should be an ‘e-nurse’, able to use technology to maximum effect for patients, service users and carers (RCN, 2018). However, to achieve this, training is required to prepare and empower the future workforce (Kispeter, 2018; Dykes & Chu, 2020). A digitally enabled profession ensures “top-quality health care of citizens” (UK Department for Business Innovation & Skills and Department for Culture Media & Sport, 2016) and maximises the benefits of patient care including better outcomes for patients, better experiences for staff, and more efficient ways of working (Booth et al., 2021).

However, research has revealed an uneven level of digital literacy of frontline healthcare professionals, and more widely in the social care sector (Good Things Foundation, 2015). The COVID-19 pandemic accelerated the need for more advanced digital skills to cope with digital transformation within healthcare (Whitelaw et al., 2020).

Learning design in Higher Education (HE) curricula should support the development of essential professional skills for healthcare workers to cope with informatics and the efficient handling of digital technologies (Dykes & Chu, 2020). This is important in today's increasingly digital, globally connected and smart health environments, which require constantly evolving digital skills development. However, incorporating digital skills training into healthcare curricula has generally been slow, and has not always reflected requirements within healthcare nor the experience of students (Risling, 2017; Cummings, 2016). Digital skills frameworks that have been adopted in education tend to focus on digital healthcare technologies and overlook required behavioural changes, goals, and outcomes skills, necessary for professionals working in a digital healthcare environment (Brice & Almond, 2020), or have a narrow focus on specific digital areas (Yoon, Yen & Bakken, 2009). The National Health Service in the U.K. identifies "six domains" of digital capabilities, "which are made up of skills, behaviours and attitudes", incorporating not only "Technical proficiency" but also "Communication, collaboration and participation", "Self-development", "Information, data and content literacies", "Creation, innovation and research" for the health and social care workforce (2018, p.5).

The Covid-19 pandemic caused major challenges in healthcare education requiring nursing students and academics to adapt to new virtual learning and teaching approaches (Leigh et al., 2020). However, despite the widespread presence of digital technologies and positive attitudes to its use, research still reports lower confidence in students when using digital technology and software for learning (Lokmic-Tomkins et al., 2022) and points to students' unfamiliarity with the scope and possibilities that digital tools may offer in personalised nursing care (Loureiro et al., 2021).

There is a need for further research that explores students' digital skills development needs as digital learners and future health professionals in relation to their awareness and use of digital tools for healthcare, as well as around their professional digital behaviour and attitudes. Current focus remains on the development of functional digital skills; only a few digital literacy empirical studies in HE have attempted to articulate digital skills relevant to specific disciplines or professional groups (Martzoukou et al., 2021; Varga-Atkins, 2020).

2. BACKGROUND: DIGITAL LITERACY

The study of nursing students' digital skills development has attracted some research attention recently, with an emphasis on both technological knowledge and critical thinking, and with reference to students' learning and their future professional practice. Nes et al. (2021) concluded that nursing students need to develop both technological literacy and a capacity to become critical thinkers around the use of technology. They found that pedagogical approaches, which aim at facilitation of all three directions holistically, are missing. Educational providers need to ensure that technological literacy is comprehensively embedded throughout curricula to support students' success as learners and future professionals (Nes et al. 2021).

Matthews (2021) discovered variability in approaches to digital literacy, highlighting again the need for the inclusion of digital skills in curricula to support a digital literate future workforce. Interestingly, the study highlighted gaps in curricula which do not represent all areas of digital

literacy found in the guidance of professional bodies (e.g., Royal College of Nursing, 2021). Matthews (2021) recommended the development of a process curriculum, inclusive of self-evaluation and that provision should consider personalisation (e.g., considering variation in demographic and clinical backgrounds across students). Further work is required on embedding digital literacy in curricula which recognises the dynamic and progressive nature of digital literacy.

Researchers investigating levels of student nurses' digital literacy (e.g., Harerimana et al., 2022) have identified a need to incorporate digital literacy education beyond digital device use related skills (e.g., basic computer, internet and digital device use related skills). To achieve this, educational providers should aim to integrate digital health or informatics modules within the nursing curriculum.

Brown et al. (2020a) conducted a descriptive, cross-sectional survey utilising a validated self-assessment nursing informatics competencies scale instrument, focusing on basic computer knowledge and applied computer skills, wireless device skills, and clinical informatics skills and attitudes. They found that nurses had high levels of basic, everyday digital literacy, but recommended that educational providers develop and implement curricula that enable further development and enhancement of digital skills, particularly for transferal to the clinical/care environment. Frings et al. (2022) compared health care students and students studying in non-health related subjects, and found that the former were not better prepared in digital literacy skills than their non-health care peers. The authors highlighted digital literacy as a process-orientated skill, which develops over time.

3. STUDY AIMS

The work presented in this paper formed part of a wider institutional project which aimed to explore the development of digital literacy skills among students in different discipline areas. In line with UK and global strategic priorities (Moore et al., 2018; UK Department for Digital, Culture, Media & Sport, 2017; UK Department for Education, 2019), the project aim was to identify pockets of digital inequalities in students across different discipline areas, to enhance their digital capacity as future professionals, and to open conversations around digital literacy training and support. It centred on understanding how to achieve digitally inclusive learning and teaching practices and empowering students to thrive in an increasingly digital learning and professional environment as it relates to their disciplines and areas of study.

The project was supported by university funding linked to the Quality Assurance Agency (QAA, 2020-23 sector-wide Enhancement Theme, 'Resilient Learning Communities', and addressed a number of areas that are key directions in HE teaching and learning agendas: a) technology enabled learning and digital behaviours expected in the online environment; b) enhancement of students' employability, exploring key digital competences for future work; and c) reflective and continuous development, focused on work-based digital skills.

With the accelerated provision of online, blended or hybrid modes of delivery in HE due to the pandemic, the development of students' digital skills has been a topic of ongoing conversation and interest, addressing skills for everyday life, education and work (Joint Information Systems Committee, 2019; UK Higher Education Academy, 2017, Spante et al., 2018; UK Department for Business Innovation & Skills and Department for Culture Media & Sport 2016). However, limited attention has been given to how students can be supported to achieve digital competences which are specific to their discipline needs, beyond general explorations of

digital skills which may be applicable to all students. The research therefore addressed the following objectives:

1. To repurpose, with the input of academic staff/students, an existing general self-assessment digital competences survey tool (BLINDED FOR PEER REVIEW) in a way that reflects digital skills needs in specific disciplines.

2. To explore the digital competences of students in different discipline areas, by means of administering the repurposed survey tool, identifying demographic and course related differences.

3. To critically discuss with students their experiences of developing digital skills and the challenges they encounter, particularly those related to lower levels of self-reported digital competences.

4. To make recommendations for a discipline specific approach that relates to the development of students' digital competences and collate useful digital literacy training resources.

This paper focuses on the dataset that relates to Nursing students (the largest group of students who took part in this study) and reports on the initial two objectives of the project, that mainly represent the quantitative strand, comprising of the staff consultation phase (objective one) followed by the survey data analysis (objective two). This is due to the extensive nature of the qualitative data collected via the other strands of the project which will be published separately.

To corroborate earlier empirical results from the initial survey which found age differences as well as explore discipline specific characteristics related to the nature of the courses offered in Nursing, Midwifery and Paramedic Practice, two working hypotheses were further put forward (Objective 2):

H1: Self-assessed digital competences of students will be correlated with age demographic differences (different generational groupings).

H2: Self-assessed digital competences of students will be correlated with the type of course (pre and post registration courses).

Age grouping is an important variable to examine in view of multiple research studies in education which explore the role that age plays in the development of different digital skills and online learning behaviours, such as the use of educational technologies (Loureiro, Sousa & Antunes, 2021) and others reporting significant differences between generations of students on online learning engagement levels (Hampton & Pearce, 2016; Hensley et al., 2021).

Although there may also be other demographic areas which could be further explored, the imbalance in the numbers of students in the year of study and level of study, in our sample, did not allow for additional group-related cross-comparisons. Mode of delivery differences also proved to be problematic as the study took place during the COVID-19 pandemic where on-campus study could alternate with online learning and therefore it was more likely that some of the delivery categories would be difficult to clearly differentiate between each other.

Pre and post registration courses were also interesting to explore as 'Pre-registration' is a course where students acquire the competencies needed to meet the criteria for registration

with the Nursing and Midwifery Council (NMC), whereas post-registration courses are designed for registered practitioners who already hold a nursing or midwifery degree and study with a view to furthering their professional development and therefore are likely to have more on-the-job practical experience (and thus potentially more experience in using digital tools and following professional digital behaviours). The examination of differences in both age and pre- and post-registration courses was of interest due to the potential effects of on-the-job experience; typically, post-registration courses recruit more mature students, and course type may provide further evidence of potential age differences in the sample.

A detailed explanation of the demographics is provided in Table 3.

4. METHODS

4.1 Study design

The study followed a cross-sectional quantitative research design, which involved two phases. The first phase consisted of initial consultations with academic staff with subject expertise and a student enrolled in Nursing, who provided subject specific insights that assisted in the further development and subject-specific repurposing of an existing general survey instrument (BLINDED FOR PEER REVIEW) that aimed to assess students' self-perceived digital competences.

The second phase involved administering the survey to a sample of Nursing, Midwifery and Paramedic students, collecting quantitative data on students' digital competences, with selected additional open-ended questions that offered further qualitative insights into students' perceptions and the challenges they encountered. These explored the following:

1. How students learned to use digital tools that are important for their study or their future professional work.
2. How students stayed up-to-date with the digital tools they use.
3. How students' digital/online skills have helped them to address challenges in their academic work.

The overall approach helped to co-design the digital skills assessment tool with staff, explore the student perspective, and interpret and further explain specific results obtained by the student population (Creswell & Plano Clark, 2020, p.12), offering a better understanding of the context in which students studied.

4.2 Repurposing the survey tool

The areas included in the original survey explored everyday life skills (e.g., feeling comfortable, in control and safe when using digital technologies), academic skills (e.g., using online databases for coursework, receiving and responding to online feedback about academic work) and professional skills (e.g., working as part of online teams, identifying online professional literature). They also addressed both technical (e.g., ICT competence, handling computers, devices) and higher-level competences expected of students (e.g., information and data literacy, communication and collaboration, safety and problem-solving).

