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Student perceptions of and attitudes towards digital health education and technology

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ABSTRACT

Digital health education and an understanding of effective technology application are essential for shaping the clinical environments of the future. This requires an understanding of nursing students' attitudes and behaviours in health education. The objective of this study was to investigate nursing students' perceptions of and attitudes towards digital health technologies. The study employed a qualitative research method focusing on the independent work of the students enrolled in the 2023/2024 Digital Technologies in Health course. Qualitative data were collected through Moodle, the common e-learning platform at Tallinn Health University of Applied Sciences. The document analysis database consisted of 185 student self-reflections and self-assessments. Trust in technology and the use of software emerged as key factors in the learning process. Students recognised the importance of quality health data and demonstrated trust in utilising electronic records, even when lacking previous experience. Despite their positive attitudes towards digital technologies, significant challenges remain in the application of fundamental digital skills. The most pressing concerns are related to digital literacy and innovation. Students perceive the use of digital tools as potentially distancing healthcare professionals from patients, which raises ethical concerns, particularly in relation to their future professional roles. Nursing educators should prioritise fostering a strong professional nursing identity, with particular emphasis on the positive impact of digital health technologies in clinical practice.

Introduction

Information and communication technologies (ICT) are integral to modern nursing practice, making the development of these skills essential for ensuring that nursing graduates are adequately prepared to enter the healthcare workforce (Hack-Polay et al. 2023; Lekalakala-Mokgele et al. 2023; Abou Hashish and Alnajjar 2024; Martzoukou et al. 2024). The use of technology in health care has been recognised as a priority across many countries for improving the delivery of quality health care (Lekalakala-Mokgele et al. 2023). To meet this demand, it is recommended that digital literacy be strengthened within nursing curricula, equipping students with the necessary knowledge and skills to effectively utilise e-health and health technologies (George et al. 2017; Lekalakala-Mokgele et al. 2023; Wong et al. 2023). Understanding nursing students' attitudes and behaviours towards these technologies is crucial for achieving this goal (Hack-Polay et al. 2023; Abou Hashish and Alnajjar 2024; Martzoukou et al. 2024). However, future nurses may hesitate to implement different artificial intelligence (AI) solutions due to ethical concerns (Cho and Seo 2024). While previous research has established the importance of ICT for students' learning and readiness for practice (Levett-Jones et al. 2009; Liu et al. 2022; Ma et al. 2024), motivation among students is influenced by their level of confidence, competence, and perceptions of the relevance of information and ICT to their future careers (Levett-Jones et al. 2009). Exploring different perspectives is therefore important for enhancing learning experiences and improving student engagement with digital health technologies (Liu et al. 2022; Ma et al. 2024).

The aim of this research was to investigate nursing students' attitudes towards digital health technologies and their perceptions of the relevance of these technologies to clinical practice. The study sought to:

- Analyse second-year nursing students' attitudes towards the use of digital skills, including the identification and profiling of these attitudes and resources available to them.
- Explore students' perceptions of the relevance of digital health technologies to clinical practice.

2. Methodology

This study employed a qualitative research method. Document analysis as a research method is particularly well suited to qualitative case studies – intensive studies that provide rich descriptions of a single phenomenon. Documents of all kinds can help researchers find meaning, develop understanding, and uncover knowledge related to the research problem. The analysis of a document involves review, reading, and interpretation. This iterative process combines elements of content analysis and thematic analysis. Content analysis is the organisation of information into categories related to the central questions of the study (Bowen 2009). The evaluation was based on an analysis of the independent work of the students enrolled in the Digital Technologies in Health course in 2023/2024. Qualitative data were collected from Moodle, the common e-learning platform of Tallinn Health University of Applied Sciences, and consisted of 185 student documents, including self-reflections and self-assessments. The analysis focused on nursing students' experiences and attitudes toward the use of digital technologies in their learning as well as their perceptions of the application of these tools in clinical settings. The data were synthesised by extracting key findings, developing categories, and identifying synthesised findings. Four overarching themes emerged from the data concerning students' perceptions: 1) the need for digital learning, 2) enablers, 3) barriers, and 4) perceived benefits for learning. Three synthesised needs related to attitudes were identified: 1) confidence, 2) the need for a clinical environment, and 3) the choice of profession.

