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eHealth4all@EU

Interprofessional European eHealth Programme in Higher Education

IO1: European eHealth Education: Policy and Practice Review

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- University of Eastern Finland, Research Group of Health and Human Service Informatics (HHS)
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Table of contents

Abstract

The University of Eastern Finland was the responsible partner of IO1: European eHealth Education: Policy and Practice Review. The aim of this intellectual output was to customize and validate the already existing international health informatics recommendations. Based on that the aim was also to describe the priorities of core competencies and learning outcomes particularly in the fields addressed by this project. The methods used were a scoping review and focus group interviews.

The aim of the scoping review was to explore how education in health informatics (HI) has been taught by evaluating the existing international frameworks and reported educations in HI. The scoping review was conducted based on the instructions of Joanna Briggs Institute to find English language publications published between 2016 and 2020. All publications found in the bibliographical database MEDLINE via PubMed, Scopus and Web of Sciences were included. The results indicated that education in HI is essential to everyone, and everyone needs skills and knowledge in both technical and non-technical skills in HI. Education in HI should be introduced already in the first year of the education and with time increase the knowledge to a more advanced level. The teaching methods can vary between lectures in class to a more hybrid method.

The aim of the online focus group interview was to investigate the needs of HI competencies in health care. To achieve the answers, two main questions were used as a base of the interview. The first question focused on how knowledge and competencies in health informatics could contribute to improving health care. The second question focused on which HI competencies are seen as important to learn and how to achieve them. Online focus group interviews were conducted in each of the three countries. The interviews were done the own languages (German, Portuguese, and Finnish) and later summarized and translated to English. The focus group interviews concluded that there are challenges and possibilities in health informatics. It also highlighted the competencies seen as important to have in daily working life. For example, skills in applications in patient care, knowledge in IT-background and IT related management are considered important.

1 Introduction

Several published educational recommendations on HI are available. They made by professional and scientific associations, such as the International Medical Informatics Association (IMIA) or the American Medical Informatics Association (AMIA). These recommendations are fed by the TIGER Recommendation Framework of Core Competencies in Health Informatics or Nurses (Hübner et a. 2018) and multi- and interprofessional (Hübner et al. 2019). They have given good guidance for this project, however, they needed to be customized to the local needs. This Output (IO1) consists of an updated list of HI recommendations. Based on this summary the priorities of core competencies and learning outcomes particularly in the fields addressed by this project are further described. The results of IO1 will also lead to discussion and debate at local, national, EU and international levels about the importance of digital competencies for all types of professionals in health and care and the urgent need for more eHealth education in an interprofessional context. This will stimulate further pedagogical research beyond the lifetime of the project and could lead to higher education institutions and policy makers adopting a more interprofessional approach to health education generally, and eHealth more specifically.

2 Methods

IO1 included the following work packages:

WP01: Create IO framework draft, work plan and briefing material

WP02: Summarize and update educational recommendations in health informatics and eHealth education

WP03: Prepare and align approach for local focus group discussions/workshop

WP04: Perform focus groups in each of the three countries involved in this project

WP05: Analyze and synthesize the results of the focus group discussions

WP06: Draw conclusions for this project

WP07: Develop recommendations for policy of education and practice in higher education institutions

The methods used were conducting a scoping review and focus group interviews.

Scoping review

The aim of the **scoping review** was to explore how education in HI has been taught by evaluating the existing international frameworks and reported educations in HI. This review focuses on the content of the HI education, learning arrangements in the HI education and who would need education in HI. The research questions were: To whom is the education in HI targeted? What are the most common contents in HI education? What are the most common ways in arranging HI education?

The scoping review was conducted by UEF according to Joanna Briggs Institute's (JBI) methodology. UEF partners are accredited JBI trainers. https://wiki.joannabriggs.org/display/MANUAL/11.2+Development+of+a+scoping+review+protocol. The PCC format was used to define the population, concept and context of the review. Keywords related to health informatics education, curriculum, recommendations for education. The bibliographical database MEDLINE via PubMed, Scopus, and Web of Science were accessed with some help from the informatics librarian. Only studies found in these three bibliographic databases were included in the review; gray literature was excluded. All publications published between 2016 and 2020 were considered.

After searching for keywords in the headings and abstracts, 51 publications were chosen for a closer review. 28 publications were selected for further analysis. The review indicated that there is no correct way of teaching HI, but the education can use a traditional way of teaching, a blended way or a hybrid teaching method. This review highlighted the importance of having skills in documentation and communication, data protection, different types of management, knowledge in computer science, ethics in health and knowledge in the health information system. It also highlighted the need to include hands-on skills in the course.

Focus group interviews

The aim of focus group interview is to investigate the needs and values of HI competencies in health care. To achieve the answers, two main questions were used as a base of the discussion. The first question focused on how knowledge and competencies in health informatics could contribute to improving health care. The second question focused on which HI competencies are seen as important to learn and how to achieve them.

Online focus group interviews were conducted in each of the three countries. The interviews were done via Zoom and each partner school facilitated two focus group interviews with four participants in each group. The focus group interviews were done in their participant's own languages (Portuguese, German and Finnish). The partner schools were also responsible for the transcription of the recordings, summary of the data and translation to English. All the interviews were analyzed as one using a thematic content analysis (Braun & Clarke, 2006).

Pre-formulated themes were identified from the focus group interview questions, and the categories found were added in them. Categories that did not fit into the themes were later discarded. Examples given by the informant regarding a certain topic are not coded. Four themes: Challenges in health care, possibilities digital competencies in HI, competencies seen as important in health care and recommended skills to include in the education.

