Discovering the importance of health informatics education competencies in healthcare practice. A focus group interview

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A B S T R A C T

Background: As healthcare and especially health technology evolve rapidly, new challenges require healthcare professionals to take on new roles. Consequently, the demand for health informatics competencies is increasing, and achieving these competencies using frameworks, such as Technology Informatics Guiding Reform (TIGER), is crucial for future healthcare.
Aim: The study examines essential health informatics and educational competencies and health informatics challenges based on TIGER Core Competency Areas. Rather than examine each country independently, the focus is on uncovering commonalities and shared experiences across diverse contexts.
Methods: Six focus group interviews were conducted with twenty-one respondents from three different countries (Germany (n = 7), Portugal (n = 6), and Finland (n = 8)). These interviews took place online in respondents' native languages. All interviews were transcribed and then summarized by each country. Braun and Clarke's thematic analysis framework was applied, which included familiarization with the data, generating initial subcategories, identifying, and refining themes, and conducting a final analysis to uncover patterns within the data.
Results: Agreed upon by all three countries, competencies in project management, communication, application in direct patient care, digital literacy, ethics in health IT, education, and information and knowledge management were identified as challenges in healthcare. Competencies such as communication, information and communication technology, project management, and education were identified as crucial for inclusion in educational programs, emphasizing their critical role in healthcare education.
Conclusions: Despite working with digital tools daily, there is an urgent need to include health informatics competencies in the education of healthcare professionals. Competencies related to application in direct patient care, IT-background knowledge, IT-supported and IT-related management are critical in educational and professional settings are seen as challenging but critical in healthcare.

1. Introduction and background

The healthcare industry is undergoing significant changes due to the rapid achievements of digital technology, leading to a shift in the roles of healthcare professionals and posing challenges for future healthcare systems [1]. Rapid health information technology (HIT) development has significantly improved health outcomes, enhanced care delivery, and advanced patient education. However, the impact of these new technologies brings about both expected and unexpected effects on managerial, clinical, and policy aspects associated with new products or processes [2].

Given the critical role of health information systems (HIS) in supporting healthcare professionals and individuals in various settings [3], digital tools have proven to be effective in improving the quality of care [4]. As a result, there is considerable interest in the widespread adoption of HIS in healthcare [3], which has enabled the development of

Table 1
The six phases of thematic analysis modified from Braun & Clarke, 2006.

Phase	Description of the process
1. Familiarizing with the data	Each country transcribed the data word for word, summarized it, and translated it into English. Using Microsoft Excel [25], the summary was organized according to the interview questions and sent to the first author for further analysis. The data were cross-referenced with the original text to increase the clarity of the English summary. Any unclear instances in the translated version were clarified in consultation with the person responsible for each country. Notably, the analysis was conducted as a single dataset. It did not compare the differences between the countries.
2. Generating initial codes	The data from the Excel file were transferred into a Word document for more in-depth analysis. They were using the qualitative data analysis software Atlas.ti [33], keywords based on TIGER core competency areas were used to search for similarities in the data. The content of the discussions was read through, and potential subcategories were added, categorized, and grouped as themes according to TIGER core competency areas ([18,19]. The proposed findings were sent to each country to confirm the correct understanding of the raw data.
3. Searching for themes	Special attention was given to competencies beneficial to healthcare professionals, challenges in health informatics, and essential educational competencies. Content related to these topics was organized into subcategories, categories, and themes. Unclear data were clarified through communication with the respective countries. The results do not include data not directly related to the research questions. Examples given by the respondents and subcategories that did not answer the research questions were not categorized.
4. Review of themes	The raw data were read several times, systematically highlighting parts of the discussion related to specific topics. Keywords were identified and used for later retrieval in the analysis phase. These keywords were then organized, merged with others, and then categorized based on TIGER competencies [16,18,19]. These categorized keywords were further grouped and placed within the relevant TIGER core competency areas. Each country reviewed the themes, categories, and subcategories, and the content and themes were agreed upon by all partners.
5. Defining and naming themes	Given the study's focus on health informatics challenges, essential competency needs, and essential educational competencies, the findings are presented through three themes: essential competencies for healthcare professionals, health informatics challenges, and essential educational competencies.
6. Producing the report	The results are organized according to the TIGER core competency areas [18,19], providing a structured framework for presenting the results while maintaining respondent anonymity. Each theme will be presented with its categories and subcategories and a discussion summary (Table 3, Table 4, Table 5). Chosen quote from respondents are added in the table to highlight the results.

strategies and guidelines to guide global efforts in digital health transformation. The strategies highlight the importance of collaboration among stakeholders to improve health outcomes and reduce risks across all levels of healthcare [5]. One strategy is the integration of HIT, creating a seamless and citizen-centric service structure where all healthcare services revolve around the patient. One aspect of these strategies is the implementation of digital patient and client records in national HISs, marking a significant change in the healthcare landscape [6].

As a result, there is a growing need for multidisciplinary health informatics (HI) expertise. HI focuses on the efficient and structured analysis and use of information to improve economic functions, well-being, and societal health [7]. It also focuses on the application of HIT in healthcare, which is an integral part of continuous healthcare delivery [5]. Therefore, the role of HI has become essential in meeting the needs of healthcare professionals involved in digital health-related tasks [8].

As healthcare professionals face challenges in keeping up with the increasing importance of HIT [9], acquiring HIT knowledge is considered a critical skill for decision-making [9]. However, with the ability to participate in the decision-making process, healthcare professionals may be able to fully adopt and utilize HIT tools [10] leading to feelings of incompetence and reluctance to use them [11]. Furthermore, students pursuing clinical practice studies need more access to HIS, hindering their ability to learn about HIT [12]. The significance of HI education for future workforces has long been a topic of discussion driven by

anticipated future challenges [4,13,14]. Several educational frameworks in HI have been established to address the growing demand for HI competencies. One widely recognized recommendation is the International Medical Informatics Association (IMIA). The IMIA provides recommendations for Biomedical Health Informatics (BMHI) education to meet the demands of globalization and digital transformation in healthcare. It supports quality BMHI education programs and emphasizes the need for healthcare professionals, decision-makers, and computer scientists to acquire BMHI competencies [15].

