

Outcomes of implementing updated curricula for enhancing digital competence in undergraduate and post-diploma nursing education

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ABSTRACT


Aim: To assess the effectiveness of updated curricula in developing digital competence and enhancing the use of information and communication technologies in healthcare at the undergraduate and post-diploma levels of nursing education.

Materials and Methods: The updated 'Digigram for Healthcare Professionals' test tool, consisting of 75 questions, was utilized to assess the digital competence of 90 students and 136 practicing nurses before and after training in the Health Informatics curricula, updated through the USAID Health Reform project grant program at Zhytomyr Medical Institute in Ukraine during the first half of 2024. Additionally, the satisfaction of both groups with the curricula content was evaluated.

Results: Students' digital competence increased by 71% following the updated curricula training. The proportion of students with digital competence levels A (Proficient) and B (Above Basic) rose by 38%, from 27% to 65%. Among nurses, digital competence improved by 10%, with the proportion of those at levels A and B increasing by 14%, from 57% to 71%. Additionally, 93% of students and 94% of nurses expressed satisfaction with the content of the new curricula.

Conclusions: The effectiveness of the updated Health Informatics curricula in developing digital competence and promoting the use of information and communication technologies in healthcare for nursing students at undergraduate and post-diploma educational institutions has been demonstrated.

KEY WORDS: curriculum, nurses, digital health, capacity building

Wiad Lek. 2024;77(11):2161-2167. doi: 10.36740/WLek/197087 

INTRODUCTION

In today's world, information and communication technologies (ICT) have become an integral part of the healthcare industry. The World Health Organization (WHO), in its Global Strategy for Digital Health 2020-2025, emphasizes the critical importance of fostering digital competence among healthcare professionals [1]. This objective is also reflected in the national digital health strategies of various countries. It is particularly essential for nurses, who constitute a vital segment of the healthcare workforce and require the necessary knowledge, skills, motivation, and support to effectively integrate ICT into their practice [2]. Insufficient digital competence can result in medical errors, compromised quality of healthcare services, and adverse patient outcomes [3]. Thus, continuous education and professional development for nurses, tailored to their levels of expertise and aimed at identifying barriers and enablers of digital competence development, are crucial for ensuring

high-quality healthcare delivery [4, 5]. This need is especially relevant for Ukraine, where the rapid expansion of eHealth initiatives and the electronic healthcare system (EHS) have increased the demand for improved digital competence among the healthcare workforce. The Digital Competence Framework for Healthcare Professionals (hereinafter – the DigComp Framework for HCPs), approved by the Ministry of Health of Ukraine in October 2023, outlines the requirements for digital competence and ICT utilization in healthcare [6].

An assessment conducted by the USAID Health Reform Support (USAID HRS) project in 2021 revealed that only 44% of healthcare workers possessed above-basic digital literacy, 35% had basic skills, and 21% were at the beginner level. Furthermore, only 37% of respondents had received digital literacy training in the last three years [7].

The low level of digital literacy among healthcare professionals in Ukraine indicates the limited involvement

of the medical education sector in the digital transformation of healthcare system. This issue stems from outdated curricula for digital competence development across all stages of medical education — undergraduate, graduate, postgraduate, and continuing professional development [8]. In response, the Government of Ukraine has adopted a number of legislative measures aimed at enhancing the level of digital competence of the healthcare workforce [9-11].

Developing digital competence among nurses has become a critical priority in the modern digital era, as it is essential for ensuring high-quality medical services and driving the successful digital transformation of the healthcare system.

AIM

The aim of this study was to assess the effectiveness of updated curricula in developing digital competence and enhancing the use of ICT in healthcare at the undergraduate and post-diploma levels of nursing education.

MATERIALS AND METHODS

To achieve the research objective, digital competence levels were assessed in accordance with the DigComp Framework for HCPs [6], which comprises five domains (Fig. 1).

The study employed an updated pilot version of the “Digigram for Healthcare Professionals” (hereinafter – Digigram) [12], which was modified in accordance with the DigComp Framework for HCPs and consisted of 75 questions. Digital competence levels were evaluated based on the number of correct responses: A – Proficient (60-75 points); B – Above Basic (45-59 points), C – Basic (30-44 points); D – Low (15-29 points); F – No Skills (0-14 points).