3 Results

Table 1: Milestones of IO1

Milestone	**Authors**	**Name of the manuscript**	**Journal, publication situation**
M1: Literature work and summary of educational recommendations completed	Pauleen Mannevaara Kaija Saranto, Ursula Hübner, Ulla-Mari Kinnunen	Recommended teaching methods, course content, and groups of students for teaching.	Health Informatics: A scoping review Submitted
M2: Focus groups conducted, and results analyzed	Pauleen Mannevaara, Ulla-Mari Kinnunen, Kaija Saranto, Ursula Hübner, Nicole Egbert, Pedro Marques, Paulino Sousa	Exploring what digital competencies are needed in health informatics education. A Focus Group Interview.	Methods of Information Medicine Will soon be submitted
M3: Report with recommendations completed and manuscript submitted for publication	Pauleen Mannevaara, Ulla-Mari Kinnunen, Kaija Saranto	IO1 Report	

4 Conclusion

All health care professionals need skills and knowledge in HI which should be included in the education already in the first year of studies and with time extend the knowledge for a deeper understanding.

There are no specific recommendations on how to teach HI competencies, but the teaching could be a combination of traditional seminars and online classes. The learning activities can also vary from individual tasks to group assignments. The most important thing is to include hands-on exercises or training in the course or education and active interaction between students and teachers and between other students.

Competencies in HI highlighted as important and should be included in the education are documentation and communication, management such as project management and change management, interoperability, basic skills in technology and entrepreneurship.

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Appendix

Submitted manuscript:

Mannevaara P, Saranto K, Kinnunen UM, Hübner U. Recommended target audience, course content and learning arrangements for teaching Health Informatics Competencies: A scoping review.

Recommended target audience, course content and learning arrangements for teaching Health Informatics Competencies: A scoping review

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Abstract

Background: As health care depends on information technology and health information technology, competencies in Health Informatics (HI) is a topic needed for all health care professionals. The aim was to explore education in HI with a focus on recommended content, learning arrangements and target audience.
Method: 28 publications, published between 2016-2020 in English and obtained from selected bibliographic databases, were reviewed. The data was analyzed using deductive content analysis with the following pre-formulated topics: *target audience, course content and learning arrangements.*
Results: The results indicate that HI competencies are valuable skills relevant to health care education. These competencies can be achieved by using different learning activities, such as different modules combined with different blended learning methods. The target audiences' previous education Influences the course content.
Conclusion: Teaching and developing skills in HI requires learning arrangements that combine both theory and practice in the education for all health care professionals.

Keywords competencies, course contents, health informatics, learning arrangements,

target audience

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Introduction

As health care services are based on patient data (1), they cannot exist without information and communication technology (ICT) or health information technology (HIT). Health information technology supports daily work routines in health care, but it may also cause challenges and affect the work in different ways (2). How well a system is integrated in the health care systems and individual health organizations varies depending on the user's level of satisfaction

(3). Some nurses, for example, may feel that they do not have the competences or training required to use digital tools for work. Currently, during typical educational programs for health care professionals, an inadequate level of education in informatics is offered, or in some cases no education in this field is offered at all (2,3).

Because of the challenges in health care, core competencies in informatics were developed to meet the needs of all health care professionals (4).There are educational frameworks that have been developed to support education and competency developments in HI (5). The International Medical Informatics Association (IMIA) recommendations on Education in Biomedical and Health Informatics guide curricula and were developed by the IMIA for all health care professionals. The IMIA recommendations define and connect skills and knowledge needed for all health informaticians and working life (6). A certain level of knowledge in HI is also essential in the nursing practice. The Technology Informatics Guiding Education Reform (TIGER), for example, was developed with a focus on how to integrate nursing, technology and informatics into research development, education, and practice (7).

A framework has also been developed to collect information on competencies and skills required for different areas and levels of knowledge and different roles in health care, i.e. the Health IT Competencies Tool and Repository (HITComp). The HITComp Repository is a searchable database developed for everyone interested in health information technology and plays an important role in connecting skills, education, and competence for all health care professionals (8). Further, the Commission on Accreditation for HI and Information Management Education (CAHIIM) focuses on establishing accreditation standards for the different programs (6). While HITComp is a tool and repository that can be used to gather information on skills and competencies required in health care (8), CAHIIM is used to accredit educational programs to students aiming for a career in HI and health information management (9).

Acquiring HI competencies is demanding, which motivates universities to create and develop courses to help students attain these skills. However, it is challenging to know at what stage of education HI topics should be introduced to students (10–12). There are discussions about whether to introduce HI in the bachelor's and the master's levels (1,10,13), or as a course for postgraduates and health care professionals (11,14). The key focus of the IMIA recommendations is the need to provide education, training, and high-quality health care in biomedical and health medical informatics (6). It suggests that undergraduates should learn HI on both introductory and advanced levels during their two first years and health information systems should be taught in the final years (15).

The IMIA recommendations also divide learners into three different roles where the first role, BMHI users, involves learners with no education in biomedical and health informatics (BMHI). The aim for the first role is to introduce the learners to the fundamental topics in BMHI, in other words a beginner's level. Learners in the second role, the BMHI generalists, are learners from a non-BMHI background. The education for the BMHI generalists requires skills and knowledge in assisting different biomedical and health informatics aspects and information technology. The third role, the BMHI specialists, are learners with a BMHI background. This role focuses on education on an advanced level where the learners focus on knowledge in their own fields and specializations (15).