Another well-known recommendation framework is Technology Informatics Guiding Education Reform (TIGER) [16]. This recommendation framework was created to support integrating technology and informatics in nursing practice, education, and research [17] and aims to guide teachers, students, and healthcare organizations in identifying core competency areas and implementing them effectively in education and work [18]. TIGER recognizes that core competencies consist of knowledge, competencies, and abilities from social, emotional, and cognitive aspects. Healthcare professionals must have competencies in various domains, including IT principles, management, ethical and legal considerations, and medical technology [16,19].

Some universities have implemented master's and doctoral programs in Health and Human Services Informatics (HHSI) following IMIA recommendations. The aim is to foster student HI competencies by integrating IT and service systems [20]. Other universities offer programs in BMHI, at the master's level in universities of applied sciences, and at the

Table 2
List of respondents, their backgrounds, professions, and primary tasks.

Profession	Number of respondents	Area and current position
Informatician	3	Technical coordinator of the functional area of information systems (n = 1), responsible for health and social services (n = 2)
IT specialist	1	CIO
Manager	3	Professor in hospital financing and hospital management (n = 1), Chief nursing officer (n = 1), health policy representative (n = 1)
Pharmacist	2	Researcher (n = 1), corresponding pharmacist, instructor of smart medicine cabinets (n = 1)
Physician	3	Head of the telemedicine department (n = 1), researcher, background in medical informatics (n = 1), chief physician, university professor (n = 1)
Physiotherapist	2	Professor of physiotherapy (n = 1), invited assistant at the school of health sciences at the university and researcher (n = 1)
Registered nurse	7	Professor of computer science and information technology in nursing and social work. Head of the institute for continuing education and training (n = 1), university teacher (n = 2), manager (n = 2), member of the working group for the development of health information systems in a hospital (n = 1), nursing supervisor and responsible for information management in healthcare (n = 1)
Total number of respondents	21	Number of respondents from different countries: Germany (n = 7), Portugal (n = 6), and Finland (n = 8)

Table 3
Essential competencies for healthcare professionals.

Themes align to TIGER domains	Categories align to TIGER core competency area	Sub-category	Examples from the discussions	Quotes by topic*
Application in direct patient care	Decision-making	Common structures Future thinking	It is essential to have a system that supports current and future decision-making without looking to what has happened in the past. A common structure should exist for when and how to make the decisions.	I find that quite interesting that we always end up with this topic at the end. I think that, in the end, it is a great success factor if you can simplify these complex issues that are at stake in a management-friendly way, so that a decision-maker in a hospital, and it doesn't matter whether it's a head physician or a commercial manager or whatever, that they recognize the value in it (DE/7). In the end, very little of this information is used, however for various reasons in decision-making, there is no need to dwell on what has happened in the past, but we should focus on being anticipatory and proactive (FI/6).
		Support		We have different documentation systems in different sectors. And no one knows how to bring them together. In geriatric care, we no longer work with nursing diagnoses or nursing problems, but in the hospital, we do, so how do we get together? (DE/1)
	Documentation	Documenting process	Understanding everything that happens in healthcare, e.g., visits, surgeries, and sending bills, affects how healthcare develops and is monitored. There are different options to create a standard structure for the data, such as how to write and what to document or report.	It will not be practical to make everyone learn the various languages, but perhaps there should be some strategy that would lead to different professionals knowing the different aspects of terminology in the health area (PT/5).
		Structuring the data Report	However, it is worth highlighting that the reporting system may not be as developed as the patient information system.	This could be confusing, but teaching healthcare professionals the basic digital information and information systems would already help them to understand the environment where information is created and stored (FI/1).
	e-Health, telemedicine, and telehealth	Pros Planning Competencies in technology use	The pros of e-health, telemedicine, and telehealth are the potential capital gains and an instrument everyone should use.	Home care, for example, started using mobile home care about ten years ago when patient information systems were beginning to be integrated. These healthcare providers need to know how to use smartphones in a completely different way today even though there was no need in the earlier times (FI/6).
		Place everyone on the same level	E-health, telemedicine, and telehealth offer everyone the same possibility of care, and the patient can choose what to do. However, competencies and knowledge are required to use the digital tools provided.	We feel the need to include a set of competencies that aims to place all people at the same level, on a level which allows them to go forward from there and learn the most specific skills of telehealth with a solid basis that is applicable to all of these professions (PT/6).
	Information communication system	Artificial intelligence (AI) Correct information Good knowledge of using technology Similar contents User's perspective	Good quality care relies on proper information; however, finding or retrieving data from patient information systems is not easy. It is not enough to only care for the patient; finding information in the system is an equally important skill. Not everyone knows how the system works or how to document, and some systems may not be user-friendly. However, AI can gather data, give instructions, and monitor patient wellbeing.	Although the final decision is made by health professionals, typically what they decide is what the machine shows. But if the machine does not show everything, or if one thing is given higher priority than another, the professional will be influenced by it (PT/3).
	Information and knowledge management	Principles in HI	Healthcare is not only about clinical competencies but also about competencies in HI. In daily practice, healthcare professionals are responsible for employing both clinical competencies and utilizing digital tools to facilitate the exchange of information in both written and verbal interactions.	This is an awfully broad area such that it is no longer enough that one can do their work – one must also be able to document information in different IT systems and communicate with different systems. That is something one must accept. Nowadays we do paperwork or documentation and then clinical work (FI/2).
	Process management	Implement theory Improve care	Many process management theories and models can be used, but these may be challenging to implement in practice. Individuals will try to bypass new processes unless they are innovative and proven more beneficial.	It is the learning of techniques in communication, i.e. the various communication techniques according to the different models that exist, or in process management. So, let's stay in process management, because I know it a bit better than the area of communication. There are also various process management change management models, such as […] etc., which you must know on the one hand, but which you also must apply on the other (DE/3).
IT background	Data protection	Legislation	Everyone needs to know about the legislations and regulations in healthcare and follow official guidelines.	I hardly know anyone who can distinguish between data protection, data security and data availability, i.e. these three things, and not only

