Journal of Information Technology Education: Research

An Official Publication of the Informing Science Institute
InformingScience.org

JITEResearch.org

Volume 21, 2022

THE LIMITED LEVEL OF DIGITAL SKILLS AND COMPETENCIES OF OPTOMETRY STUDENTS

Kim Phuong Nguyen	The University of Melbourne, Parkville, Victoria, Australia	kimn2@student.unimelb.edu.au
Ayd'n Ken Luke	The University of Melbourne, Parkville, Victoria, Australia	aluke@student.unimelb.edu.au
Yutong Cheng	The University of Melbourne, Parkville, Victoria, Australia	yutongc1@student.unimelb.edu.au
Aditya John	The University of Melbourne, Parkville, Victoria, Australia	adityaj@student.unimelb.edu.au
Kwang M Cham*	The University of Melbourne, Parkville, Victoria, Australia	ckwang@unimelb.edu.au

* Corresponding author

ABSTRACT

Aim/Purpose	Digital health is increasingly being utilized in clinical practice given its ease of accessibility, but it lacks emphasis from universities and accreditation bodies. This study attempted to better understand the digital capabilities of optometry students.
Background	With technological advancements transforming the Australian workforce and healthcare, there is a growing demand for digitally competent graduates. This study investigated digital perceptions and preferences of optometry students relating to their studies and readiness for work in healthcare.
Methodology	Current optometry students participated in an anonymous online survey. Questions were designed to evaluate their understanding and awareness of digital skills and competencies for learning whilst at university, and for use in the health sector workforce. Results were analyzed to underscore key trends and answers to open-ended questions underwent inductive thematic analysis to generate themes for discussion.

Accepting Editor Kay Fielden | Received: November 22, 2021 | Revised: February 28, 2022 | Accepted: March 5, 2022.
Cite as: Nguyen, K. P., Luke, A. K., Cheng, Y., John, A., & Cham, K. M. (2022). The limited level of digital skills and competencies of optometry students. *Journal of Information Technology Education: Research, 21,* 97-114. https://doi.org/10.28945/4929

Contribution	Optometry educators can bridge the gap in digital practices between students and the workplace by obtaining a baseline of their capabilities and incorporating specific activities within the curriculum to increase student awareness and support their understanding and development in this aspect.
Findings	Most students were confident in using daily technologies for learning. Reference management software was perceived to be most important and useful skill to attain. While students were less confident in creating applications, they were keen to learn even though it seemed peripheral to their career and professional development. 70% of the students knew how to manage their online privacy and security. Of the students, 92% highlighted that attaining competency in digital skills would enhance their career and professional development, but only 54% believed they possessed the relevant skills for entering the workforce. Only 19% of the students reported having sufficient university support.
Recommendations for Practitioners	Digital capabilities of learners do need to be taught explicitly and should not be assumed. To improve student learning outcomes, digital skills and competencies need to be embedded throughout the curriculum and addressed through learning objectives.
Recommendations for Researchers	More work needs to be done in implementing digital training and services at a subject, course, and institutional level. Some international benchmarking of optometry curricula and optometry research would clarify the need for digital education, to educators and students alike.
Impact on Society	Currently, there is a lack of recognition of digital health by accrediting bodies, thus preventing digital competency from being a priority in the curriculum of schools. There is a further need to establish dialogue between universities, employers, and accrediting bodies to set consistent and realistic expectations of digital skills and competencies.
Future Research	Future studies should consider having larger sample sizes to observe similarities and differences in digital capabilities between year levels. Student focus groups and interviews can be performed to better understand the rationale behind the desire and interest to learn digital technologies that seemed irrelevant to optometry.
Keywords	optometric education, digital literacies, digital health, digital skills and competencies

INTRODUCTION

With the accelerating evolution of technology, there is a growing demand for engagement in digital technologies in healthcare. The World Health Organization (WHO) has published guidelines and frameworks surrounding digital health interventions and the value of utilizing technologies is well-recognized (WHO, 2016, 2018, 2019). Recently, WHO (2020) has also drafted a global strategy on digital health that aims to "strengthen health systems through the application of digital health technologies for consumers/people and healthcare providers towards achieving the vision of health for all". Similarly, Australia has developed the National Digital Health Strategy (Australian Digital Health Agency, 2018) with the purpose of innovating digital health, developing digital competencies within the healthcare workforce, and providing digital solutions resulting in excellent healthcare. It is evident that healthcare professionals will need to become digitally competent in the future to gain full benefit from the advances in digital health technology.

Implementing digital tools are not the only means to meet the growing demand for healthcare, and they also serve to improve the delivery of health service. Gaspard and Yang (2016) introduced the term 'Digital Health Worker' to describe the need for a diverse workforce to complement this growing demand. They suggested that a digital health worker should be able to utilize, manage, and sustain an electronic health environment. When information technology is applied in a healthcare setting, it can improve clinical outcomes, advance patient care, and reduce human errors – this is known as the healthcare information systems model (Altotaibi & Federico, 2017). Whilst the specifics of this model may differ from country to country, the underlying principle remains the same; an approach that is "patient oriented" and the infrastructure supporting it provides the most optimal access to healthcare service (WHO, 2020).