A review by Nazeha (16) indicates that skills and knowledge in HI are identified as relevant for all health care professionals and can be implemented into HI education (16). From a clinical practice perspective, it was shown that knowledge and positive experiences in HI contribute to the safe use of patient data and knowledge to avoid errors in health care systems (17). If there is no training nor

HI education offered, health care professionals may be less interested and less willing to learn, or use HIT due to feelings of incompetency (18). Positive experiences will not only encourage a willingness to adopt technology in daily work routines, but the work environment will also be affected positively (17).

Objective

The aim of this review was to explore how education in HI has been taught by evaluating the existing international frameworks and reported educations in HI. This study focuses on the content of the HI education, learning arrangements in the HI education and who would need HI education. The research questions were: Who are the targets for HI education? What are the most common contents in HI education? What are the most common ways of arranging HI education?

Methods

The scoping review methodology guidelines of the Joanna Briggs Institute (JBI) were used to identify English language publications published between 2016 and January 2020. Only publications published within this time frame were searched because of the competence needs generated by recent technology advancements (19).

The PCC format (19) was used to define the study population (P), concept (C), and context (C) (**Error! Reference source not found.**, Table 2). The population was defined as the audience, including teachers, education planners, study advisers, executive teams, and teams related to HI. The concept was defined as educational recommendations, curricula, and degree programs in HI. The context included educational levels such as university education on all levels, basic studies, and advanced studies in HI. The bibliographical database MEDLINE via PubMed, Scopus, and Web of Science were accessed with help from the informatics librarian. Only publications found in these three bibliographic databases were included in the review; gray literature was excluded. All publications were considered.

Table 1: The search strategy

Data base	Search string
Scopus	(TITLE-ABS-KEY ("health informatics" OR "medical informatics") AND TITLE- ABS-KEY (education* OR curricul* OR program) AND TITLE-ABS-KEY (recommendation* OR proposition* OR endorse*))
PubMed	((("health informatics" OR "medical informatics")) AND (education OR curricul* OR program*)) AND (recommendation* OR proposition* OR endorse*)
Web of Science (From Web of Science Core Collection	TOPIC: (("health informatics" OR "medical informatics") AND (education* OR curricul* OR program) AND (recommendation* OR proposition* OR endorse*))

Table 2: Inclusion criteria

Inclusion Criteria

PCC format	**Participants**	**Concept**	**Context**
	Synonyms included - Education planners - Study advisors - Executive teams	- Teachers - Students - Different teams related to the teaching area	- Educational recommendations - Curricula - Degree programs in HI	- Educational environments in HI - University educational levels (undergraduate, graduates and postgraduates)
Timeline	2016 – 2020		
Document type	- Articles (qualitative and quantitative) - Chapters in book - Conference proceedings - Book series		
Language	English		

Three members of the scoping review team screened the headings and abstracts of 359 publications (Figure 1). 72 full-text publications met the criteria for the second screening, of which 21 publications were excluded after the inclusion and exclusion criteria or were duplicates. Keywords (Table 1) that could be found in both the headings and abstracts were used as main inclusion criteria to find relevant publications. Figure 1 shows the PRISMA flowchart with a step-bystep method for how the scoping review was done (20). Twenty-eight publications (Appendix 1) were chosen for the in-depth analysis and each of them was reviewed by at least two reviewers independently. The content was analyzed with deductive content analysis using a structured matrix (21): 'target audience', learning arrangement', and 'course content'. Further, these preformulated themes were categorized into more accurate main themes and sub-themes. The content of the selected publications was read thoroughly and only content relevant to the preformulated themes were analyzed, categorized, and added under suitable main categories and sub-categories. Each main category and sub-category are presented in the tables with presentation of the results. Microsoft excel was used as the data extraction tool.

[insert Figure 1_flowchart_PRISMA.]

Figure 1: Flow chart of the data collection according to PRISMA (20)

Results

Out of the 28 publications included, five publications were conducted in the USA, eight in

Germany, four in Austria, three each in Finland and the UK, two in Canada, and one in Australia, Norway, and the Netherlands. Eight publications were published in both the years 2019 and 2017, six publications in 2018, and five publications in 2016. Only one study was published in January 2020.

Among all the topics discussed in the selected publications, competency framework was the most discussed. Twelve publications discussed adapting and validating competencies in informatics, different standardized framework (e.g. TIGER and IMIA), nursing informatics and education in HI. Seven publications focused on the educational curriculum in HI and two publications discussed recommendations in HI. Two highlighted courses in HI, two highlighted hands-on skills, and one of each was concerned with online education, continuous education, and Health Data Sciences (Table 3).

Table 3: Topics discussed in the publications

Topics	Sub-category	References
Competency framework	Nursing informatics	(22–24)
	Technology Informatics Guiding (TIGER) Educational Reform	(25–27)
	American Medical Informatics Association (AMIA)	(28)
	International Medical Informatics association (IMIA)	(29)
	Inter-professional eHealth competencies	(30)
	Health informatics competencies	(31)
	Medical informatics	(32)
	Nursing curricula	(33)
	Biomedical and health informatics	(34)
Curriculum in HI	Health informatics curricula	(35–37)
	Pharmacy informatics	(38)
	Public health informatics	(39)
	Health IT-evaluation	(40)
Recommendation		
	National health information work force	(41)
	Joint program	(42)
Online course		
	Cross-countries and inter-professional	(43)
	Assess health informatics training	(44)
Hands-on skills		
	Refresh (45)	
Online degree	Online master's program	(46)
Continuous education	Topics for continuous education in nursing informatics	(40)
Health data science	Health data system	(47)

Who are the targets for HI education

Previous publications (Appendix 1, Table 4) recommend competencies in HI for health care professionals such as physicians (25,30,32,44) and nurses (23,25,26,30,31,46,48). Managers (25,31,46,48) should also have competence in HI. It is also recommended for health care organizations (26,27), employers (24) and workforces (41).

