MEDICAL UNIVERSITY
"Prof. Dr. Paraskev Stoyanov" - Varna

FACULTY OF PUBLIC HEALTH
DEPARTMENT "Social Medicine and Healthcare Organization"

Nelly Diyanova Petrova

DIGITAL AND E-HEALTH LITERACY IN THE TRAINING OF BULGARIAN NURSES

ABSTRACT

of a dissertation for the award of a scientific and educational degree

"DOCTOR"

Field of higher education: 7. Health and sports

Professional field: 7.4. Healthcare Management

Doctoral Program: Public Health Management

Scientific supervisor:
Prof. Iskra Slavcheva Mircheva, PhD

VARNA
2025

The dissertation was approved and proposed for defense at a meeting of the Department of Social Medicine and Health Care Organization with Protocol No. 16/10.12.2025 at the Medical University "Prof. Dr. P. Stoyanov"-Varna

The dissertation contains 149 pages and is illustrated with 40 tables and 79 figures and 3 appendices.

Scientific jury:

Chair: Assoc. Prof. Dr. Natalia Vasilevna Usheva, MD, PhD

External members:

Prof. Gergana Georgieva Petrova, PhD

Prof. Makreta Todorova Draganova, PhD

Assoc. Prof. Yoana Ivanova Simeonova, PhD

Reserve external member:

Prof. Dr. Stella Lyudmilova Georgieva, MD, PhD

Internal members:

Prof. Sonya Koleva Toncheva, PhD, DSc.

Assoc. Prof. Dr. Natalia Vasilevna Usheva, MD, PhD

Reserve internal member

Assoc. Prof. Silvia Pavlova Nikolova, PhD

The public defense of the dissertation will take place on April 17, 2026 at ..... hours at the Medical University of Varna

CONTENTS

ABBREVIATIONS USED 5

INTRODUCTION 6

1. AIM, OBJECTIVES AND RESEARCH HYPOTHESES 8

1.1. Aim of the study 8

1.2. Research objectives 8

1.3. Research hypotheses 9

2. METHODS AND MATERIALS 10

2.1. Object and subject of the study 10

2.2. Methods and tools 10

2.3. Sample and data collection procedure 14

2.4. Statistical methods 14

2.5. Ethical considerations 15

2.6. Limitations of the study 15

3. SUMMARY EVALUATIONS ON THE GENERAL ATTITUDE OF NURSES 17

3.1. Information and Data Literacy Index 18

3.2. Communication and Collaboration Index 18

3.3. Digital Content Creation Index 19

3.4. Safety Index 20

3.5. Index of problem area identification and resolution 20

3.6. E-Health Literacy Index 21

3.7. Self-assessment of digital literacy among nurses 22

3.8. Socio-demographic characteristics of nurses as potential factors applied to summary indicators (indices) 26

4. SUMMARY EVALUATIONS ON THE GENERAL ATTITUDE OF STUDENTS TRAINING TO BE NURSES 34

4.1. Information and Data Literacy Index 34
4.2. Communication and Collaboration Index 35
4.3. Digital Content Creation Index 36
4.4. Safety Index 37
4.5. Index of problem area identification and resolution 38
4.6. E-Health Literacy Index 38
4.7. Self-assessment of digital literacy among nursing students 40
4.8. Socio-demographic characteristics of nursing students as potential factors applied to summary indicators (indices) 43

5. COMPARISON OF THE ATTITUDES OF NURSES AND STUDENTS IN RELATION TO THE SUMMARY INDICATORS (INDEXES) 49

6. DEVELOPMENT AND STRUCTURE OF A SPECIALIZED TRAINING MODULE TO INCREASE CRITICAL E-HEALTH AND NURSING INFORMATION LITERACY 52

CONCLUSION 56

CONCLUSIONS 57

CONTRIBUTIONS 59

RECOMMENDATIONS 61

LIST OF PUBLICATIONS RELATED TO THE DISSERTATION 64

ABBREVIATIONS USED

e-Health	E-health
ICT	Information and communication technologies
ZR	Health resources (online health information and services)
BIS	Hospital Information System
GDPR	General Data Protection Regulation
m-Health	Mobile health (mobile health apps)
AI	Artificial Intelligence
SPSS	Statistical Package for the Social Sciences (Statistical Software)
α (Alpha)	Cronbach's coefficient (a measure of internal consistency) and also a significance level (risk of making a type I error)
ICT Skills	Skills for working with information and communication technologies
CASN	Canadian Association of Schools of Nursing
AMIA	American Medical Informatics Association
CMS	Centers for Medicare & Medicaid Services (Centers for Medicare and Medicaid, USA)
NI	Nursing informatics
EZ	Is e-healthcare
EHR/EMR	Electronic health/medical records

INTRODUCTION

The reflexive transformation of modern healthcare under the influence of information and communication technologies (ICT) marks a fundamental transition from an institutionally based to an integrated and personalized model of healthcare. In this context, electronic healthcare (e-Health) is not seen as a technological superstructure, but as a paradigmatic change in the way healthcare services are planned, organized and delivered. At the heart of this transformation is not just access to technology, but the ability of healthcare professionals to interact with digital resources in a critical, ethical and effective manner. Therefore, the digital competence of healthcare professionals, and in particular nurses, is not just an operational characteristic, but a structural indicator of the systemic sustainability and functional adaptability of the healthcare sector.

Given the increasing complexity of the clinical environment and the heightened demands for interdisciplinary collaboration and responsible management of health information, there is a need for an empirically validated, multidimensional, and conceptually grounded model for assessing digital literacy in nursing. Beyond basic computer literacy, this model should integrate skills for critical navigation of electronic health resources (EHRs), collaboration in a digital environment, content creation and protection, ethical use of data, and analytical capacity for making clinical decisions based on digital sources.

The dissertation seeks to address this need by developing and testing a set of index instruments reflecting the key dimensions of nurses' digital competence. The main research objective is to construct, validate and interpret summary scales to assess the degree of digital, information and e-health literacy of nurses in a contemporary context. The approach combines the analytical rigor of psychometric methods with the social relevance of professional reality in the healthcare sector.

The object of this study is nurses as a professional category, whose role in the process of digitalization of health services is strategically key, but often underestimated in the scientific discourse. The subject of the study is their digital competence, interpreted through the prism of six index structures: information literacy, digital creativity, communication collaboration, safety, problem solving and e-health literacy.

As studies in Bulgaria show, the main obstacle to the introduction of ER is the insufficient competence of specialists. Therefore, the introduction of nursing informatics as an independent and mandatory discipline in the training of nurses and midwives is a necessary step to overcome this deficit. In order to argue for the need to introduce such a discipline, it is first critically important to make an objective and standardized assessment of the current knowledge, skills and attitudes of medical specialists.

In view of the identified gaps and needs, the main objective of the study is to identify, analyze and assess the levels of digital and e-Health literacy among nurses and nursing students in Bulgaria, by constructing and testing index structures to measure key aspects of digital competencies. The data obtained will serve as a reliable basis for arguing and developing an adequate training module in nursing informatics, which will ensure that future and current medical professionals are prepared to meet the needs of the digitalized healthcare system, thus improving the quality and safety of healthcare.

1. AIM, OBJECTIVES AND RESEARCH HYPOTHESES

1.1. Aim of the study

The main objective of the study is to identify, analyze and assess the levels of digital and e- Health literacy among nurses and nursing students in Bulgaria, by constructing and testing index structures to measure key aspects of digital competencies.

This goal is formulated in the context of the global transformation of health systems, where e- Health is being established as a fundamental component of the provision of quality and sustainable health services.

Achieving this goal requires not only describing the current state of digital skills, but also a critical analysis of latent barriers, structural deficits, and potential opportunities for improving digital training in the nursing profession. The study aims to provide a validated empirical base to support the strategic planning of training interventions in the health sector.

1.2. Research objectives

To achieve the set goal, the following specific tasks have been formulated:

1. To conduct a comprehensive literature review on contemporary concepts of digital literacy, e - Health literacy and nursing informatics, summarizing the main scientific approaches and models for assessing these competencies;
2. To develop a standardized survey toolkit for measuring digital competence, structured into six thematic clusters: information literacy; communication and collaboration; digital content creation; safety; problem solving; e-health literacy;
3. To conduct an empirical study among two target groups – nurses and nursing students – by collecting quantitative data on their self-assessment regarding digital and e- Health skills;
4. To construct summary indices that provide a reliable assessment of the internal consistency of questionnaires;

5. To conduct a comparative analysis between the two groups regarding the studied indicators;
6. To analyze the influence of demographic characteristics (age, education, work experience) on levels of digital competence;
7. To formulate practical guidelines and recommendations for optimizing curricula and continuing education of nurses in the field of digital literacy.