Guided by the DigComp Framework for HCPs and addressing the needs of Ukraine’s modern healthcare system, the staff of Zhytomyr Medical Institute (hereinafter – ZhMI) working alongside with external experts on digital health education, developed new curricula for ‘Basics of Health Informatics’ aimed at both nursing students and practicing nurses [13]. During the first half of 2024 the curricula engaged 101 second-year undergraduate students from ZhMI enrolled in the updated Health Informatics programs, as well as 171 practicing nurses who attended continuing professional development courses at ZhMI. The students’ training under the updated program spanned 15 weeks, comprising a total of 90 hours: 20 lecture hours, 22 hours of practical sessions, and 48 hours of individual work. Classes were delivered in a hybrid format (both in-person and online) by Health Informatics instructors.

For practicing nurses, an intensive 6-hour advanced training course on the use of ICT in healthcare was organized, with 2 hours dedicated to lectures, and 4 hours to practical exercises. The training was conducted online by the faculty from the Department of Health Informatics and Postgraduate Education at ZhMI.

To assess the effectiveness of these curricula, the number of correct answers for each domain of the DigComp Framework for HCPs was recorded before and after training, and the statistical significance of the differences between the results was evaluated.

Additionally, a survey was conducted to assess satisfaction with the list of topics and the relevance of the information provided both prior to the modified curricula implementation and after the completed training. Satisfaction with the updated curricula was measured using an anonymous online questionnaire, employing a 5-point Likert scale.

The results were statistically analyzed using the D’Agostino-Pearson test to assess the normality of the sample distribution. The median (Me), 95% confidence interval was determined for each quantitative parameter. Qualitative data were presented as a percentage of the trait and 95% confidence interval. For normally distributed data, the Student’s paired T-test was applied to compare the means of two samples (before and after training). For non-normally distributed data, the Wilcoxon W-test was used to compare the central tendencies of paired samples. The McNemar’s test with the continuity correction was used to calculate the p-value in a binary comparison of the level of digital competencies and satisfaction of curricula. Statistical analysis was conducted using MedStat v5.2 software. A p-value <0,05 was considered as statistically significant.

The study adhered to the ethical standards and principles of the Helsinki Declaration. Ethical approval was obtained from the Zhytomyr Medical Institute Bioethics Committee (Protocol No. 4 June 12, 2024).

RESULTS

The analysis of learning outcomes was based on data from participants who completed both pre- and post-training surveys: 90 students (89,1% of those engaged with the updated curricula) and 136 nurses (79,5% of those engaged). The mean age of students was $17\pm 0,4$ years, with a male-to-female ratio of 0,37. Among practicing nurses, the mean age was $39\pm 1,8$ years, with a male-to-female ratio 0,09.

Table 1 presents a comparative analysis of digital competence levels among nursing students, before and after training, categorized by the domains of the DigComp Framework for HCPs.