These competencies are also important for undergraduates (33,34,36,42,43,46,48), graduates (23,27,28,34,35,39,40,42–46,49) PhD students and PhD candidates (28,49), researchers (28) and teachers (24,26,27). For those who want a certificate (36) or are interested in learning HI (24,28,29), a continuing education program can be offered.

Table 4: Target audience

Main category	Sub-category	References
Graduates	Master's degree	(23,27,28,34,35,39,42–46,49)
Undergraduates	Second-year students	(38)
	Bachelor's degree	(33,34,36,42,43,48)
	Student trainees	(28)
PhD students	PhsciD iencn escli nical transitional	(28)
Teachers	Postgraduates	(49)
	Educators	(22)
Health care professionals	Teachers	(24,26,27)
	Employers	(24)
	Health care organizations	(25,26,42)
	Nurses	(25,26,30,31,40,48)
	Nurse managers	(23,25,31,40,48)
	Other staff members	(29,37,40,41,44)
	Physicians	(25,30,32,44,47)
	Specialists	(29)
Other	Learners with different backgrounds	(24,28,29)
	Certificates in informatics	(36)
	Frontline clinicians	(44)

Course content

The publications (Appendix 1, Table 5) highlighted **documentation and communication** as one of the most important competencies in HI education. Documentation is the legal basis for electronic patient records and electronic medication and documentation systems (40) for transferring data between different systems in the care process (24). To optimize the use of the health care systems, a standardized language is needed (24,28,29,31,33,37–40,43) to ensure the quality of documentation (40). This also enables a better understanding of the care process (24) and patient-related work (31). It is important to understand both clinical and non-clinical data (43) and how to store, collect and access them (28). The ideal is that every nursing and IT curriculum would teach basic terminologies in HI, classification systems and generic health care terminologies, although in practice not every

nursing and IT curricula has included them (29,30,33). Competencies in documentation and communication have an impact on hands-on skills (31) in patient-related communication (30,31,48), leadership-related communication (26), and institutional-related communication (28,30,33,42,44). These competencies can be achieved by completing a practical training in which one could learn communication and documentation with the terminology used in HI (26). **Data protection and security** is an essential part of documentation (22,25,30,31,43,47) that needs to be taught. The same was true in the case of **ethics in health IT** (24,25,30).

Another competency which was highlighted is different types of **management**. The differences between the information systems in hospitals can be significant, but in any case, it is important to have organizational structures for process management to monitor (25,41–43) and at the same time to have access to correct data (27,28,32). Information and knowledge management in patient care is considered important (22,33,34,44), even though it is not taught in all curricula (33). Other skills, such as project management (22), change management (25,29), and quality management (26,30) were also mentioned. Additionally, leadership in patient-related work (24,30) are ongoing current topics of interest (42,43).

Apart from learning skills in management, knowledge in using the **health information systems** was also highlighted as a competency health care professionals need to learn (37), especially knowledge about how the systems and data are structured, function and are processed (37,42). They also need to be able to evaluate the quality of the information system (39,42,43) and eHealth technologies or IT tools used in health care (40).

Learning health information systems requires basic **knowledge in computer science** to better understand the use of information systems within health care organizations (37,42). Competencies such as data security, and interoperability are considered as basic knowledge in computer science (30), and these skills are seen as qualifications that can be taught as either a separate qualification or as a certificate offered as part of continuing education (34). In some curricula, knowledge in computer science is included as a part of the education (33,44), whereas in some curricula competencies in computer science are seen as less important (40).

In a computerized environment in which technology changes rapidly and the use of technology is a part of daily routines, there is a need for **hands-on training**. Compulsory practical training (37,48) supports practical experiences (32,33,37) and is a possibility to learn the implementation of technical skills (33,39,43). There should be a mentor or supervisor to show the skills (32,42), to set the learning objectives and evaluate the skills (49). However, hands-on trainings are not yet included in all curricula (33).

Internationally accepted **frameworks** such as the Technology Informatics Guiding Education Reform (TIGER) (22), The Canadian Medical Education Directives for Specialists (CanMEDs) (32) and other guidelines (28,34,36,48) contain different competency areas or domains. These competency areas can be used as guidelines for employers, learners, and teachers (24), but not all the competency areas are necessarily needed in every HI education program or related course (44). For researchers, skills in entrepreneurship should be an additional aim (26).