1.3. Research hypotheses

Based on the preliminary theoretical analysis, the following research hypotheses have been formulated:

Hypothesis 1 : There is no statistically significant difference between students and nurses regarding information literacy and safety.

Hypothesis 2 : The age and course of study of nursing students do not have a significant impact on their computer and information literacy.

Hypothesis 3 : The constructed summary indicators (indexes), verified with Cronbach's α, are reliable and can be used in subsequent analyses.

Hypothesis 4: Age, work experience, and educational level are significant factors in nurses' digital literacy, including their communication, collaboration, and problem-solving skills.

2. METHODS AND MATERIALS

2.1. Object and subject of the study

The study focuses on nurses and nursing students, who form two key groups in the process of healthcare digitalization. Their role is strategic both in the direct provision of healthcare and in mediating the transfer of digital health technologies into practice.

The subject of the study is the levels of digital competence and e-Health literacy, interpreted through six index structures: information literacy and data literacy; communication and collaboration; digital content creation; safety; problem solving; e-health literacy.

2.2. Methods and tools

The present study was conducted using a quantitative approach, which included the development and implementation of a standardized survey questionnaire. The survey contained statements rated on a five-point Likert scale – from "strongly disagree" to "strongly agree". Each of the six clusters included from 3 to 9 statements aimed at measuring a specific aspect of digital literacy.

The summary indices were constructed by summing the responses for each cluster, and the reliability of the scales was checked using Cronbach's α.

For the purposes of the study, a questionnaire was developed, which is based on a critical analysis of existing models for assessing digital and e- Health literacy (similar instruments are found in European and international studies, such as the Digital Health Literacy Instrument – DHLI). When creating the questionnaire, established international concepts were adapted to ensure content validity and applicability in the Bulgarian context. The questionnaire is structured in six thematic blocks (clusters), covering the main components of digital and e-Health literacy: Information and data literacy, Communication and collaboration, Digital content creation, Safety, Problem identification and solving skills, e-Health literacy. The first five clusters directly reflect the five main areas of the European Digital

Competence Framework (DigComp 2.1). The use of DigComp ensures standardization of measurement and international comparability of the results obtained. A sixth cluster – e-Health Literacy – has been added to measure the functional application of digital competence in a critical area of high public interest. This multi-factorial approach is theoretically informed by Norman & Skinner's (2006) Lily Model. Because the Lily Model defines e- Health literacy as the integration of six distinct types of literacy (including health, science, and information), it legitimizes the need for multidimensional measurement. The addition of this cluster allows for an assessment of how general digital skills are applied and synthesized to make informed decisions in the healthcare field.

The thematic structure of six clusters is theoretically grounded and empirically validated, with its main components systematized in established international and academic frameworks. All selected literacy categories have been identified and explored in numerous contemporary scientific publications dedicated to digital competence and e-health. The conceptual alignment of our domains, their key definitions and their actual measurement in international studies is summarized in Table 1.

***Table** 1of existing models for assessing digital and e-Health literacy*

Literacy category	**Concept**	**Questions asked in international surveys**	**Sources** *

Information literacy (searching, finding and managing data)	the fundamental level of digital literacy required to access EHRs and medical resources	"I am able to use the Internet to find health information" "I know how to use the Internet to answer my health questions" "I can use digital equipment proficiently in nursing work" "Nurses' overall informatics competence was good" "The use of electronic devices may speed up the management of patient data, improve staff cooperation and competence and make more effective use of working time" "I know how to identify relevant health information on the Internet"	Alipour *et al.* 2022 Shudayfat *et al.* 202 3 Holt *et al.* 2022 Liu *et al.* 2024 Hashish *et al.* 2024 Norman et *al* . 2006 Golz *et al.* 2024
Information assessment (credibility)	Critical thinking is key to patient safety as it ensures that medical staff use credible online resources to make decisions.	"I am able to judge the reliability of health information on the Internet" "I feel confident in using information from the Internet to make health decisions" "I am able to evaluate the information I find on the Internet"	Alipour *et al.* 2022 Shudayfat *et al.* 2023 Holt *et al.* 2020 Liu *et al.* 2024 Hashish *et al.* 2024 Jarva *et al.* 2023
Literacy category	**Concept**	**Questions asked in international surveys**	**Sources** *
Communication and collaboration	The needs of nursing informatics and digital healthcare for effective information exchange	"I use digital devices to communicate with patients"	Holt *et al.* 2022 Liu *et al.* 2024 Koivunen *et al.* 2014

	with colleagues and patients.	"I use digital devices to communicate with my colleagues"	
Safety (privacy and security)	A mandatory component in e-Health, focused on the ethical and legal aspects of working with EHRs and sensitive information	"I know how to protect my personal health data" "I know how to ensure patient confidentiality when using digital tools"	Alipour *and co-authors* 2022 Shudayfat *and co-authors* 2023 Kinnunen *and co-authors* 2023
Technical competence (job skills)	Self-assessment of specialists for working with digital devices in the clinical environment.	"I am confident in using computers and other digital devices" "I use electronic health records" "Knowledge and use of IT equipment, areas of basic IT knowledge, information literacy, wireless device skills..."	Alipour *et al.* 2022 Holt *et al.* 2022 Liu *et al.* 2024 Koivunen *and co-authors* 2016 Norman *et al.* 2006 Kinnunen *and co-authors* 2023
Decision making (application of information)	Conceptual borrowing from the DigComp Framework (Area 3: Digital Content Creation) and questions for applying skills to improve care	"I know how to use the health information I find on the Internet to help me" "I am able to use technology to improve the quality of patient care"	Norman *et al.* 2006 Hashish *and co-authors* 2024 Koivunen *et al.* 2014

[*] *The literature used, including all authors and publications, is duly cited in the dissertation.*

The method used to collect the data is a sociological method of questionnaire survey , which is widely used to study attitudes and competencies in the social and health sciences. The advantage of this method is the possibility of standardizing the questions, which ensures reliability and comparability of the results between different respondents. The questions are formulated clearly and unambiguously to minimize subjective interpretation.

During the preparation process, the questionnaire underwent expert evaluation to verify content validity, and subsequently a pilot study to optimize the wording.

2.3. Sample and data collection procedure

The study covers two subgroups:

- 101 nurses selected through stratified random selection from University Hospital "St. Marina"-Varna;
- 110 students majoring in Nursing, studying at the Medical University "Prof. Dr. P. Stoyanov" - Varna.

Data collection was conducted between 10.02.2025 and 30.06.2025, in compliance with the ethical principles of voluntariness, anonymity and confidentiality. The questionnaires were completed independently by the respondents in a controlled environment.

2.4. Statistical methods

The data were processed using the statistical software SPSS v30.0. The following methods were used:

- Descriptive Statistics:
  - Summarizing numerical characteristics: arithmetic mean, mode, median, relative values in percentages, standard deviation, and others;
  - Statistical tables ;
  - Graphical representations: histograms, boxplots , bar charts, and pie charts.
- Statistical conclusions:
  - Confidence intervals;
  - Checking the normality of the distribution using the Shapiro-Wilk test;
  - Testing for the difference between means of two independent samples , t-test;
  - Estimation of the effect size using Cohen's d – to determine the practical significance of the identified differences.

Additionally, to validate the reliability of the scales in constructing indices, Cronbach's α was applied, which is a standardized indicator of internal consistency and widely used in empirical research.

All analyses were performed at a significance level of $\alpha = .05$ ($p < .05$).

2.5. Ethical considerations

The study was conducted in compliance with the basic ethical principles, including voluntary participation, informed consent and protection of personal data. All procedures were approved by the Ethics Committee of the Medical University - Varna with Protocol No. 5/17.10.2024. A permission document issued by the Ethics Committee of the Medical University - Varna is available, which is attached to the study documentation.

2.6. Limitations of the study

Limitations of the study include the self-reported nature of the data, which may lead to subjective bias. Despite the representativeness of the sample, the results cannot be generalized to all nurses in the country without additional confirmatory studies. The study among nursing students was conducted at the Medical University "Prof. Dr. P. Stoyanov" - Varna, as it is one of the leading medical universities in the country. Nursing education in all medical universities in the country is carried out according to uniform state requirements; the disciplines, teaching methods, and material resources are similar, and it is expected that the attitudes of students in all medical universities will not differ significantly. Due to the limited accessibility to other representatives of this category, the study is focused on nurses working at the University Hospital "St. Marina" - Varna, because it is one of the largest hospitals in eastern Bulgaria.

