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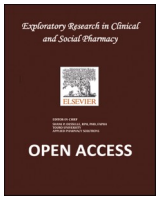

Exploring research and education opportunities in digital health for pharmacy, medicine and other health disciplines: Insights from a multinational workshop

Emina Obarcanin [a,b,*], Parisa Aslani [c], Andy H.Y. Ho [b], Carole Bandiera [c], Melissa Baysari [d], Iva Bojic [b], Adeola Bamgboje-Ayodele [d], Qi Chwen Ong [b], Heiko Spallek [e], Ronald J. Clarke [f], Stephanie Läer [a]

[a] Institute for Clinical Pharmacy and Pharmacotherapy, Henrich-Heine University Duesseldorf, Germany
[b] Lee Kong Chian School of Medicine, Nanyang Technological University Singapore, Singapore
[c] The University of Sydney, Faculty of Medicine and Health, School of Pharmacy, Australia
[d] The University of Sydney, School of Medical Sciences, Australia
[e] The University of Sydney, School of Dentistry, Australia
[f] The University of Sydney, Faculty of Science, School of Chemistry, Australia

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ABSTRACT

Digital healthcare has rapidly evolved during and in the post-COVID pandemic era, expanding the roles and responsibilities of community pharmacists. Services like telepharmacy, e-prescriptions, remote medication therapy management, and digital monitoring of chronic conditions, have evolved into everyday routine pharmacy practices. Pharmacists are at the forefront and the most accessible healthcare professionals for patients and are increasingly pivotal in providing comprehensive patient care, including digital patient care services. To ensure that future generations of pharmacists are digitally competent, it is crucial that digital health education is provided to pharmacy students. Furthermore, fostering high-quality multidisciplinary research, particularly in collaboration with medicine and other health disciplines, is essential for advancing the digital health skills of the future pharmacy workforce. Despite the growing use of digital health technologies, there are significant between-country differences in digital health education, the clinical settings in which digital health technologies are used, and their implementation in day-to-day practice. This commentary summarizes key insights from the International Digital Health Workshop held at the University of Sydney in November 2023. To help ensure pharmacists are included as participants in future digital health research, recent advances in digital health education and interprofessional research projects across three universities from far-off world regions were presented. Participants discussed a possible collaborative, interprofessional, and international research project on chronic disease prevention using digital health technologies. The need for interdisciplinary digital health curricula was highlighted in the workshop discussions, specifically tailored to address the knowledge requirements of pharmacists and other healthcare professionals.

1. Introduction

During and after the COVID-19 pandemic, digital healthcare became an important component of pharmaceutical care services within hospitals and community pharmacies.[1] Digital health technologies can help improve healthcare delivery and ensure continuous healthcare provision, supporting pharmacists and other healthcare professionals to overcome some of the current challenges such as shortages and disparities in healthcare.[2] By utilizing digital health tools and solutions healthcare professionals can deliver efficient and cost-saving interventions, as well as provide support to patients' self-management of their medications and chronic diseases.[3]

To prepare future pharmacists for the evolving landscape of digital healthcare, the education provided to pharmacy students must align with international trends in digital health.[4] In addition, schools of pharmacy should explore new options for collaborating with schools of

* Corresponding author at: Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore, 11 Mandalay Road, 308232, Singapore.
E-mail address: emina.obarcanin@ntu.edu.sg (E. Obarcanin).

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medicine and other health schools in interdisciplinary digital health projects. With this in mind, an international Digital Health Workshop was organized in November 2023 by the Institute of Clinical Pharmacy, Heinrich Heine University (HHU) Düsseldorf, Germany,[5] and the School of Pharmacy, The University of Sydney (USYD), Sydney, Australia,[6] and supported by the Lee Kong Chian School of Medicine (LKC Medicine), Nanyang Technological University (NTU), Singapore.[7]

This commentary provides a summary of the discussion that occurred around the following two major workshop goals:

1. To develop a concept for an **interdisciplinary, collaborative research project** investigating the use of digital health in pharmaceutical care and chronic diseases, involving researchers in Australia, Germany, and Singapore.

Expected outcomes included: a.) Establishing an international collaboration between universities encompassing pharmacy, medicine, and other health disciplines, b.) Identifying key research area in digital health and pharmaceutical care in chronic diseases, and c.) Facilitating the exchange of knowledge and sharing best practices among three universities.

2. To discuss an **international digital health competency framework** focused on pharmacy and to **explore opportunities for a joint digital health curriculum**.