Self-reflection data were analysed employing inductive content analysis, a method well suited for interpreting text-based qualitative data. Qualitative content analysis enables a focus on the underlying implications of the text, which is particularly relevant when assessing its likelihood of acceptance and integration into broader contexts. It allows one to analyse latent contents, which means 'reading between the lines' to identify underlying meanings, intentions, and connotations within the text, providing a more nuanced understanding of the authors' perspectives (Kalmus et al. 2015).

The free-text feedback was simplified into expressions with similar meanings, categorised using substantive codes, and organised under relevant titles. Categories were named according to the content of the expressions. During the analysis, the results were grouped by academic year and compared to identify trends and patterns. The analysis resulted in fourteen subcategories, which were further merged into seven main categories, reflecting their interconnections (see Table 1).

Table 1. Categorisation of students' self-reflection

Substantive code	Subcategory	Main category
Previous experience	IT competences	Need for digital learning
Different levels of students		
Understanding the goals	Achievement of learning outcomes	
Level of competence achievement		
Technical support	Technical resources	Enablers
Means of study		
IT knowledge	Individuality of the student	
IT skills		
Learning styles		
Ethical concepts	Values	Barriers
Embracing		
Skills gaps	Gaps	
Knowledge gaps		
Quality of data	Support	Benefits for learning
Use of applications		
AI solutions	Assessment tools	
Decision support		
Equipment	Technology solutions	Confidence
E-platforms		
Telemedicine	Feasibility	
Cybersecurity		
Proliferation of e-solutions	Practical environments	Need for a clinical environment
Availability		
Ability to use	Quality of implementation	
Patient satisfaction		
Students' preferences	Essence of profession	Choice of profession
Philosophical insight		
Patient confidence	Personal value judgements	
Ethical values		

3. Results

The analysis revealed seven main categories: the need for digital learning, enablers, barriers, benefits for learning, confidence, the need for a clinical environment, and the choice of profession. The analysis revealed a strong correlation between nursing students' perceptions of the need for technology and their overall attitudes toward digital health solutions.

The results of the *need for digital learning* category showed that the topics covered in the course, including information processing, data analysis, and the interpretation of information according to professional specialisation, encouraged students to think more broadly. However, digital health solutions, particularly in healthcare administration, remained distant from many students' immediate concerns. By the end of the course, students reported significant improvements in their digital skills compared to their initial baseline. This was expressed in the following comments: '*… this knowledge is definitely important and will help me...*', '*... I can exchange information faster…*', '*… this helps me to document...*', '*... I can be precise...*'.

The category *enablers* showed that while most students recognised the importance of digital communication and collaboration for improving the quality of care, many lacked a clear understanding of the broader scope and benefits of these technologies, particularly from the patient's perspective. This was expressed in the following comments: '*... I need time to understand it...*', '*... I have used this system, I really liked it...*'.

One of the main *barriers* identified was students' previous IT experience and competence in using technology, which heavily influenced their attitudes. Students with limited IT literacy were more reluctant to engage with digital tools, found it difficult to comprehend the learning objectives, and required more time to complete assignments. Their overall satisfaction with the acquisition of new knowledge was low. This sentiment was reflected in comments such as: '*I just felt overwhelmed...*', '*... I thought, I can't do this...*', '*... Online learning is no way to learn…*'.