Table 5: Recommended course content

Main category	Subcategory	References
Documentation	Institutional-related information	(28,30,33,42,44) and (26)
	Leadership and communication	
communication	Nursing-related documentation	(22,25,27,31,40)

	Standardized terminology	(24,28,29,31,33,37–40,43)
	Patient-related communication	(30,31,48)
Data protection and security	Data privacy	(43,49)
	Patient privacy	(22)
Management	Change management	(25,29)
	Data management	(27,28,32)
	Leadership in direct patient care	(24,30)
	Interoperability	(43)
	Knowledge management	(22,33,34,44)
	Process management	(25,41–43)
	Project management	(22)
	Quality management	(26,30)
Health information systems	Architectures of health information	(42)
	Basics in information system	(37,42)
Consumer focused eHealth technology		(32,47,48)
Health information system	Electronic health record	(28,38,42,43)
	Information exchange	(43)
	Nursing information system	(29)
	Patient data	(43)
	System evaluation	(39,42,43)
Ethics in health informatics	Confidentiality	(24,26)
	Direct patient care	(30)
Knowledge in computer science	Basic computer skills	(28,33,34,40,44)
	Interoperability	(48)
	Health literacy	(27)
	Competency	(32)
	CanMeds framework	(22,27)
	TIGER	
Research	Guidelines	(28,34,36,48)
	Entrepreneurship	(26)
	Funding opportunity	(48)

Most common learning arrangements

Previous publications (Appendix 1, Table 6) have shown that **integration and cooperation** are relevant pedagogical methods and were used as examples when developing online learning courses(46). A course in HI is not only a blend of practice and theory, but also an integration and collaboration with other students (38,42,46) and teachers (28,35,36,39,41–43,46). Another relevant pedagogical method used was creating **learning activities** suitable for the participants. Creating courses in HI could vary from face-to-face, online and hybrid teaching to blended learning activities (46,49).

Since learning is an individual process, a variety of options for primary learning and teaching periods should be offered to the learners (26). This process can be actively stimulated with both general learning objectives and personal goals set by the participants (27,46). Each participant is given time to build his or her own **learning outcomes** based on the content of the course (26,27,46).

Setting personal goals in the learning process prepares students to think critically (28) and to develop their HI competencies (33,40).

HI courses are divided into different **building blocks** that can be realized as classroom lectures or as interactive seminars (36,42). Publications reported various HI course offerings on campus, online, or in a hybrid learning fashion. Each block has different assignments (42,44) with separate learning objectives (49), instructions, and literature (39), and the content may be independent publications and lectures to better understand the practical use and implementation of the information systems (42). The publications reported that some of the building blocks were divided into learning modules (27,32,36,39,44–46,49), some were integrated into another course (44), and some were only one weeklong (27). The building blocks are planned and created depending on the target audience's background and knowledge (23,28,44).

Creating and structuring a course in HI can be achieved in different ways. One way is to provide **teaching materials** consisting of both online materials (41), regional and local materials (32) and tools (28). The teacher presents necessary materials and instructions (46) for each learning activity that were decided before the course (42).

The assessment of the course is based on the evaluation (29,42) and evaluation criteria can be pre-defined for all assignments (42,43). It is also important to present how the tasks are to be assessed (29,32,42), e.g. examinations (32,43), and the criteria should be presented during the first week (43). Feedback should be given after an accomplished task (42,44).

The benefits associated with digital health and data science should be acknowledged by all health care professionals (47). Not only should HI be taught to students, but it is also recommended as a component of **continuous education**, job training, internships, and academic training (28,37,45,48). If the participant does not have knowledge about the topic, they are recommended to take courses to increase their competence (41). They can take further education to become a specialist in HI or become educators (46).

In a computerized environment in which technology changes rapidly and the use of technology is a part of daily routines, there is a need for **hands-on training**. Compulsory practical training (37,48) supports practical experiences (32,33,37) and is a possibility to learn the implementation of technical skills (33,39,43). There should be a mentor or supervisor to show the skills (32,42), to set the learning objectives and evaluate the skills (49). However, hands-on trainings are not yet included in all curricula (33).

Table 6: Learning arrangements in the course

Main category	Subcategory	References
Assessment	Evaluation	(29,42)
	Evaluation criteria	(43)
	Examination	(32,43)
	Feedback	(42,44)
Building blocks	Assignments	(42,43)
	Learning modules	(27,32,36,39,44–46,49)
	Learning objectives	(49)
	Learning techniques	(39)
	Seminars	(36,42)
	Validation and adaption	(23,28,44)
	Workloads	(35)

Continuous education	Educators in HI	(46)
	Professional training	(37,45,48)
	Refresh knowledge	(41)
	Specialist in HI	(49)
Interaction and cooperation	Multi-professionally	(23,28,33,35,48)
	Cooperation internationally	(42,48)
	Discussion platform	(41,43)
	With other students	(38,42,46)
	With students and educators	(28,35,36,39,41–43,46)
Learning activities	Deadlines (41)	Drop-in sessions (49)
	Have knowledge in HI	(33,40)
Pre-requisites	Sufficient background knowledge	(35,49)
Teaching and learning before the course	Appropriate tools (42)	(28) materials Decided
	Easy to access	(41,42)
	Necessary materials presented	(46)
	Online materials	(41)
	Relevant regional and local materials	(32)
Hands-on skills	Evaluation of practical training	(49)
	Learning objectives	(49)
	Practical skills experience	(28,30,32,36,38,39,42,43,45,48)

Discussion

Looking back at how health care systems have changed over the years and how the roles of ICT and HIT have changed, the needs for effective use of IT in daily working lives (42), as well as knowledge and skills in informatics, are growing. HI is a relevant subject at the intersection of practical use, development, and implementation of a technology and the interprofessional provision of patient care.

As a result, educational recommendations such as IMIA (29) and competency frameworks such as TIGER (25) are useful in terms of improving competencies in HI. These recommendations and competency frameworks can be included in every curriculum (33) to support future education (26). The competencies and recommendations can be interpreted and ranked differently (25,27) according to the health care professions (44).

As health care professionals may feel they are not confident or satisfied with their own skills and knowledge in HI (2,3), we suggest offering more education in HI to all health care professionals. Having positive experiences in using digital technology creates more awareness on every organizational level (38). To achieve this goal, we found that one university does not need to be responsible for the whole content, but the responsibility can be shared among several universities (43).