The theoretical frameworks that formed a basis for the survey, included the European Digital Competence Framework for Citizens (Carretero et al*.,* 2017) and The Digital Capabilities framework, developed by JISC (2012). The former places focus on the diversity of digital environments and digital literacy skills needed for work, learning, and everyday life digital

participation. The latter focuses on the Higher Education learning context and explores developing digital skills with a view to requirements for both students and educators. The survey was also informed by findings of previous academic research emphasising the impact of the everyday life digital context on the development of students' digital literacy skills (Martzoukou & Sayyad, 2017), as well as key UK government publications that highlight digital skills gaps in education and the workplace (e.g., U.K. Department for Education, 2019; U.K. Department for Business Innovation & Skills and Department for Culture Media & Sport, 2016). More information on the study frameworks used can be found in (BLINDED FOR PEER REVIEW).

For the purposes of this study, a number of changes and additions were made to the original survey, which included the following key areas (the survey questions are fully given in Table 1):

a) Expanding Q.2 'Everyday participation as a digital citizen', which originally included only five items to capture more holistically everyday digital skills on areas such as e-finance, e-commerce, e-wellbeing and e-employment, with the latter considered to be of interest in light of the pandemic restrictions, which created new demands in the future working place and increasing wellbeing concerns in the context of academia.
b) Amending Q.5 'Information identification in different contexts' and Q. 6 'Information Literacy skills' to address discipline related literature and sources (e.g., CINAHL, Medline, Cochrane Library) that were relevant for the areas of Nursing, Midwifery and Paramedic practice.
c) Expanding upon Q.7 'Digital creation skills' to incorporate activities the students were involved in as part of their studies, including creating online posters, using simulation/virtual reality tools (e.g., virtual hospital/community) and discipline specific apps (such as BNF British National Formulary).
d) Incorporating new items to Q.8 'Digital research skills' to include research raw/open data online found in the area of health, using health specific critical appraisal tools, such as the Critical Appraisals Skills Programme (CASP), evidence-based research and survey tools that students use in class (such as Mentimeter).
e) Adding health related examples in Q.9 'Digital communication skills' (such as from the Nursing and Midwifery Council) for understanding expected behaviour/code of practice in online environments.

Table 1. Structure and dimensions of the questionnaire developed for the survey

Questionnaire Dimensions	Dimension study items
Q.1 Demographics (Items N=6)	Sex, Age, Country of residence, Marital Status, Current level of Study, Year of Study
Q.2 Everyday participation as a digital citizen (Items N=9)	e-democracy (e.g., accessing voting information and political information online; taking an active role in democratic processes online) e-government (e.g., obtaining knowledge about current laws, legislation and government, accessing and using government online services, such as legal information) e-finance (e.g., online banking, price comparison websites, managing personal/student finance) e-commerce (e.g., online shopping, buying & swap apps) e-health (e.g., accessing and using health services online, e-consult with doctors, NHS 24 online services) e-wellbeing (e.g., personal health tracking, e-fitness, e-mental health self-management) e-leisure (e.g., playing online games, socialising online) e-learning (e.g., looking for new digital opportunities to grow as a person such as online webinars, online training, watching YouTube videos and following an active approach to sourcing information) e-employment (e.g., working remotely, using digital content and tools for work purposes)

Q.3 ICT Proficiency with completing different tasks (Items N=8)	Technological devices (e.g., laptops, tablets, smartphones, desktop computers; connecting to the Internet/wi-fi) Software (e.g., document editing, presentation, spreadsheets, image or video editing tools) Web browsers (e.g., Chrome, Explorer, Firefox, Safari etc.) Search engines (e.g., Google, Bing etc.) University digital administrative services (e.g., email, student data portal) University learning management systems (e.g., Moodle, Blackboard, Brightspace) Personal digital services (e.g., social media, online shopping, online government sites, online travel sites, etc.) Communication Platforms (e.g., Zoom, Skype, Microsoft Teams, Google Hangouts)
Q.4 ICT productivity (Items N=2)	Data Management: organising, managing, storing, and sharing digital files for your learning through Internet spaces and/or your university's online systems (e.g., saving coursework securely, sharing your work on Moodle) Using tools, such as calendars, task lists, project and time management apps, to make learning more efficient (e.g., Trello, Toggl, Microsoft Project, Outlook/Google calendar)
Q.5 Information identification in different contexts (Items N=3)	Scholarly/academic literature (e.g., journal articles, conference papers, book chapters, other publications written and vetted by subject experts) Professional literature (e.g., Professionals Organisations such as Nursing and Midwifery Council publications, Royal College of Nursing Publications, Royal College of Midwives Publications, Health Professional Blogs, The Royal College of Paramedics, Scottish Government publications/policy) Popular information (e.g., general discussions on social media, websites and blogs)
Q.6 Information Literacy skills (Items N=8)	Finding digital information relevant to your academic studies, using informal Web sources (e.g., Google, Google Scholar, Bing or other search engines). Finding digital information relevant to your academic studies, using databases (e.g., CINAHL, Medline, Science Direct, Cochrane Library) Using online collection tools for gathering digital information together in new ways (e.g., SlideShare, List.ly, Pinterest, Quora, Scoop.it, etc.) Evaluating whether digital information is trustworthy and relevant Organising the digital information you find for your learning through folders, bookmarks, reference management software, and tagging Understanding academic integrity/honesty when accessing & using information online (e.g., plagiarism, collusion) Understanding how to share information publicly online, respecting and acknowledging the work of others (e.g., using creative commons licensing, providing references/citations to original works) Referencing digital information sources, adhering to a referencing style (e.g., Harvard referencing style)
Q.7 Digital creation skills (Items N=4)	Document formatting and presentation (e.g., Microsoft Word) Social media content creation (e.g., LinkedIn posts, Facebook, WhatsApp) Video creation (e.g., creation and editing) Infographics (e.g., Canva) Online posters Blogs/Wikis Vlogs/Podcasts Creation of audio files (e.g., using Audacity, Voice-over presentations) Using Simulation/Virtual Reality Tools (e.g., virtual hospital/community) Data visualisation (e.g., Excel, SPSS) Presentation tools (e.g., PowerPoint, Zoom, Microsoft Teams) Using Apps (e.g., BNF British National Formulary)
Q.8 Digital research skills (Items N=5)	Finding research raw/open data online (e.g., open health data, national statistics sources such as the Scottish Public Health Observatory, Information Services Division Scotland, The World Health Statistics) Organising and storing research raw/open data online (e.g., using tools such as RefWorks or Microsoft Word to annotate or summarise findings) Using a Critical Appraisal Tool (e.g., CASP) Using a survey tool (i.e., Mentimeter) Understanding how evidence-based research are used to construct arguments, make decisions, and/or solve problems
Q.9 Digital communication skills (Items N=7)	Participating professionally (e.g., reviews, comments, likes) in a range of digital networks (e.g., social and professional networks) related to your interests, work, and/or academic subject Understanding expected behaviour/code of practice in online environments (e.g., NMC/HCPC Social Media guidance) Communicating respectfully, inclusively & confidentially, recognising that digital media can be used to intimidate, shame, and harass other people Communicating professionally via email with others (e.g., peers, tutors, mentors) Recognising false or damaging online communications (e.g., fake news, misinformation) Actively sharing your specialist ideas (e.g., academic or professional) in a range of online communication media (e.g., social media such as LinkedIn, Twitter, Facebook) Designing online communications for different purposes (e.g., online discussions, blog messages, twitter threads to persuade, inform, entertain, guide, and support)
Q.10 Digital innovation (Items N=3)	Developing new ideas and projects using online tools and technologies (e.g., using tools in innovative ways to create presentations, projects, apps, video resources and designs) Working collaboratively on different aspects of a creative/innovative project/service design & managing the process as a team

	Promoting new online tools and opportunities to others (e.g., proactively promoting creative ideas and projects)
Q.11 Digital learning and development (Items N=10)	Participating in online learning opportunities and resources (e.g., online courses, podcasts, tweetfests/global conversations on Twitter, quizzes, online tutorials, simulations, or open lectures) Adopting new ways of learning online (e.g., online workshops, virtual labs, video-tutorials, webinars) Working collaboratively and supportively with other learners, using online technologies where appropriate (e.g., via your university's online education system (Campus Moodle), Office 365, other apps and online environments or via your previous working experiences) Using online tools to take notes, annotate, and collate learning materials, review, and revise learning (e.g., Evernote, Notion, Google Apps, Scribble) Using online tools to record learning events/outcomes and use them for self-analysis, reflection, and showcasing of achievement (e.g., in an e-portfolio or learning blogs) Receiving and responding to online feedback about your academic work Engaging and participating in online learning environments (e.g., discussion forums) Using learning management systems (e.g., Blackboard Collaborate, Zoom, Teams) to learn collaboratively Sharing information using external communication tools (e.g., WhatsApp, Viber, Skype) Sharing your online knowledge and skills, helping other learners (e.g., mentoring others)
Q.12 Digital abilities to complete academic work (Items N=1)	Which level best describes your digital abilities to complete your academic work?
Q.13 Digital identity management (Items N=6)	Managing your online profiles on different digital media (e.g., social media) in a way that is suitable for personal, professional, and academic purposes Understanding how your online personal data are collected and used in different systems and use privacy settings appropriately Being aware of the potential positive or negative impact of what you communicate online on your online reputation Making sure outcomes of learning and other achievements are accessible in online forms (e.g., via an e-portfolio, digital CV, personal website) Understanding the impact of your online interactions (e.g., how you project yourself to others online) Using online analytics to explore your impact and influence on others
Q.14 Digital wellbeing (Items N=6)	Feeling comfortable, in control, and safe when using digital technologies Recognising that digital information and media can cause distraction, overload, and stress, and disconnecting when necessary Considering the rights and wrongs and the possible consequences of your online behaviour Acting positively against cyberbullying and other damaging online behaviours Managing online and real-world interactions in ways that support healthy relationships Using digital media to access wellbeing services, monitor health conditions (e.g., student support services)

The survey measurement retained the five-point Likert scale of digital competences, used in the original survey, which represented different levels of competence in performing specific digital tasks, ranging from Level 1 *Novice* to level 5 *Expert*, and addressed different levels of knowledge and self-sufficiency on the basis of performing specific digital tasks (BLINDED FOR PEER REVIEW) (Table 2).