The category *benefits for learning* reflected the use of digital solutions that supported and facilitated students' work, positively influencing their attitudes. AI solutions, applications (apps), and decision support tools were generally well received. This was expressed in the following comments: '*… digital devices make my interactions with other health professionals faster…*', '*... digital devices help me to provide better care…*', '*… I didn't know that there are so many different apps to help patients...*', '*... I would like to try these solutions right now...*', '*… these decision support tools are convenient and save time...*'.

Confidence in using technology and software emerged as a key factor in successful learning. Many students felt confident using various applications, even without prior experience. However, the sheer number of applications made them uneasy, as they lacked the competence to assess their reliability. Despite this, students found healthcare-related smartphone apps useful for accessing evidence-based clinical information relevant to patient care. Many indicated they intended to continue using such apps in the future. Comments included: '*... what should I choose then?*', '*... how do I know which one is the better solution?*'.

The *need for a clinical environment* category shows that despite the positive attitude towards digital technology, there are still significant gaps in basic digital skills. Digital literacy and innovation posed major challenges, and digital tools were seen by some as a threat that could lead to disengagement with patients. Safety strategies related to digital identity, privacy, and personal data protection were highlighted as key concerns. Students expressed doubts about remote services, particularly in relation to patient trust and safety, with comments such as: '*... remote service is not suitable for all patients…*', '*… I wouldn't trust it myself...*', '*... how do I know who's speaking on the other side...*', '*… I can't assess a patient's condition from a distance...*', '*… most older people find it harder to use digital technology...*', '*... people are afraid to use digital technology…*'.

These concerns also raised ethical questions about students' *choice of profession*. The introduction of AI healthcare solutions often generated negative attitudes, particularly regarding professional identity. Students questioned the role of machines in health care, as reflected in their comments: '*... is a machine better than a human being?*', '*... why am I learning all this?*', '*… patients need warmth and closeness, only I can provide that...*', '*... I don't like these machines and modern things...*'.

4. Discussion

Despite the generally positive attitudes towards digital technologies and their widespread use in students' personal lives, gaps in confidence regarding the use of digital tools and software for learning remains. This study revealed that students' prior experience with technology significantly influences their attitudes toward digital health solutions. As Levett-Jones et al. (2009) argued, prior experience is a key factor in knowledge acquisition. The findings of this study confirm that prior exposure to digital tools incentivises students to engage more deeply with learning and explore new technological solutions. Conversely, students with limited experience were less confident and more hesitant to adopt new tools and approaches. Furthermore, the lack of clinical experience among students appears to restrict their understanding of the broader applicability of digital health technologies.

The study also found that students recognise the convenience of health apps for accessing evidence-based clinical resources, aligning with previous findings by George et al. (2017), Lekalakala-Mokgele et al. (2023), and Wong et al. (2023). Encouraging the early use of such tools within the nursing curriculum is critical for fostering familiarity with and confidence in digital health technologies. To address the identified gaps in digital literacy, nursing curricula must provide opportunities for hands-on experiences with these tools. Early, targeted digital literacy training, particularly before students begin clinical practice, is essential for improving their foundational digital skills.

Enhancing digital literacy throughout the nursing programme will facilitate a more seamless transition from the educational environment to clinical practice in an increasingly digital healthcare landscape. Previous studies by Levett-Jones et al. (2009), Liu et al. (2022), and Ma et al. (2024) have similarly emphasised the importance of technological literacy, particularly as students prepare to enter clinical environments where digital solutions are becoming integral to healthcare delivery.

Students expressed mixed feelings regarding the use of digital technologies, particularly from a safety and ethical standpoint. Many students were sceptical about the effectiveness of remote technologies, voicing concerns that not all patients are ready to engage with these tools and questioning whether they are truly safe. Additionally, students raised concerns about patient identification and the ability of patients to fully comprehend and use these technologies. While these doubts are justified and show that students are critically engaging with the potential risks, they were unable to articulate ways to mitigate these concerns or recognise the potential benefits of these technologies in improving the quality of care. AI solutions were met with a lukewarm response from students, many of whom expressed concerns about losing control over clinical decision-making and activities. This reluctance to embrace AI seems to stem from concerns about automation replacing core elements of nursing practice, including decision-making and patient care. Ethical concerns regarding the mechanisation and oversimplification of nursing tasks were prominent, with students highlighting how these trends conflict with the foundational philosophy of caring that defines the nursing profession. Cho and Seo (2024) identified similar issues, noting that students' fear and distrust of ICT in nursing practice are likely due to their limited clinical experience.