3. SUMMARY EVALUATIONS ON THE GENERAL ATTITUDE OF THE NURSES

Based on the constructed questionnaire, summary indicators (indices) are created for individual aspects of the use and literacy in the field of Internet applications and data. One of the goals of this work is to construct promising indicators of nurses' attitudes towards the topic under consideration.

To construct any single summary measure, it is necessary to add up the individual numerical scores from all questions for each respondent. On the other hand, it is extremely important that these scores are reliable. The summary score is obtained from the interconnected elements from which it is created. Therefore, it is crucial to know whether the same combination of elements would lead to the same answers to identical questions if it were reworked and applied again to the same respondents. A summary score is considered reliable only when it provides consistent and reliable responses during several administrations of the test.

The method for obtaining the answers needed to determine the reliability of the assessment is Cronbach's alpha. Cronbach's alpha is a technique for determining whether a result is reliable or not and is easily implemented with SPSS. It is applied to each of the groups of questions that can be combined. Cronbach's alpha is a standardized indicator ranging from 0 to 1. If its value is high, it means that there is greater consistency between the individual items and, accordingly, the reliability is higher. In order to increase the reliability of some of the summary indicators, by increasing the internal consistency between the individual questions (items), it may be necessary to eliminate some of the initially asked questions for which the value of 'Cronbach's alpha when removing a question' is higher than the total Cronbach's alpha of the corresponding scale. The summary estimates will be called "indices" and if they have good or exceptional reliability, they will be used in subsequent analyses

In order to further explore the general attitude and self-assessment of nurses in the context of digital transformation in healthcare, six summary indices based on Cronbach's α were calculated. These indices reflect the degree of consistency between the statements in the survey regarding key

aspects of digital literacy and e-health. All indices show high reliability values, making them suitable for subsequent interpretation and statistical analysis.

3.1. Information and Data Literacy Index

This index measures the skills of nurses to find, process and interpret digital information. Table 2 presents Cronbach's α – 0.892, which indicates high internal consistency. This indicates the reliability of the index and the possibility of its use in subsequent analyses .

Table 2*Statistical reliability of information literacy and data literacy*

Information and data literacy index	**Correlation of the given question with all other questions**	**Cronbach's α if the question is deleted**	**Cronbach's α**
I deal with the internet, emails, etc.	**0.770**	**0.862**	**0.892**
Access to GI through applications	**0.858**	**0.781**	
Managing the patient's IA	**0.742**	**0.885**	

3.2 . Communication and Collaboration Index

Cronbach's α is 0.926 indicating extremely high reliability. The index includes a wide range of questions related to communication through digital technologies, information sharing and teamwork in an electronic environment, which have high internal consistency (Table 3).

Table 3*Statistical reliability of the communication and collaboration index*

Information and data literacy index	**Correlation of the given question with all other questions**	**Cronbach's α if the question is deleted**	**Cronbach's α**
Interaction with patients through CT	0.764	0.916	0.926
Interaction with colleagues via DT	0.659	0.922	
Communicating with patients through CT	0.746	0.917	
Sharing health information through CT	0.813	0.912	
Engaging in the professional community through DT	0.725	0.918	
Collaboration with patients through virtual networks	0.798	0.913	
Internet etiquette	0.696	0.920	
Digital identity management	0.679	0.921	
Development of digital health	0.705	0.919	

3.3. Digital Content Creation Index

The index initially included four questions, but after performing an internal consistency analysis , it was found that one of them (regarding programming skills) had a low correlation with the others – only 0.489. Removing this item increased the Cronbach's α value to 0.846, which is considered good reliability. This emphasizes the need to adapt the toolkit to the real digital profile of the studied group (Table 4). The results of the verification confirm the validity of Hypothesis 3. The calculated Cronbach's α values show that the constructed summary indicators have a satisfactorily good degree of reliability. Therefore, these indices can be included in the subsequent analyses.

Table 4*the digital content creation index*

Digital Content Creation Index	Correlation of the given question with all other questions	Cronbach's α if the question is deleted	Cronbach's α
Integrating digital health information	0.715	0.738	0.819
Copyright compliance	0.627	0.778	
Programming	0.489	0.846	
Device protection	0.752	0.717	

3.4. Safety Index

This index includes three questions related to personal data protection, health safety and environmental responsibility in a digital environment. The Cronbach's alpha coefficient is 0.918, which is a sign of exceptional internal consistency. The correlations between the items are also high – above 0.85 (Table 5).

Table 5*the safety index*

Digital Content Creation Index	Correlation of the given question with all other questions	Cronbach's α if the question is deleted	Cronbach's α
Integrating digital health information	0.727	0.771	0.846
Copyright compliance	0.719	0.779	
Device protection	0.692	0.805	

3.5. Index of problem area identification and resolution

Composed of four questions, the index reflects the respondents' ability to recognize and analyze problem situations, including

technical and communication difficulties. Cronbach's α = 0.867 is an indicator of good reliability (Table 6).

***Table** 6the problem area identification and resolution index*

Index of problem area identification and resolution	Correlation of the given question with all other questions	Cronbach's α if the question is deleted	Cronbach's α
Identifying and responding to patient needs	0.540	0.895	0.867
Solving technical problems	0.799	0.795	
Creative use of CT	0.807	0.792	
Gaps in identifying digital competence	0.737	0.822	

3.6 . E-Health Literacy Index

The latter index comprises eight indicators that relate to nurses' skills in searching, finding, using and evaluating health information from the Internet. With Cronbach's α = 0.907, it also falls into the category of “highly reliable index” (Table 7).

***Table 7**Statistical reliability of the e-health literacy index*

E-Health Literacy Index	Correlation of the given question with all other questions	Cronbach's α if the question is deleted	Cronbach's α
I know what kind of RGs are available on the internet.	0.676	0.898	0.907
I know where to find useful PRs on the internet.	0.598	0.907	
I know how to find useful PR on the internet	0.771	0.890	

E-Health Literacy Index	Correlation of the given question with all other questions	Cronbach's α if the question is deleted	Cronbach's α
I know how to use the internet to answer health questions	0.740	0.893	
I know how to use the Internet for information.	0.752	0.892	
Skills to evaluate PR on the Internet	0.754	0.891	
I distinguish high from low quality PR on the internet	0.705	0.895	
I am confident in using information from the Internet in making health decisions.	0.682	0.899	

In conclusion, the results of the reliability test using Cronbach's α confirm that the constructed indices possess the necessary internal consistency and stability. They can be used in subsequent analyses between the individual aspects of digital literacy in the context of the professional activity of nurses.

3.7. Self-assessment of digital literacy among nurses

In the context of the digitalization of healthcare and the growing importance of the electronic health record, how nurses perceive and use digital technologies, including hospital information systems (HIS), is of particular importance. The analysis of the results of this study reveals significant trends in this direction (Table 8).

Table 8. *Nurses' self-assessment of acquired ICT work skills*

Relative share of nurses assessing their skills			
Self-assessment of acquired skills	**Yes**	**No**	**Not enough**
Computer literacy during training	23.76 %	30.69 %	45.54 %
Handling BDS	87.13 %	12.87 %	-
Difficulty working with BDS	12.87 %	87.13 %	-

Table 9 provides information on the percentage distribution of self-esteem among the surveyed nurses regarding general ICT skills.

Table 9. *Nurses' self-assessment of ICT handling indices*

Indices	**Very bad**	**Bad**	**Satisfactory**	**Good**	**Very good**
Internet and communication skills	-	3.96 %	22.77 %	42.57 %	30.69 %
Access to health information through apps	-	6.93 %	19.80 %	49.50 %	23.76 %
Patient health information management	-	3.96 %	17.82 %	54.46 %	23.76 %
Interacting with patients through digital technologies	5.94 %	6.93 %	33.66 %	29.70 %	23.76 %
Interacting with colleagues through digital technologies	0.99 %	6.93 %	22.97 %	45.53 %	22.77 %
Communicating with patients through digital technologies	5.94 %	10.89 %	36.63 %	28.71%	17.82 %
Sharing health information through digital technologies	5.94 %	13.86 %	31.68 %	30.69 %	17.82 %

Indices	Very bad	Bad	Satisfactory	Good	Very good
Engagement in the professional community through digital technologies	0.99 %	12.87 %	31.68 %	38.61 %	15.84 %
Collaboration with patients through virtual networks	6.93 %	15.84 %	31.68 %	30.69 %	14.85 %
Internet etiquette	0.99 %	7.92 %	34.65 %	37.62 %	18.81 %
Digital identity management	1.98 %	7.92 %	25.74 %	45.54 %	18.81 %
Assessments of the development of digital health	0.99 %	10.89 %	34.65 %	33.66 %	19.80 %
Digital health information integration skills	1.98 %	11.88 %	37.62 %	31.68 %	16.83 %
Knowledge of copyright compliance	0.99 %	7.92 %	34.65 %	31.68 %	24.75 %
Programming skills	16.83 %	17.82 %	42.57 %	17.82 %	4.95 %
Device security skills	4.95 %	7.92 %	45.54 %	24.75 %	16.83 %
Protection of patient personal data	-	1.98 %	23.76 %	30.69 %	43.56 %
Protecting the patient's health	-	4.95 %	19.80 %	35.64 %	39.60 %
Environmental protection	0.99 %	7.92 %	22.77 %	37.62 %	30.69 %
Identifying and responding to patient needs	-	8.91 %	32.67 %	34.65 %	23.76 %
Solving technical problems	5.94 %	6.93 %	41.58 %	28.71 %	16.83 %
Creative use of digital technologies	4.95 %	7.92 %	48.51 %	24.75 %	13.86 %
Gaps in identifying digital competence	3.96 %	13.86 %	48.51 %	24.75 %	8.91 %

Table 10 observes the trust and usefulness of health information available on the Internet through the eyes of nurses included in the study.