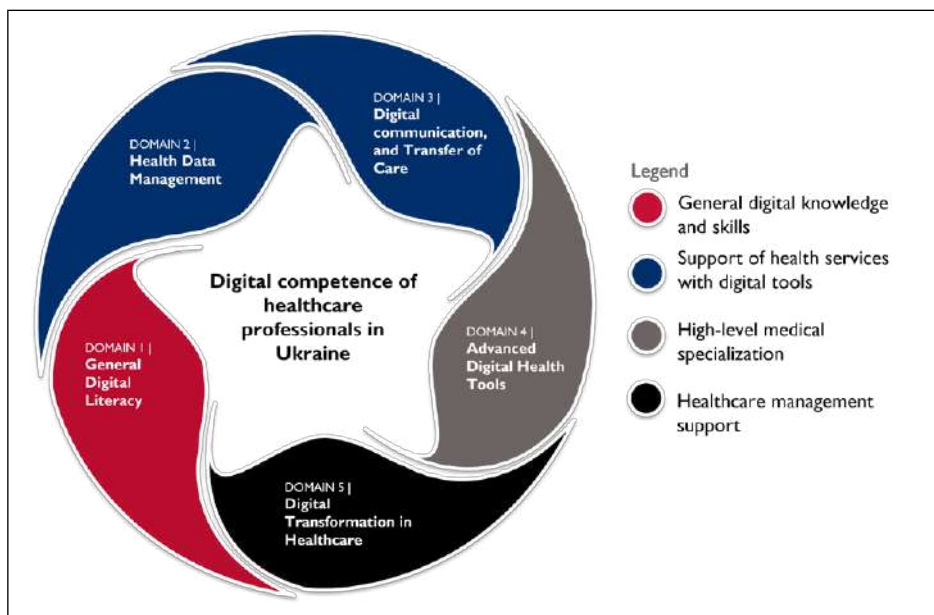


Fig. 1. Domains of the DigComp Framework for HCPs for Healthcare Professionals.

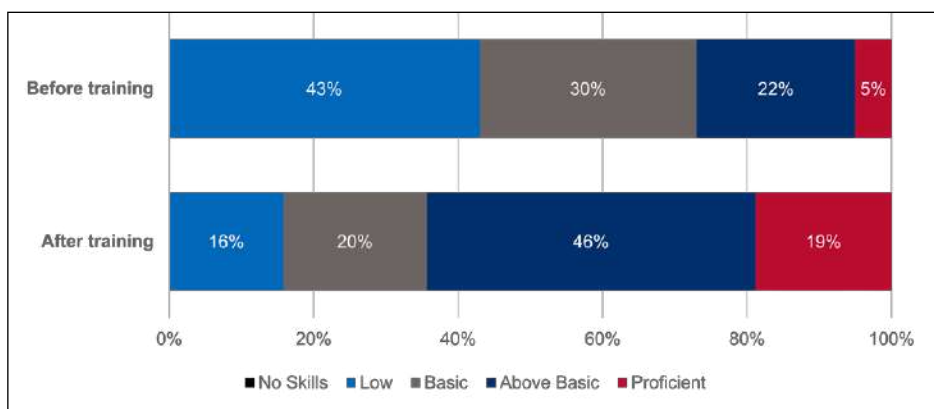


Fig. 2. Proportion of Students by Levels of Digital Competence Before and After Training (N=90).

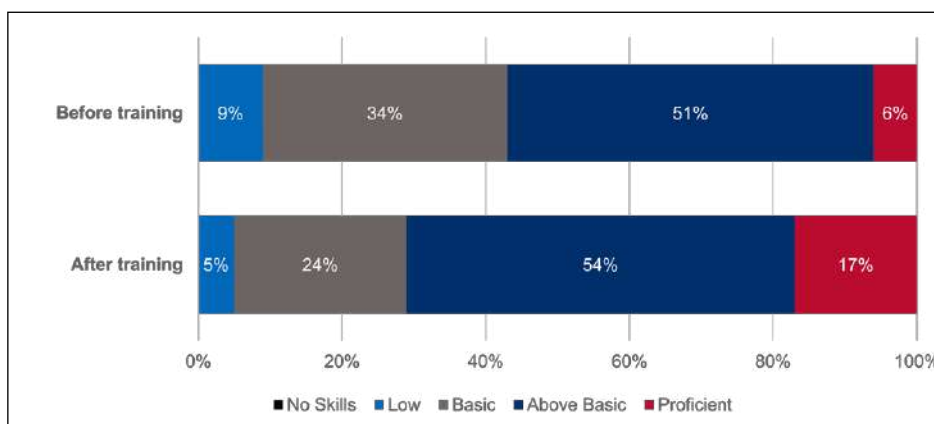


Fig. 3. Proportion of Nurses by Digital Competence Levels Before and After Training (N=136).

The results demonstrated a high level of digital competence in Domain 1, which covers general digital literacy. Additionally, the updated training curricula led to a 30% increase in the number of correct responses within Domain 1. For the other domains of the DigComp Framework for HCPs, the number of correct responses increased by 67% to 100% following the training.

Before the training, the number of correct answers across all areas of the DigComp Framework for HCPs

was $31 \pm 1,8$ (95% CI: 29-37), representing 42% of the total 75 possible answers. After the training, the proportion of correct answers increased to 71%, with the number of correct answers rising to $54 \pm 1,8$ (95% CI: 49-56).