From an educational perspective, the extensive use of digital technologies has rendered students as digitally literate (Prensky, 2001). This notion has since been overturned as it is now understood that extensive technology use does not necessarily equate to good digital practices (Coldwell-Neilson, 2018; McLachlan et al., 2016). Current students, brought up through the technological age, are not digitally competent (Coldwell-Neilson, 2017), especially when using technologies for a specific purpose, such as content creation or consumer usage, unless explicitly taught (Ng, 2012). Adding to this misconception, there is no shared understanding of what level of digital skills and competencies university students are expected to possess to enhance employability, and a singular definition has yet to be achieved (Coldwell-Neilson, 2017; Helsper, 2001).

A survey conducted in the UK by the Joint Information Systems Committee in 2019 examined four important measures: digital lives of learners, the institution and digital technology, course-specific digital technology, and the attitudes of students to digital learning. In brief, it was found that there was a lack of opportunity for students to self-reflect and enhance their digital skills. There was also difficulty in navigating through the virtual learning environment, which posed as a major barrier of learning to use digital technologies. It seems that current university-level health systems training is not standardized to facilitate the transition from a student to an ideal "digital health worker" (Howarth et al., 2018). It remains questionable whether universities are prepared for digital transformation, and such change may be well overdue (Watermeyer et al., 2021). In the field of optometry, no research has focused on understanding the level of digital skills and competencies of students. Therefore, this study attempts to contribute to current literature by investigating the attitudes, confidence, experience, and understandings of students about digital skills and competencies relating to their studies and future readiness for work in healthcare. The structure of the paper is as follows: the second section gives an overview of the literature, followed by the study methods presented in the third section and the results presented in the fourth section. The fifth section discusses the findings, and, finally, the sixth section concludes this work and presents recommendations for future research.

LITERATURE REVIEW

To understand the importance of technology in optometry, an overview of the historical perspective is essential. Optometry has been a profession since the early 1300s where the only way eyesight could be improved was by using eyeglasses. The advances in technology have allowed more sophisticated development of prescription correction, such as contact lenses and laser surgery. In a modern optometric setting, apart from managing electronic patient records, the increasing use of optical coherence tomography, autorefractors, corneal topography, and fundus photography has proven digital technologies to be inseparable from eyecare provision. Telehealth, an umbrella term to describe the telecommunication and electronic-based expansion of clinical and non-clinical health care (Bursell et al., 2013), has facilitated remote optometric consultations during the COVID-19 pandemic and resulted in further exploration of digital eye examinations (Patel et al., 2020).

Gupta and Gupta (2016) have alluded to the importance of incorporating information and communication technology into optometry education as it prepares students for complex situations in the

future, expands research skills and enables students to be competent with enhanced technology. Innovative clinical technologies such as the 3D Eyesi Binocular Indirect Ophthalmoscope simulator have been integrated into learning processes to enhance performance and outcomes (Cham & Cochrane, 2017; Douglass et al., 2021). Coldwell-Neilson and colleagues (2019) reviewed digital literacy in the optometric curriculum at Deakin University and developed a spiraling curriculum to augment and improve students' graduate outcomes in digital capabilities. To identify the level and type of digital skills and competencies taught in Australian optometry schools, the course learning outcomes of seven institutions were reviewed (Table 1). Unsurprisingly, the learning outcomes pertaining to digital skills and competencies were largely vague or absent, despite expectations that students will be taught digital skills that could be used after graduation (Duncan-Howell, 2012).

Table 1: Descriptions of digital skills and competencies from course learning outcomes of seven Australian optometry schools (from university websites).

Name of Institution	Descriptors
University of Melbourne (2021)	An ability to adapt to scientific, technological, and social change, and a capacity to be creative and innovative.
Deakin University (2021)	Choose appropriate technologies to effectively find, use and disseminate clinical and research findings; demonstrate skills in applying new technologies in clinical settings to implement examination plans and manage patient records.
University of Canberra (2021)	Make creative use of technology in their learning and professional lives. Evaluate and adopt new technology.
University of New South Wales (2021), University of Western Australia (2021), Flinders University (2021), QueenslandUniversity of Technology (2021)	Not found online.

METHODS

This research was approved by the School of Health Sciences Ethics Research Committee (Ethics ID: 1750872). All students currently enrolled in the Doctor of Optometry at the University of Melbourne were invited to participate in the study. The Doctor of Optometry is a four-year postgraduate course with an Australian Qualifications Framework Level 9 (Australian Qualifications Framework, 2013). This study was a 12-month student research project and the method of sampling chosen was convenience sampling with participation being voluntary. A 2-factor, 2-tailed power analysis and n=80 enables detection of a 5% margin of error with a 95% confidence level. Based on that, the study aimed to recruit approximately 90 subjects for the sample to be statistically significant. All participants gave informed consent to take part in the study. They completed an anonymous online survey via Qualtrics, which required them to indicate responses on Likert scales and open-ended questions (Appendix). Questions were clustered across five category types, as described below.

- Demographic data and access to technologies and frequency of use (Questions 1-5)

This category focused on access and regular use of digital technologies and internet usage. Students selected from a checklist of tools to indicate the range of technologies they used. Frequency of use was indicated by selecting from a 6-point frequency scale.

- Themes of confidence, willingness to learn and importance of digital skills and competencies to career and professional development (Question 6)

The second category asked students to indicate responses across the three themes. A checklist of 24 digital technologies and their creative uses, mapped to a 4-point Likert scale, required students to rate their levels of confidence in using and creating with digital technologies in a learning and research context at the university. The same checklist and context also pertained to the remaining two themes - willingness to learn and understanding the importance of digital skills and competencies to career and professional development.