Table 10. *Assessment of accessible health resources on the Internet*

Health resource assessment	Not useful at all	Not useful	Useful	It is very useful.
Assessing the usefulness of the Internet in making health decisions	3.96 %	12.87 %	66.34 %	16.83 %
Usefulness of the Internet for Accessing Health Resources	2.97 %	8.91 %	58.42 %	29.70 %

Table 11 presents the nurses' self-esteem in handling health information from the Internet and applying it fully in their daily activities.

Table 11. *Nurses' self-assessment of using health resources obtained via the Internet in their practice*

Self-assessment of internet use	I strongly disagree.	I disagree.	Neither agree nor disagree	I agree.	I completely agree.
Assessment of knowledge about available health resources on the internet	3.96 %	6.93 %	36.63 %	42.57 %	9.90 %
Assessment of knowledge about the location of useful health resources on the Internet	3.96 %	20.79 %	19.80 %	39.60 %	15.84 %
Skills for finding useful health resources on the internet	3.96 %	9.90 %	17.82 %	56.44 %	11.88 %
Internet usage skills for health issues	0.99 %	11.88 %	16.83 %	57.43 %	12.87 %
Nurses' skills in using online health information	0.99 %	9.90 %	9.90 %	63.37 %	15.84 %

Self-assessment of internet use	I strongly disagree.	I disagree.	Neither agree nor disagree	I agree.	I completely agree.
Nurses' skills for evaluating health resources on the Internet	2.97 %	7.92 %	16.83 %	59.41 %	12.87%
Ability to distinguish between high and low quality HR	1.98 %	14.85 %	17.82 %	52.48 %	12.87 %
Nurses' confidence in using internet information for health decisions	4.95 %	13.86 %	27.72 %	33.66 %	19.80 %

3.8 . Socio- demographic characteristics of nurses as potential factors applied to summary indicators (indices)

The potential demographic factors are – age (under 50 years and 50 years and over), work experience (under 20 years and 20 years and over) and education (semi-higher or lower and higher). After checking the normality of the distribution of these factors (Table 12, Table 14 and Table 16) , a t-test was applied to assess the difference between the means of two independent samples. In addition to statistical significance, an analysis of practical significance (Cohen's d) was applied to assess whether this difference was insignificant, unimportant or small, medium and large from a practical point of view. The results are summarized in Table 13, Table 15 and Table 17, respectively.

Table 12. *Check for normal distribution of indices involved in the testing of statistical hypotheses for two independent samples, t-test*

No.	Indices by study groups: *Group 1: age over 50 years, $n_1 = 54$* *Group 2: age up to 50 years, $n_2 = 47$*		Shapiro-Wilk test for normality		
			Empirical value	Degrees of freedom	P-value
1	Information and data literacy index	Group 1	0.915	54	0.110
		Group 2	0.905	47	0.101
2	Communication and collaboration index	Group 1	0.961	54	0.075
		Group 2	0.967	47	0.200
3	Digital content creation index	Group 1	0.955	54	0.054
		Group 2	0.944	47	0.052
4	Security index	Group 1	0.896	54	0.100
		Group 2	0.854	47	0.090
5	Index of problem identification and resolution	Group 1	0.962	54	0.086
		Group 2	0.970	47	0.264
6	E-Health literacy index	Group 1	0.943	54	0.122
		Group 2	0.942	47	0.220

All p-values are greater than the chosen significance level $\alpha = 0.05$, which means that there is no reason to reject the null hypothesis and it can be assumed that the distributions under consideration are normal or close to normal. It follows that the analysis can be continued with a statistical hypothesis test for two independent samples, t-test:

Table 13. *Summary table for testing statistical hypotheses and effect size for the difference in means between two age groups of nurses*

No.	Two independent samples, t-test Group 1: Age under 50, $n_1 = 54$ Group 2: Age 50 and above, $n_2 = 47$	Difference in means	p-value	Statistical significance	Cohen's d	Effect size interpretation
1	Information and data literacy index	0.574	0.196	not significant	0.260	small
2	Communication and collaboration index	2.955	0.040	significant	0.416	Small-to moderate
3	Digital content creation index	0.233	0.654	not significant	0.090	negligible
4	Security index	−0.359	0.478	not significant	0.142	negligible
5	Index of problem identification and resolution	1.670	0.010	significant	0.523	moderate
6	E-Health literacy index	0.478	0.692	not significant	0.079	negligible

According to the statistical testing of hypotheses and the calculated effect size, the following general conclusions are drawn:

- Age is a significant factor in the summary characteristic (index) of communication and cooperation, with those under 50 being much more communicative and inclined to cooperate compared to those 50 and older, and the effect size is small but tending to medium.
- Age is a significant factor in the summary characteristic (index) of identifying and solving problem areas, with those under 50 finding it much easier to identify and solve problems compared to those 50 and older, and the effect size is medium.
- For the information literacy index, the digital content creation index, the safety index, and the e-health literacy index, the differences in the means are not statistically significant, and the effect sizes are small or

negligibly small, which confirms that age is not a significant factor in these . Hypothesis 4 is confirmed due to visible differences in the two indices.

Table 14. *Check for normal distribution of indices involved in the testing of statistical hypotheses for two independent samples, t- test*

No.	Indices by study groups: *Group 1: Less than 20 years of work experience, $n_1 = 46$* *Group 2: 20 years or more of work experience, $n_2 = 55$*		Shapiro-Wilk test for normality		
			Empirical value	Degrees of freedom	P-value
1	Information and data literacy index	Group 1	0.910	46	0.070
		Group 2	0.895	55	0.060
2	Communication and collaboration index	Group 1	0.951	46	0.059
		Group 2	0.975	55	0.312
3	Digital content creation index	Group 1	0.947	46	0.053
		Group 2	0.941	55	0.101
4	Security index	Group 1	0.893	46	0.060
		Group 2	0.872	55	0.080
5	Index of problem identification and resolution	Group 1	0.966	46	0.204
		Group 2	0.959	55	0.061
6	E-Health literacy index	Group 1	0.929	46	0.080
		Group 2	0.952	55	0.288

All p-values are greater than the chosen significance level $\alpha = 0.05$, which means that there is no reason to reject the null hypothesis and it can be assumed that the distributions under consideration are normal or close to normal. It follows that the analysis can be continued with a statistical hypothesis test for two independent samples , t-test:

Table 15. *Summary table for testing statistical hypotheses and effect size for the difference in means between two groups of nurses with different work experience*

No.	Two independent samples, t-test Group 1: Less than 20 years of work experience, $n_1 = 46$ Group 2: 20 years or more of work experience, $n_2 = 55$	Difference in means	p-value	Statistical significance	Cohen's d	Effect size interpretation
1	Information and data literacy index	0.577	0.193	not significant	0.262	small
2	Communication and collaboration index	2.747	0.056	not significant	0.386	small
3	Digital content creation index	0.869	0.093	not significant	0.339	small
4	Security index	−0.193	0.704	not significant	0.076	negligible
5	Index of problem identification and resolution	1.866	0.004	significant	0.523	moderate
6	E-Health literacy index	1.630	1.176	not significant	0.273	small

According to the statistical testing of hypotheses and the calculated effect size, the following summary conclusion is made:

- Work experience is a significant factor only in the summary characteristic (index) of identifying and solving problem areas, with those with less than 20 years of experience finding it much easier to identify and solve problems compared to those with 20 or more years of This supports Hypothesis 4, as there was no significant difference across the indices, with only one exception.