TABLE 2. Likert scale digital competence levels
Level 1: Novice The digital task is new to me. I am currently developing basic knowledge and skills in this area, but I need help either to complete or to learn how to complete this sort of task.
Level 2: Basic I have foundational knowledge in this area. I can perform simple digital tasks with help from others.
Level 3: Intermediate I have more than foundational knowledge, but I am not yet advanced in this area. I can usually complete complex digital tasks independently, although I sometimes need help from someone more advanced than I am.
Level 4: Advanced I have advanced knowledge in this area, though I am not an expert. I can perform complex digital tasks without assistance. I adapt easily to learning new knowledge and skills. Others sometimes ask me for help.
Level 5: Expert I have mastered the knowledge and skills for this area. I apply my knowledge and skills to create and redesign processes, tools, and/or technologies appropriately and effectively. As an expert in this area, I frequently show others how to complete these tasks.

The survey repurposing consultation took place in the summer of 2021 and included a total of four hours of consultation with staff in Nursing, Midwifery and Paramedic Practice within a single institution and school, following convenience sampling. The consultation included five members of staff (an Online Learning Developer, a Lecturer in Midwifery, two Academic Team Leads in Nursing, and a Strategic Team Lead of Student Experience and Enhancement) as well as an undergraduate (UG) student enrolled in Nursing who was invited by the school for insights into the survey tool development from the student voice perspective via their role as Class Representative.

4.3 Administering the survey

For administration of the survey, total population sampling was followed with invitations to all the student population of the school, consisting of 1200 students, undergraduate (UG) and postgraduate (PG), via school emails sent by administration staff. The student recruitment strategy was based on voluntary participation with informed online consent. Students were drawn from a variety of nursing undergraduate courses, although the areas of midwifery and paramedic practice were underrepresented. However, ensuring a representative sample created increased difficulty because of the pandemic restrictions imposed at the time of the survey which had an impact on participation. Furthermore, because of the project's ethical clearance requirements for students' anonymous participation, it was not possible to gain access to the overall age demographics of the entire student population.

4.4 Ethical considerations

The ethics committee of the school in the participating institution approved the research project design and data collection. Further, the survey was anonymous and was administered using JISC 'Online Surveys', which is a *General Data Protection Regulation* (GDPR) approved data collection tool. Informed consent was sourced from both students (via the online survey explaining anonymity, confidentiality, informed consent, the right to withdraw, how the data was going to be handled, any risks, privacy and that the study was not connected to assessment or academic performance of students) and staff members, consulting the Research Governance and Integrity Policy and the Research Ethics Policy of the university. The project received a formal letter of ethical approval, covering the period of one year from its commencement. As it involved only students and not NHS patients or staff, no further external approval was deemed necessary by the ethics committee.

5. DATA ANALYSES

5.1 Statistical analyses

IBM SPSS Statistics (v28) was employed for the statistical analysis of the survey (IBM Corp, 2021) of the survey. Cronbach's alpha was used to assess the internal consistency reliability of the re-purposed tool. The results were reported through descriptive statistical analysis (frequencies, valid percentages, mean, median, mode) on students' demographics and self-assessed digital competences. According to Kolmogorov-Smirnov and Shapiro-Wilk normality tests the study items of the questionnaire did not follow the normal distribution. Therefore, Mann-Whitney (U-test) and Kruskal-Wallis (H-test one-way analysis of variance by ranks) non-parametric statistical tests were used to identify differences between groups. A P value <0.05 was used to indicate statistical significance for all tests.

5.2 Validity and rigour

The majority of the main survey questions were drawn from an existing survey which has been previously validated and empirically tested with a range of students from different disciplines (BLINDED FOR PEER REVIEW). The project direction was further validated by subject experts in a way that reflects disciplinary needs in the context of both learning and professional practice. Appropriate use of statistical methods to answer the study research questions and make meaningful and accurate inferences based on data were used in the collection and analysis of data (Hildebrandt & Prenoveau, 2020) with the use of non-parametric tests that deliver accurate results even when the sample size is small with ordinal scale data (Corder & Foreman, 2014).

5.3 Survey open data

Thematic analysis (Kiger & Varpio, 2020) was applied to the survey qualitative open data. The analysis was conducted manually coding the data according to the following key themes reflected in the questions and coding new subthemes emerging from the data.

1. How students learned to use digital tools
    a. Informally
        i. Everyday life/trial-and-error/word of mouth
    b. Formally
        i. Previous education/work
2. How students stayed up-to-date with the digital tools they use.
    a. No updating
    b. Formal/continuing/systematic
    c. Informal/trial-and-error
3. How students' digital/online skills have helped them to address challenges. The data was analysed according to the main digital competences categories of the survey while new categories emerging from the data were given a unique code (e.g., 'special needs').

6. RESULTS

6.1 Survey results

Survey data was collected online from November to December 2021, from a total of 182 students who replied to the school emails, representing a response rate of around 15%, which is consistent for online surveys (Fan & Yan, 2010). Due to the pandemic restrictions present at the time of the research, the online approach followed was deemed suitable considering that a significant proportion of the course delivery was hybrid. Due to the situation, it was also difficult to ensure a balanced representation of different courses with a controlled sample.

6.2 Demographic characteristics of survey respondents

Table 3 presents the demographic characteristics of the survey respondents. Most students were female (n=170, 93.4%), an expected result, which reflects the broader gender imbalance evident in this profession in the U.K. (Royal College of Nursing, 2018). Additionally, most of the survey respondents were from the U.K (n=136, 77.7%), while the remaining students (n=39, 22.3%) were international students from 20 different countries, with the top countries being Nigeria (n=8), Ireland (n=4) and Poland (n=4). Most of the students were undergraduate (n=146, 81%), in their first year of study (n=136, 76%) and studied in a blended format (n=84,

47%) as the survey took place during the second year of the pandemic, where on-campus students mostly followed a hybrid study method.

Participating students came from a variety of courses, which represent the diversity of subjects offered in the school that participated in the study. However, the majority were nursing students. A third of students studied BSc Nursing Adult (n=60, 33%), followed by BSc Nursing Children and Young People (n=29, 16%) and BSc Nursing Mental Health (n=29, 16%). The 'other' category included return to practice courses. The majority of the students were found in the Generation Z category (n=75, 41.2%,), followed by Generation Y (n=56, 30.8%) and Generation X (n=50, 27.5%) and were studying in pre-registration courses (n=139, 76.8%) (Table 3).

TABLE 3. Student sample demographics

Student Demographics	Variables	Respondents	Percentage
Sex (valid N=182)	Female	170	93.4
	Male	12	6.6
Age/generation (valid N=182)	Generation Z (1997-2012) post-millennial	75	41.2
	Millennial Generation Y (1981-1996)	56	30.8
	Generation X (1965-1980)	50	27.5
	Baby Boomer (1946-1964)	1	0.5
Country of birth (valid N=175)	Great Britain	136	77.7
	Other countries (Bahrain, Switzerland, Cameroon, Denmark, Spain, Hungary, Ireland, India, Iran, Jersey, Lithuania, Nigeria, Netherlands, Nepal, Philippines, Poland, Russia, Ukraine, United States, South Africa)	39	22.3
Level of study (valid N=181)	Undergraduate University Study (3 years or longer: e.g., BA, BEd, BSc, Integrated Masters)	146	80.7
	Postgraduate Studies (PG Certificate, PG Diploma, MSc, PhD)	27	14.9
	Other	8	4.4
Mode of delivery (valid N=180)	Full-time on-campus	18	10
	Part-time online	33	18.3
	Full-time online	45	25
	Blended (mix of on-campus and online)	84	46.7
Year of study (valid N=180)	1st year	136	75.6
	Progressing students (2nd, 3rd year students)	44	24.4
Course Type (Valid N = 181)	Pre-registration	139	76.8%
	Post-registration	42	23.2%
Current course (valid N=181)	BSc Midwifery	3	1.7
	BSc (Hons) Nursing - Dual Registration in Adult and Children and Young People	5	2.8
	BSc (Hons) Nursing - Dual Registration in Adult and Mental Health	3	1.7
	BSc (Hons) Nursing - Dual Registration in Children and Young People and Mental Health	2	1.1
	BSc (Hons) Nursing Adult	12	6.6
	BSc Nursing Adult	60	33.1
	BSc Nursing – Children and Young People	29	16
	BSc Nursing – Mental Health	24	13.3
	BSc Occupational Health	5	2.8
	BSc Paramedic Practice	1	0.6

BSc Professional Nursing Practice	8	4.4
MSc Advancing Practice	21	11.6
Return to Practice (Short Course)	5	2.8
Other	3	1.7

6.3 Scale internal consistency

The reliability of the questionnaire dimensions is reported in Table 4. The internal consistency expressed through Cronbach's alpha reliability coefficient for all dimensions (Nunnally & Bernstein, 1994) was found to be adequate with no problematic variables identified through the 'Scale if item deleted' option in the SPSS Reliability Analysis procedure. Further analysis employing Exploratory Factor Analysis (EFA) may be used in the future to group items within the construct.

TABLE 4. Internal consistency of survey dimensions

Questionnaire Dimensions	Inter-item reliability coefficient Cronbach's alpha
Q.2 Everyday participation as a digital citizen (Items N=9)	0.908
Q.3 ICT Proficiency with completing different tasks (Items N=8)	0.952
Q.4 ICT productivity (Items N=2)	0.830
Q.5 Information identification in different contexts (Items N=3)	0.878
Q.6 Information Literacy skills (Items N=8)	0.924
Q.7 Digital creation skills (Items N=12)	0.944
Q.8 Digital research skills (Items N=5)	0.868
Q.9 Digital communication skills (Items N=7)	0.904
Q.10 Digital innovation (Items N=3)	0.925
Q.11 Digital learning and development (Items N=10)	0.952
Q.12 Digital abilities to complete academic work (Items N=1)	--
Q.13 Digital identity management (Items N=6)	0.915
Q.14 Digital wellbeing (Items N=6)	0.948

This section provides survey results for both closed and open questions, which included students' comments on the different ways in which they develop digital competences.