- Social media preferences and use and the management of online privacy and security (Questions 7-10)

In this category, students were asked about their preferences and frequency of use for social media platforms. They chose from a list of reasons for engagement on social media and were also asked to rate their awareness of the lasting nature of digital material and how well they managed their privacy and security online.

- Definition of the term *digital skills and competencies* (Question 11)

Students were asked to expand on their understanding of the term digital skills and competencies.

- Importance of digital capabilities for career and professional development and knowledge and perceptions of support they receive from the university in developing such capabilities (Questions 12-17)

In this final category, students were asked if they had developed and achieved the relevant digital skills and competencies during their course of study; if they possessed the digital skills when entering the workforce, and if they had received sufficient university support and services in developing their digital capabilities. The survey concluded with a free text comment.

All data were extracted from Qualtrics and both quantitative and qualitative analyses were performed. The free text responses (Question 11 and Question 16) were analyzed using thematic analysis, which is an accessible and flexible process for identifying themes within qualitative data regardless of data sets (Clarke & Braun, 2017). Thematic analysis was used due to its appropriateness for seeking to understand experiences, thoughts, or behaviors across a data set (Kiger & Varpio, 2020).

Initially, two authors independently analyzed the responses and organized them into a set of themes. These were based on key phrases and identifying patterns in responses. To increase legitimation and analytic rigor, another two authors independently checked and confirmed the identified themes. Finally, the whole team reviewed and refined the themes together until an agreement was reached (Braun & Clarke, 2006).

RESULTS

This section reports students perceived understanding of digital skills and competencies, displayed as a percentage of a category or response.

- Demographic data and access to technologies and frequency of use (Questions 1-5)

A total of 107 students participated in the study, with most participants being female (62%) and between 18 to 24 years of age (81%). Most students were in their second (43%) and fourth year (28%) of the optometry course, with a smaller sample representation from the first year (13%) and third year (16%) students. The two most commonly used digital technologies were a laptop (99%) and a smartphone (97%). All participants indicated they had broadband/Wi-Fi access from home and accessed the internet several times a day.

- Themes of confidence, willingness to learn and importance of digital skills and competencies for career and professional development (Question 6)

The confidence in using the digital technologies is summarized in Figure 1. Most of the students were very/reasonably confident in using daily technologies for learning such as email (98%), followed by presentation software (90%), word processing software (88%), video conferencing tools (83%), and file-sharing and storage (80%). Interestingly, Canvas, the university learning management system, only attracted a response rate of 69%. In using the digital tools, students reported being least confident in 3D printing (86%), geospatial technologies (84%), curation tools (83%), and data visualization tools (76%). When it came to creating technologies, computer programs (84%) and applications (82%) stood out as being least confident.

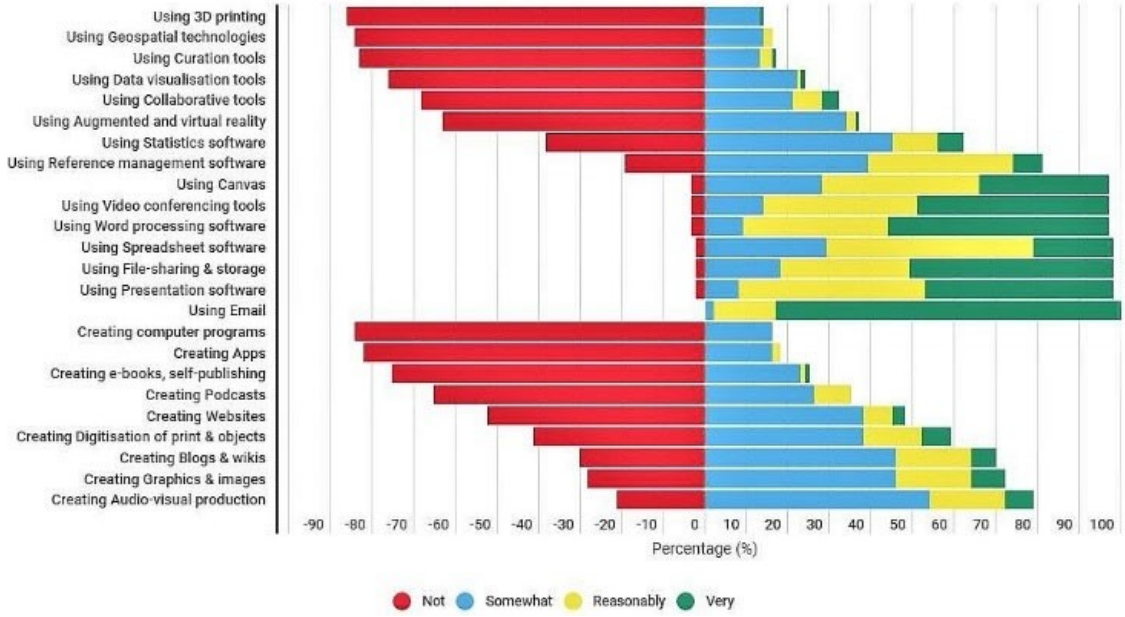

Figure 1: Students' perceived confidence in utilizing 24 digital technologies.

Next, the perceptions of students on the importance and willingness to learn these skills for their career and professional development were evaluated. In terms of software, reference management (43%) was perceived as the most important and useful digital skill to attain, followed by presentation (38%), spreadsheet (37%), and file-sharing and storage (37%) (Figure 2). Participants were most interested in learning how to create applications (53%), websites (44%), computer programs (43%), and 3D printing (43%) (Figure 3).

