

Expert Perspectives on Competencies in Health Informatics for Informatics Students

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Background and Purpose: Informatics practitioners who are knowledgeable in health informatics and understand the need for clinical practitioner workflows contribute towards improved health information systems. The aim of this paper is to discuss insights gained from health informatics experts on their perspectives on competencies that could be taught to informatics students. The researcher explores (i) the competency needs of ICT students and practitioners to develop health ICTs with the involvement of healthcare practitioners, and (ii) how informatics education can be designed to incorporate healthcare domain knowledge in the training of ICT practitioners.

Methods: A questionnaire was administered to health informatics experts. The research sample was purposively selected to include practitioners who have worked in the Health Informatics domain, and have at least a Master's degree. Respondents identified topics and competencies appropriate for teaching undergraduate informatics students.

Results: Thematic analysis identified key competencies for different levels of study and design considerations for a Health Informatics course.

Conclusions: Having Health domain Knowledge may provide opportunities for more roles that IT practitioners can play, especially for those who are not scientifically strong.

Keywords: Health Informatics, Informatics Education, Expert Perspectives.

1 Introduction

Nurses, the largest group of Healthcare Information Systems (HISs) end users, are unable to have an impact on HIS development in the way they would choose [1]. Having informaticians who understand the needs of clinical practitioners based on the workflows in a health environment will result in enhancing the advantages of the use of HIS [2][1]. The advantages of Information and Communications technology (ICT) proven by literature, are: promoting ease of documentation; quick retrieval of required information; prevention of medication errors; monitoring alerts; and increasing the use of Evidence Based Practise[3][4]. Information Technology (IT) practitioners in their praxis as they design, develop, implement, and maintain Health Information Systems (HISs) work through collaborative efforts with domain experts in the various contexts that they work [2]. These collaborative efforts, however, are impeded, because health practitioners have insufficient time to dedicate to HIS development and they lack end user engagement, as users prefer to engage with practitioners that are familiar with the context of practice. Having hybrid informatics and clinical practitioners onsite who understand both the health workflow as well as the information technology development needs, aids in improving and providing safer HISs [1][6]. It is therefore imperative for informatics practitioners to have health knowledge, for them to be hybrid practitioners that understand the context of informatics in the health field [2][7].

The process of digitalising health databases and patient electronic records has enabled convenient, affordable, and timely provision of care in African countries [8]. This has provided a great promise in Africa where much of the population are urban rural and have public health systems that have many constraints in terms of infrastructure and capacity [9][10][11][12]. A diversity of emerging Information and Communications Technologies (ICTs) are being used in healthcare [13], thereby providing a plethora of

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technologies that IT practitioners can implement for different health contexts in both urban and rural settings. This also offers a diversity of roles which IT practitioners can take up within the health field. This they have done in the following ways: (1) In the design and development, implementation, support and maintenance of HITs [14]); (2) By re-using and implementing custom made software within HISs; as well as (3) Working in an entrepreneurial capacity [15]; and (4) Encapsulating legacy electronic medical records into new enterprise-wide Electronic Health Records (EHR) applications [16].

The IT practitioners learn these competencies from their training institutions as part of their courses in their curriculum [17][18]. In order to design, develop and implement ICT Systems for a particular context, IT practitioners work in collaboration with domain experts within that context. This is not unfamiliar to them as, traditionally, IT practitioners in their praxis work collaboratively within their different roles [19]. Challenges with collaboration have been that domain experts consider the time spent on the effort as an 'overhead', and additionally, the participants' authority may be limited [1][20][21]. This has led to many unsuccessful implementations of HITs [22][23][24] as there would be a disconnect between the design of the health ICT system and the 'desired use' of the systems [25][26]. Having ICT practitioners who have Health Informatics competencies aids in reducing the implementation challenges of health ICT systems that are irrelevant [2][27][28].

According to Valenta et al. [31], a competency is, '...an observable ability of a ... professional, integrating multiple components such as knowledge, skills, values, and attitudes. Since competencies are observable, they can be measured and assessed to ensure their acquisition. Competencies can be assembled like building blocks to facilitate progressive development.' While there is much literature on the determination of competencies for health practitioners, there is paucity in literature in the determination of competencies for informatics practitioners. Internationally there are two Health Informatics competency frameworks that have researched various contexts to derive competencies for informatics practitioners within the health field, these are the International Medical Informatics Association (IMIA) competencies [32], and the Health Information Technology Competencies (HIT Comp) competencies [32] frameworks.