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Table 3 (*continued*)

Themes align to TIGER domains	Categories align to TIGER core competency area	Sub-category	Examples from the discussions	Quotes by topic*
knowledge for health professionals				distinguish between them, but they are mixed up with each other and that is a major obstacle in the […] healthcare system (DE/7).
	Data Security	Define the knowledge	It is essential to define what data security is already in the beginning and highlight the significance of this topic.	The level of competency in legal issues in health IT, for example, is the same as documentation and secrecy and you need to know the regulations and rules that regulate the whole environment (FI/1).
	Interoperability and integration	Know the differences	Interoperability can be learned step by step, and the impact of this topic can be defined.	To know the different levels of interoperability and be able (in view of the existence of integrations) to analyze what is happening and what is not happening and the impact it has (PT/3).
IT-related personal and social dimensions	Common language	Guidelines Standards Strategy to learn the terminology	For adequate comprehension, implementing standardized guidelines and protocols for data storage is vital, irrespective of the system utilized. These guidelines ensure consistency and a better understanding of stored information. Healthcare professionals may not require in-depth knowledge of various professional terminologies or an understanding of the different aspects and how they are used.	We can try to find similarities to compare the topics and it is found that the definitions for the same topics are different. In the end, it is not possible to compare the work because the definition of the concepts is different and the information (e.g. statistics and reports) we get from the information systems is different (FI/8).
	Communication (social perspective)	Cooperation Good communication competencies Human communication Respect others	Communication is about patient safety and requires good communication competencies. Practical cooperation relies on understanding, communication, and familiarity with the workplace, people, systems, and routines. We must know what type of communication we aim for, as due to digitalization, empathic communication and human communication may not be possible. People cannot understand each other if they do not respect and listen to each other.	So, in principle, it's about having the ability not only to understand what's in the study, but of course you also must be able to communicate that, and, for example, this is now also about interdisciplinarity between clinician and scientist. At this level, one needs to be able to pass on the scientific findings to the clinician in an appropriately digested form so that he or she can also implement them (DE/2).
IT-supported education and research	Digital literacy	Applied computer science Digital pathway Principle in HI	Due to digital literacy, it is worth paying attention to teaching computer science, engineering, and technology to help people better understand what digitalization means. Healthcare professionals need to understand and adapt the use of digital care pathways and have the competencies required to support digital care. Digital services like digital pathways require basics in HI, and all patients may not have the competencies for it.	Luckily digital care pathways are here, and the citizens are encouraged to actively take part, fill in the information, and make appointments, and this trend is going in the right direction (FI/5).
	Teaching, training, and education in healthcare	Further education	Teaching, learning, and education in HI are the cornerstones, and more focus should be on them. This is not only about education, but it is also about patient safety, teaching healthcare professionals to implement knowledge into practice, and changing their ways of working.	I think that's a very important point when you go to a course of study, continuing education event, or training, that you don't just focus on the pure transfer of knowledge, but also look at how I can, I don't know, through supervised internships, etc., get the students to actually implement their acquired knowledge. So, in medical training, that is also the knowledge, then on the one hand the competence, that is, the ability to apply this knowledge and the next step. Of course, the application of this ability to actually apply knowledge imitatively (DE/3).
	Data analytics	Basics in data analytics	When healthcare professionals become more interested in reading data and how things work, data analytics competencies may be more common in the future.	I think that in management we must train people who are able to look at the data and have the skills to easily analyze that data without constantly resorting to experts (PT/5).
IT-supported, IT-related management	Entrepreneurship	Encourage Experience supporting innovation Holistic view	Having an innovative mindset and entrepreneurial spirit can lead to re-evaluation of tasks and new ways of thinking. Students should be encouraged to be creative and not be afraid of changes. Experiences in innovation and entrepreneurship are not limited to any specific area but can be implemented everywhere. There is a need for people with an open mindset who can implement innovations in the work environment.	In my workplace I can constantly have a positive attitude toward innovation and entrepreneurship, for example when I change the way I work, when I have a certain task that we do in a certain way. If I have the innovative spirit and the spirit of entrepreneurship, I can rethink this way of doing this task and start doing it differently (PT/6).
	Financial management	Cost Understanding	The demands and interests in digitalization, combined with limited financial resources, make prioritizing digitalization challenging. A digital system is neither cheap nor easy to develop, and criteria should guide prioritizing the project.	From the economical perspective, I would like to highlight the understanding that the systems are not easy nor cheap (FI/1).

Table 3 (*continued*)

Themes align to TIGER domains	Categories align to TIGER core competency area	Sub-category	Examples from the discussions	Quotes by topic*
	Project management	Common understanding	A common understanding of how a project works should exist, especially within healthcare and HIS.	It is evident that it does not make sense to see a project manager in each health professional, but it is necessary to understand what this is and that there are different roles in this process (PT/5).
	Strategy management	Understand how an organization works.	Strategy is a part of work and a vision of the workplace, and as an employee, one needs to understand how the organization works.	I would like to highlight competencies in strategy and competencies related to it. When working in an organization it is good to understand how the organization works. The strategy should be a part of the work but sometimes the organization, strategy and the vision of the organization might be very out-of-range (FI/3).

*The abbreviations in the table stand for Finland (FI), Germany (DE), and Portugal (PT), and the number after each abrivation is respondent ID. FI/6 is respondent number 6 from Finland, DE/1 is respondent number 1 from Germany, and PT/3 is respondent number 3 from Portugal.

PhD level [21]. In Germany, a national strategy supports the development of informatics curricula, focusing on national competency-based learning objectives [22].

Despite various educational recommendations, the absence of health technology gaps remains in the education of healthcare professionals. Lack of national policies and educational programs [23], underinvestment in healthcare education, and uncertainty about alternative practices prevent universities from incorporating informatics into education [24]. This deficit extends beyond students to nurse educators who lack health technology skills and competencies [25]. Previous studies have shown that without education in HI, those interested in learning may shine in its absence [11].