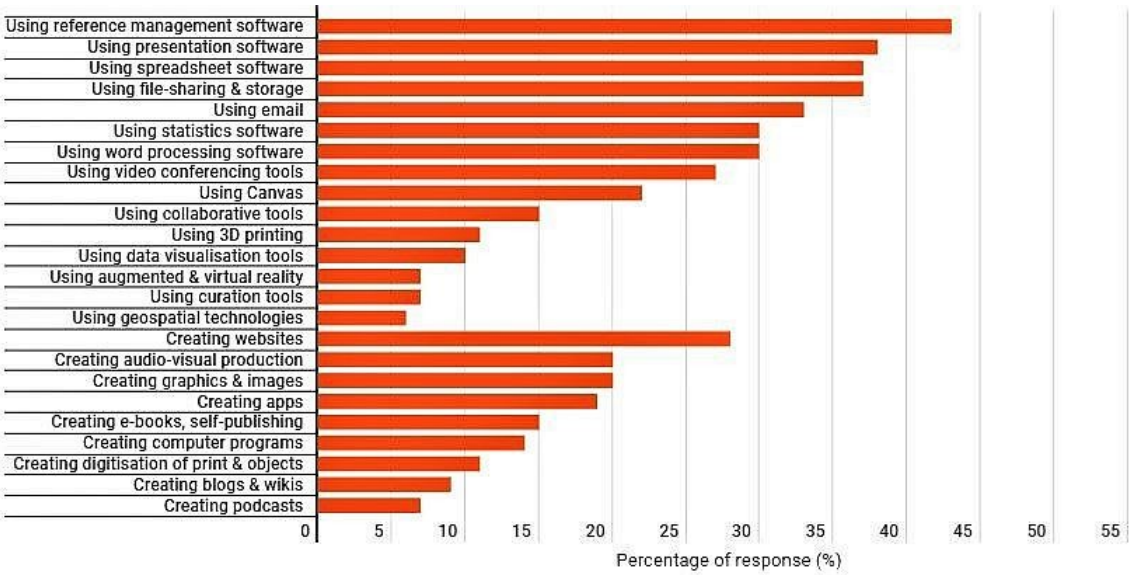

Figure 2: Percentage of respondents that thought a digital skill was important for their career and professional development.

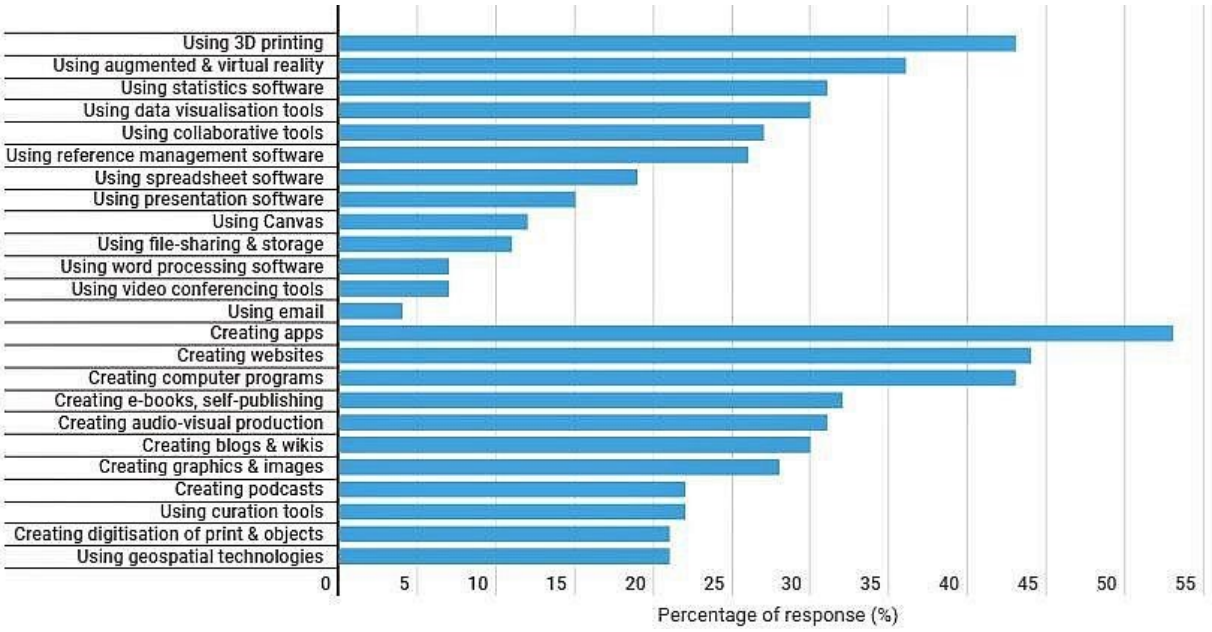

Figure 3: Percentage of respondents that were interested in learning a digital technology.

- Social media preferences and use and the management of online privacy and security (Questions 7-10)

In this section, 82% of the participants reported using social media several times a day, mostly for social engagement (94%) and learning (82%). Less than half of the participants used it for career and professional development (47%) or research (41%). Facebook (92%) was frequently used, followed by YouTube (91%) and Instagram (73%). 70% of students were very/reasonably aware of the lasting nature of digital material and knew how to manage their digital privacy and security.

- Definition of the term *digital skills and competencies* (Question 11)

The majority of the students defined the term as "general use of technology" (96%).