Expected outcomes included a.) Defining core digital health competencies for pharmacy, b.) Comparing existing curricula in pharmacy education to identify gaps and to map where to include digital health content, and c.) Promoting collaboration between schools of pharmacy and other health disciplines, particularly medicine to create joint digital health curricula.

2. Workshop goal 1: discuss a concept for an international digital health research project

Participants from Australia, Germany, and Singapore discussed possibilities for developing a collaborative, interdisciplinary, and international project focused on chronic disease prevention using human-supported digital health technologies. To provide background information on developing such a project, presentations were given on several digital health projects, as well as on the creation and funding of research projects. Intellectual property, data protection, and other important regulations in digital health research were also discussed.

2.1. Examples of current digital health research

To facilitate brainstorming and ideas exchange, the three universities presented current digital health projects, followed by brainstorming sessions to explore collaboration opportunities. Projects presented were jointly evaluated based on feasibility, scalability, and impact. The aim was to identify whether a joint project could be built upon the presented results.

2.1.1. HHU - GIZ Germany mobile health project: Improving diabetes type 1 care in children and adolescents in Bosnia and Herzegovina

HHU presented a project that showed the value of mobile health apps in bridging healthcare gaps in underserved and remote areas. This collaborative project between the HHU and the German Development Agency in Bosnia-Herzegovina (GIZ) used mobile health apps to digitally connect adolescents with type 1 diabetes from rural and remote areas of Bosnia-Herzegovina to the main pediatric diabetology clinic in the capital city of Sarajevo.[8] Patients were trained to use a mobile health app and record their blood glucose levels through the app. The clinic diabetologists used these digital reports and app data to monitor the patients, offer digital counseling and advice, and provide immediate interventions if acute complications occurred. This project was evaluated as being an important project to safeguard young patients with diabetes from rural and remote areas, especially since long-term complications of poorly controlled diabetes can be debilitating, leading to retinopathy or nephropathy in many cases. The importance of the project to improve access to qualified diabetes care in rural and remote areas by using the mobile health app, and the ability to reduce the risk of long-term complications and project long-term implementation were discussed among workshop participants.

2.1.2. Artificial intelligence (AI) Symbiosis, digital health, and human health coaching (CADENCE) in Singapore

LKC Medicine presented the design of their Artificial Intelligence (AI) Symbiosis, Digital Health, and Human Health Coaching project (CADENCE), as part of the national clinical translational program, aimed at synergizing cardiovascular research and technology capabilities across Singapore.[9] CADENCE (Platform 3/Use Case 3) is a multicenter randomized controlled trial (RCT), which entails the development of CADENCE D-PHA (CADENCE **D**igital **P**ersonal **H**ealth **A**ssistant) mobile health app by the LKC-NTU Singapore team. The effect of the app combined with integrated human health coaching on improving medication adherence to cholesterol-lowering medications in patients with hyperlipidemia will be compared to that of standard care. Usage analytics will be used to provide patients with a personalized learning experience. Moreover, large language models will be fine-tuned based on the health coaching transcripts collected from this RCT to build an AI-driven health coach within the CADENCE D-PHA mobile health app. Following the presentation of the CADENCE project, it was discussed if a similar project would be scalable for other countries and other chronic disease conditions, such as hypertension or diabetes to prevent cardiovascular complications.

2.1.3. Optimizing virtual care technologies between general practice and residential aged care: a human factors approach in Sydney, Australia

The Digital Health Human Factors research group at the USYD presented a project addressing the lack of timely access to high-quality general practice services for people in residential aged-care homes.[10] The Optimizing Virtual Care Technologies between General Practice and Residential Aged Care: A Human Factors Approach project will evaluate a suite of virtual care and remote monitoring technologies across a primary health network. Human Factors is a scientific discipline that applies knowledge about people's limitations and capabilities to improve interactions between people and their environments, including technologies.[11] An example of a human factors theoretical model is the Systems Engineering Initiative for Patient Safety (SEIPS). SEIPS depicts how work systems affect health-related outcomes and facilitates understanding or designing sociotechnical systems.[12] The model looks at the interaction between the human workforce, assignments, tools, and technology, conditions at work, and work organization to enhance processes and safety (Fig. 1). SEIPS provides a comprehensive structure for understanding work systems, processes, and outcomes in health care and has been used extensively in patient safety research.[14]