1.1. Aim

The aim of this study examines the essential HI, educational competencies, and HI challenges based on TIGER Core Competency Areas. The focus is on the essential knowledge and competencies relevant to healthcare professionals and managers in Germany, Finland, and Portugal. Rather than examining each country independently, the focus is on uncovering commonalities and shared experiences across these diverse contexts.

1. What knowledge and competencies are essential in health informatics for the healthcare sector?
2. Which competencies are crucial to acquire in health informatics?
3. What challenges are encountered in developing health informatics competencies?

2. Methods and materials

2.1. Study design

2.1.1. Study setting and samples

The data collection was conducted using a focus group interview (FGI) and respondents with expertise in HI were purposely selected from Finland, Germany, and Portugal. The selection process aims to identify individuals who could contribute to educational development [26] based on the TIGER core competency areas [16,18,19]. This FGI followed established strategies to ensure trustworthiness in qualitative research projects [27]. Several emails and meetings were held between the partner universities to align and standardize the FGI process.

Each respondent was contacted individually by e-mail and the date for the FGI [28] was agreed upon by all respondents using the online scheduling tool Doodle [29]. Prior to the FGI, research permissions were obtained for organizations from each country. After the research permissions were approved and the interview date was set, an introduction letter with the interview questions was sent. All respondents were asked to rate TIGER core competencies [18,19] in an online questionnaire. The results of the online questionnaire and the pre-written questions served as a guideline for the country-specific interviews. The interview questions focused on how TIGER competencies contribute to improving healthcare, the needs of specific competencies, and what competencies are needed. Results were presented via PowerPoint [27] and remained visible throughout the interviews, with questions discussed one at a time.

2.1.2. Data collection

The semi-structured online interview was conducted following the Sage research method [30] for FGIs. Each country organized two FGIs, inviting respondents with similar backgrounds. To facilitate discussion, each FGI consisted of three to four respondents. The FGIs were scheduled at a time suitable for all participants, respondents and one or two interviewers conducted the interview. A ninety-minute FGI was conducted over Zoom video conferencing software [31]. Only audio was recorded and used in the analysis. Each country recorded, transcribed, summarized, and translated the FGI data into English. The translated data were sent to the first author for further study and analyzed as one data set.

2.1.3. Thematic analysis

Thematic analysis, known for its flexibility and iterative nature, allows a deeper understanding of the data and the presentation of key findings through a thematic map. The data were analyzed according to Braun and Clarke's six phases of thematic analysis, which are detailed in Table 1 [30]. The TIGER framework [19,20] was used to identify the categories and subcategories, and the raw data was deductively analyzed [32].

3. Results

3.1. Respondent characteristics

The FGI involved twenty-one respondents from three countries: Germany, Portugal, and Finland. All respondents, such as nurses, physicians, pharmacists, physiotherapists, informaticians, and computer engineers, had different educational backgrounds. The respondents are involved in HI professionally, with experience ranging from day-to-day work to teaching HI, doing research, and holding management positions. Some of the respondents work with HI on a national level (Table 2).

3.2. Empowering healthcare professionals: Essential competencies for healthcare professionals, health informatics challenges, and essential educational competencies

The results of the study showed that competencies related to direct patient care, communication, ethics in health IT, change management,

Table 4
Health Informatics challenges in healthcare.

Themes align to TIGER domains	Categories align to TIGER core competency area	Sub-category	Examples from the discussions	Quotes by topic*
Application in direct patient care	Documentation	Lack of documentation	Various systems work differently, and everyone can learn how to document in those systems and understand the value of documentation. If nothing is documented, the tasks have not been done.	I find it is difficult to function in my day-to-day life in the absence of these areas. And I'll start with documentation. I think that when I talk about documentation, data recording, non-standardized data recording, I think it is so important in providing care, especially in removing information necessary to provide better health care. I do not know. Communication is also a very important point for the day-to-day activities in the provision of health care, the passage of information between the different care providers and it is here that this communication often fails (PT/1).
	Information and knowledge management	Lack of interest	Healthcare professionals might lack interest in learning computer science due to the complexity of HIS. This may not motivate them enough to acquire the competencies needed to use and develop such a system. If managers do not possess comprehensive knowledge on a higher level, this can result in a lack of understanding of the utilization of a particular system.	It is evident that some people in particular do, but very few if we are talking about health professionals (doctors, nurses, physiotherapists, technicians in general). They will have no interest in these areas but will need to develop skills in everything that has to do with documentation (PT/5).
		Lack of knowledge		
	Process management	Challenges in the healthcare profession	Process management is a challenge in healthcare because processes are not always transparent. Not everyone sees the whole picture of the systems and processes or how to utilize them.	I have to say that. Including everything, that's also a very big aspect that I think is much more relevant here than in other industries – everything that's there in terms of legal foundations or who has a say in public bodies. You must know a great deal about how the entire healthcare system comes about and the way it is now. Also, why it changes and why it may not change (DE/6).
		Holistic view		
IT background knowledge for health professionals	Data protection	Need to improve	Patient privacy and data protection must be improved, especially in patient care, where patient information is shared between wards.	In the hospital world, with wards and working together, these things are often highlighted and discussed. It is a challenge, especially when a patient transfers from one ward to another. Also, how information is transferred to another ward is important (FI/2).
	Data Security	Lack of knowledge	Not everyone understands what data security is or the basics of how to use a computer safely. Not everyone understands that you should not share usernames and IDs.	They don't understand, and they try on the other hand, often putting at risk the whole system. This is because there are flaws in security and I think they should understand better and even have the skills. I admit this because many times the institutions provide training in this area of security, but the training is often far from the reality of everyday life and professionals do not show any interest in going to these training courses(PT/5).
	Ethics in health IT	Lack of ethics	Ethics is easily overlooked when working, especially when teaching IT systems. Not everyone knows that sending information as text messages or storing data in some places is ethically wrong.	Ethical issues are perhaps something that is often forgotten when teaching IT systems (FI/1).
	Interoperability and integration	Lack of interoperability	Lack of competencies in interoperability is a challenge because everyone needs to understand what it means to move information from one place to another.	But let's stay with interoperability. We have already mentioned the prejudice or the bias, so to speak, so as with all other topics, I believe that if this digitization is not a management task and has not been understood, then the programmer at the bottom will also have a relatively difficult time (DE/7).
IT-related personal and social dimensions	Common language	Mutual language	Healthcare professionals with different educational backgrounds may use different languages for the same treatment, and other professional groups have various ways of writing about the same information. It is essential to have a common language, standard concepts, and standardized terms to ensure that everyone involved understands each other. The same language should be used with professionals outside healthcare to avoid misunderstandings.	We came to that next meeting […] that change had been made quite differently because we had misunderstood each other, even though we all spoke the same language, and all worked in the same organization. It was overwhelming because this wasn't what we were meant to do, and we all thought that, and the respondents in the meeting thought we all had a common understanding, but we didn't. What do you do then (FI/5)?
	Communication (social perspective)	Lack of communication	Lack of communication competencies can lead to anxiety and misunderstandings. Poor or inadequate communication is a challenge that needs to be addressed. The lack of time may result in poor	We experience this every day, again, poor communication and information sharing with family members can lead to anxiety (DE/5).
		Lack of time		