- Importance of digital capabilities for career and professional development and knowledge and perceptions of support they receive from the university in developing such capabilities (Questions 12-17)

Of the students, 92% highlighted that attaining competency in digital skills would enhance their career and professional development, but only 54% believed they possessed the relevant skills for entering the workforce. Only 19% of the students reported having sufficient university support via library resources and learning digital skills through assignments. 81% of the students were unsure if university support was sufficient.

When asked what the university needed to do to help students succeed in achieving these digital capabilities, the three main suggestions included providing online tutorials and professional workshops (55%), allocating time in the current course to develop digital skills (17%), and targeted classes for relevant digital technologies specific to optometry (14%). These responses were obtained via thematic analysis as discussed earlier.

DISCUSSION

In this study, the digital experiences and practices of optometry students relating to their studies and future readiness for work in healthcare were examined. The findings support that this cohort of students were active and routine digital users, reporting high levels of confidence using day-to-day digital tools for learning and exhibiting a preference for using mobile devices (laptops and smart phones) rather than fixed desktop workstations. As expected, frequency of use and confidence were highest for essential technologies, such as email for staff and student communication, and resources (word processing, file-sharing and storage, video conferencing tools, and presentation software) for attending online classes and completing assignments and seminars. However, it is concerning to see that approximately one-third of the participants are still not confident using Canvas, which is the university learning management system to access and manage online course learning materials. It is worth noting that the data was collected during the COVID-pandemic in 2020, which would be a rather accurate representation of student confidence in wholescale online learning in its current context.

Of the students, 43% perceived reference management software as the most important and useful digital skill to learn for their career and professional development. While one might expect a higher response rate with students accessing journal articles routinely to complete the numerous assignments in this course, it is the software *per se*, i.e., resource compilation, that some students viewed as less important or were unaware of best practices for reference collation. To solve this potential learning gap, it would be beneficial to educate students the importance of good reference management and best ways of resource compilation during their course of study.

Unsurprisingly, low levels of confidence and interest were reported for digital tools peripheral to optometry, such as curation and geospatial technologies. However, it is important to observe that some students reported a positive attitude and willingness to engage with technologies that might be implicit for their study, if given the opportunities. An example is creating applications. While students reported low levels of confidence, they were very interested to learn this digital skill even though it is presumed to be irrelevant to their optometric career and professional development. This desire and interest to learn this digital technology could potentially be triggered by the daily exposure and usage of applications on mobile devices. Hence, when designing activities to develop digital skills and competencies, the influence and usage of portable devices and applications should be strongly considered. In all, these findings support the notion that the digital capabilities of learners do need to be taught explicitly and should not be assumed (Ng, 2012). Indeed, tertiary students tend to overestimate their ability to apply digital skills to solving real-world problems (Murray & Perez, 2014). Should educators make the same assumptions, the development of digital skills and competencies would be greatly challenged in universities (English, 2016).

Most students engaged with social media platforms mainly for social interactions and learning. However, it was unclear regarding the context of learning (e.g., formal or informal, superficial or deep) and the type of activities (e.g., chat groups on Facebook) that occurred online. Focus groups and interviews could be conducted to gain further insights to understand the value and impact of using social media platforms for learning purposes initiated by students, and how that might compare to scheduled online classes.

As Australia increases its uptake of electronic health, it is anticipated that all patient records and personal information will be managed via My Health Record online eventually. Under the Optometry Board of Australia (2020) Code of Conduct, optometrists have a legal obligation to respect privacy laws and ensure patient records are protected from any unauthorized access. As such, whilst most students were very/reasonably aware of good practices surrounding online data security and privacy management, there was still a significant proportion of students being less aware of its importance. As future optometrists, this lack of awareness of digital privacy and security can demerit the trustworthiness of clinicians and subject them to liability and potential legal dispute.

Likewise, any in-depth understanding of being digitally competent was absent in student definition of digital skills and competencies. The Digital Competence Framework (European Commission, 2019) defined digital competence as being highly capable in information and data literacy, communication and collaboration, digital content creation, safety, and problem solving. Bond et al. (2020) discussed digital literacy/ies as encapsulating a merging of technologies, attitudes, and capabilities. This finding of simplistic definition and low awareness of digital skills and competencies could potentially hinder the optometry workforce to work towards digitalization of eyecare, a goal of the Australian government to universalize digital health by 2022 (Australian Digital Health Agency, 2018). Considering these findings, optometry curricula should familiarize students with the concepts of being digitally competent, and specifically assess and evaluate students on the ethics and principles of digital privacy and security from an individual and patient perspective.

Most students reported being unsure about university offerings and learning opportunities to develop their digital capabilities. It is important to note that this observation was implied and self-reported, and students may possess different understandings about the relevance and type of digital skills they should attain. This could also be explained by a lack of student awareness, possibly due to limited or ineffective promotion of these digital services to the students. Indeed, universities have placed limited attention on expanding the range of digital skills training (Soomro et al., 2020). Students were not adequately improving their digital skills during their time in university and consequently, would be unprepared for the rapidly changing demand of the health workforce (Coldwell-Neilson, 2018; Spitzer et al., 2013). To improve student learning outcomes, digital skills and competencies need to be embedded throughout the curriculum and addressed through learning objectives (Johnson & Adams Becker, 2016). However, the digital skills development within optometry curricula are largely implied or absent. An exception is Deakin University, whereby a digital literacy skills mapping exercise showed that these skills are well taught and assessed in the early years of the optometry program. (Coldwell-Neilson et al., 2019). Edirippulige et al. (2018) discussed the barriers to incorporate eHealth skills and competencies into medical education in Australia. These included the crowded curriculum and competing priorities for inclusion of new topics, a perceived lack of support from the health systems in which students gain experiential learning, and a lack of demand from accrediting bodies. The presence of these impediments is also anticipated within optometry education.