SEIPS model has been reported as a powerful tool for identifying barriers and facilitators in healthcare work processes to understand healthcare work processes relevant to primary care,[14] medication administration in hospitals,[15] and outpatient care in patient homes.[16] More specifically, in a case study applying the SEIPS model to identify work system barriers and facilitators to three primary care processes, the authors purposively selected staff (care managers, providers, nurses, administrators, and patient access representatives) from two clinics to observe and interview. Based on the data collected, they conducted a work system analysis, creating process maps that showed the activities within a process and their corresponding barriers which could be targeted using implementation strategies to facilitate uptake.[15] In total, they identified 17 barriers and 10 facilitators spread across the people, tasks, organizations, environment, tools, and technology domains. With

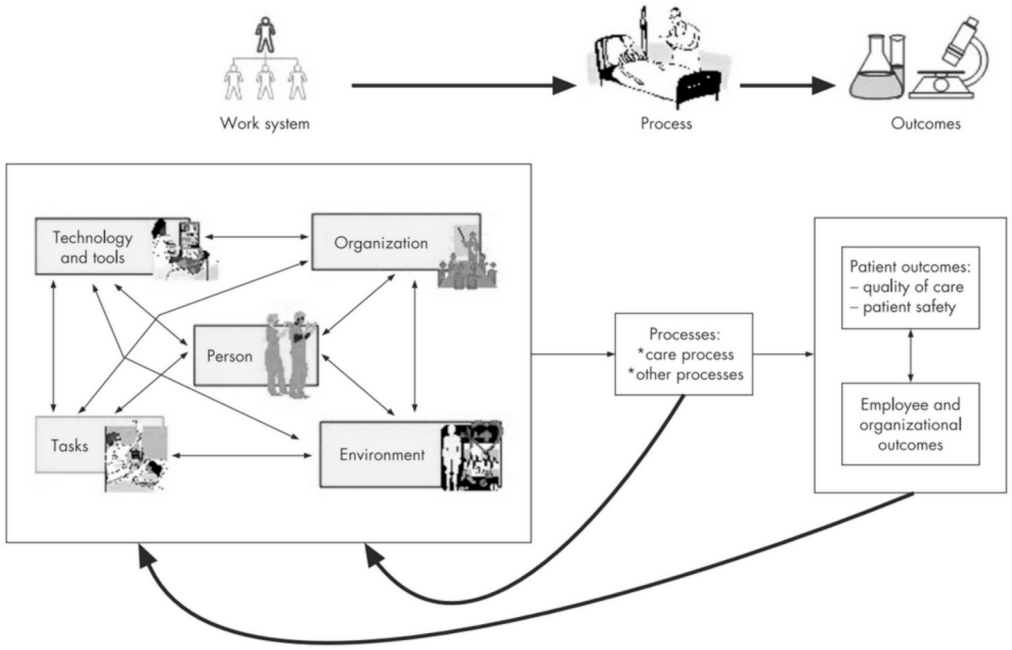

Fig. 1. SEIPS model of work system and patient safety[13] reproduced from [Carayon P, Schoofs Hundt A, Karsh BT, et al. Work system design for patient safety: the SEIPS model. Qual Saf Health Care. 2006 Dec;15 Suppl 1(Suppl 1):i50–8.] with permission from BMJ Publishing Group Ltd.

tools and technology having the highest number of barriers ($n = 11$), efforts (e.g. re-design of technologies) to improve uptake could be concentrated on this domain. Similarly, a human-factors approach using the SEIPS model will be used to evaluate the usability of the technologies and factors impacting their uptake and sustainability in the residential care setting.[13] The SEIPS model will also be applied to analyze how individuals, tasks, technologies, tools, and environmental and organizational factors interact when the suite of virtual care technologies is used. We will conduct scenario-based observations, interviews, and cognitive walkthroughs. We will then use the SEIPS model to guide observations of scenario-based simulations, semi-structured interviews, and cognitive walkthroughs to explore staff and resident perceptions of the virtual care service and how it integrates into the 'work system'.[17] To ensure the successful uptake of virtual-care technologies and digital health tools, it is imperative that their design considers end-user factors, including clinician workflow and patient 'life flow'. Moreover, to enable their successful use, the design of digital health tools should be aligned with human capabilities and limitations.