Table 4 (*continued*)

Themes align to TIGER domains	Categories align to TIGER core competency area	Sub-category	Examples from the discussions	Quotes by topic*
IT-supported education and research	Teaching, training, and education in healthcare	Teach others	reporting and communication between different groups of healthcare professionals. Healthcare professionals need to work with different technologies to build their digital competencies. They cannot teach, support, or guide the patients using a system if they are not familiar with it. The educational role of healthcare professionals is essential.	Nurses need to work with technology so they can build appropriate skills. For example, if they recommend patients use a specific app, they must also be familiar with how to use that app to adequately advise the patient. In the future, physicians will increasingly have to advise their patients on which technologies they can use as part of their therapy, such as apps. Doctors must therefore also have the competencies in the use of this technology to be able to advise their patients (DE/1, DE/3).
IT-supported, IT-related management	Change management	Attitude Ignorance	Healthcare professionals may not be interested in utilizing new technologies at work because of past experiences where technologies did not meet expectations. Change management is a valuable skill that should not be ignored, as willingness to change depends on the management. When the management shows a positive attitude towards a specific task, it sets an example for others to follow.	The second competence where I see this is leadership behavior. I believe that how the manager behaves is quite decisive. If you have a manager with an affinity for IT, who works a lot with the iPad, with the iPhone, exactly the things you just said, then the employees who follow will orient themselves to the manager and we will also experience this on the ward (DE/5).

*The abbreviations in the table stand for Finland (FI), Germany (DE), and Portugal (PT), and the number after each abrivation is respondent ID. FI/6 is respondent number 6 from Finland, DE/1 is respondent number 1 from Germany, and PT/3 is respondent number 3 from Portugal.

digital literacy, information and knowledge management, teaching, and education were commonly discussed and highlighted by all countries.

As the data has been analyzed as one, the themes are presented alongside the TIGER core competency areas [16,18,19] and the results are organized to align with TIGER domains (themes) and core competency areas (category). The subcategory highlights the topics closely related to TIGER's core competencies. Along with the findings for each category and examples of the discussion presented in Table 3, Table 4, and Table 5, selected quotes from the empirical data were chosen to highlight the content. The square brackets indicate that names are removed to maintain the anonymity of the discussion. These quotes are translated, language-proofed, and were originally in Finnish, German, or Portuguese. The abbreviations in the table stand for Finland (FI), Germany (DE), and Portugal (PT), and the number after each abrivation is respondent ID. FI/6 is respondent number 6 from Finland, DE/1 is respondent number 1 from Germany, and PT/3 is respondent number 3 from Portugal.

3.2.1. Essential competencies for healthcare professionals

The findings (Fig. 1) showed that TIGER core competencies related to applications in direct patient care, IT-background knowledge and IT-supported and IT-related management were identified as important for healthcare professionals. Commonly discussed and highlighted in by all three countries are the competencies in communication, basics in computer science, project management and education.

The Portuguese respondents' data focused on competencies related to data analysis, digital literacy, basics in computer science, innovation and entrepreneurship, and interoperability. The Finnish respondents highlighted the value of ethics in health IT, decision-making, information technology, data protection, leadership, documentation, and further education. The German respondents focused on the nursing care process, financial and process management, and education in scientific reading.

3.2.2. Health informatics challenges in healthcare

The results (Fig. 2) reveal that challenges in HI are found within all five TIGER core competency areas. Most challenges identified (Table 4) and discussed are competencies related to application in direct patient care and IT background knowledge, IT-supported, IT-related management.

Commonly discussed in all three countries are the lack of communication, ethics in health IT, education and information and knowledge management competencies. The Portuguese and the Finnish respondents also highlighted the lack of change management, basics in computer science, data protection, data security, documentation, and digital literacy. In the German discussion, the respondents highlighted the competencies in process management as a challenge.

3.2.3. Essential educational competencies

The results presented in Fig. 3 show the importance of acquiring competencies from all TIGER core competency areas. Table 5 indicates that competencies related to application in direct patient, IT-background knowledge and IT-supported and IT-related management care are identified as essential to learn and incorporate into educational programs.

Commonly highlighted for all three countries are the competencies in communication, information and communication technology, project management, and education. The Portuguese data highlighted competencies such as data analysis, innovation, and entrepreneurship. The Finnish discussion also discussed competencies in eHealth and data protection. The German debate highlighted competencies in decision-making, information and knowledge management, teaching, training, and data security.

4. Discussion

This study examines essential competencies for healthcare professionals, HI challenges, and what competencies should be included in education based on TIGER core competency areas [18,19]. The findings show that the respondents commonly discussed and highlighted competencies related to direct patient care, communication, ethics in health IT, change management, digital literacy, information and knowledge management, teaching, and education. Rather than comparing the differences between the three countries, this study chooses to highlight the similarities and commonalities across diverse contexts.