CONCLUSION

This research has provided useful and valuable baseline information about the digital skills and competencies of optometry students. Optometry educators can bridge the gap in digital practices between students and the workplace. This can be done by obtaining a baseline of their capabilities and incorporating specific learning activities (e.g., evidence-based practice)

(Coldwell-Neilson et al., 2019) within the curriculum to increase student awareness and support their understanding and development in this aspect.

Currently, there is a lack of recognition of digital health by accrediting bodies, thus preventing digital competency from being a priority in the curriculum of schools (Edirippulige et al., 2018). There is a further need to establish dialogue between universities, employers, and accrediting bodies to set consistent and realistic expectations of digital skills and competencies.

It is acknowledged that the sample largely consisted of two-year levels in a postgraduate course in a single institution. This might not directly translate to other optometry programs with different course structures. Future studies should consider having larger and equal sample sizes from each year level of their program to observe similarities and differences in digital capabilities between year levels. To better understand if they have developed and achieved the relevant digital skills and competencies during their study and when entering the workforce, a description of each skill and competency needs to be described specifically. Student focus groups and interviews can be performed to better understand the rationale behind the desire and interest to learn digital technologies that seemed irrelevant to optometry. More work also needs to be done in implementing digital training and services at subject, course, and institutional level. Some international benchmarking of optometry curricula and optometry research would clarify the need for digital education, to educators and students alike.

ACKNOWLEDGEMENTS

The authors would like to thank Anand Komandur, Joel Joseph and Leta Elias who assisted with data collection and analyses for this project.

REFERENCES

Alotaibi, Y. K., & Federico, F. (2017). The impact of health information technology on patient safety. *Saudi Medical Journal*, *38*, 1173-1180. https://doi.org/10.15537/smj.2017.12.20631

Australian Digital Health Agency (2018). *Australia's national digital health strategy: Framework for action*. https://www.digitalhealth.gov.au/sites/default/files/2020-11/Framework_for_Action.pdf

Australian Qualifications Framework (2nd ed.). (2013). https://www.aqf.edu.au/framework/australian-qualifications-framework

Bond, M., Buntins, K., Bedenlier, S., Zawacki-Richter, O., & Kerres, M. (2020). Mapping research in student engagement and educational technology in higher education: A systematic evidence map. *International Journal of Educational Technology in Higher Education, 17*, 2. https://doi.org/10.1186/s41239-019-0176-8

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*, 77-101. https://doi.org/10.1191/1478088706qp063oa

Bursell, S-E., Jenkins, A. J., Brazionis, L., Rowley, K. G., & Brown, A. D. (2013). Telehealth in Australia: An evolution in health care services. *Medical Journal of Australia, 199*, 23-24. https://doi.org/10.5694/mja12.11324

Cham, K., & Cochrane, A. (2107). Using technology to enhance student learning and clinical teaching outcomes. *Optometric Education, 42*, 40-1.

Clarke, V., & Braun, V. (2017). Thematic analysis. *Journal of Positive Psychology, 12*, 297-298. https://doi.org/10.1080/17439760.2016.1262613

Coldwell-Neilson, J. (2017). Assumed digital literacy knowledge by Australian Universities: Are students informed? *Proceedings of the 19th Australasian Computing Education Conference,* 75–80. https://doi.org/10.1145/3013499.3013505

Coldwell-Neilson, J. (2018). Digital literacy expectations in higher education. *Proceedings of the 35th International Conference of Innovation, Practice and Research in the use of Educational Technologies in Tertiary Education, Australasian Society for Computers in Learning in Tertiary Education*, 103-112. https://dro.deakin.edu.au/view/DU:30119998

Coldwell-Neilson, J., Armitage, J. A., Wood-Bradley, R, J., Kelly, B., & Gentle, A. (2019). Implications of updating digital literacy – A case study in an optometric curriculum. *Issues in Informing Science and Information Technology, 16*, 33-49. https://doi.org/10.28945/4285

Deakin University. (2021). *Bachelor of Vision Science/Master of Optometry*. https://www.deakin.edu.au/course/bachelor-vision-science-master-optometry

Douglass, A., Cham, K. M., Jaworski, A., Maillet, A., Cochrane, A., & Armitage, J. A. (2021) The equivalency of the binocular indirect ophthalmoscope simulator to peer practice: A pilot study. *Optometry and Vision Science, 98*, 1239-1247. https://doi.org/10.1097/OPX.0000000000001799

Duncan-Howell, J. (2012). Digital mismatch: Expectations and realities of digital competency amongst pre-service education students. *Australasian Journal of Educational Technology, 28*, 827-840. https://doi.org/10.14742/ajet.819

Edirippulige, S., Brooks, P., Carati, C., Wade, V. A., Smith, A. C., Wickramasinghe, S., & Armfield, N. R. (2018). It's important, but not important enough: eHealth as a curriculum priority in medical education in Australia. *Journal of Telemedicine and Telecare, 24*, 697-702. https://doi.org/10.1177/1357633X18793282

English, J. A. (2016). A digital literacy initiative in honors: perceptions of students and instructors about its impact on learning and pedagogy. *Journal of the National Collegiate Honors Council*. https://digi-talcommons.unl.edu/nchcjournal/533/