2.1.4. Dentroid technologies: development of a miniaturized robotic laser device for ultra-precise and pain-free dentistry in Australia

The School of Dentistry at USYD reported on the importance that healthcare professionals are not only equipped to digitally utilize data and informatics but are also ready to contribute to the development and advancement of future technologies. The essentials for successful digital health projects, including the need for clear objectives and expected patient-related and other outcomes were presented. As an example of pioneering new technology, an overview of the Dentroid technology was provided.[18] Dentroid technologies provide minimally invasive dentistry by employing miniature robotics, and advanced lasers to replace conventional dental tools, such as drills, needles, and water sprays, and support the decisions of the clinician by incorporating built-in smart analytics and diagnostic aids. This project was evaluated as a breakthrough project with high relevance for dentistry. However, it is not directly applicable to pharmacy or medicine. Nevertheless, this project gave the participants important insights into the need for developing new tools that optimize the delivery of chronic patient care and enhance patient outcomes.

3. Creation and funding of research

The creation and funding of successful research projects, including collaboration with industry, were among the topics examined by an industry-academia panel. The panel involved national incubators, law experts, and industry consultants to bring together academia and science to elicit how to better address healthcare shortages, build interprofessional research, and connect important stakeholders in chronic disease with digital health. The discussion focused on the important relationship between industry and academia, focusing on the relevance of the project, its innovation, and scalability.

It is challenging to obtain funding for digital health academic research projects. These projects need to be aligned with the digital health industry's needs, even before their initiation. The outcomes considered need to be relevant and applicable in the real-world setting. The industry is often willing to invest in research that addresses its needs, expecting, however, that the results translate into commercially viable applications in return. Considering industry needs is a very important step, as such research projects are more likely to be funded, ensuring continuation and success. For example, a collaborative digital health project, which will create an app or medical device/tool for managing a chronic health condition should primarily focus on the rapid adoption of that specific app or tool. Demonstrating the real-world usage of such digital health tools through a small feasibility study can be an important step in attracting investors. The project needs to address long-term public health problems and identify potential investors who have an interest in resolving such problems. Concerning the workshop goal of developing a concept for a joint project in digital health, the potential sources of research funding were explored, including programs offered by the Deutscher Akademischer Austauschdienst (DAAD, German Academic Exchange Service) to support young researchers and academic projects[19] and the EU Framework Program for Research and innovation.[20]

To successfully address the primary workshop goal, the participants discussed the development of an international (i.e., Australia, Germany, and Singapore) research project involving an interdisciplinary team of pharmacists, physicians, and other health professionals. It was agreed that the joint project needs to focus on the use of human-supported

digital health technologies in chronic disease, particularly in patients in under-serviced rural and remote areas. The area of diabetes was agreed upon as the disease area of interest, especially in pediatric and adolescent populations, with a focus on the key area of prevention and long-term implementation of the intervention using implementation sciences methodologies and designs.[21]

In addition, the workshop participants agreed on the advantages of having a collaborative digital health project, as such a project offers shared expertise, best practice, and resources, and brings together international digital health perspectives and diverse study populations and settings.

To move forward with the project, the project teams need to be chosen to conduct a literature scoping review to identify key chronic disease area requiring further study, define project goals, and search for funding opportunities. The EU Framework Program for Research and Innovation may be a potential source of funding, emphasizing the importance of collaboration between the European Union and non-EU countries such as Australia and Singapore.[20]

4. Workshop goal 2: exploring the potential for an interdisciplinary competency framework for digital health

The second goal of the workshop was to develop an international interdisciplinary competency framework for digital health focused on pharmacy. This goal was set to guide digital health curricula for pharmacy, medicine, and allied health disciplines and to include recent digital health technologies in teaching and clinical practice. To achieve this goal, interdisciplinary curricula in digital health that have been implemented across the three participating universities were presented and discussed, which served as a starting point for discussion on the future development of enhanced digital health curricula.

4.1. Examples of current digital health curricula and education

4.1.1. Digital health elective practical and teaching at HHU Duesseldorf, institute of clinical pharmacy and pharmacotherapy

Mobile health and digital health tools have been successfully integrated into the curriculum of clinical pharmacy at HHU since 2019. The German Government has emphasized the need for increased use of mobile health, which involves the use of mobile devices and digital technology in healthcare, with Germany being the first country to allow digital health applications to be prescribed and reimbursed.[22,23] This recommendation encouraged collaboration among physicians, healthcare professionals, and patients to harness the potential benefits of such technology.[23] The integration of digital healthcare has swiftly progressed in the routine delivery of pharmaceutical care in both hospitals and community pharmacies.[24] In response to these, the Institute of Clinical Pharmacy and Pharmacotherapy at HHU introduced in October 2019 an elective practical course in digital health. The initial focus of the practical course was on the use of mobile health apps in managing diabetes.[25,26] This innovative approach by HHU aims to align pharmacy education with the trends in digital health and to ensure that the practice of pharmacists reflects these advancements.