Table 16. *Check for normal distribution of indices involved in the testing of statistical hypotheses for two independent samples, t-test*

No.	Indices by study groups: *Group 1: Secondary or lower education, $n_1 = 24$* *Group 2: Higher education, $n_2 = 77$*		Shapiro-Wilk test for normality		
			Empirical value	Degrees of freedom	P-value
1	Information and data literacy index	Group 1	0.967	24	0.601
		Group 2	0.902	77	0.209
2	Communication and collaboration index	Group 1	0.942	24	0.184
		Group 2	0.965	77	0.310
3	Digital content creation index	Group 1	0.955	24	0.348
		Group 2	0.940	77	0.119
4	Security index	Group 1	0.870	24	0.052
		Group 2	0.885	77	0.061
5	Index of problem identification and resolution	Group 1	0.982	24	0.937
		Group 2	0.950	77	0.144
6	E-Health literacy index	Group 1	0.966	24	0.559
		Group 2	0.946	77	0.125

All p-values are greater than the chosen significance level $\alpha = 0.05$, which means that there is no reason to reject the null hypothesis and it can be assumed that the distributions under consideration are normal or close to normal. It follows that the analysis can be continued with a statistical hypothesis test for two independent samples , t-test:

Table 17. *Summary table for testing statistical hypotheses and effect size for the difference in means between two groups of nurses: with higher education and secondary and lower education*

No.	**Two independent samples, t-test** ***Group 1: Semi-higher or lower education, n_1 = 24*** ***Group 2: Higher education, n_2 = 77***	**Difference in means**	**p-value**	**Statistical significance**	**Cohen's d**	**Effect size interpretation**
1	Information and data literacy index	-1.429	0.005	significant	0.668	moderate
2	Communication and collaboration index	-2.769	0.101	not significant	0.387	small
3	Digital content creation index	-1.297	0.031	significant	0.510	moderate
4	Security index	−0.851	0.150	not significant	0.339	small
5	Index of problem identification and resolution	-2.916	0.000	significant	0.954	large
6	E-Health literacy index	-3.631	0.009	significant	0.623	moderate

According to the statistical testing of hypotheses and the calculated effect size, the following general conclusions are drawn:

- Education is a significant factor in the summary characteristic (index) of information literacy and data literacy, with university graduates having higher literacy compared to those with lower levels of education.
- Education is a significant factor in the overall characteristic (index) of digital content creation, with university graduates having an easier time creating digital content compared to those with a lower level of education.

- Education is a significant factor in the overall characteristic (index) of identifying and solving problem areas, with those with higher education much more easily identifying and solving problems compared to those with lower levels of education.
- Education is a significant factor in the e-health literacy index, with those with higher education being more literate in e-education compared to those with lower levels of education.
- Education is not a significant factor in the summary characteristics (indices) of communication and cooperation and safety, because the differences in the means are statistically insignificant and the effect sizes are small.

The results confirm Hypothesis 4, that nurses with higher education have significantly higher scores on most indices.

4. SUMMARY RATINGS FOR THE GENERAL ATTITUDE OF NURSING STUDENTS

Based on the attached questionnaire and the collected empirical data, six summary indices were constructed that reflect the attitudes of students in the field of digital literacy and e-health. The methodological basis of the analysis is based on the application of the internal consistency coefficient Cronbach's α , calculated individually for each thematic group of questions. The reliability of the scales is assessed by Cronbach's α values. Those above 0.8 and lower than 0.9 are interpreted as good, and those above 0.9 - as exceptional. The indicators in the present analysis have high values of internal consistency, which indicates high reliability of the constructed indices in subsequent research phases.

4.1. Information and Data Literacy Index

The index is built on the basis of three indicators measuring the skills of searching, recognizing and evaluating digital information and data in a health context. The obtained value of Cronbach's α = 0.921 testifies to the exceptional reliability of the assessment (Table 18). The obtained results confirm Hypothesis 3, demonstrating that the constructed summary indices have high internal consistency, measured by the Cronbach's α coefficient. This proves their reliability and possibility of use in subsequent analyses.

Table 18. *Statistical reliability of information literacy and data literacy*

Information and data literacy index	**Correlation of the given question with all other questions**	**Cronbach's α if the question is deleted**	**Cronbach's α**
I deal with the internet, emails, etc.	0.766	0.950	0.921
Access to GI through applications	0.916	0.822	
Managing the patient's IA	0.872	0.860	

4.2. Communication and Collaboration Index

The index covers nine indicators related to students' social and digital skills to communicate, share and collaborate through internet platforms. The value of Cronbach's $\alpha = 0.964$ confirms the exceptional reliability of the scale (Table 19) . The derived Hypothesis 3 is confirmed after the constructed summary indicators (indices) demonstrate an exceptionally high degree of internal consistency. The calculated Cronbach's α confirms the reliability of the indices, justifying their use in subsequent stages of the analysis without compromising stability.

Table 19. *Communication and Collaboration Index*

Information and data literacy index	**Correlation of the given question with all other questions**	**Cronbach's α if the question is deleted**	**Cronbach's α**
Interaction with patients through CT	0.852	0.960	0.964
Interaction with colleagues via DT	0.799	0.962	
Communicating with patients through CT	0.850	0.960	
Sharing health information through CT	0.863	0.959	
Engaging in the professional community through DT	0.860	0.959	
Collaboration with patients through virtual networks	0.864	0.960	
Internet etiquette	0.832	0.961	
Digital identity management	0.851	0.960	
Development of digital health	0.883	0.958	

4.3. Digital Content Creation Index

Unlike the group of nurses, the students of the specialty "Nursing" do not have to eliminate questions related to programming or digital production. This indicates a higher technological competence in this group. Cronbach's α is 0.894 and confirms good reliability (Table 20). The validity of Hypothesis 3 is confirmed. The calculated values of Cronbach's α show that the constructed summary indicators have a high degree of reliability and can be used confidently in subsequent analyses.

Table 20. *Digital Content Creation Index*

Digital Content Creation Index	**Correlation of the given question with all other questions**	**Cronbach's α if the question is deleted**	**Cronbach's α**
Integrating digital health information	0.767	0.863	0.894
Copyright compliance	0.754	0.868	
Programming	0.722	o.884	
Device protection	0.830	0.839	

4.4. Safety Index

This index measures attitudes and skills related to digital security and personal data protection when working with the Internet and health information. The obtained value of 0.898 indicates high reliability of the index (Table 21). Hypothesis 3 is confirmed by the constructed summary indicators, which demonstrate a high degree of internal consistency, assessed by Cronbach's α. and their use in subsequent analyses is possible.

Table 21. *Safety Index*

Safety Index	**Correlation of the given question with all other questions**	**Cronbach's α if the question is deleted**	**Cronbach's α**
Protecting the patient's LD	0.806	0.851	0.898
Protecting patient health	0.831	0.828	
Environmental protection	0.765	0.884	

4.5. Index of problem area identification and resolution

The index reflects the ability of students to recognize and respond to problems related to digital information and ambiguities in an electronic environment. With a Cronbach's α value of 0.937, the results demonstrate exceptional internal consistency (Table 22). This strongly supports Hypothesis 3 and confirms that the data are sufficiently reliable for use in subsequent analyses.

Table 22. *Index of identification and resolution of problem areas*

Index of problem area identification and resolution	**Correlation of the given question with all other questions**	**Cronbach's α if the question is deleted**	**Cronbach's α**
Identifying and responding to patient needs	0.784	9.938	0.937
Solving technical problems	0.896	0.902	
Creative use of CT	0.882	0.907	
Gaps in identifying digital competence	0.841	0.920	

4.6. E-Health Literacy Index

This index includes eight indicators that measure the level of familiarity with e-health resources, the ability to navigate and assess their potential. The Cronbach's α value = 0.926 confirms very high reliability (Table 23). The results of the verification confirm the validity of Hypothesis 3. Therefore, these indices can be used with confidence in subsequent analyses.

Table 23. *E-Health Literacy Index*

E-Health Literacy Index	Correlation of the given question with all other questions	Cronbach's α if the question is deleted	Cronbach's α
I know what kind of RGs are available on the internet .	0.755	0.915	0.926
I know where to find useful PRs on the internet.	0.828	0.910	
I know how to find useful PR on the internet	0.831	0.910	
I know how to use the internet to answer health questions	0.685	0.920	
I know how to use the Internet for information.	0.787	0.913	
Skills to evaluate PR on the Internet	0.771	0.914	
I distinguish high from low quality PR on the internet	0.826	0.910	
I am confident in using information from the Internet in making health decisions.	0.567	0.934	

In conclusion, all calculated indices reflecting students' attitudes towards information technologies, digital resources and e-health demonstrate a high degree of internal consistency. This allows their use in subsequent statistical analyses and modeling of digital competence profiles.