As the necessity of learning HI competencies increases (10–12), some competencies were considered more relevant than others. To create **content for a course in HI**, our findings suggest that the main outcome for the course is to better understand how health information systems work. We see this as important because health care services are built on patient data (1), documentation and communication (24,28,37), and different types of management are identified as relevant competencies to learn (25,27,33). Having competencies in management and leadership in HI would add more value, as health care professionals are trained to make decisions in health care (28) and health IT (23,47).

However, we noticed that learning HI competencies only in theory is not enough, and a handson training program is required to learn them properly (39,48). Key competencies such as documentation and communication, data protection and data security and different types of management are suggested for inclusion in both theoretical and hands-on skills sessions (28,32,33,37–39,43,45,48). We also suggest creating a plan for the competencies that can be taught at school and competencies that are easier to acquire as work experience (45). It is advisable to define and present the course content and the learning arrangements to the target audience at the beginning of the course (29,31,38).

As for **learning arrangements** used in teaching HI, there were no specific methods applied. However, it was found that teaching HI competencies is structured from different building blocks and levels where an active interaction between students and teachers takes place (32). The focus is on individual and team-based learning, interactions between students, teachers and employed professionals (35–37,48) and evaluation of the learning activity of each participant is suggested (35).

When **creating, planning, and developing** a course in HI, we noticed that the teaching and learning styles varied between different universities (25), and between different countries (22,24,48). There are joint programs (34) and co-operative activities between other countries and universities (43) and some appear to prefer a hybrid teaching methodology. These courses typically consist of a combination of online sessions, discussion panels and regular feedback from the teacher. However, online courses in HI appear to face challenges such as student isolation, lack of applicable knowledge, and no hands-on learning for the participants. The rate of dropout is potentially higher, and the teacher might not be able to have interactive discussions with online students (40,49). Further, some students might also have less experience in using the learning platform, or different levels of interest in learning online (43).

One notable finding is the importance of awareness of student backgrounds. Some students may not be confident with IT security, may be unfamiliar with the terminology (36), or lack confidence in their own skills or competencies. There could also be differences in required skills and existing competencies (45), and older health care professionals may need more support in using digital tools (31,44). Another relevant aspect is the number of learning activities and tasks in a course, and their length (29,44,49). We found that the competencies taught depend on the course level, and therefore having pre-requisites for each course would be recommended (49).

As for the **target audience,** our findings suggested that everyone, no matter their background or health care-related profession, need skills in HI. However, these skills are first and foremost important for health care professionals (28,39,49), including health care managers (25,31,40,48) who are directly working with the systems. Skills in HI are also relevant for health care students and organizations on all levels (29), as well as for teachers (24,26,27) and researchers (28,47).

Limitations

Three well-known databases were used to find the selected publications, but there is always a possibility of missing important publications. Data retrieval was limited to January 2016 to January 2020, and as this review has taken time to finalize, there is possibility newer publications were missed. Additionally, the indexation of publications based on specific keywords in databases always affects the use of keywords in data retrieval and search results. All the publications were read and commented on independently, and the reviewers were not influenced by each other. The first author did the content analysis, summarized, and analyzed the content independently from coreviewers.

Most of the publications in HI were performed in developed countries, and we found only one study from the continent of Africa. A similar study with a focus on developing countries would provide an interesting and valuable comparison to this study.

Conclusion

Education in HI is especially relevant for health care professionals and students in all health care fields, as it may affect students and teachers as well as managers, researchers, and other health care professionals. It is worth including HI informatics at an early educational stage and slowly increase the content with time. As HI is an applied topic, it requires different types of learning arrangements to blend both theory and practice to support HI competencies through practical skills and theoretical publications. Regular interaction and cooperation among the students, the teachers and different types of learning activities seems to work well. The recommendation is to include HI competencies as a part of health care education.

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Declaration of conflicting interests

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Ethical statement

All data used in this study is available to public. This study does not contain any personal data, or any data connected to a particular individual and therefore no ethical approval is required.

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Appendix

Appendix 1: List of selected publications 2016-2020

First author, Year (reference), Country. Title	Population Context	Course content, Learning arrangements, Who to teach	Results
Ahonen et al. 2018 (33). Finland. Title: Identifying Biomedical and HI Competencies in Higher Education	Population: undergraduates. Context: undergraduate curriculum.	Course content: IMIA recommendations. Learning arrangements: not specified. Who: undergraduates.	The nursing curriculum contains more competencies than any other health care curricula, but IT has the highest number of competencies. It is important to take the student's background into consideration.
Ammenwerth et al. 2018 (46). Austria. Title: Building a Community of Inquiry Within an OnlineBased Health Informatics Program: Instructional Design and Lessons Learned	Population: graduates. Context: online-based program.	Course content: health informatics. Learning arrangements: learning activities (deadlines, interactions, literatures). Who: graduates.	An environment of effective learning and inquiry can be built. A guideline on how to create online cooperative learning is included.
Ammenwerth et al. 2017 (49). Austria. Title: How to teach health IT evaluation: Recommendations for health IT evaluation courses	Population: experts in health IT and/or ITevaluation courses. Context: course in health technology and informatics.	Course content: learning outcomes and activities. Learning arrangements: online, practical parts, different Learning arrangements. Who: employed professionals and graduates.	A course in HIT with fifteen mandatory topics and fifteen optional topics is recommended. Practical training should also be included.
Ammenwerth et al. 2019 (40). Austria. Title: Topics for Continuous Education in Nursing Informatics: Results of a Survey Among 280 Austrian Nurses	Population: health care professionals. Context: education.	Course content: information systems, common language, computer sciences Learning arrangements not specified Who: employed professionals, graduates	Five topics in health informatics are considered important in continuous education: project management, IT in nursing, eHealth, nursing terminologies, and computer science basics. Both nursing managers and nurses with IT responsibilities see continuing education as necessary. However, suitable continuous education is missing.