Because students have not yet had sufficient exposure to various technological solutions, they are unable to fully appreciate the benefits these tools offer, both in terms of improving the quality of care and optimising time resources. To address these concerns and better equip students with the skills and confidence needed to integrate technology into their future practice, it is essential to embed a range of technological experiences throughout the nursing curriculum. Integrating ICT into the nursing curriculum should include practical exercises and simulations that allow students to experience the use of technology in a real clinical environment. For example, students could participate in simulations where they use electronic health record systems, telemedicine solutions, and AI-powered diagnostic tools. Such hands-on experiences would allow students to see firsthand how these solutions can enhance care delivery and streamline processes, thereby reducing their apprehensions and building trust in technology. In addition to practical exercises, the curriculum should include theoretical instruction covering the ethical, legal, and practical implications of ICT. This would help students comprehend the impact of technology on patient privacy and confidentiality and introduce them to best practices for using these tools safely and effectively.

Given the critical and diverse roles that nurses fulfil across various healthcare domains, there is a pressing need for research to identify the foundational frameworks and alternative approaches to developing the digital competencies required for these professionals to work both effectively and efficiently.

5. Conclusion

Educators should place greater emphasis on the development of nursing identity, with a particular focus on the positive impact that digital health technologies can have in clinical practice.

Data availability statement

All data are available in the article.

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References

Abou Hashish, E. A. and Alnajjar, H. 2024. Digital proficiency: assessing knowledge, attitudes, and skills in digital transformation, health literacy, and artificial intelligence among university nursing students. *BMC Med. Educ.*, **24**(1), 508. https://doi.org/10.1186/s12909-024-05482-3

Bowen, G. A. 2009. Document analysis as a qualitative research method. *Qual. Res. J.*, **9**(2), 27–40. https://doi.org/10.3316/QRJ0902027

Cho, K. A. and Seo, Y. H. 2024. Dual mediating effects of anxiety to use and acceptance attitude of artificial intelligence technology on the relationship between nursing students' perception of and intention to use them: a descriptive study. *BMC Nurs.*, **23**, 212. https://doi.org/10.1186/s12912-024-01887-z

George, T. P., DeCristofaro, C., Murphy, P. F. and Sims, A. 2017. Student perceptions and acceptance of mobile technology in an undergraduate nursing program. *Healthcare*, **5**(3), 35. https://doi.org/10.3390/healthcare5030035

Hack-Polay, D., Mahmoud, A. B., Ikafa, I., Rahman, M., Kordowicz, M. and Verde, J. M. 2023. Steering resilience in nursing practice: examining the impact of digital innovations and enhanced emotional training on nurse competencies. *Technovation*, **120**, 102549. https://doi.org/10.1016/j.technovation.2022.102549

Kalmus, V., Masso, A. and Linno, M. 2015. Sotsiaalse analüüsi meetodite ja metodoloogia õpibaas. Kvalitatiivne sisuanalüüs (Learning base of social analysis methods and methodology. Qualitative content analysis). https://samm.ut.ee/kvalitatiivne-sisuanalyys/ (accessed 2024-12-12).