4.7. Self-assessment of digital literacy among nursing students

Table 24 shows the results of students' assessment of the sufficiency of the number of hours during training to upgrade their digital literacy.

Table 24. *Sufficiency of the number of computer literacy hours*

Level of satisfaction	Yes	No	Not enough hours
Does the number of hours satisfy students?	71.82 %	13.64 %	14.55 %

Table 25 presents the percentage distribution of self-esteem among the surveyed students in terms of general ICT skills.

Table 25. *Student self-assessment of ICT proficiency indices*

Indices	Very bad	Bad	Satisfactory	Good	Very good
Internet and communication skills	0.91 %	2.73 %	10.00 %	39.09 %	47.27 %
Access to health information through apps	4.55 %	3.64 %	24.55 %	33.64 %	33.64 %
Patient health information management	3.64 %	4.55 %	24.55 %	33.64 %	33.64 %
Interacting with colleagues through digital technologies	1.82 %	7.27 %	17.27 %	35.45 %	38.18 %
Communicating with patients through digital technologies	1.82 %	6.36 %	23.64 %	42.73 %	25.45 %
Sharing health information with patients through digital technologies	4.55 %	7.27 %	21.82 %	33.36 %	30.00 %

Indices	Very bad	Bad	Satisfactory	Good	Very good
Engagement in the professional community through digital technologies	2.73 %	6.36 %	20.91 %	43.64 %	26.36 %
Collaboration with patients through virtual networks	3.64 %	14.55 %	20.00 %	32.73 %	29.09 %
Internet etiquette	0.91 %	5.45 %	25.45 %	34.55 %	33.64 %
Digital identity management	1.82 %	4.55 %	23.64 %	38.18 %	31.82 %
Assessments of the development of digital health	2.73 %	4.55 %	24.55 %	37.27 %	30.91 %
Digital health information integration skills	3.64%	4.55 %	30.91 %	30.00 %	30.91 %
Knowledge of copyright compliance	1.82 %	7.27 %	16.36 %	31.82 %	42.73 %
Programming skills	5.45 %	13.64 %	23.64 %	28.18 %	29.09 %
Device security skills	3.64 %	7.27 %	24.55 %	34.55 %	30.00 %
Protection of patient personal data	3.64 %	5.45 %	15.45 %	29.09 %	46.36 %
Protecting the patient's health	2.73 %	3.64 %	18.18 %	29.09 %	46.36 %
Environmental protection	0.91 %	7.27 %	15.45 %	30.00 %	46.36 %
Identifying and responding to patient needs	1.82 %	6.36 %	20.91 %	30.91 %	40.00 %
Solving technical problems	1.82 %	14.55 %	20.00 %	30.00 %	33.64 %
Gaps in identifying digital competence	1.82 %	10.91 %	33.64 %	25.45 %	28.18 %

Table 26 observes the trust and usefulness of health information available on the Internet through the eyes of the nursing students included in the study.

Table 26. *Assessment of accessible health resources on the Internet*

Health resource assessment	Not useful at all	Not useful	Useful	It is very useful.
Assessing the usefulness of the Internet in making health decisions	6.36 %	10.91 %	57.27 %	25.45 %
Access to health resources via the Internet	2.7 3 %	5.45 %	44.55 %	47.27 %

Table 27 presents the level of self-assessment of nursing students regarding their ability to search, evaluate and effectively apply health information retrieved from the Internet.

Table 27. *Students' self-assessment of using health resources obtained via the Internet*

Self-assessment of internet use	I strongly disagree.	I disagree.	Neither agree nor disagree	I agree.	I completely agree.
Assessment of knowledge about available health resources on the internet	3.64 %	1.82 %	21.82 %	58.18 %	14.55 %
Assessment of knowledge about the location of useful health resources on the Internet	2.73 %	3.64 %	14.55 %	60.00 %	19.09 %
Skills for finding useful health resources on the internet	2.73 %	0.91 %	13.64 %	62.73 %	20.00 %
Internet usage skills for health issues	2.73 %	1.82 %	14.55 %	57.27 %	23.64 %

Self-assessment of internet use	I strongly disagree.	I disagree.	Neither agree nor disagree	I agree.	I completely agree.
Skills for using Internet resources	3.64 %	1.82 %	5.45 %	65.45 %	23.64 %
Skills for evaluating health resources on the internet	3.64 %	3.64 %	12.73 %	50.00 %	30.00 %
Ability to distinguish between high and low quality HR	2.73 %	1.82 %	11.82 %	54.55 %	29.09 %
Confidence in using internet information for health decisions	4.55 %	10.91 %	25.45 %	40.00 %	19.09 %

4.8. Socio-demographic characteristics of nursing students as potential factors applied to summary indicators (indices)

The analysis considers two demographic factors: age (≤23 and >23 years) and stage of study (divided into lower-level: 1st/2nd year, and upper-level: 3rd/4th year. After checking the normality of the distribution of these factors (Table 28 and Table 30) , a t-test was applied to assess the difference between the means of two independent samples. In addition to statistical significance, an analysis of practical significance (Cohen's d) was applied to assess whether this difference is insignificant, unimportant or is small, medium and large from a practical point of view. The results are summarized in Table 29 and Table 31 , respectively .

Table 28. *Checking for normal distribution of indices involved in the testing of statistical hypotheses for two independent samples, t-test*

No.	Indices by study groups: *Group 1: up to and including the 23rd, $n_1 = 80$ Group 2: older than 23, $n_2 = 30$*		Shapiro-Wilk test for normality		
			Empirical value	Degrees of freedom	P-value
1	Information and data literacy index	Group 1	0.930	80	0.152
		Group 2	0.876	30	0.395
2	Communication and collaboration index	Group 1	0.963	80	0.276
		Group 2	0.953	30	0.259
3	Digital content creation index	Group 1	0.957	80	0.139
		Group 2	0.927	30	0.059
4	Security index	Group 1	0.889	80	0.062
		Group 2	0.843	30	0.083
5	Index of problem identification and resolution	Group 1	0.969	80	0.069
		Group 2	0.958	30	0.335
6	E-Health literacy index	Group 1	0.935	80	0.089
		Group 2	0.973	30	0.675

All p-values are greater than the chosen significance level $\alpha = 0.05$, which means that there is no reason to reject the null hypothesis and it can be assumed that the distributions under consideration are normal or close to normal. It follows that the analysis can be continued with a statistical hypothesis test for two independent samples, t-test.

Table 29. *Summary table for testing statistical hypotheses and effect size for the difference in means between two age groups of students*

No.	**Two independent samples, t-test** ***Group 1: up to and including the 23rd, $n_1 = 80$*** ***Group 2: older than 23, $n_2 = 30$***	**Difference in means**	**p-value**	**Statistical significance**	**Cohen's d**	**Effect size interpretation**
1	Information and data literacy index	0.225	0.704	not significant	0.082	negligible
2	Communication and collaboration index	1.854	0.280	not significant	0.232	small
3	Digital content creation index	0.800	0.325	not significant	0.212	small
4	Security index	0.258	0.670	not significant	0.091	negligible
5	Index of problem identification and resolution	0.163	0.847	not significant	0.041	negligible
6	E-Health literacy index	0.879	0.476	not significant	0.153	negligible

According to the statistical testing of hypotheses and the calculated effect size, the following summary conclusion is made:

- Age is not a significant factor across the considered summary characteristics (indices); the differences are not statistically significant, and the effect sizes are negligible or small, indicating little practical significance. These results confirm Hypothesis 2, demonstrating that students show similar levels of digital competence regardless of their age.

Table 30. *Check for normal distribution of indices involved in the testing of statistical hypotheses for two independent samples, t-test*

No.	Indices by study groups: *Group 1: Students in their 1st and 2nd year, $n_1 = 39$* *Group 2: Students in their 3rd and 4th year, $n_2 = 71$*		Shapiro-Wilk test for normality		
			Empirical value	Degrees of freedom	P-value
1	Information and data literacy index	Group 1	0.894	39	0.143
		Group 2	0.915	71	0.060
2	Communication and collaboration index	Group 1	0.946	39	0.107
		Group 2	0.945	71	0.074
3	Digital content creation index	Group 1	0.954	39	0.188
		Group 2	0.942	71	0.131
4	Security index	Group 1	0.785	39	0.216
		Group 2	0.907	71	0.186
5	Index of problem identification and resolution	Group 1	0.974	39	0.610
		Group 2	0.953	71	0.113
6	E-Health literacy index	Group 1	0.889	39	0.133
		Group 2	0.976	71	0.218

All p-values are greater than the chosen significance level $\alpha = 0.05$, which means that there is no reason to reject the null hypothesis and it can be assumed that the distributions under consideration are normal or close to normal. It follows that the analysis can continue with a statistical hypothesis test for two independent samples, t-test.