European Commission. (2019). *The digital competence framework*. https://joint-research-centre.ec.europa.eu/digcomp/digital-competence-framework-20_en

Flinders University (2021). *BMSVMOPT Bachelor of Medical Science (Vision Science), Master of Optometry*. https://handbook.flinders.edu.au/courses/current/bmsvmopt#program-of-study

Gaspard, J., & Yang, C-M. (2016). Training needs assessment of health care professionals in a developing country: The example of Saint Lucia. *BMC Medical Education, 16,* 112. https://doi.org/10.1186/s12909-016-0638-9

Gupta, V. K., & Gupta, V. B. (2016). Using technology, bioinformatics and health informatics approaches to improve learning experiences in optometry education, research and practice. *Healthcare (Basel), 4*, 86-98. https://doi.org/10.3390/healthcare4040086

Helsper, E. (2001). *Digital inclusion: An analysis of social disadvantage and the information society*. http://eprints.lse.ac.uk/26938/

Howarth, A., Quesada, J., Silva, J., Judycki, S., & Mills, P. R. (2018). The impact of digital health interventions on health-related outcomes in the workplace: A systematic review. *Digital Health, 4*, 1-18. https://doi.org/10.1177/2055207618770861

Johnson, L., & Adams Becker, S. (Eds.). (2016). *The NMC Horizon Report: 2016 Higher Education Edition*. https://library.educause.edu/resources/2016/2/2016-horizon-report

Joint Information Systems Committee. (2019, September). Digital experience insights survey 2019: Findings from students in UK further and higher education. https://www.jisc.ac.uk/reports/digital-experience-insights-survey-2019-students-uk

Kiger, M. E., & Varpio, L. (2020). Thematic analysis of qualitative data: AMEE Guide No. 131. *Medical Teacher*, *42*, 846–854. https://doi.org/10.1080/0142159X.2020.1755030

McLachlan, C., Craig, A., & Coldwell-Neilson, J. (2016). Students' computing use and study: When more is less. *Australasian Journal of Information Systems, 20*, 1-17. https://doi.org/10.3127/ajis.v20i0.990

Murray, M., & Perez, J. (2014). Unravelling the digital literacy paradox: How higher education fails at the fourth literacy. *Issues in Informing Science and Information Technology, 11*, 85-100. https://doi.org/10.28945/1982

Ng, W. (2012). Can we teach digital natives digital literacy? *Computers & Education, 59*, 1065-1078. https://doi.org/10.1016/j.compedu.2012.04.016

Optometry Board of Australia. (2020). *Codes, guidelines and policies*. https://www.optometryboard.gov.au/policies-codes-guidelines.aspx

Patel, J., Morettin, C., McLeod, H., Wyles, E., Sanghera, N., Kattouf, V., Randhawa, H. Chaglasian, M., & Messner, L. (2020). Patient experience of tele-optometry in the comprehensive eye examination; A pilot study. *Investigative Ophthalmology & Visual Science, 61*(7), 1596. https://iovs.arvojournals.org/article.aspx?articleid=2769495

Prensky, M. (2001). Digital natives, digital immigrants Part 1. *On the Horizon, 9*, 1-6. https://doi.org/10.1108/10748120110424816

Queensland University of Technology (2021). *Master of Optometry*. https://www.qut.edu.au/courses/master-of-optometry

Spitzer, B., Morel, V., Buvat, J., & Subrahmanyam, K. V. J. (2013). *The digital talent gap: Developing skills for today's digital organizations*. Capgemini Consulting. https://www.capgemini.com/wp-content/uploads/2017/07/the_digital_talent_gap27-09_0.pdf

Soomro, K. A., Kale, U., Curtis, R., Akcaoglu, M., & Bernstein, M. (2020). Digital divide among higher education faculty. *International Journal of Educational Technology in Higher Education, 17*, 21. https://doi.org/10.1186/s41239-020-00191-5

University of Canberra. (2021). *Master of Optometry*. https://www.canberra.edu.au/course/374JA/1/2021

University of Melbourne. (2021). *Doctor of Optometry (MC-DOPTOM): Attributes, outcomes and skills*. https://handbook.unimelb.edu.au/2021/courses/mc-doptom/attributes-outcomes-skills

University of New South Wales (2021). *Vision Science/Clinical Optometry*. https://www.handbook.unsw.edu.au/undergraduate/programs/2021/3182

University of Western Australia (2021). *Doctor of Optometry*. https://www.uwa.edu.au/study/courses/doctor-of-optometry

Watermeyer, R., Crick, T., Knight, C., & Goodall, J. (2021). COVID-19 and digital disruption in UK universities: Afflictions and affordances of emergency online migration. *Higher Education, 81*, 623-641. https://doi.org/10.1007/s10734-020-00561-y

World Health Organization. (2016). *Monitoring and evaluating digital health interventions: A practical guide to conducting research and assessment*. https://www.who.int/reproductivehealth/publications/mhealth/digital-health-interventions/en/

World Health Organization. (2018). *Classification of digital health interventions v1.0: A shared language to describe the uses of digital technology for health*. https://www.who.int/reproductivehealth/publications/mhealth/classification-digital-health-interventions/en/

World Health Organization. (2019). *WHO guideline: Recommendations on digital interventions for health system strengthening. Research considerations*. https://www.who.int/publications/i/item/9789241550505

World Health Organization. (2020). *Global strategy on digital health: 2020-2025*. https://www.thecompass-forsbc.org/sbcc-tools/who-global-strategy-digital-health-2020-2025