Appendix 1 summarises descriptive statistics in all the survey items using mean, median and mode values. In this paper we only discuss the lowest (mode = 1 or 2) and the highest (mode = 4 or 5) values, designating areas of strength ('advanced' and 'expert') and further development ('novice' and 'basic').

Appendix 2 demonstrates that students reported 'advanced' competences in five dimensions: "Everyday Participation as a Digital Citizen", "ICT Proficiency", "Digital Creation", "Digital Communication" and "Digital wellbeing" with several items indicating 'advanced' (mode=4) values, while there were no 'expert' mode values found in any of the dimensions. A final overarching question asked students about their overall level of digital competences to complete their academic work. Results were found at 'intermediate' level (mode=3).

Four dimensions stood out in relation to lower values ('novice' mode=1 and 'basic' mode=2), including "Information Literacy", "Digital Creation", "Digital Research" and "Digital Innovation", with several items indicating 'novice and 'basic' values. Notably, in the 'Digital Creation' category there were four items with 'novice' values: "Infographics", "Blogs/Wikis",

"Vlogs/Podcasts" and "Simulation/Virtual Reality Tools", while in the "Digital Research" category there were two items with 'novice' values: "Using a Critical Appraisal Tool" and "Using a Survey Tool". One additional dimension, "Everyday Participation as a Digital Citizen" included a single construct at 'basic' level (mode=2).

6.4 Age group and pre and post registration differences

Statistically significant findings from the two tests, based on Mann-Whitney U-test and Kruskal-Wallis H-test, are reported following identification of the relevant digital competence items in Appendix 1. As there was only a single case of a respondent in the 'Baby Boomer' category this result was merged with the next closest group 'Generation X'.

Comparison of digital competencies based on age grouping indicated that, in most cases, the self-perceived competences of younger students (Generation Z respondents) were higher than those perceived by the other age groups (Generation Y and X). Statistically significant differences in responses from pre- and post-registration students were also identified in most of the survey items with pre-registration students self-assessing higher than post-registration students overall (exceptions include items in the "Everyday Participation as a Digital Citizen', 'Information Identification' and 'Information Literacy' dimensions, were no statistical differences were observed).

6.5 Responses to open questions

There were three open-ended questions in the survey focused on how students learn to use different digital tools/developed digital skills, how they update their digital skills, and how their digital skills have helped them to address challenges in their learning. Synoptic results are presented below.

6.5.1 How students learned to use digital tools

Respondents stated there was no one way of learning how to use digital tools and developing digital skills; however, they provided most references to the informal everyday life environment, predominantly via "trial-and-error" approaches, exploration, and being "self-taught": "Trial and error, I've always been interested in tech and have tried to keep myself as up to date as possible", "Practice and making errors and learning from them", "Self-education or accessing online information (tutorials etc.)", "Just exploring, YouTube tutorials and asking classmates and family members", "Working on my phone and laptop a lot since a younger age has allowed me to develop skills to help me with relation to digital skills", "here and there and figuring it out for myself", "Taking the time to be on sites or software long enough to get used to the features…", "Discord I used for gaming... Teams is now very similar... so it was easy to pick up".

For several respondents the family environment, other peers and friends constituted key sources of learning, in addition to personal experimentation and self-learning approaches, when using online tools and technologies: "Word of mouth from friends and family", "Learnt as I went along with some help from family & colleagues and online self-help guides", "Learnt from colleagues, family, self-taught/Google", "By living my everyday life in the 21 century".

Previous and current formal education (school, college or university) was mentioned in relation to developing key ICT skills, but, comparatively, by fewer respondents: "I completed Office and Information Studies at School along with ICT in college courses", "In the College and high school". One of the digital skills that students specifically mentioned with reference to their previous education was e-learning, using different online learning management

systems and other online tools: “e-learning was taught in high school”, “I have attended online lectures on how to navigate Moodle and other university online tools”, “College, during HNC study I learnt to use Brightspace/online learning and lectures via Teams, Blackboard etc.”, “Blackboard was taught in high school due to college preparatory courses”, “I learned to use university learning management systems at a session in university”.

Similarly, some digital skills were developed as part of students’ previous working experiences: “Working in admin”, “learnt from colleagues for example spreadsheets was learnt from a colleague”, “working with different software/programmes in different countries from the UK” and online working environments: “I worked in a corporate job for 4 years after my first degree, my role was half online and half face to face”, “I got training in my job on best ways to use online environments”.

However, in several of the respondents’ verbalisations, formal work-based or education related learning featured more prominently together with other informal learning approaches rather as a single means of learning. “A combination of formal training, peer support, self-directed learning and trial and error”, “I have had my own laptop since I was in high school which I have used for both studying and socialising. I have also used a lot of digital resources throughout my employment history in retail” and “In part through use, in part through a multimedia journalism Masters which taught me to sift through online data”, and “Over time with continued use, some training for work roles and a paid for ECDL course”.

6.5.2 How students stay up to date with the digital tools they use

The most popular way of staying up-today with digital tools was “frequent”, “continued”, “regular”, “repeated”, “daily” and “constant” use: “I use then frequently so don't feel the need to formally update myself”, “Just keep using them”, “Natural osmosis through persist use”. Informal, self-learning approaches were, again, predominant: “Trial and error, using Google or YouTube for advice or tips if required” while “University and outside training”, and “Using guidance from university” were mentioned in a few cases only. Some respondents also acknowledged that they do not tend to update their skills: “I don’t think I do”, “I don’t”, “I don’t think I do unless I am using it regularly”, “I’m not sure that I do”.

6.5.3 How students’ digital/online skills have helped them to address challenges

The third open question focused on examples of how students’ digital/online skills helped them to address challenges in their academic work. From the students’ comments, it was interesting to note that they referred to several different digital skills that addressed the main areas of the survey, showcasing the importance of digital literacy support in education and how it relates to their academic achievements. For example, in relation to ICT Proficiency/Productivity, digital skills were deemed useful for accessing the online environment and gaining familiarity with tools and processes as well as organising time and navigating through one’s course. Students also placed emphasis on the transferability of digital skills that allowed them to understand new digital environments and pointed to the value of being more adaptable. In addition, students’ comments emphasised how digital/online skills helped them to address challenges in their academic work, reinforcing the importance of interacting with others, communication and flexibility. Comments also addressed the importance of developing digital skills that were relevant to professional practice and helped students boost their employability while the support that digital tools and processes provided helped other students to overcome special needs challenges, such as dyslexia. A complete set of data is provided in Appendix 3.

Despite the multiple skills mentioned, a few students still struggled with developing some of the necessary skills demanded as part of their study. For example, some students said characteristically: “I have to ask all the time, I can’t cope with online learning”, “I am working on updating my skills”, “My lack of digital skills is a hindrance I wish I knew more as I feel it would enhance my work and academic life”, “I don’t feel confident with online technologies I feel I muddle through”, “Still learning about Moodle”, “Self-taught, not very well”.

When dealing with IT issues, students mentioned a combination of different strategies, including asking people in the familiar home environment, friends and other colleagues, in addition to contacting the IT helpdesk, trying to solve the problem on their own and searching for online help. Several students, however, also expressed strong negative emotional reactions when things went wrong in using digital tools and technologies: “get stressed and anxious”, “take a deep breath”, “get very confused”, “shout at the machine and walk away stressed”, “cry and scream at the computer”, “get annoyed”, “panic”, “cry”, “very frustrated”, “get in a rage”, “get annoyed”.

7. DISCUSSION OF SURVEY DATA

The survey data revealed that respondents were confident in several areas which address general ICT and social media skills. However, interestingly, none of the digital competences dimensions achieved an ‘expert’ overall result. In addition, students assessed themselves as ‘intermediate’ in their overall self-perceived digital competences to complete their academic work. Finally, there were no ‘advanced’, or ‘expert’ mode values reported in “ICT Productivity”, “Information Literacy” and “Digital research”, which designate fundamental digital skills for academic study. The same applied to the dimensions of “Digital Innovation”, “Digital Learning and Development” and “Digital Identity Management”, which are more linked to professional skills.

A number of areas required further support and development with low competences (‘basic’) and (‘novice’) results. These are discussed in detail below with recommendations.

7.1 Information literacy

The results of the survey demonstrated that students require additional support in a number of information literacy related areas, including organising and evaluating information, understanding academic integrity issues, sharing information online and referencing. Students may therefore benefit from additional support in understanding referencing conventions and referencing management software. Information literacy as an overarching concept relates to the ability to identify, locate, retrieve, critically evaluate, use and share information, which is an important aspect of learning, within an academic environment but also of continuing professional development within work-related settings. Relevant information literacy skills development in nursing education programmes is a key to academic success and should be a key priority in curricula as it helps students to develop the ability to access, evaluate and use healthcare information to both support evidence-based practice and the future use of technology in nursing practice (Harerimana et al., 2022). Information Literacy also plays a key role in health, especially in the context of evidence-based practice (EBP), where clinical activities are informed by research evidence. In order to succeed in providing comprehensive patient health care, health professionals need to be in a position to identify, critically evaluate and utilise the best evidence available (Barker, 2019). “Health information literacy”, “describes skills and competencies that enable people to gain access to, understand and apply

health information to positively influence their own health and the health of those in their social environments" (Levin-Zamir & Bertschi, 2018).