The IMIA Competency framework, formulated in 2010, was conceptualised by a multidisciplinary team of International Experts who had competencies in both the Health Field and the Informatics field [33]. The Working Group first met in 2008 to conceptualise the methodology for acquiring the competencies and deriving the conceptual framework that guided the inquiry. The final IMIA competency framework is structured into knowledge domains that are offered to two types of roles of professionals at different levels of knowledge. The knowledge domains are classified in the following categories: (1) biomedical and Health Informatics core knowledge and skills; (2) medicine, health and biosciences, health system organisation; (3) informatics/computer science, mathematics, biometry and (4) optional modules in BHMI and from related fields. These knowledge domains were developed for the following roles of users: (1) IT users and (2) Biomedical Health Informatics Specialists. They are designed to be offered at the following levels of skill: (1) Introductory, (2) Intermediate or (3) Specialist. In their review of the IMIA competencies, Mantas and Hasman [2] note that the competencies were still relevant and that informatics practitioners should have Health Informatics knowledge to enable the implementation of relevant and sustainable Health Information Applications.

The HIT Comp framework was also formed from a combination of international perspectives. An international survey was conducted requiring Practitioners who had knowledge in both the Health and Informatics to indicate competencies they felt were necessary for both Health and Informatics Practitioners [32]. The result of the survey was a selection of 250 health IT-impacted competencies throughout the continuum of care. Competencies may be selected according to one of five grades of experience and skills for HIT competence and competencies, these may be Baseline, Basic, Intermediate, Advanced and Expert. Additional criteria include that the IT practitioner may be working in one of six general areas of interactions, which are: administrative; clinical; communication; health data; operational and patient.

Expert perspectives were used in the two competency inquiries to derive the competencies. The perspectives of experts have been used in studies to obtain a greater paradigm of the discipline in question. Experts are better able at synthesising relevant details from large sets of information, and have spent more

time analysing problems, therefore are better at identifying multidisciplinary knowledge for other domains [34][35]. Thus, for Health Informatics competencies, which are multidisciplinary in nature, exploring expert perspectives forms a valuable component. This paper focuses on gaining insights into health informatics experts' perspectives on competencies that could be taught to informatics students, and it forms part of a larger study. The paper explores the following: 1. The competency needs of African ICT Students and practitioners for developing Health ICTs with the involvement of healthcare practitioners as part of their work activities in practice.; 2. How Informatics education can be designed to incorporate healthcare domain knowledge in the training of ICT practitioners.

2 Materials and methods

This study was conducted using a cross-sectional design data was collected using an unstructured questionnaire which was administered to Health Informatics Experts. Purposive sampling of experts who had diverse experiences across multiple domains of Health Informatics, was conducted. The respondents were recruited by sending an email invitation with a link enabling them access to the questionnaire. Respondents were selected from both informatics and health backgrounds to gain a wide perspective from both disciplines. All experts have experience working in South Africa or similar low- and middle-income country (LMIC) contexts. Thematic analysis was conducted on the results from the responses.

2.1 The Questionnaire

The questionnaire was designed to be completed in approximately 30 minutes and was pre-tested for face validity and readability by two practitioners, with Health Informatics Knowledge at Doctoral Level. The questionnaire was then administered online via Google Forms to the participants. The questionnaire had two sections: (1) Demographics, which required the background and professional experience of the respondents; and (2) Questions on topics and competencies in Health Informatics. The latter provided a contextual setting to providing a landscape on the background of the students as well as the focus of the subject that the students would be taking. The contextual setting was:

‘If you were asked to design a Health Informatics course in an undergraduate programme to teach it students to develop, implement and evaluate health information systems, health information technologies or health applications for the African context, what topics would you suggest? Please list the five to ten most important topics?’