Ammenwerth et al. 2017 (*Ammenwerth et al., 2017c). Germany.	Population: students learning health information systems.	Course content: information systems, management, learning outcomes.	Positive feedback on an international course and international exchange on HI systems.
Title: On teaching international courses in health information systems: Lessons learned during 16 years of Frank – van Swieten lectures on strategic information	Context: online joint program.	Learning arrangements: module, learning material, learning activities, seminar. Who: undergraduates and graduates.	
Bhyat et al. 2017 (32). Canada. Title: Implementing Informatics Competencies in Undergraduate Medical Education: A National-Level "Train the Trainer" Initiative	Population: students. Context: webinar.	Course content: framework. Learning arrangements: learning activities, practical part, assessments. Who: employed professional, undergraduates.	Two Canadian faculties created an online collection of e-health educational resources with open access and two activities: endorsement of eHealth and involvement in curriculum planning. Workshops and webinars were a great success and improved awareness of eHealth
Breil et al. 2018 (37). Germany. Title: A Comparative Literature Analysis of the HI Curricula	Population: students. Context: health informatic curricula.	Course content: competencies in Information systems. Learning arrangements: practical part, learning outcomes. Who: employed professionals.	Key competencies in HI are identified. Students are recommended to learn skills, critical skills, and health information management.
Butler-Henderson et al. 2017 (41). Australia. Title: The development of a national census of the health information workforce: Expert Panel recommendations	Population: experts. Context: recommendations.	Course content: management. Learning arrangements: online, learning activities, interactions, learning materials. Who: employed professionals.	Highlighted themes for the national census of the health information workforce: census delivery, global census and census advertisement, longitudinal study, and participants. Recommended types of data elements are development, ownership, standards, access, and governance.

Egbert et al. (24). 2018, Germany. Title: Competencies for nursing in a digital world. Methodology, results, and use of the DACH–recommendations for nursing informatics core competency areas in Austria, Germany, and Switzerland	Population: experts (nursing and management). Context: competencies in nursing education.	Course content: framework, management. Learning arrangements: not specified. Who: employed professionals, teachers.	Learning across other countries in a combined course in nursing informatics; evidence-based nursing is supported.
Egbert et al. 2017 (22), Germany. Title: An iterative methodology for developing national recommendations for nursing informatics curricula	Population: experts. Context: competencies in nursing informatics.	Course content: framework. Learning arrangements: not specified. Who: teachers.	Core competencies in HI are defined and tailored to each country's specific needs.
Fossum et al. 2017 (43). Norway. Title: Crossing borders: An online interdisciplinary course in HI for students from two countries	Population: graduates. Context: online course.	Course content: common language, learning activities, information systems, learning outcomes, management, interoperability, practical work. Learning arrangements: interactions, assessment, learning activities. Who: undergraduates.	Learning internationally is an advantage for students. Students can conduct discussions and create relationships between disciplines and international boundaries.
Haux et al. 2017 (34). Germany. Title: Should Degree Programs in Biomedical and HI be Dedicated or Integrated?	Population: dual master's degree students. Context: education.	Course content: computer science, extended studies, HI. Learning arrangements: combined degree. Who: undergraduates and graduates.	Students with a dual master's degree in biomedical and HI may not be seen as computer scientists.

Hincapie A. et al. 2016 (38). United States. Title: Incorporating Health Information Technology and Pharmacy Informatics in a Pharmacy Professional Didactic Curriculum - with a Team-based Learning Approach	Population: second-year students. Context: online course.	Course content: management, information systems, interoperability. Learning arrangements: interactions, extended studies. Who: undergraduates.	Students are positive towards the course and have met the learning outcomes of the course content. The appropriate time for teaching informatics should be considered.
Hübner et al. 2019 (26). Germany. Title: Towards the TIGER International Framework for Recommendations of Core Competencies in HI 2.0: Extending the Scope and the Roles	Population: experts. Context: framework.	Course content: framework. Learning arrangements: not specified. Who: employed professionals.	Core competencies in informatics are highly important for nurses. The framework can be used as a support when shaping education in HI to improve safety and quality in using health information systems.
Hübner et al. 2017 (25). Germany. Title: Towards an international framework. recommendations of core interactions, learning inter-professional informatics:	Course content: modules, framework for management, Learning arrangements: learning competencies in nursing & outcomes, activities. Who: teachers, employed professionals, others.	Informatics core competencies are highlighted in all The TIGER competency domains. Different countries have their own ways of synthesis project learning.	Population: experts. Context: framework.
Hübner et al. 2018 (27). Germany. Title: Technology Informatics Guiding Education Reform –	Population: experts. Context: education or	Course content: framework, learning outcomes. Learning arrangements: not specified. Who: employed professionals,	24 core competency areas are defined for five major nursing roles. Greater awareness of intrapreneurship and innovation are key factors to successful health