7.2 Digital creation

There were several areas in relation to digital creation skills that required additional support for students, as indicated by the survey data. For example, video creation skills are necessary when student-generated video creation assessments are used in education. Hawley and Allen (2018) discuss how student-generated video creation can have several benefits, supporting the "development of digital and communication skills relevant to today's world and in enhancing learning" (p.1). Using evidence from a number of studies within different disciplinary areas, they argue that using student generated video creation enables students to gain increased competency and efficacy in using technology. Pereira et al. (2014) evaluated nursing students' video recorded oral presentations about different techniques of diagnosis in medical imaging and found that working with self and peer recorded videos similarly proves to be an effective didactic approach that contributes to the development of both cross-curricular competencies (intrapersonal, interpersonal and instrumental) and curricular specific competencies (e.g. knowledge about different techniques of diagnosis in medical imaging) than traditional methodologies. Other creative skills include creating infographics, posters, blogs/wikis and audio files/vodcasts. It is also important to note that "Being digitally literate across a range of domains to proficient levels helps us more easily acquire other skills and competencies in life" (Health Education England, 2021).

Another area related to digital creation skills, that created difficulty for students, was data visualisation and analytics, which is linked to "Making the most of digital data by linking datasets to enable 'Big Data' analysis" and is considered to be "the epitome of secondary data analysis in many areas of science" (O'Connor, 2017). According to O'Connor (2020) "Secondary data analysis is now firmly embedded in nursing science, helping researchers to uncover new insights that can improve nursing education, patient care, health service delivery, public health, and health policy" (p.282).

Another form of digital creation, which performed lower in this study, simulation-based education, refers to a variety of different activities (e.g., patient simulators, lifelike virtual environments, roleplaying) and it is an increasingly popular pedagogical approach, as it affords students the opportunity to put in practice both clinical and decision-making skills, through various simulated real-life situational experiences. This educational intervention helps address the lack of clinical placements, patient safety and ethical concerns, and allows students to gain the closest to a real experience, with patient care and opportunities to handle problem-based clinical situations as well as develop effective non-technical skills, and practice emergency situations. It offers the opportunity for immediate feedback, repetitive practice learning, the ability to adjust the difficulty level, and opportunities to individualise learning (Kim, Park, & Shin, 2016). Laschinger et al., (2008) found, for example, that "human patient simulators which are used for teaching higher level skills, such as airway management, and physiological concepts are useful". Qaisar et al. (2020), in a study of the use of digital virtual simulators as an innovative teaching method, concluded that the vast majority of students found learning with a digital simulator to be an enriching experience and that it would be beneficial to adopt this mode of teaching in other areas of nursing education.

More emphasis on assessed coursework that incorporates elements of video, poster, blog/vlog/wiki/visualisation creation may help students to develop more confidence in their skills and further encourage them to experiment with a variety of digital creation tools.

7.3 Digital research

Best evidence-based healthcare service has a positive impact on patient outcomes (Fiset et al., 2017; Nibbelink & Brewer, 2018). Nursing research helps in improving clinical decisions and evidence-based activities, providing healthcare to patients during long term illnesses, developing advancements that aid patients in recovery, developing high standards to reduce the number of diseases in the community, promoting healthy lifestyles in the community, preventing the onset of preventable diseases and illnesses, and implementing techniques and treatments to increase patients' perception of service quality (Vera, 2020). Previous research has recommended that nursing research courses and concepts should be introduced into the nursing curriculum as early as possible (Ertuğ & Önal, 2014; Hung et al., 2019). However, insufficient attention has been paid to research skills development in undergraduate nursing students (Allari, 2016; Nind et al., 2019). Similarly, use of research evidence into nursing clinical practice is moderate (Yates, 2015) which may be indicative of a need for additional research training in nursing education. Student data from a number of areas in this theme highlight the need to develop further skills related to digital research, particularly around organising research data and using critical appraisal and survey tools.

Educators should encourage students to critically read and evaluate research articles related to their areas of study from the beginning of a course and to develop a proactive attitude towards independently searching and evaluating a good quality evidence base and its importance on informed decision-making. Educators should also aim to present research and evidence as important components of professional health practice throughout students' study and incorporate research tasks in the core curriculum and assessed coursework. Even if students do not intend to formally conduct research, it is important that they acquire the necessary knowledge, skills and attitudes towards research, so that they can be ready to further develop these skills and utilize them effectively in their professional practice. They should reinforce the practical skills and theoretical knowledge necessary for searching for quality evidence and further support the critical understanding of different sources of evidence available, that are essential for promoting informed decision-making. This could include focusing on the context of Evidence Based Practice in working contexts, within taught materials:

- The variety of different types of evidence and the main approaches, strengths and limitations of different methodologies used in the evaluation of interventions (qualitative, quantitative, and mixed methods).
- Critical/evidence, appraisal/analysis skills and use of critical appraisal tools that can inform decision making.

7.4 Digital innovation

Students self-reported lower levels of digital innovation skills. Educators should aim to integrate critical discussions on the digital future of nursing and explore digital innovations case studies, for instance, on the positive outcomes of telehealth initiatives, the use of smartphones and health online applications that enable remote consultations and assistance for patient care, particularly placing emphasis on how nurses "champion and lead digital health initiatives" and promoting, "investing in informatics education, research, and practice", upskilling in data science (Booth et al., 2021). The provision of innovative pedagogical approaches in teaching and learning could also help towards enabling a digital innovation mindset. For example, Loureiro, Sousa & Antunes (2021) found that although a range of digital technologies are used by academics, more formal training is required and both staff and students were "still unfamiliar with the scope and possibilities of these tools, not taking full advantage of the potential they have to offer" (p.11).

7.5 Digital learning and development

Although this area had moderate results, it is reported here as students predominately followed informal and 'trial-and -error' approaches to learning. This is a vital set of skills that health care professionals require for ensuring they keep up-to-date and that they develop competence practice. In the United Kingdom, Continuing Professional Development (CPD) is required for the purposes of revalidation by regulatory authorities for those working in healthcare settings to retain their registration to practice/licensure, e.g., general practitioners, general practice nurses and registered pharmacy staff. CPD motives and activities can be found in Pool et al. (2016). Using online tools and technology, can help to foster and share ideas beyond institutional or disciplinary boundaries, promote interprofessional education and reinforce the power of learning via social connectedness. Students could also be further supported in mentoring others and contributing back to the learning community. It is therefore important for educators to encourage students to seek opportunities for digital learning and development, to follow a proactive attitude and to reflect upon their future roles as professionals with continuing growing skills and competences. This could take the form of embedding digital literacy into assessed modules, organising opportunities for students to take part in online webinars and encouraging them to explore online sources and useful blogs that critically reflect on the value of ongoing professional learning and development.

7.6 Age and pre and post registration findings

Nonparametric group statistics of the survey data with age demographics and pre/post registration courses demonstrated that digital competence across a number of areas was found to differ based on age or registration status, with younger students, and those in preregistration courses self-assessing as more competent in most instances. This is not a surprising result considering that, although older students in post-registration courses may have more experience of practical skills for coping with real-life patient care and the realities of clinical settings, previous research indicates a need for additional support in the development of information technology and study skills amongst older students (Kenny et al., 2011). For instance, Frings et al. (2022) measured the association of age and the competency scores of nursing students around basic computer knowledge and applied computer skills and found that participants who were more likely to perceive themselves as having more advanced computing skills were found in the younger group.

Brown et al. (2020b) also highlight the need to incorporate digital skills development into nursing curricula design and for further professional development of more experienced and older nurses who appear to be less digitately capable than their younger counterparts. Kleib et al. (2022) similarly found that undergraduate students voiced concerns about working with more senior staff who struggled with using technology in practice. Indeed, a negative culture towards computers in practice discouraged junior staff from developing digital literacy (Shin, Cummings & Ford, 2018), supporting the need for encouraging postgraduate nurses to develop their digital skills. With the ongoing and evolving digitalisation of the health care system, the younger generation of nursing students could act as a vehicle for peer support in digital learning and digital skills development for mature students, and as an extension of this, for the provision of digital health and social care services, supporting and training older service users to address existing digital divides (Harerimana et al., 2022).

7.7 Survey Limitations

It is important to acknowledge any existing limitations of the process of self-assessment, that was employed in the survey of students. The most common criticism of the approach could be potential cognitive bias created by the Dunning-Kruger (2011) effect, where students with lower ability, expertise, or experience could be overestimating their ability or knowledge. However, this may be the case when assessment of skills is directly connected to students' performance and not anonymous, as has been done in this study. It should be also noted that, unlike other self-assessment rankings, our survey provided a specific explanation of each competence level (i.e., basic to advanced), offering less space for variation due to subjective interpretations.

Lokmic-Tomkins et al. (2022) have found that "there are no validated digital literacy instruments to determine actual digital literacies for this student population either at Bachelor or Masters pre-registration level" (p.2) and therefore it is common to explore students' self-perceived competences or confidence. Self-assessment methods have been used widely in previous research, focusing on students' Internet skills (Van Deursen et al., 2014) and have been found to present a useful platform for reflective exploration of students' digital skills development needs. This is achieved by means of engaging students in further dialogue around their digital literacy needs, experiences and behaviours (JISC, 2019) when using digital tools that are important for their learning and academic progression. Using Klenowski's (1995) definition of self-assessment as "the evaluation or judgment of 'the worth' of one's performance and the identification of one's strengths and weaknesses with a view to improving one's learning outcomes" (p.146), self-assessment is a process that is directly connected to improving learning, via a reflective learning practice which provides timely feedback and reflection opportunities. The value and accuracy of self-assessment has also been previously reviewed by Ross (2006) who similarly found that it does not only produce consistent results but also has benefits in the learning process.

A further limitation of the study includes that the research was restricted to a narrow group of students within a single university and country, which is not representative of other universities, and which should be generalised with caution. However, the approach followed presents a process that could be replicated in other learning contexts to provide a structure for the exploration of students' digital competences in a discipline focused way to design appropriate learning interventions.