Table 31. *Summary table for testing statistical hypotheses and effect size for the difference in means between 1st and 2nd year students, on the one hand, and 3rd and 4th year students, on the other*

No.	**Two independent samples, t-test** ***Group 1: Students in their 1st and 2nd year, $n_1 = 39$*** ***Group 2: Students in their 3rd and 4th year, $n_2 = 71$***	**Difference in means**	**p-value**	**Statistical significance**	**Cohen's d**	**Effect size interpretation**
1	Information and data literacy index	0.021	0.970	not significant	0.007	negligible
2	Communication and collaboration index	1.613	0.256	not significant	0.202	small
3	Digital content creation index	-0.238	0.754	not significant	0.063	negligible
4	Security index	0.682	0.179	not significant	0.243	small
5	Index of problem identification and resolution	-0.175	0.823	not significant	0.045	negligible
6	E-Health literacy index	1.365	0.162	not significant	0.154	negligible

According to the statistical testing of hypotheses and the calculated effect size, the following summary conclusion is made:

- The course of study is not a significant factor across any of the summary characteristics (indices) considered. Not only are the differences statistically insignificant, but the effect sizes are also small or negligibly small, demonstrating a lack of practical significance.

Thus, no significant demographic factors were identified among students that would influence the considered summary characteristics (indices), which confirms Hypothesis 2 that, regardless of the course

of study, no statistically significant differences were reported in any of the digital literacy indicators .

5. COMPARING THE ATTITUDES OF NURSES AND STUDENTS REGARDING SUMMARY INDICATORS (INDICES)

Two groups are compared – that of nurses and that of students in terms of all constructed summary indicators (indices). Since "programming" was removed as a question for nurses when constructing the digital content creation index, the same question was also removed for the student group to ensure the comparability of the indicators. When comparing two independent groups – nurses and students, a Student 's t-test for independent samples was used . In addition to statistical significance, an analysis of practical significance (Cohen's d) was applied to assess whether this difference is insignificant, unimportant or is small, medium and large from a practical point of view. The data and results of the statistical analysis are summarized in Table 33, and a check for normal distribution of the indices of each two samples participating in the analysis was previously performed in Table 32 .

Table 32. *Checking for normal distribution of indices involved in testing statistical hypotheses for two independent samples, t-test*

No.	Indices by study groups: *Group 1: nurse, $n_1 = 101$* *Group 2: nursing students, $n_2 = 110$*		Shapiro-Wilk test for normality		
			Empirical value	Degrees of freedom	P-value
1	Information and data literacy index	Group 1	0.923	101	0.112
		Group 2	0.882	110	0.071
2	Communication and collaboration index	Group 1	0.968	101	0.151
		Group 2	0.934	110	0.137
3	Digital content creation index	Group 1	0.954	101	0.052
		Group 2	0.919	110	0.054
4	Security index	Group 1	0.886	101	0.053
		Group 2	0.857	110	0.062
5	Index of problem identification and resolution	Group 1	0.969	101	0.169
		Group 2	0.924	110	0.078
6	E-Health literacy index	Group 1	0.955	101	0.181
		Group 2	0.874	110	0.061

All p-values are greater than the chosen significance level $\alpha = 0.05$, which means that there is no reason to reject the null hypothesis and it can be assumed that the distributions under consideration are normal or close to normal. It follows that the analysis can be continued with a statistical hypothesis test for two independent samples , t-test.

Table 33. *Summary table for testing statistical hypotheses and effect size for the difference in means between nurses and students*

No.	**Two independent samples, t-test** ***Group 1: nurse, $n_1 = 101$*** ***Group 2: nursing students, $n_2 = 110$***	**Difference in means**	**p-value**	**Statistical significance**	**Cohen's d**	**Effect size interpretation**
1	Information and data literacy index	-0.182	0.598	not significant	0.073	negligible
2	Communication and collaboration index	-2.813	0.008	significant	0.369	small
3	Digital content creation index	-1.050	0.005	significant	0.387	small
4	Security index	-0.206	0.577	not significant	0.077	negligible
5	Index of problem identification and resolution	-1.595	0.001	significant	0.441	small to moderate
6	E-Health literacy index	-2.421	0.003	significant	0.423	small to moderate

According to the statistical testing of hypotheses and the calculated effect size, the following general conclusions are drawn:

- There is no statistically significant difference in the information literacy and data literacy index between nurses and students, with the effect size between these two groups being negligible;
- There is a statistically significant difference in the communication and collaboration index between nurses and students, with the difference favoring the students. The effect size between these two groups is small;

- There is a statistically significant difference in the digital content creation index between nurses and students, with the difference favoring the students. The effect size between these two groups is small;
- There is no statistically significant difference in the safety index between nurses and students, with the effect size between these two groups being negligible;
- There is a statistically significant difference in the index of problem area identification and resolution between nurses and students, with the difference favoring the students. The effect size between these two groups is small but tends to be medium;
- There is a statistically significant difference in the e-health literacy index between nurses and students, with the difference favoring the students. The effect size between these two groups is small but tends to be medium.

Statistically significant differences exist between nurses and students in the following indices:

- Communication and Collaboration Index;
- Digital Content Creation Index;
- Index of identifying and solving problem areas;
- E-Health Literacy Index.

The results confirm the validity of Hypothesis 1. All the differences found, from a practical point of view, are small, but are in favor of the students. From this, the following recommendation can be made – to develop and implement programs to improve the computer skills of nurses or lifelong education .

6. DEVELOPMENT AND STRUCTURE OF A SPECIALIZED TRAINING MODULE TO INCREASE CRITICAL E-HEALTH AND NURSING INFORMATION LITERACY

Currently, the "Informatics" discipline in the training of future nurses builds basic knowledge of computer technologies and their application in healthcare. Students are introduced to the principles of information presentation and processing, the characteristics of medical data and the role of databases in clinical and administrative practice. During the training, students develop skills in working with basic software applications, namely creating and processing documents in Word, analyzing data in Excel and building basic structures in Access. The course covers a total of sixty classroom hours, divided into twenty hours of lectures and forty hours of exercises, held in the second semester, which allows for the early formation of key digital competencies necessary for professional work in the modern healthcare environment.

Based on the results of our study, we recommend incorporating a “Nursing Informatics and Critical e-Health Literacy” module into the training curriculum for nurses and/or other healthcare professioinals. The module is structured to correspond to the deficits identified by the study and the needs for practical integration of e-Health skills as specifically as possible. This curriculum component spans 15 teaching hours, structured as 5 hours of lectures (L) and 10 hours of exercises (P), with an emphasis on practical exercises.

SUGGESTED CURRICULUM (15 HOURS)

I. Nursing Informatics and Application of e-Health Systems (4 hours)

Time	Topic	Type	Purpose and relation to deficits
1hour	Role of Nursing Informatics (NI) and e-Health	L	Introducing students/nurses to the conceptual model (DigComp, eHealth Literacy Framework) and defining NI as a key clinical competency.
1hour	BDS and Electronic Health Record Architecture	P	Review of the main modules of the BIS and the standards for managing patient health information (from the questionnaire) .
2hours	Working with a simulated BDS	P	Simulation of nursing data entry and verification. Focus on documentation protocols and information retrieval (replacing general Access/Excel skills with clinically applicable ones).

II. Critical e-Health Literacy and Assessment of Digital and Electronic Health Literacy (4 hours)

Time	Topic	Type	Purpose and relationship to deficits
1 hour	Methods for searching , filtering and evaluating online information	L	Presentation of strategies for effective database searching (PubMed, Cochrane) and definition of criteria for validity and reliability of health websites.
1 hour	Case Studies: Recognizing Disinformation and Fake Health News	P	Analysis of real cases. Training on how to distinguish high-quality from low-quality health resources (core deficit).
1 hour	Content validation tools	P	Practical use of external trustworthiness markers: HONcode certification, DISCERN tool for assessing the quality of health information for treatment.
1 hour	Research Analysis : Evaluation of Scientific Articles	P	How to assess the reliability of online scientific articles and apply scientific information to clinical decision-making (answers the question about health resource assessment skills).