Regarding the distribution of respondents by their levels of digital competence (Fig. 2), it was observed that before the training, 27% of respondents achieved levels A (Proficient) and B (Above Basic). Following the

Table 1. Assessment Results of Students' Digital Competence Before and After Training of the Updated Curriculum (N=90)

DigComp Framework for HCPs domains	Number of correct answers (max – 15)		% increase
	Before training	After training	
Domain 1	10±0,4 (95% CI: 9-11)	13±0,4 (95% CI: 12-14)	30*
Domain 2	6±0,3 (95% CI: 5-7)	10±0,4 (95% CI: 9-11)	67*
Domain 3	6±0,4 (95% CI: 5-7)	10±0,4 (95% CI: 9-11)	67*
Domain 4	5±0,4 (95% CI: 4-6)	9±0,5 (95% CI: 8-10)	80*
Domain 5	5±0,4 (95% CI: 4-9)	10±0,5 (95% CI: 8-11)	100*
Total	31±1,8 (95% CI: 29-37)	54±1,8 (95% CI: 49-56)	71*

Note: *p<0,001.

Table 2. Assessment Results of nurses' Digital Competence Before and After Training with the Updated Curriculum (N=136)

DigComp Framework for HCPs domains	Number of correct answers (max – 15)		% increase
	Before training	After training	
Domain 1	11±0,3 (95% CI: 10-12)	13±0,3 (95% CI: 12-14)	18*
Domain 2	8±0,2 (95% CI: 7-9)	9±0,2 (95% CI: 8-10)	13*
Domain 3	9±0,3 (95% CI: 8-10)	10±0,3 (95% CI: 9-11)	11*
Domain 4	8±0,3 (95% CI: 7-9)	9±0,3 (95% CI: 8-10)	13*
Domain 5	9±0,3 (95% CI: 8-10)	10±0,3 (95% CI: 9-11)	11*
Total	46±1,1 (95% CI: 44-49)	51±1,2 (95% CI: 49-52)	10*

Note: *p<0,05.

training, this proportion increased to 65%, reflecting 38% improvement (p <0,001).

Table 2 presents a comparative analysis of the digital competence levels among the surveyed nurses before and after training, across the domains of the DigComp Framework for HCPs.

Before engaging with the updated program, nurses averaged 46 correct answers out of 75, representing 61% of the total, which is higher than the 42% average achieved by undergraduate students. Additionally, the updated program led to a notable increase in the number of correct answers across all areas by 10%, based on the 6 hours of training provided.

Regarding the distribution of nurses by their levels of digital competence (Fig. 3), it was observed that before the training, 57% of respondents were at levels A (Proficient) and B (Above Basic). After the training, this proportion rose to 71%, representing a 14% increase (p=0,004).

The final phase of the study involved comparing subjective assessments of satisfaction with the previous and the updated curricula among 57 students and 96 nurses (56,1% and correspondingly 56,4% of those engaged with the updated curricula). For students, satisfaction rose from 63% (95% CI: 50%-75%) with the previous curriculum to 93% (95% CI: 85%-98%) with the updated curriculum (p<0,001). Likewise, for nurses, satisfaction increased from 60% (95% CI: 50%-70%) with the previous curriculum to 94% (95% CI: 88%-98%) with the updated curriculum (p<0,001).

DISCUSSION

The study allowed for the assessment of digital competence levels among students and practicing nurses before and after their participation in the updated Health Informatics curricula. The findings revealed that the revised curricula significantly enhanced digital competence at both the undergraduate and post-diploma levels.

In particular, the number of correct answers increased by 71% (from 32 to 54 out of 75 possible) following the students' engagement with the updated curricula. The most significant improvements were observed in the domains of "Digital Transformation in Healthcare" (100%), "Advanced Digital Health Tools" (80%), "Health Data Management" and "Digital Communication, and Transfer of Care" (67%). The proportion of students demonstrating Proficiency and Above Basic skills increased by 38% (from 27% to 65%). The relatively modest increase in the domain of "General Digital Literacy" is likely to the fact that students are from a generation already familiar with active ICT development.