8.0 CONCLUSIONS AND FURTHER RESEARCH

The design and results of this study have demonstrated that the concept of digital competences is not only complex, but also constantly evolving and, as new tools, technologies and digital behaviours emerge, incorporating ongoing discussion and dialogue about what is expected of students, and in what stage of their learning journey, is pertinent. This research supported that students should develop not only technology mastery, but also the attitudes and behaviour necessary to develop as critical, reflective and lifelong learners and future professionals. It is the task of all staff who are involved in teaching and learning to help students develop this dual perception of digital skills and emphasise the importance of lifelong digital learning and development, with awareness of the diversity of learning contexts and the learners involved. When thinking about the diversity of students' skills and backgrounds and designing support in the overall continuum of students' learning for life, this involves, not only past and present learning experiences, but also future anticipated development of core digital skills and behaviour. This may also mean critically reflecting on the digital competences of staff and ensuring that training and support for upskilling is available, where and when that is

required. Supporting the development of digital skills that the future workforce needs to be equipped with for working within healthcare (Health Education England 2019) should a priority for Higher Education, together with an understanding of what skills are important to be developed and at what level. These could be, for example, basic/generic, intermediate or digital champion/specialist skills that require understanding of specific care and support focused digital technologies (Dunn & Braddell, 2014).

The development of digital skills could be reflected in educational curricula at different levels. For instance, targeted digital literacy education interventions can be part of foundational nursing studies to improve students' baseline digital literacy across a program, before commencing clinical placement, and ensure an effective transition to nursing practice in evolving digitally driven healthcare environments (Lokmic-Tomkins et al., 2022; Peacock et al., 2022).

The design of this study offered a methodology that could be replicated with students studying within different health care courses to enable additional empirical insights into the digital competence gaps present in students in different educational settings. Not every student arrives in HE with a similar level of digital skills, behaviour and attitudes and, therefore, understanding students' perceptions of their digital competences for learning and their future professional practice should be a systematic process that is embedded in learner-centred programmes supporting students to develop discipline-based digital competences at the right level.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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Appendix 1. Descriptive Statistics

	Measurement Scale (1" Novice", 2 "Basic", 3 "Intermediate", 4 "Advanced", 5 "Expert")							
1. Everyday participation as a digital citizen (Items N=9)	1	2	3	4	5	Median	Mode	Mean
e-democracy (e.g., accessing voting information and political information online; taking an active role in democratic processes online) (Valid N= 182)	29 (15.9%)	59 (32.4%)	57 (31.3%)	25 (13.7%)	12 (6.6%)	3	2	2.63
e-government (e.g., obtaining knowledge about current laws, legislation and government, accessing and using government online services, such as legal information) (Valid N= 182)	15 (8.2%)	49 (26.9%)	74 (40.7%)	33 (18.1%)	11 (6.0%)	3	3	2.87
e-finance (e.g., online banking, price comparison websites, managing personal/student finance) (Valid N= 181)	6 (3.3%)	16 (8.8%)	67 (37.0%)	61 (33.7%)	31 (17.1%)	4	3	3.52
e-commerce$^{\nu***,\rho***}$ (e.g., online shopping, buying & swap apps) (Valid N= 180)	3 (1.7%)	12 (6.7%)	42 (23.3%)	73 (40.6%)	50 (27.8%)	4	4	3.86
e-health$^{\nu**}$ (e.g., accessing and using health services online, e-consult with doctors, NHS 24 online services) (Valid N= 181)	7 (3.9%)	14 (7.7%)	70 (38.7%)	64 (35.4%)	26 (14.4%)	3	3	3.49
e-wellbeing (e.g., personal health tracking, e-fitness, e-mental health self-management)	6 (3.3%)	32 (17.7%)	65 (35.9%)	60 (33.1%)	18 (9.9%)	3	3	3.29
e-leisure$^{\nu***,\rho***}$ (e.g., play**i**ng online games, socialising online)	7 (3.9%)	28 (15.5%)	56 (30.9%)	49 (27.1%)	41 (22.7%)	3	3	3.49
e-learning$^{\nu**,\rho*}$ (e.g., looking for new digital opportunities to grow as a person such as online webinars, online training, watching YouTube videos and following an active approach to sourcing information)	10 (5.5%)	18 (9.9%)	65 (35.7%)	67 (36.8%)	22 (12.1%)	3	4	3.40
e-employment (e.g., working remotely, using digital content and tools for work purposes)	13 (7.2%)	38 (21.0%)	66 (36.5%)	44 (24.3%)	20 (11.0%)	3	3	3.11
2. ICT Proficiency with completing different tasks (Items N=8)	1	2	3	4	5	Median	Mode	Mean
Technological devices$^{\nu***,\rho***}$ (e.g., laptops, tablets, smartphones, desktop computers; connecting to the Internet/wi-fi)	2 (1.1%)	17 (9.3%)	52 (28.6%)	77 (42.3%)	34 (18.7%)	4	4	3.68
Software$^{\nu***,\rho***}$ (e.g., document editing, presentation, spreadsheets, image or video editing tools)	10 (5.5%)	40 (22.0%)	67 (36.8%)	54 (29.7%)	11 (6.0%)	3	3	3.09
Web browsers$^{\nu***,\rho***}$ (e.g., Chrome, Explorer, Firefox, Safari etc.)	3 (1.6%)	21 (11.5%)	57 (31.3%)	70 (38.5%)	31 (17.0%)	4	4	3.58
Search engines$^{\nu***,\rho**}$ (e.g., Google, Bing etc.)	2 (1.1%)	13 (7.2%)	55 (30.6%)	74 (41.1%)	36 (20.0%)	4	4	3.72
University digital administrative services$^{\nu***,\rho***}$(e.g., email, student data portal)	10 (5.5%)	21 (11.5%)	71 (39.0%)	64 (35.2%)	16 (8.8%)	3	3	3.30
University learning management systems$^{\nu***,\rho***}$ (e.g., Moodle, Blackboard, Brightspace)	10 (5.5%)	25 (13.7%)	75 (41.2%)	60 (33.0%)	12 (6.6%)	3	3	3.21

Personal digital services$^{\gamma***,\rho***}$ (e.g., social media, online shopping, online government sites, online travel sites, etc.)	4 (2.2%)	11 (6.0%)	47 (25.8%)	73 (40.1%)	47 (25.8%)	4	4	3.81
Communication Platforms$^{\gamma***,\rho***}$(e.g., Zoom, Skype, Microsoft Teams, Google Hangouts)	6 (3.3%)	25 (13.7%)	63 (34.6%)	71 (39.0%)	17 (9.3%)	3	4	3.37

Note(s): **γ** Kruskal-Wallis test between age groups (*p <0.05, **p <0.01, *** p <0.001); **ρ** Mann-Whitney U test between pre and post registration (*p <0.05, **p <0.01, *** p <0.001)

3. ICT productivity (Items N=2)	1	2	3	4	5	Median	Mode	Mean
Data Management: organising, managing, storing, and sharing digital files for your learning through Internet spaces and/or your university's online systems$^{\gamma***,\rho***}$ (e.g. saving coursework securely, sharing your work on Moodle)	14 (7.7%)	50 (27.5%)	77 (42.3%)	31 (17.0%)	10 (5.5%)	3	3	2.85
Using tools, such as calendars, task lists, project and time management apps, to make learning more efficient$^{\gamma***,\rho***}$ (e.g., Trello, Toggl, Microsoft Project, Outlook/Google calendar)	13 (7.1%)	57 (31.3%)	68 (37.4%)	28 (15.4%)	16 (8.8%)	3	3	2.87
4. Information identification in different contexts (Items N=3)	1	2	3	4	5	Median	Mode	Mean
Scholarly/academic literature (e.g., journal articles, conference papers, book chapters, other publications written and vetted by subject experts)	16 (8.8%)	43 (23.6%)	86 (47.3%)	29 (15.9%)	8 (4.4%)	3	3	2.84
Professional literature (e.g., Professionals Organisations such as Nursing and Midwifery Council publications, Royal College of Nursing Publications, Royal College of Midwives Publications, Health Professional Blogs, The Royal College of Paramedics, Scottish Government publications/ policy)	8 (4.4%)	47 (25.8%)	85 (46.7%)	31 (17.0%)	11 (6.0%)	3	3	2.95
Popular information$^{\gamma**,\rho**}$ (e.g., general discussions on social media, websites and blogs)	5 (2.8%)	37 (20.6%)	67 (37.2%)	52 (28.3%)	19 (10.6%)	3	3	3.24
5. Information Literacy skills (Items N=8)	1	2	3	4	5	Median	Mode	Mean
Finding digital information relevant to your academic studies, using informal Web sources$^{\gamma***}$ (e.g., Google, Google Scholar, Bing or other search engines).	5 (2.7%)	36 (19.8%)	78 (42.9%)	48 (26.4%)	15 (8.2%)	3	3	3.18
Finding digital information relevant to your academic studies, using databases (e.g., CINAHL, Medline, Science Direct, Cochrane Library)	31 (17.0%)	45 (24.7%)	78 (42.9%)	21 (11.5%)	5 (2.7%)	3	3	2.58
Using online collection tools for gathering digital information together in new ways$^{\gamma***,\rho***}$ (e.g., Slideshare, List.ly, Pinterest, Quora, Scoop.it, etc.)	39 (21.4%)	62 (34.1%)	54 (29.7%)	22 (12.1%)	5 (2.7%)	2	2	2.41
Evaluating whether digital information is trustworthy and relevant$^{\gamma**,\rho*}$	13 (7.1%)	51 (28.0%)	76 (41.8%)	33 (18.1%)	7 (3.8%)	3	3	2.83
Organising the digital information you find for your learning through folders, bookmarks, reference management software, and tagging$^{\gamma***,\rho***}$	24 (13.2%)	64 (35.2%)	64 (35.2%)	27 (14.8%)	3 (1.6%)	3	.	2.57
Understanding academic integrity/honesty when accessing & using information online$^{\gamma***,\rho*}$ (e.g., plagiarism, collusion)	9 (4.9%)	52 (28.6%)	60 (33.0%)	46 (25.3%)	15 (8.2%)	3	3	3.03