4.1. Health informatics challenges in healthcare

As healthcare and HIT continue to evolve, the rapid changes in digital technology have created new challenges and increased the need

Table 5
Essential educational competencies for healthcare professionals.

Themes align to TIGER domains	Categories align to TIGER core competency area	Sub-category	Examples from the discussions	Quotes by topic*
	Documentation	Maintain patient safety	Electronic recording of sensitive patient data highlights the importance of data security and how to store confidential patient data. Therefore, documentation, communication, and patient safety competencies are essential.	I feel that documentation in patient work is one core part, and communication and reporting are maybe the priorities for maintaining patient safety" (FI/3).
	Information communication system	Understand the information system.	A patient information system helps track changes in patient well-being but does not support the secondary use of data or reporting. To use the system, healthcare professionals must collaborate and understand how it works.	That is why I think these two dimensions are needed to understand the informational ecosystem, and what an information system is for (PT/3).
Application in direct patient care		Applied computer science	Even if healthcare professionals' IT skills have improved compared to the past, competencies in basic computer science are essential. Basic computer competencies include using computers, e-mails, and common software tools.	In other words, a technology can be very sophisticated and the benefit that is derived from it is very low. The reverse can also happen, having a "very basic, even simplistic" technology, but if the people are able to deal with it well and a well-designed process, technology will help them a lot (PT/6).
	Information and knowledge management		Having theoretical knowledge is not enough, and theory should be combined with practice.	
		Implementing knowledge	Healthcare professionals lack knowledge on how to use HIS effectively. Adapting to new technology and seeking knowledge and competencies are vital, and this adaptability should start with management.	
	Data protection	Overlooked competency	Competencies in data protection and security, patient safety, and privacy are missing in education and should be prioritized.	I have to say that it is too late to teach data protection and patient secrecy when we are already working (FI/1).
IT background knowledge for health professionals	Data Security	Preliminary competency	The curriculum should include data protection and data security. Healthcare professionals need to understand these competencies, and there should be a continuous focus on improving data processing methods.	This should be taught already in the first year as one of the basic topics for all health care professionals (FI/1).
	Ethics in health IT	Ethical Integration	Ethics and legal considerations play an important role and should be covered in education and applied to HIS. It is essential to bridge the gap between ethical and legal aspects and technological security matters. An ethical standard should be implemented in HIS.	Regarding ethical issues, the program should focus on the notion of these concepts, because this will help professionals to critically analyse the development of health information systems. Because if the professionals do not have the notion that it is unethical, for example, the administrative ability to see what the diagnosis of the patient is, nobody will call anyone's attention to it because of that (PT/2).
	Interoperability and integration	Fundamental competency	Both regular users and healthcare professionals need basic knowledge of interoperability. Interoperability goes beyond data transfer between systems, and a specific structure is required to exchange data successfully. Depending on the roles, some may need more knowledge than others.	I think there must be levels of knowledge about interoperability depending on who the person is (PT/3).
IT-related personal and social dimensions	Communication (social perspective)	Good communication competencies	Excellent and clear communication competencies are crucial for improving patient safety and processes. Whether digitalization or direct patient contact, high-quality communication is preferred. Understanding the specific communication needs and applying appropriate competencies in different contexts can contribute to positive outcomes and better engagement.	So, I think these are very important communication issues that we must address in order to improve patient safety, which is why I emphasized this in my survey, for example (DE/5).
IT-supported education and research	Teaching, training, and education in healthcare	Training	Training in HI and the use of HIS should be included in education to support a better understanding of the systems.	The competency IT support training would be good if new staff would have an introduction on how to use the different systems, for example introduction to the use of the smart medicine cabinet (FI/2).
IT-supported, IT-related management	Change management	Willingness to change	Competencies in change management are crucial for enhanced employee adaptability; the leader is the one who shows examples of these. Individuals can adapt to changes if the processes fit seamlessly into daily routines.	It takes one person to drive change. One who says that changes are necessary and directs how to implement the changes? This goes more in the direction of soft skills. For digitization, you need a certain technical affinity (DE/4).
	Financial management	Economic thinking	Economic thinking should be included in education, as the relationship between costs and health outcomes plays an essential role in healthcare. Examples of this are the costs of transporting patients and the cost-effectiveness of technology.	I was thinking about the third question about financial management. The economical perspective should be included in the education and of course in the whole process (FI/4).
	Project management	Competencies to finalize	Project management competencies are beneficial for fostering common understanding and allowing	It is important to have the necessary skills in project management; how we set up a whole

Table 5 (*continued*)

Themes align to TIGER domains	Categories align to TIGER core competency area	Sub-category	Examples from the discussions	Quotes by topic*
		Project techniques	effective leadership within a project. These competencies enable individuals to gather ideas from team members and effectively transform them into concrete projects.	project, how we think, how we define it, how we implement it and how we evaluate it (PT/5).