Following the implementation of the updated training program, the number of correct answers provided by nurses increased by 10% (from 46 to 51 out of 75 possible). The proportion of nurses demonstrating Proficiency and Above Basic skills increased by 14% (from 57% to 71%). Compared to students, nurses initially achieved higher results, which can be attributed to their existing practical experience. As they are already employed in the healthcare system and frequently use

EHS and other digital tools, this practical exposure contributes to their enhanced digital competence.

Overall, previous research has demonstrated the importance of a digital literacy curriculum, showing that it can significantly enhance nurses' knowledge and skills, as well as improve their self-efficacy.

For example, a study by A. Kuek and S. Hakkennes [14] demonstrated that a digital literacy curriculum significantly enhanced nurses' knowledge and skills in using information systems before the introduction of an electronic health record.

In the research by J. Kang and E. Suh [15] the effectiveness of smartphone applications designed for the care of patients with chronic diseases was developed and assessed. Their study found that these applications significantly improved nurses' knowledge and self-efficacy in managing hypertension and diabetes. This underscores the potential of integrating digital technologies into educational programs as an effective means of enhancing the competencies of future nurses.

We argue that our results underscore the urgent need for continuous professional development to enhance nurses' digital competence. Previous research by U. Kinnunen et al. [16] has also highlighted the necessity of expanding educational programs to include training on digital devices and assisting patients with digital services, emphasizing that this need is especially critical for older nurses.

A systematic review by E. Kulju et al. [17] demonstrated the effectiveness of educational interventions in enhancing the digital competence of health professionals. The review indicated that interventions are most successful when they incorporate diverse learning modalities, such as theoretical knowledge, practical exercises, and interactive training. Furthermore, the authors highlight the importance of organizational support and personalized guidance throughout the learning process. These findings support the implementation of updated curricula that integrate multiple methods and learning approaches.

C. Buchanan et al. [18] research highlights the shared responsibility of nurses in shaping decisions regarding the integration of artificial intelligence into the healthcare system. This illustrates the importance of not only technical skills but also ethical and communication competence among nurses in the context of the digital transformation in healthcare.

A study by A. Tubaishat and L. Habiballah [19] revealed that Jordanian nursing students demonstrated a moderate level of eHealth literacy. While they were aware of online health resources and knew how to use them, they showed a lack of ability to critically evaluate the quality of these resources. The authors highlight the need to incorporate eHealth competence into nursing curricula. These findings are consistent with the goals of our educational programs, which aim to develop not only technical proficiency but also critical and analytical abilities.

The incorporation of innovative digital competence curricula that integrate diverse teaching modalities and address contemporary healthcare needs – while encompassing technical ethical, communication, and research skills – enhances nurses' preparedness to effectively utilize ICT in their professional practice.

LIMITATIONS AND DIRECTIONS FOR FURTHER RESEARCH

Several limitations should be noted in this study:


1. The study was conducted exclusively at ZhMI, which means that the results cannot be generalized beyond the specific context of this study.
2. Digital competence was assessed immediately following the training program; future studies should evaluate the long-term impact of such training.
3. The evaluation of respondents' satisfaction is inherently subjective and may be influenced by bias.

Further research should expand to include the assessment of the digital competence among healthcare professionals in various regions of Ukraine and investigate how digital skills affect the efficiency of professional activities and the quality of medical services.

CONCLUSIONS

The study results demonstrate the effectiveness of implementing updated Health Informatics curricula in developing digital competence among nurses at both undergraduate and post-diploma levels. By enhancing nurses' digital skills, these curricula support their ability to navigate the national eHealth landscape, utilize electronic healthcare system and other digital tools in their practice, and ultimately improve the quality of medical services and contribute to the successful digital transformation of the healthcare industry.

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This study is made possible by the support of the American people through the United States Agency for International Development (USAID). The contents of this article are the sole responsibility of the authors and Deloitte consulting, LLP and do not necessarily reflect the views of USAID, United States Government, official policy. The study was conducted under contract number 72012118C00001 and USAID Health Reform Support Project Grant Program G-2309-02391 to develop digital competence of healthcare professionals and medical students.

The authors would like to express their gratitude to Anna Tokar, Monitoring and Evaluation Lead at the USAID Health Reform Support Project, for her valuable insights and edits to the article.

CONFLICT OF INTEREST

The Authors declare no conflict of interest

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RECEIVED: 09.06.2024
ACCEPTED: 24.10.2024