APPENDIX

1. Gender:

- ☐ Male
- ☐ Female
- ☐ Other identities

2. Age:

- ☐ 18-24
- ☐ 25-29
- ☐ 30-34
- ☐ 35-39
- ☐ 40-44
- ☐ 45-49
- ☐ 50-54
- ☐ 55-59
- ☐ 60-64
- ☐ 65-69
- ☐ 70-74
- ☐ 75-79

3. What type of digital equipment do you use (you may select more than one option)?

- ☐ Smart phone (e.g., iPhone)
- ☐ Non-smart phone
- ☐ Tablet (e.g., iPad)
- ☐ Desktop computer
- ☐ Laptop
- ☐ Video camera (e.g., GoPro)
- ☐ Others (please specify: _____)

4. Do you have access to broadband/Wi-Fi internet at home?

- ☐ Yes
- ☐ No

5. If yes, how often do you access the Internet?

- ☐ Never
- ☐ Rarely (once a month)
- ☐ Once a week
- ☐ Several times a week
- ☐ Once a day
- ☐ Several times a day

6. In the following section, indicate how **confident** you are with creating/using the technology for your learning and research at the University. In addition, if you are not familiar with any of them, would you **like to learn** how to use this technology? Do you think it is **important and useful** for you to develop and achieve these skills to enhance career and professional development?

Technologies	I am confident with creating and/or using this tool □ Very □ Reasonably □ Somewhat □ A little □ Not	I would like to learn how to use this technology □ Yes □ No	It is important and useful for me to develop and achieve this skill □ Yes □ No
Creating blogs and wikis			
Creating audio-visual production			
Creating websites			
Creating applications			
Creating computer programs			
Creating graphics and images			
Creating podcasts			
Creating digitization of print and objects			
Creating e-books, self-publishing			
Using email			
Using Learning Management System (LMS)			
Using word processing software			
Using spreadsheet software			
Using presentation software (e.g., PowerPoint, Prezi)			
Using file-sharing and storage (e.g., Google Drive, Dropbox)			
Using statistics software (e.g., SPSS, MATLAB)			

Using reference management software (e.g., Endnote, Mendeley)
Using video conferencing tools (e.g., Skype, Facetime)
Using collaborative tools (e.g., Padlet, Trello)
Using curation tools (e.g., Diigo, Scoop.it)
Using data visualization tools (e.g., Tableau, Qilkview)
Using augmented and virtual reality
Using 3D printing
Using geospatial technologies (e.g., FalconView, GeoDa)

7. Please indicate if you use social media tools for the following activities (you may select more than one option).

- ☐ Learning
- ☐ Research
- ☐ Career and professional development
- ☐ Social
- ☐ No, I do not use social media tools

8. If yes, what kind of tools do you use (you may select more than one option)?

- ☐ Pinterest
- ☐ Google+
- ☐ Flickr
- ☐ Vimeo
- ☐ Facebook
- ☐ Twitter
- ☐ YouTube
- ☐ Instagram
- ☐ LinkedIn
- ☐ Other tools (please specify: _____)

9. Please indicate how often you use these online tools.

- Never
- Rarely (once a month)
- Once a week
- Several times a week
- Once a day
- Several times a day

10. I am aware of the lasting nature of digital material, and hence **actively** manage my security and privacy online.

- Very
- Reasonably
- Somewhat
- A little
- Not
- Not sure

11. In your own words, what do you understand by the term **digital skills and competencies?**

12. Do you think possessing digital skills and competencies will enhance your career and professional development?

- Yes
- No
- Not sure

13. Do you think you develop and achieve the relevant digital skills and competencies during your course of study?

- Yes
- No
- Not sure

14. Do you think you have the relevant digital skills and competencies when entering the workforce?

- Yes
- No
- Not sure

15. Do you think there is sufficient University support and services in developing your digital skills and competencies?

- Yes
- No
- Not sure

16. If you selected Yes to the previous question, please describe what the University has done to help you succeed in developing and achieving digital skills and competencies. If you selected No/Not sure to the previous question, please describe what the University needs to do to help you succeed in developing and achieving digital skills and competencies.

17. Any other comments?

AUTHORS

Kim Phuong Nguyen completed a Bachelor of Science at the University of Melbourne in 2018. She is currently studying Doctor of Optometry at the University of Melbourne.

Ayd'n Ken Luke completed a Bachelor of Science (Honours) at the University of Melbourne in 2017. He is currently studying Doctor of Optometry at the University of Melbourne.

Yutong Cheng completed a Bachelor of Biomedicine at the University of Melbourne in 2018. She is currently studying Doctor of Optometry at the University of Melbourne.

Aditya John completed a Bachelor of Science at the University of Melbourne in 2018. He is currently studying Doctor of Optometry at the University of Melbourne.

Kwang Meng Cham is an optometrist and a senior lecturer at the University of Melbourne. His educational scholarship interests include using digital technologies for feedback and assessment, inter-professional education, and inter-disciplinary object-based learning engaging with material culture. Kwang has received numerous educational research grants and has presented at national and international conferences on the scholarship of learning and teaching. He is currently a Fellow of the Melbourne Academy and an Associate Fellow of the Australian and New Zealand Association for Health Professional Educators. In recognition of his contributions to the scholarship of learning and teaching, Kwang received the Faculty of Medicine, Dentistry and Health Sciences Award for Sustained Excellence in Learning and Teaching in 2021.