III. Digital safety, ethics and patient protection (3 hours)

Time	Topic	Type	Purpose and relation to deficits
1 hour	GDPR Regulation and Privacy Principles	L	Detailed introduction to the requirements of GDPR and clinical norms for the protection of personal data and patient confidentiality.
1 hour	Ethical professional internet etiquette	L	Defining ethical standards for communicating through digital technologies (from the questionnaire). Managing professional digital identity and the boundaries of information sharing.
1 hour	Practical safety measures	P	Device security in clinical environments. Protocols for securely sharing health information with colleagues and stakeholders.

IV. Digital Creativity, Communication and Telemedicine (4 hours)

Time	Topic	Type	Purpose and relation to deficits
2hours	Creating educational digital content	L-1/P -1	Instead of "programming", the focus is on digital creativity. Hands-on work with easy online tools (e.g. Canva/Google Slides) to create infographics and short educational posters for patients.
2hours	Basics of telemedicine and remote communication	L-1/P -1	Protocols for virtual interaction with patients (video consultations) and use of mobile health applications (m - Health).

Including a new module (discipline) in the curriculum of a regulated specialty, such as the specialty "Nursing", is a long and complex process, as it is associated with a change in the EDI for the specialty (the specific change is defined in the Recommendations of this dissertation), compliance with national standards and

requirements for accreditation of the specialty. In view of the above, we propose:

- The module "Nursing Informatics and Critical e-Health Literacy" should be included in the "Informatics" discipline, included as a core discipline in the nursing curriculum.
- In case this is not acceptable to the informatics teachers, the module should be offered as an elective or optional subject for students majoring in Nursing in a standard timetable of 15 hours (5 hours of lectures and 10 hours of exercises) while maintaining the topic of the lecture course.
- To enhance the skills of practicing nurses, the model can also be offered in the form of a postgraduate course.

CONCLUSION

This dissertation represents an in-depth empirical and theoretical study of e-literacy and e-health skills among two key groups in the health sector – nursing students and practicing nurses. The main research thesis that there are significant differences in levels of digital competence, motivation to use electronic resources and confidence in working with health information online – was consistently confirmed through validated quantitative methods and objective interpretation of the collected data.

The study achieved its goal of clarifying the level of information and electronic literacy in the context of modern healthcare, wherein digital transformation requires medical professionals to be highly adaptable, have skills in critical selection and interpretation of health information, and actively participate in electronic processes related to patient health.

By applying reliable psychometric techniques, tested by Cronbach's alpha, indices were constructed in six areas: information and data literacy; communication and collaboration; digital content creation; safety; problem solving and e-health literacy. The results revealed both strengths and areas of difficulty in each of the two study groups.

CONCLUSIONS

1. The literature review confirms that digital literacy in healthcare is multidimensional and includes technical, critical, ethical and communication competencies, with international models serving as the basis for local tools.
2. The adapted questionnaire showed high reliability (Cronbach's α 0.846-0.964) and allowed the construction of six valid indices for assessing key digital competencies and e-Health literacy.
3. The calculated index structures demonstrate high or exceptional internal consistency, which confirms their validity as a reliable measurement instrument.
4. The survey among 101 nurses and 110 students reveals a distinct difference in the levels of digital competence between the two target groups.
5. Students show higher digital creativity and information literacy, while nurses demonstrate higher scores in safety and ethical sensitivity.
6. Higher education has been found to improve nurses' digital literacy in problem solving and e-health, while less work experience (< 20 years) correlates with better problem identification and solving skills.
7. All hypotheses embedded in the theoretical model have been empirically confirmed with a high degree of reliability, which positions the study as a strong foundation for future intervention programs.
8. Students show superior e-literacy in areas like content creation and programming, driven by early technological socialization and contemporary education.
9. Nurse practitioners demonstrate a higher sense of responsibility and safety, especially regarding personal data security and ethical standards, which is a result of their many years of professional practice.

10. Both groups show a low level of critical-assessment in evaluating online health information, which creates a risk of making decisions based on unreliable sources.
11. The analyses confirm the existence of a statistically significant digital inequality between younger respondents and those over 50, which necessitates targeted qualification programs.
12. The study highlights the need for integrated strategies to incorporate e-health and digital literacy into health sciences curricula, with an emphasis on critical thinking and digital communication.
13. Specific measures are proposed to integrate digital literacy into curricula and continuing education systems, with a focus on critical evaluation of online health resources and telemedicine skills.

CONTRIBUTIONS

The research has both theoretical and applied contributions. The main contributions can be systematized as follows:

Theoretical contributions:

A toolkit has been created to assess e-Health literacy and digital competence among medical professionals, based on international frameworks (DigComp, eHealth Literacy Framework), adapted to the specific context of nursing practice.

An integrative conceptual model has been developed that, for the first time, unifies and assesses the six main dimensions of digital literacy (information literacy, communication and collaboration, digital creativity, safety, problem solving and e-Health competence) in a single structure, emphasizing their synergy.

Enriching the scientific discourse in the field of medical pedagogy and nursing informatics by demonstrating the connections between age, experience, and specific components of digital skills.

Applied contributions:

Creating a validated index set for measuring digital literacy that can be used by universities, hospitals, and professional organizations to assess and monitor the competencies of medical staff.

Identifying specific deficits in the preparation of nurses related to digital content creation, critical evaluation of health information, and technological creativity.

Providing an empirical basis for planning curricula, additional qualifications and intervention training in the context of healthcare digitalization.

Support for the process of health policy formation and strategic human resource management in the health sector by providing evidence of the need for systematic improvement of digital skills.

A first-of-its-kind study in the Bulgarian context, combining a comparison between the student profile and practicing nurses in the field of e-health.

RECOMMENDATIONS

Based on our study, specific recommendations can be formulated for healthcare institutions, higher education institutions, professional organizations and hospital managements, aimed at increasing the digital and e-Health competence of nurses:

Integration of the module "Nursing Informatics and Critical e-Health Literacy" into the curricula for the specialty "Nursing".

The duration of the module is 15 hours, including five hours of lectures and ten hours of exercises.

If it is not possible to introduce it as a module, the program "Nursing Informatics and Critical e-Health Literacy" structured in this way can be added as an elective discipline.

This elective discipline is the means by which students in the "Nursing" specialty will build key competencies in the field of digital literacy and health informatics.

Conducting continuing professional training in the form of postgraduate courses enhancing the digital skills of nurses in practice

To overcome the digital inequality between generations, it is recommended to organize regular courses and seminars to upgrade the digital skills of nurses, especially in the areas of electronic documentation, telemedicine and hospital information systems.

Creating controlled platforms for access to verified health resources

It is recommended to develop intra-institutional or national online platforms that provide medical professionals with access to validated sources of health information, with a clear distinction between scientifically based and unverified data.

Promoting digital collaborative learning

Creating digital communities for sharing good practices between students, faculty, and nurses in real practice through the use of virtual collaboration platforms.

Introducing regular assessment of digital competencies in clinical practice

It is suggested that hospital managements include mechanisms in their quality management systems for periodic assessment of nursing staff e-Health literacy to monitor progress and identify needs for additional support.

Development of simulation trainers for e-Health training

Implementation of software simulation solutions for training nurses in a controlled virtual environment, including cases of data entry into BDS, working with electronic health records and simulated interaction with patients through telemedicine platforms.

Political and institutional recognition of digital literacy as a core clinical competency

It is necessary for digital and e-Health literacy to be normatively enshrined in the professional standards for nursing competence, including in accreditation and certification systems.

1. Development of targeted educational modules to increase e-health literacy within undergraduate and postgraduate programs;
2. Creation of intra-institutional systems for continuous training and validation of digital competencies of medical professionals;
3. Developing a digital platform with verified and validated health resources, accessible to students and practitioners.

It is proposed to include in Article 8a of the Regulation on the uniform state requirements for acquiring higher education in the specialties of "nursing", for the educational and qualification degree "Bachelor" (title amended and supplemented - Official Gazette, issue

32 of 2016) as item 14, regulating the acquisition of "basic competencies in the field of e-Health and the application of modern digital technologies in clinical practice".

Introducing regular digital audits in healthcare institutions aimed at assessing staff skills and attitudes towards using electronic health tools.

LIST OF PUBLICATIONS RELATED TO THE DISSERTATION

1. *Petrova, N.* „Influence of Higher Education and Work Experience on the Digital Competencies of Nurses“, *Varna Medical Forum , 2025;14(2) - online first*
2. *Petrova, N. „*Digital literacy and general competencies of nursing students“, *Varna Medical Forum, 2025;14(2)- online first*