4.1.2. Digital health education: a faculty-wide approach embedding digital health content into the curriculum of health disciplines at USYD

The importance of unifying digital health education between the schools of medicine, pharmacy, and other health disciplines was presented by the USYD. The USYD has prioritized digital health education and has taken a faculty-wide approach to embedding digital health content into the curriculum of health disciplines. This process involved auditing content and mapping content to a digital health capability framework to identify education gaps. Those gaps are now being filled by taking an individualized approach (e.g., new study units, guest lectures, and assessments) to suit the needs of each health school.

4.1.3. Digital health coaching curriculum for sleep improvement undergraduate and postgraduate students at NTU Singapore

Peer coaching for sleep improvement, a digital health coaching curriculum for undergraduate and postgraduate students at NTU Singapore was presented. This 8-week elective module is aimed at nurturing digitally competent peer health coaches and preparing them to take the role of health ambassadors within the campus and their community. This curriculum differs from conventional health coaching training programs as it highlights the integration of digital health technologies into coaching practice, such as remote monitoring using mobile health apps and wearables, remote coaching, and conversational agents. It also incorporated practical sessions, in which students were given a wearable device to use throughout the course, offering them hands-on experience in monitoring and interpreting various parameters. Some of the students who completed the course further participated in a pilot program that used AI-assisted health coaching intervention to improve sleep among university students.[27]

These presentations were followed by a discussion on the implications of digital health technologies on the education provided by pharmacy schools. The participants concluded that it is of the utmost necessity to provide a basic level of digital health education in schools of pharmacy to achieve uniform and consistent digital health competency levels. Standardized digital health education for pharmacy students would ensure consistent and adept use of digital technologies, ensuring that potential errors are minimized and patient safety improved. Future pharmacists should understand how to use electronic health records, telemedicine platforms, and other digital tools and be able to provide digital education and counseling to patients. Furthermore, standardizing digital health education between pharmacy, medicine, and other healthcare disciplines will ensure that all future healthcare professionals possess a baseline level of digital health competency.

4.2. Limitations and future directions

While our digital health workshop successfully met its primary goals of exchanging knowledge and discussing potential joint projects in digital health care delivery and teaching, it also entails certain limitations. Firstly, an in-depth analysis and evaluation of the presented projects and initiatives, including discussing strengths, weaknesses, challenges, and opportunities associated with each project could not be discussed due to time constraints. It remains a crucial future task to conduct an in-depth analysis to elicit the most suitable joint initiative. Secondly, ethical considerations and limitations associated with digital health research and education initiatives have been briefly touched upon, but a more detailed discussion and analysis of data privacy and security, equal access to digital technologies, and the reliability of digital health tools is warranted and needs to be included in future discussions and planning steps. Thirdly, the different cultural and contextual factors and different digital healthcare practices were not discussed. However, the attendees acknowledged its significance and were aware that each region has unique cultural and contextual factors, which need to be analyzed and included in further project planning.

Future directions include discussing the long-term impacts and implications of integrating digital health education into pharmacy and healthcare curricula, such as improved patient outcomes and healthcare delivery, creating a digitally enabled healthcare workforce, and promoting sustainability in the healthcare system. However major challenges such as resistance to change and insufficient uptake of digital technologies need to be considered, and also lack of resources, digital healthcare disparities, and cultural and contextual factors need to be evaluated to ensure the project's success. Specific strategies to overcome resistance to change and to increase uptake of digital technologies may include:

- Providing education and training in digital health tools and technologies

- Introducing digital health tools and technologies in clinical education and teaching to ensure their continuous adoption
- Ensuring support by higher management and faculty
- Providing pilot programs across the curricula and collecting feedback from students and faculty
- Using simulations, electronic health records (EHRs), telehealth, mobile and wearable health technology (mHealth), and artificial intelligence (AI) across clinical curricula.
- Providing hands-on experience and creating more opportunities for faculty and students to learn about existing technologies and become involved in the design and implementation of new technologies[28]
- Offering collaboration with the digital healthcare industry, start-ups, and workforce in hospitals and pharmacies
- Offering specific training programs in digital health technologies to support the effective use of digital technologies for education and in the workplace[28]