Understanding how to share information publicly online, respecting and acknowledging the work of others$^{\gamma***,\rho*}$ (e.g., using creative commons licensing, providing references/citations to original works)	19 (10.5%)	48 (26.5%)	66 (36.5%)	40 (22.1%)	8 (4.4%)	3	3	2.83
Referencing digital information sources, adhering to a referencing style$^{\gamma**}$ (e.g., Harvard referencing style)	28 (15.4%)	58 (31.9%)	54 (29.7%)	31 (17.0%)	11 (6.0%)	3	2	2.66
6. Digital creation skills (Items N=12)	1	2	3	4	5	Median	Mode	Mean
Document formatting and presentation$^{\gamma***,\rho***}$ (e.g., Microsoft Word)	5 (2.7%)	32 (17.6%)	52 (28.6%)	62 (34.1%)	31 (17.0%)	4	4	3.45
Social media content creation$^{\gamma***,\rho***}$ (e.g., LinkedIn posts, Facebook, WhatsApp)	11 (6.0%)	27 (14.8%)	52 (28.6%)	62 (34.1%)	30 (16.5%)	4	4	3.40
Video creation$^{\gamma***,\rho***}$ (e.g., creation and editing)	50 (27.5%)	59 (32.4%)	51 (28.0%)	13 (7.1%)	9 (4.9%)	2	2	2.30
Infographics$^{\gamma***,\rho***}$ (e.g., Canva)	76 (41.8%)	58 (31.9%)	32 (17.6%)	8 (4.4%)	7 (3.8%)	2	1	1.96
Online posters$^{\gamma***,\rho***}$	51 (28.0%)	59 (32.4%)	45 (24.7%)	18 (9.9%)	8 (4.4%)	2	2	2.30
Blogs/Wikis$^{\gamma***,\rho***}$	63 (34.6%)	59 (32.4%)	40 (22.0%)	15 (8.2%)	4 (2.2%)	2	1	2.10
Vlogs/Podcasts$^{\gamma***,\rho***}$	65 (35.7%)	58 (31.9%)	34 (18.7%)	18 (9.9%)	4 (2.2%)	2	1	2.09
Creation of audio files$^{\gamma***,\rho***}$ (e.g. using Audacity, Voice-over presentations)	50 (27.5%)	56 (30.8%)	49 (26.9%)	17 (9.3%)	9 (4.9%)	2	2	2.33
Using Simulation/Virtual Reality Tools$^{\gamma***,\rho***}$ (e.g. virtual hospital/community)	69 (38.1%)	63 (34.8%)	36 (19.9%)	7 (3.9%)	6 (3.3%)	2	1	1.99
Data visualisation$^{\gamma***,\rho***}$ (e.g., Excel, SPSS)	50 (27.6%)	56 (30.9%)	51 (28.2%)	19 (10.5%)	5 (2.8%)	2	2	2.30
Presentation tools$^{\gamma***,\rho***}$ (e.g., PowerPoint, Zoom, Microsoft Teams)	12 (6.6%)	32 (17.6%)	70 (38.5%)	45 (24.7%)	23 (12.6%)	3	3	3.19
Using Apps$^{\gamma***,\rho**}$ (e.g. BNF British National Formulary)	18 (9.9%)	43 (23.6%)	56 (30.8%)	44 (24.2%)	21 (11.5%)	3	3	3.04

Note(s): **γ** Kruskal-Wallis test between age groups (*p <0.05, **p <0.01, *** p <0.001); **ρ** Mann-Whitney U test between pre and post registration (*p <0.05, **p <0.01, *** p <0.001)

7. Digital research skills (Items N=5)	1	2	3	4	5	Median	Mode	Mean
Finding research raw/open data online$^{\gamma***,\rho**}$ (e.g., open health data, national statistics sources such as the Scottish Public Health Observatory, Information Services Division Scotland, The World Health Statistics)	25 (13.8%)	55 (30.4%)	74 (40.9%)	22 (12.2%)	5 (2.8%)	3	3	2.60
Organising and storing research raw/open data online$^{\gamma***,\rho***}$ (e.g., using tools such as RefWorks or Microsoft Word to annotate or summarise findings)	34 (18.7%)	66 (36.3%)	63 (34.6%)	15 (8.2%)	4 (2.2%)	2	2	2.39
Using a Critical Appraisal Tool$^{\gamma**}$ (e.g. CASP)	91 (50.0%)	57 (31.3%)	27 (14.8%)	4 (2.2%)	3 (1.6%)	1.50	1	1.74
Using a survey tool$^{\gamma***,\rho**}$ (i.e., Mentimeter)	63 (34.6%)	56 (30.8%)	46 (25.3%)	13 (7.1%)	4 (2.2%)	2	1	2.12
Understanding how evidence-based research are used to construct arguments, make decisions, and/or solve problems$^{\gamma**}$	28 (15.5%)	52 (28.7%)	69 (38.1%)	24 (13.3%)	8 (4.4%)	3	3	2.62
8. Digital communication skills (Items N=7)	1	2	3	4	5	Median	Mode	Mean
Participating professionally (e.g., reviews, comments, likes) in a range of digital networks (e.g., social and professional networks) related to your interests, work, and/or academic subject$^{\gamma***,\rho***}$	19 (10.4%)	46 (25.3%)	64 (35.2%)	40 (22.0%)	13 (7.1%)	3	3	2.90

Understanding expected behaviour/code of practice in online environments$^{\gamma***,\rho**}$ (e.g., NMC/HCPC Social Media guidance)	5 (2.7%)	27 (14.8%)	54 (29.7%)	67 (36.8%)	29 (15.9%)	4	4	3.48
Communicating respectfully, inclusively & confidentially, recognising that digital media can be used to intimidate, shame, and harass other people$^{\gamma**,\rho*}$	3 (1.6%)	22 (12.1%)	51 (28.0%)	66 (36.3%)	40 (22.0%)	4	4	3.65
Communicating professionally via email with others$^{\gamma**,\rho*}$ (e.g., peers, tutors, mentors)	2 (1.1%)	13 (7.1%)	56 (30.8%)	69 (37.9%)	42 (23.1%)	4	4	3.75
Recognising false or damaging online communications$^{\gamma**,\rho*}$ (e.g., fake news, misinformation)	5 (2.7%)	18 (9.9%)	76 (41.8%)	59 (32.4%)	24 (13.2%)	3	3	3.43
Actively sharing your specialist ideas (e.g., academic or professional) in a range of online communication media (e.g. social media such as LinkedIn, Twitter, Facebook) $^{\gamma***,\rho***}$	26 (14.3%)	45 (24.7%)	67 (36.8%)	36 (19.8%)	8 (4.4%)	3	3	2.75
Designing online communications for different purposes$^{\gamma***,\rho***}$ (e.g., online discussions, blog messages, twitter threads to persuade, inform, entertain, guide, and support)	44 (24.2%)	49 (26.9%)	66 (36.3%)	18 (9.9%)	5 (2.7%)	2	3	2.40

Note(s): **γ** Kruskal-Wallis test between age groups (*p <0.05, **p <0.01, *** p <0.001); **ρ** Mann-Whitney U test between pre and post registration (*p <0.05, **p <0.01, *** p <0.001)

9. Digital innovation (Items N=3)	1	2	3	4	5	Median	Mode	Mean
Developing new ideas and projects using online tools and technologies$^{\gamma***,\rho***}$ (e.g., using tools in innovative ways to create presentations, projects, apps, video resources and designs)	47 (25.8%)	62 (34.1%)	53 (29.1%)	16 (8.8%)	4 (2.2%)	2	2	2.27
Working collaboratively on different aspects of a creative/innovative project/service design & managing the process as a team$^{\gamma***,\rho***}$	39 (21.4%)	54 (29.7%)	58 (31.9%)	26 (14.3%)	5 (2.7%)	2	3	2.47
Promoting new online tools and opportunities to others$^{\gamma***,\rho***}$ (e.g., proactively promoting creative ideas and projects)	58 (32.0%)	60 (33.1%)	44 (24.3%)	14 (7.7%)	5 (2.8%)	2	2	2.16
10. Digital learning and development (Items N=10)	1	2	3	4	5	Median	Mode	Mean
Participating in online learning opportunities and resources$^{\gamma***,\rho***}$ (e.g., online courses, podcasts, tweetfests/global conversations on Twitter, quizzes, online tutorials, simulations, or open lectures)	12 (6.6%)	40 (22.0%)	79 (43.4%)	36 (19.8%)	15 (8.2%)	3	3	3.01
Adopting new ways of learning online$^{\gamma***,\rho***}$ (e.g., online workshops, virtual labs, video-tutorials, webinars)	16 (8.8%)	41 (22.5%)	78 (42.9%)	33 (18.1%)	14 (7.7%)	3	3	2.93
Working collaboratively and supportively with other learners, using online technologies where appropriate$^{\gamma***,\rho***}$ (e.g., via your university's online education system (Campus Moodle), Office 365, other apps and online environments or via your previous working experiences)	11 (6.0%)	40 (22.0%)	78 (42.9%)	40 (22.0%)	13 (7.1%)	3	3	3.02
Using online tools to take notes, annotate, and collate learning materials, review, and revise learning$^{\gamma***,\rho***}$ (e.g., Evernote, Notion, Google Apps, Scribble)	48 (26.4%)	53 (29.1%)	58 (31.9%)	18 (9.9%)	5 (2.7%)	2	3	2.34
Using online tools to record learning events/outcomes and use them for self-analysis, reflection, and showcasing of achievement$^{\gamma***,\rho***}$ (e.g., in an e-portfolio or learning blogs)	48 (26.4%)	49 (26.9%)	64 (35.2%)	16 (8.8%)	5 (2.7%)	2	3	2.35
Receiving and responding to online feedback about your academic work$^{\gamma***,\rho***}$	22 (12.1%)	37 (20.3%)	72 (39.6%)	34 (18.7%)	17 (9.3%)	3	3	2.93
Engaging and participating in online learning environments$^{\gamma***,\rho***}$ (e.g., discussion forums)	20 (11.0%)	38 (20.9%)	64 (35.2%)	48 (26.4%)	12 (6.6%)	3	3	2.97