Lekalakala-Mokgele, E., Lowane, M. P. and Mogale, N. M. 2023. Knowledge, perceptions and attitudes of eHealth and health technology among nursing students from Gauteng Province, South Africa. *Healthcare*, **11**(12), 1672. https://doi.org/10.3390/healthcare11121672

Levett-Jones, T., Kenny, R., Van der Riet, P., Hazelton, M., Kable, A., Bourgeois, S. et al. 2009. Exploring the information and communication technology competence and confidence of nursing students and their perception of its relevance to clinical practice. *Nurse Educ. Today*, **29**(6), 612–616. https://doi.org/10.1016/j.nedt.2009.01.007

Liu, J. Y. W., Kor, P. P. K. and Kwan, R. Y. C. 2022. Exploring nursing students' perceptions of their learning experience in a

gerontological nursing course with a technology-mediated learning environment. *Innov. Educ. Teach. Int.*, **59**(3), 263–274. https://doi.org/10.1080/14703297.2020.1861963

Ma, H., Niu, A., Tan, J., Wang, J. and Luo, Y. 2024. Nursing students' perception of digital technology in clinical education among undergraduate programs: a qualitative systematic review. *J. Prof. Nurs.*, **53**, 49–56. https://doi.org/10.1016/j.profnurs.2024. 04.008

Martzoukou, K., Luders, E. S., Mair, J., Kostagiolas, P., Johnson, N., Work, F. et al. 2024. A cross-sectional study of discipline-based self-perceived digital literacy competencies of nursing students. *J. Adv. Nurs.*, **80**(2), 656–672. https://doi.org/10.1111/jan.15801

Wong, A. K. C., Bayuo, J., Wang, S., Kwan, R. Y. C., Lam, S. C. and Wong, F. K. Y. 2023. Factors associated with the perceptions of eHealth technology of Chinese nurses and nursing students. *Nurse Educ. Pract.*, **69**, 103605. https://doi.org/10.1016/j.nepr.2023.103605

Õendusüliõpilaste arusaamad digitaalsetest tervishoiutehnoloogiatest ja suhtumine nendesse

Jandra Sule

Digitaalsete tehnoloogiate rakendamise oskus tervishoius on õendusüliõpilaste jaoks võtmetähtsusega, et tulevikus kliinilises keskkonnas hakkama saada. Selleks on vaja mõista õendusüliõpilaste hoiakuid ja käitumist, mis mõjutavad otseselt teadmiste omandamist selles valdkonnas. Uurimuse eesmärk oli analüüsida õendusõppe üliõpilaste arusaamu digitaalsetest tervishoiutehnoloogiatest ja suhtumist nendesse. Uurimuses kasutati kvalitatiivset uurimismeetodit, keskendudes 2023./2024. õppeaasta kursuse „Digitaalsed tehnoloogiad tervishoius" üliõpilaste iseseisvatele töödele. Kvalitatiivsed andmed koguti Tallinna Tervishoiu Kõrgkooli ühise e-õppe platvormi Moodle'i kaudu. Dokumendianalüüsi andmebaas koosnes 185 üliõpilase enesereflekssioonidest ja -hinnangutest. Peamised tulemused näitavad, et usaldus tehnoloogia vastu ja erinevate tarkvarade rakendamise oskus osutusid õppeprotsessis võtmeteguriteks. Üliõpilased tunnistasid kvaliteetsete terviseandmete tähtsust ja näitasid üles usaldust elektroonilise dokumentatsiooni kasutamise suhtes, isegi kui neil puudusid eelnevad kogemused. Hoolimata positiivsest suhtumisest digitehnoloogiasse on digipädevuste baasteadmiste rakendamine märkimisväärne probleem. Samuti arvavad üliõpilased, et digitaalsete vahendite kasutamine võib distantseerida tervishoiutöötajaid patsientidest, mis omakorda tõstab esile mitmeid eetilisi küsimusi, eelkõige seoses nende tulevase kutsealaga. Õenduse õppejõud peaksid seadma prioriteediks tugeva professionaalse õendusidentiteedi edendamise, pöörates erilist tähelepanu digitaalsete tervishoiutehnoloogiate positiivsele mõjule kliinilises praktikas.