*The abbreviations in the table stand for Finland (FI), Germany (DE), and Portugal (PT), and the number after each abrivation is respondent ID. FI/6 is respondent number 6 from Finland, DE/1 is respondent number 1 from Germany, and PT/3 is respondent number 3 from Portugal.
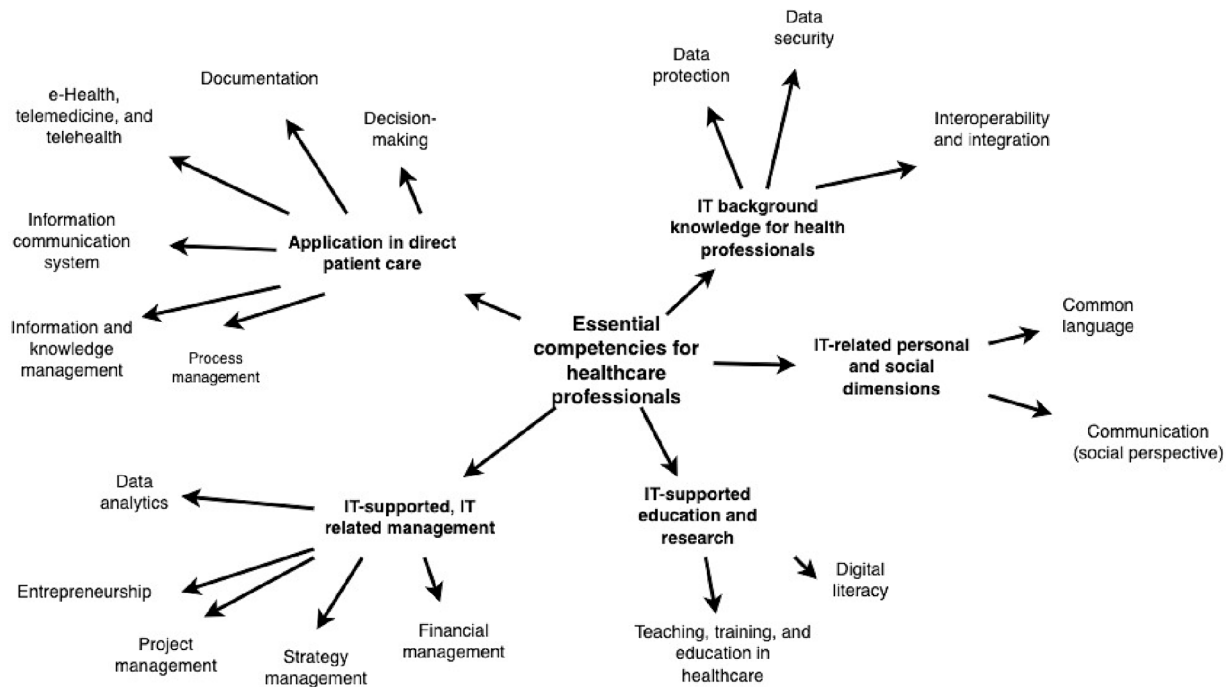
Fig. 1. Thematic map of essential competencies for healthcare professionals aligned with the TIGER framework.

for HI competencies [1,2]. This study confirms that the main challenges faced in healthcare revolve around knowledge and competencies in IT-related management and IT background knowledge. This highlights the critical nature of the lack knowledge of IT background knowledge, such as data protection and security, particularly in direct patient care. Many healthcare professionals do not understand how information is stored or transferred between systems [10,11,34]. This study confirms that there are challenges in process management, documentation, and information and knowledge management. It also shows that competencies such as process management were identified as challenging but not identified as necessary in education.

The growing significance of HIT and HIS poses challenges for healthcare professionals, leading to feelings of incompetence and resistance to digital tools [3,4,11].This study highlights the essential roles of IT-related management in areas such as financial management, and project management. These issues are challenging as professionals may feel incompetent and resist digital tools [3,4,11]. This is critical because healthcare professionals may hesitate to acquire new technological competencies, hindering their ability to guide patients in using digital tools when they need more proficiency [10,34]. The findings emphasize the importance of having competencies related to decision-making in direct patient care. It also supports a holistic view of the whole process management and knowing how to utilize the different digital tools and strategic management supports staff in understanding and adapting to and using new technologies. All three countries in this study pointed to the importance of having competencies in IT background knowledge, IT-supported management, IT-supported education, and IT-related communication. Communication in healthcare includes verbal interactions, written documentation, and reporting, underlining the need for standardized guidelines and terminologies.

4.2. Essential health informatics competencies for healthcare professionals

Despite years of discussion about HI education, the different levels of HI education available [20–22], and the development of educational recommendations such as IMIA [16] and TIGER [18–20], the results of this study indicate that a solution still has not yet been found for these seemingly everlasting and global issues. Acquiring competencies in direct patient care, IT background knowledge, and IT-related management play an essential role in the future of healthcare [8], leading both national [6] and global strategies [5] to develop guidelines and support for collaboration and integration of HIS in healthcare. Although healthcare professionals work with digital tools daily, they still need continuing education and training in HI to understand better and use the digital tools provided by their employers.