TIGER	recommendation.	graduates, teachers.	information technology.
Jidkov et al. 2019 (44). United Kingdom. Title: HI competencies in arrangements: existing digital education and training in the A mixed methods study	Course content: competency. Population: postgraduates. Context: practical training.	and should be included in training curricula. The postgraduate medical competencies are not designed for modules, assessments. Who: postgraduates, trainees	Competencies in HI should be universal for clinicians Learning physicians, and not all competencies are relevant to all UK: specialties.
Kinnunen et al. 2018 (35). Finland. Title: A Synthesis of Students' thesis writing.	Learning arrangements: seminars. Population: graduates. Who: graduates.	Course content: learning activities. qualitative methods are used. There is a need for encouraging and guiding teachers to use more quantitative methods.	Students focus on different research areas, and Theses in the Accredited HHSI Master's Program Context:
Kinnunen et al. 2019 (31). Finland. Title: Factors Related to HI National Electronic Health Record	systems. Learning materials. Population: health care professionals. Context: competencies in nursing informatics.	Course content: information One-third of respondents do not have sufficient Competencies for Nurses- Learning arrangements. Not specified. Who: employed professionals (nursing, management).	training, and older nurses need complementary training Results of a and support in using Electronic Health Records (EHR). Nurses with higher education are more informaticsSurvey competent and more experienced in using EHR.
Mantas et al. 2017 (29). The Netherlands. Title: IMIA Educational Recommendations and Nursing Informatics	Population: students. Context: education.	Course content: framework, management. Learning arrangements: learning outcomes, assessments. Who: employed professionals, education workers on all levels.	Information technology skills are a part of most nursing courses, but it is not clear whether all undergraduate nursing programs teach Nursing Informatics. However, there are courses in HI for postgraduates. Reconsidering educational recommendations for nurses and other professionals is recommended.

Sapci et al. 2020 (45). United States. Title: Teaching Hands-On Informatics Skills to Future Health Informaticians: A Competency Framework Proposal and Analysis of Health Care Informatics Curricula	Population: graduates. Context: practical training.	Course content: information systems, competencies in health informatics, learning activities, extended studies. Learning arrangements: modules. Who: graduates.	Not many publications have been conducted on handson skills in health informatics. There is a gap between in-demand skills and existing competencies, and most of the practical skills are gained from work experience. Occupational-specific terms in HI would enable technological solutions to health problems, and a specific competency assessment framework would be needed.
Scott et al. 2018 (47). United Kingdom. Title: Learning health systems need to bridge the 'two cultures' of clinical informatics and data science	Population: research. Context: health data science.	Course content: management, information system. Learning arrangements: not specified. Who: not specified.	The gap between conclusion policy makers and research funders needs to be acknowledged to recognize the social and economic benefits of eHealth.
Strudwick et al. 2019 (23). Canada. Title: Adapting and validating informatics competencies for senior nurse leaders in the Canadian context: Results of a Delphi study	Population: management (nurse). Context: framework.	Course content: competency. Learning arrangements: not specified. Who: employed professionals, graduates.	24 informatics competencies are identified by Canadian nurse leaders. Competencies related to collaboration are rated as important and highly relevant. The results will be presented to nursing informatics organizations and the senior national nursing leaders for approval.
Thye et al. 2018 (30). Germany. Title: What Are InterProfessional eHealth Competencies?	Population: health care professionals, management, researchers, experts, education. Context: education in eHealth.	Course content: direct patient care, IT, management, common language, learning outcomes, information system, practical part. Learning arrangements: not specified. Who: employed professionals (nurses, doctors).	There were not many differences between the various professions, but professionals involved in direct patient care rated some competencies differently from executives. Organizations issuing educational recommendations are encouraged to clarify their competency areas (e.g., communication and leadership, and ethics in health IT).

Topaz et al. (48). 2016, Canada. Title: Advancing nursing informatics in the next decade: Recommendations from an international survey	Population: students. Context: nursing informatics curricula.	Course content: practical work, research, visibility, collaboration, and integration. Learning arrangements: learning activities, learning outcomes, interactions. Who: undergraduates.	Nursing informatics includes five central areas of recommendation: nursing informatics visibility, practice, research, collaboration and integration, and education and training.
Valenta et al. 2016 (28), United States. Title: Core informatics competencies for clinical and translational scientists: what do our customers and collaborators need to know?	Population: others (trainees). Context: framework.	Course content: information systems Learning arrangements: learning activities, learning materials, interactions. Who: graduates, PhD candidates, researchers.	A set of new competencies updated by the Clinical Research Informatics Workgroup of American Medical Informatics Association (AMIA) is presented. In the future, the current model of competencies can be used as a model for editing competencies over time.
Walpole et al. 2016 (36). United Kingdom. Title: HI in UK Medical Education: an online survey of current practice	Population: teachers from school and work life. Context: curriculum in HI.	Course content: framework (national guidelines). Learning arrangements: learning activities, lectures and seminars, modules, Learning arrangements. Who: undergraduates.	Three main findings: 1) little education in HI is included in the curricula, 2) the pedagogy, content, and timing of teaching HI vary between schools, 3) the course content is not always updated, and HI is seldom assessed.
Wholey et al. 2018 (39), United States. Title: Developing Workforce Capacity in Public Health Informatics: Core Competencies and Curriculum Design	Population: master's degree and certificate. Context: training curriculum.	Course content: practical part. Learning arrangements: learning activities, practical part. Who: graduates, certificate programs.	Competencies in Public HI are taken from information and organizational sciences and computer sciences. There is a need for core competencies in public health and in data sciences. The proposed educational program in public health can be used as a guideline.