Some examples of successful strategies for integrating digital health technologies into pharmacy and medical curricula include MyDispense, which was developed by Monash University.[29] It simulates a community pharmacy where students can practice dispensing prescriptions, supply of medicines, and provision of advice. MyDispense has been used in over 80 schools of pharmacy and over 630,000 digital (virtual) exercises have been completed by students all over the world.[29] Another example is SimPHARM™ which is a web-based program with virtual patient cases, ranging from very simple medical ailments through to more complex cases that reflect the complexity of pharmacy practice.[30] At HHU Duesseldorf a High Fidelity Simulator, a sophisticated mannequin operated by software that simulates changes in physiological parameters, is used to teach vaccination to pharmacy students. The innovative course developed by HHU was tested by other pharmacy schools, the universities in Bonn and Greifswald, with plans to integrate vaccination training into the German pharmacy curriculum in the future.[31]

Future planning needs to include actions such as stakeholder engagement (i.e., collaboration with government, ministries of health and education), policy frameworks, and more flexible digital health curricula to help tackle major challenges. To ensure the relevance and effectiveness of the proposed initiatives, future planning should encompass end-users (i.e., patients and healthcare professionals), students, and educators/faculty to obtain their feedback throughout the process and ensure that the project's goals align with their needs and priorities. To collect end-user feedback surveys of faculty, students, practicing pharmacists, and clinicians will be planned and conducted. The surveys will help elicit their requirements, preferences, and expectations regarding the digital health curricula and a joint digital health project. In addition to surveys, a focus group study to explore the views of faculty and practicing pharmacists on digital health competencies, training needs and strategies to address challenges with digital health technologies will be carried out. Incorporating end-user feedback will make our project outcomes more relevant, comprehensive, and applicable.

Finally, after a comprehensive, relatable, and relevant project has been agreed upon, a robust evaluation and monitoring plan will need to be implemented to assess the effectiveness and impact of digital health interventions.

5. Conclusion

This workshop held at the University of Sydney in Australia marked a significant step towards advancing international collaboration in digital health research and education with pharmacy at the forefront. The workshop successfully addressed the important goal of developing a concept for an international digital health research project, focusing on chronic disease prevention. Collaboration among three universities from three distant world regions was successfully established, enabling the exchange of knowledge and sharing of best practices. The main research area of utilization of digital health in pharmaceutical care and chronic disease management was successfully explored. The workshop was designed with a vision to promote digitally enabled pharmacists in the long run, collaborating with other health disciplines. Topics could be addressed to explore a competency framework for digital health in pharmacy education, providing opportunities for a joint digital health curriculum among participating universities. Moreover, insights gained during discussions of multidisciplinary curricula for digital health highlighted the importance of integrating digital health education into pharmacy and other health curricula. This workshop represented a first step on the way to building an international competency framework, needed to ensure the full benefit of digital health technology for patients and future healthcare providers across very distant global regions.

Moving forward, the first step will include a comprehensive joint literature review to support the first workshop goal, which is to define the scope of the collaborative research project. This process will involve identifying gaps in primary prevention strategies for chronic diseases and highlighting areas where digital health interventions can make significant contributions. Mapping competencies across the three participating universities and a comparison of current local frameworks as a next step will assist with achieving the second workshop goal of creating an international competency framework that spans three regions of the world.

More international programs and initiatives like this are needed to provide our upcoming healthcare workforce with the digital skills necessary to effectively address the current issues related to the shortage of healthcare, the aging population, and preserving health and well-being.

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CRediT authorship contribution statement

Emina Obarcanin: Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Parisa Aslani:** Writing – review & editing, Supervision, Project administration, Formal analysis, Data curation, Conceptualization. **Andy H.Y. Ho:** Writing – review & editing, Writing – original draft, Formal analysis. **Carole Bandiera:** Writing – review & editing, Writing – original draft, Formal analysis. **Melissa Baysari:** Writing – review & editing, Writing – original draft, Formal analysis. **Iva Bojic:** Writing – review & editing, Writing – original draft. **Adeola Bamgboje-Ayodele:** Writing – review & editing, Writing – original draft. **Qi Chwen Ong:** Writing – review & editing, Writing – original draft. **Heiko Spallek:** Writing – review & editing. **Ronald J. Clarke:** Writing – review & editing. **Stephanie Läer:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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