Considering the insufficient IT competencies, the lack of HI education [4,13,14], and HI competencies [10,34] among healthcare professionals, the findings highlight the importance of financial management, change management, and project management in education. The results underline economic thinking, an understanding of the relationship between cost and health outcomes, how the system works, and effective collaboration. Project management competencies were identified as supportive in this regard, enabling leaders to have the
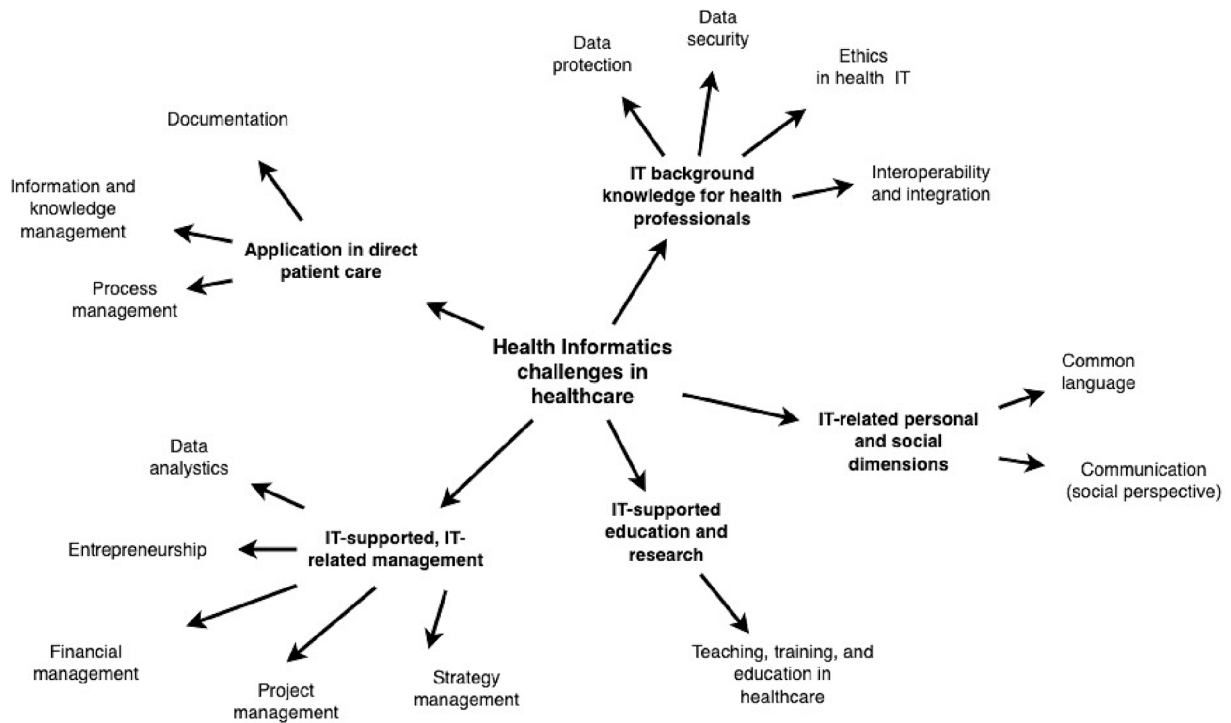
Fig. 2. Thematic map of health informatics challenges in healthcare aligned with the TIGER framework.
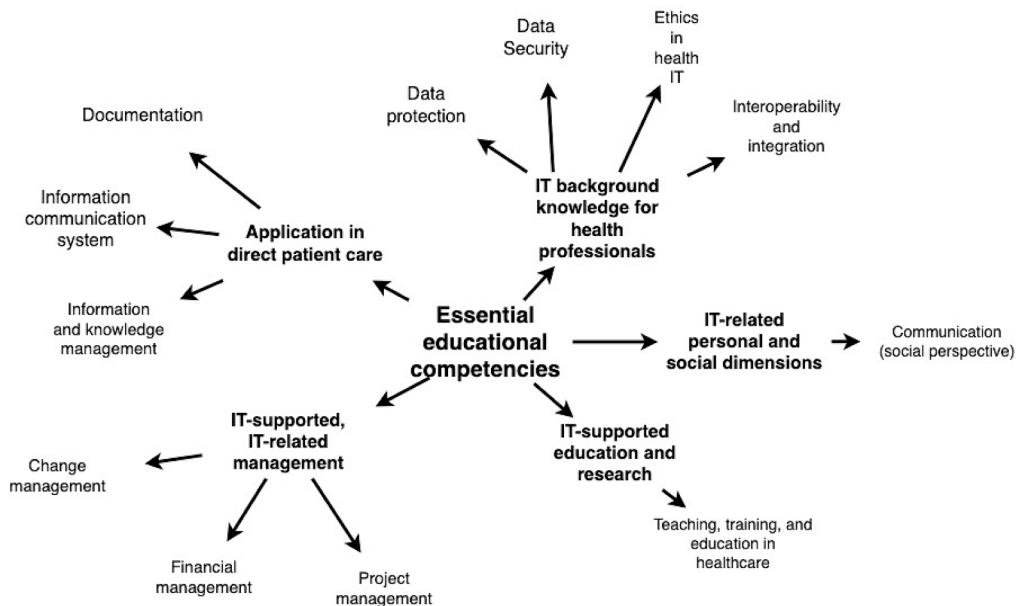

Fig. 3. Thematic map of essential educational competencies for healthcare professionals aligned with the TIGER framework.

necessary knowledge and competencies to turn ideas into concrete projects. There is a need for competencies in IT background knowledge such as data protection, data security, ethics in health IT, and interoperability.

This study confirms that the knowledge gap in ethics in health IT tends to be disregarded in educational settings and healthcare practice. Given the evolving roles of healthcare professionals [8], the findings emphasize the need for improved communication competencies among diverse professional groups based on mutual understanding and shared concepts. It also confirmed that the knowledge gap in ethics in health IT

tends to be disregarded in both educational settings and in healthcare practice.

In short, the results present competencies related to application in direct patient care, IT-background knowledge, IT-supported and IT-related management are critical in educational and professional settings. It also highlighted functional proficiency in data protection and security, information and communication technology, documentation and communication in a universal language are central, recognized, and essential for education.

4.3. Strengths and limitation

The strength of this study is that the three partner countries, all of which included non-native English speakers, contributed different perspectives, and enriched the findings. However, the small group size and selection of respondents based on their work backgrounds, along with a limited number of facilitators encourage dynamic and informal discussions.

Several limitations affect the comprehensiveness and depth of analysis of this study. First, the goal of having four respondents per focus group interview was not consistently met, potentially affecting discussion quality and content. Furthermore, due to concern about respondent anonymity, important information such as background, title, and profession was excluded from the quotes, affecting the context, and understanding of the findings. In addition, the study's failure to explore cultural differences and comparisons between countries and healthcare professionals limits the insight gained from the data.

To address these limitations and improve the strengths of the study, future research should ensure consistent numbers of respondents, innovative methods of respondent anonymity, explore cultural differences, and refine translation process for accuracy.

4.4. Conclusion

This study suggests implementing HI in education focusing on several core competency areas highlighted as challenges and essential competencies. Competencies related to application in direct patient care, IT-background knowledge, IT-supported and IT-related management in educational and professional settings are seen as challenging but critical in healthcare. More research is needed on what competencies should be included in education and how to achieve them. There is also a need for broader research on HI education, including other European countries. This study was conducted in Europe, but more studies about this topic in resource-limited countries are yet to be done.

CRediT authorship contribution statement

Pauleen Mannevaara: Writing – original draft. **Ulla-Mari Kinnunen:** Writing – original draft. **Nicole Egbert:** Writing – original draft. **Ursula Hübner:** Writing – original draft. **Pedro Vieira-Marques:** Writing – original draft. **Paulino Sousa:** Writing – original draft. **Kaija Saranto:** Writing – original draft.

Declaration of competing interest

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

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