Using learning management systems$^{\gamma***,\rho***}$ (e.g., Blackboard Collaborate, Zoom, Teams) to learn collaboratively	12 (6.7%)	30 (16.7%)	66 (36.7%)	51 (28.3%)	21 (11.7%)	3	3	3.22
Sharing information using external communication tools$^{\gamma***,\rho***}$ (e.g., WhatsApp, Viber, Skype)	11 (6.0%)	32 (17.6%)	65 (35.7%)	53 (29.1%)	21 (11.5%)	3	3	3.23
Sharing your online knowledge and skills, helping other learners$^{\gamma***,\rho**}$ (e.g., mentoring others)	14 (7.7%)	47 (26.0%)	75 (41.4%)	32 (17.7%)	13 (7.2%)	3	3	2.91
11. Digital abilities to complete academic work (Items N=1)	1	2	3	4	5	Median	Mode	Mean
Which level best describes your digital abilities to complete your academic work?$^{\gamma***,\rho**}$	11 (6.1%)	37 (20.7%)	87 (48.6%)	36 (20.1%)	8 (4.5%)	3	3	2.96

Note(s): **γ** Kruskal-Wallis test between age groups (*p <0.05, **p <0.01, *** p <0.001); **ρ** Mann-Whitney U test between pre and post registration (*p <0.05, **p <0.01, *** p <0.001)

12. Digital identity management (Items N=6)	1	2	3	4	5	Median	Mode	Mean
Managing your online profiles on different digital media (e.g., social media) in a way that is suitable for personal, professional, and academic purposes$^{\gamma***,\rho***}$	7 (3.8%)	36 (19.8%)	68 (37.4%)	51 (28.0%)	20 (11.0%)	3	3	3.23
Understanding how your online personal data are collected and used in different systems and use privacy settings appropriately$^{\gamma***,\rho***}$	7 (3.8%)	40 (22.0%)	75 (41.2%)	44 (24.2%)	16 (8.8%)	3	3	3.12
Being aware of the potential positive or negative impact of what you communicate online on your online reputation$^{\gamma***,\rho*}$	4 (2.2%)	22 (12.1%)	63 (34.6%)	60 (33.0%)	33 (18.1%)	4	3	3.53
Making sure outcomes of learning and other achievements are accessible in online forms$^{\gamma***,\rho***}$ (e.g., via an e-portfolio, digital CV, personal website)	20 (11.0%)	41 (22.5%)	72 (39.6%)	37 (20.3%)	12 (6.6%)	3	3	2.89
Understanding the impact of your online interactions$^{\gamma***,\rho**}$ (e.g., how you project yourself to others online)	5 (2.7%)	22 (12.1%)	67 (36.8%)	61 (33.5%)	27 (14.8%)	3	3	3.46
Using online analytics to explore your impact and influence on others$^{\gamma***,\rho***}$	45 (24.9%)	44 (24.3%)	58 (32.0%)	25 (13.8%)	9 (5.0%)	3	3	2.50
13. Digital wellbeing (Items N=6)	1	2	3	4	5	Median	Mode	Mean
Feeling comfortable, in control, and safe when using digital technologies$^{\gamma***,\rho***}$	8 (4.4%)	37 (20.3%)	61 (33.5%)	47 (25.8%)	29 (15.9%)	3	3	3.29
Recognising that digital information and media can cause distraction, overload, and stress, and disconnecting when necessary$^{\gamma***,\rho***}$	5 (2.7%)	25 (13.7%)	55 (30.2%)	62 (34.1%)	35 (19.2%)	4	4	3.53
Considering the rights and wrongs and the possible consequences of your online behaviour$^{\gamma**,\rho*}$	3 (1.6%)	17 (9.3%)	55 (30.2%)	65 (35.7%)	42 (23.1%)	4	4	3.69
Acting positively against cyberbullying and other damaging online behaviours$^{\gamma***,\rho***}$	9 (4.9%)	17 (9.3%)	57 (31.3%)	65 (35.7%)	34 (18.7%)	4	4	3.54
Managing online and real-world interactions in ways that support healthy relationships$^{\gamma***,\rho***}$	6 (3.3%)	15 (8.3%)	60 (33.1%)	65 (35.9%)	35 (19.3%)	4	4	3.60
Using digital media to access wellbeing services, monitor health conditions$^{\gamma***,\rho***}$ (e.g., student support services)	10 (5.5%)	33 (18.1%)	66 (36.3%)	45 (24.7%)	28 (15.4%)	3	3	3.26

Note(s): **γ** Kruskal-Wallis test between age groups (*p <0.05, **p <0.01, *** p <0.001); **ρ** Mann-Whitney U test between pre and post registration (*p <0.05, **p <0.01, *** p <0.001)

Appendix 2. Highest and lowest mode values

Theme	Advanced Digital Competences (mode=4)	Basic Digital Competences (mode=2)	Novice Digital Competences (mode=1)
Everyday Participation as a Digital Citizen	"e-commerce", "e-learning"	"e-democracy"	Not found
ICT Proficiency	"Technological devices", "Web browsers", "Search engines", "Personal Digital Services", "Communication Platforms"	Not found	Not found
ICT Productivity	Not Found	Not found	Not found
Information identification in different contexts	Not found	Not found	Not found
Information Literacy	Not found	"Using online collection tools for gathering digital information together in new ways", "Organizing the digital information you find for your learning through folders, bookmarks, reference management software, and tagging", "Referencing digital information sources, adhering to a referencing style"	Not found
Digital Creation	"Document formatting and presentation", "Social media content creation"	"Video creation, "Online posters", "Creation of audio files", "Data visualisation"	"Infographics", "Blogs/Wikis" "Vlogs/Podcasts", "Simulation/Virtual Reality Tools"
Digital Research	Not found	"Organising and storing digital research data"	"Using a critical appraisal tool" "Using a survey tool"
Digital Communication	"Understanding online behaviour/code of practice in online environments", "Communicating respectfully, inclusively & confidentially, recognising that digital media can be used to intimidate, shame, and harass other people", "Communicating professionally via email with others"	Not found	Not found
Digital Innovation	Not found	"Developing new ideas and projects using online tools and technologies", "Promoting new online tools and opportunities to others"	Not found
Digital Learning and Development	Not found	Not found	Not found
Digital Identity Management	Not found	Not found	Not found
Digital Wellbeing	"Recognising that digital information and media can cause distraction, overload, and stress, and disconnecting when necessary", "Considering the rights and wrongs and the possible consequences of your online behaviour", "Acting positively against cyberbullying and other	Not found	Not found

	damaging online behaviours", "Managing online and real-world interactions in ways that support healthy relationships"		
Digital Abilities to Complete Academic Work	Not found	Not found	Not found

Appendix 3. Examples of how students digital/online skills help them to address challenges

ICT Proficiency/Productivity	Information Literacy	Digital research	Digital Creation	Digital Communication	Digital Learning and Development	Graduate Employability	Special Needs	Digital Collaboration
Know how to access online Moodle, modules, BbC, MS Teams, Ms Office etc.	Able to find information from various sources, knowing where to look	Advertise to larger sample sizes	Creating and presenting team academic work during Simulated practice.	Being familiar with different online forums has allowed me to adapt my knowledge to understand new online forums	Successful completion of online activities, assignments and participation in forums while working towards my MSc	Completed TURAS modules in preparation for joining vaccination team	I am dyslexic so using digital and online skills have always helped me. I had to learn digital and online skills at a younger age as it helped my learning. By doing this it has given me a great advantage now in covid times as I am very confident when using technology	Learning how to use different online education tools such as blackboard collaboration through video tutorials to allow me to take part in course work with others
Familiarity with sites similar to Moodle helps me navigate to the area of information I require.	Being able to access journals etc. effectively in order to reference credible sources	Knowing what and how to research properly	Creating a presentation	Supervision sessions easier to organise	learning how to use different online education tools such as blackboard collaboration through video tutorials to allow me to take part in	Have learned so much about online working.	I use digital skills to use software to help with overcoming with my dyslexia.	Working with team members over Zoom / MS Teams and facilitated a discussion space to help better understand how we as a group could interact and share

					course work with others			information to help us all succeed
Starting uni has improved online skills	Able to access resources	Research and validation		Able to interact and attend session online	Adapting to online teaching full time. Using different programmes with big class numbers, sharing of content resources online that work and are enriching. Learning to use programmes such as zoom, blackboard, teams, Grademark, Panopto to ensure we improve the students experience			Group WhatsApp/ video conferences in order to discuss weekly work
Familiarity with sites similar to Moodle helps me navigate to the area of information I require	Using guides on how to use ref works			It has helped as you can get a fast response over communication services if you aren't sure about work assigned	They have allowed me to study and join classes during covid			Created a Ms Teams group for our remote placement team-working activities
Being familiar with different online forums has allowed me to adapt my knowledge to	When needing to search for academic articles, knowing that Google has, and how to use, its			I have become more confident to speak to my peers	Creating and presenting team academic work			Started a MS Teams chat for a group activity

understand new online forums	academic function to full effect				during Simulated practice.			
My digital skills have helped me find my way around campus Moodle	Finding other sources to explain things I don't understand			As a group we have set up a WhatsApp chat and we will send 'How to' videos if anyone is struggling with any of the work	They have helped me to make the best use of online learning			Collaborating with others digitally has helped
Getting to know websites better and organising my work for effectively	Has made it more efficient for me to find information and how to access resources, it allows me to have the knowledge about where to go or who to ask for support or help if I need any			Created a Teams meeting with other members of my tutor group so that we could have a shared platform where we could share our ideas and opinions on the task at hand.	Able to interact and attend sessions online			In group work I volunteered to make the PowerPoint just to learn how to work it
It helps me save a lot of time doing assignments.	To understand a particular topic, knowledge about searching internet and finding a relevant and true content helps to finish my study work and to feel confident			Messenger group team for first year science group work	Accessed online tutorial with tutor			Made group working easier online

Help me navigate through my course	more information can be found on the internet on different things				Adapting to online teaching full time			Making group presentations
When doing the audio assessment for our module, the speed doubled up when I spoke and I knew how to fix it	Searching for relevant materials to help me understand more about the subject				During use of final assessment projects. In example when I was required to complete a auditorial assessment of care plan protocol			
Using MS Teams					It has forced me out of my comfort zone and I had had to adapt from pen and paper to online submission, my skills have greatly improved since starting and I hope I continue to learn more digital skills as I progress			
					I have gained knowledge of how to use online learning effectively			I contribute to group activities where I can