The respondents were then asked to conduct the following: (1) Please list your suggested topics and add a short description for each; (2) Please indicate the proposed level of study for each of your suggested topics. This was either as a 1st year degree, diploma, 3rd year degree or 4th year degree level of education; (3) Please indicate for each of the suggested topics what students would be expected to do; (4) Please indicated for each of the suggested topics the competencies that students should have; (5) How can IT practitioners already working in the field acquire the necessary healthcare; and (6) Anything you would like to add that may be useful to consider for the African context?

3 Results

3.1 Demographics

Twenty invitations were sent out to Health Informatics experts, and 10 responded. Of the ten respondents, four were female and six were male. For their highest qualification, five of the respondents had a Master's degree and five had Doctorate degrees. One respondent was retired, and some respondents came from organisations from South Africa, Mozambique, UK and Finland.

3.2 Topics and competencies

The results indicate that 57 sub-competency themes were identified by the respondents and grouped into 18 key competency themes. A wide variety of important areas of competencies was identified and proposed to be offered at different levels of study. Most of the topics had a health focus, providing health domain knowledge to integrate with the IT knowledge that the students would already know. Seven of the topics, however, were suggested for offering across all the levels of study. These are: Introduction to HI; Governance and Policy in HI; Governance and Management of HI; Ethics in HI; The Health Provision Context; Healthcare Knowledge in HI; Health Information Systems Reliability; and Logical Use and Patient Centric Development of Digital Solutions. These seven topics in the degree Programmes would be staggered across 1st year, 3rd year and/or 4th year courses. There were three Health Domain Specific competency topics that were suggested, these were suggested for both the 4-year course and the Diploma course and are: An overview of Health functioning and biosciences, a knowledge of the countries or context Health Systems Structures; Health practitioners workflow practise, and Public Health knowledge. As Public Health knowledge is broad experts suggested the following content: (1) Introduction to Public Health; (2) Patients, Citizens and Community Centred Healthcare and (3) Social Determinants of Health. This knowledge is suggested to be staggered across the 4-year course, with Public Health being offered for the third year and fourth years only. Additionally, Epidemiology is suggested as a competency topic for the 4-year course, with it being offered staggered across the third year and fourth year.

3.2.1 First year competencies

In total, 11 key competencies were identified as appropriate for teaching to First Year students. These were broken down into 23 competency topics identified by the health experts as appropriate. A broad overview of the topics needs to be conducted for the students to gain knowledge and some understanding of the fundamentals of the topics.

Table 1: Suggested Topics and Competencies for 1st Year Students

Key Competencies	Sub-Competency Topics
Health Informatics (HI) Fundamentals	<ul style="list-style-type: none"> • Introduction to HI • History of Information Management of ICT Apps in Healthcare
Healthcare Systems	<ul style="list-style-type: none"> • Models of Healthcare Systems
Trends in Health Informatics	<ul style="list-style-type: none"> • Current Trends in HI • Examples of Current and Future ICT in Healthcare
Governance	<ul style="list-style-type: none"> • Governance and Policy in HI • Governance and Management of HI
Ethics	<ul style="list-style-type: none"> • Ethics in HI • Privacy, Data Security and Information Quality • Patient Confidentiality
Healthcare Work Practice	<ul style="list-style-type: none"> • Healthcare Professionals and their Work • Understanding Healthcare Work Context • The Health Provision Context
Data Science	<ul style="list-style-type: none"> • Data Presentation and Visualisation • Data Integrated Care and Ethical Principles
Health	<ul style="list-style-type: none"> • Definition of Health • Right to Health
Management of Change	<ul style="list-style-type: none"> • Management of Change
Health Information Systems	<ul style="list-style-type: none"> • Healthcare Knowledge in HI • Basics of Healthcare and Usability • Health Information Systems Reliability and Logical Use • Patient Centric Development of Digital Solutions
Public Health	<ul style="list-style-type: none"> • Back-end Systems
Health Information Systems Practical Experience	<ul style="list-style-type: none"> • Work Integrated Knowledge

3.2.2 Third year competencies.

In total, 16 Key Competencies were identified as important for third year students to learn. Within these thirty-nine competency topics were noted by the Health Informatics experts. Students at this stage of the course are expected to have the foundational concepts of the topics indicated for the 1st year and are building on that knowledge so that they are able to have competencies of judgement, analysis and evaluation of health contexts and health information systems.

Table 2: Suggested Topics and Competencies for 3rd Year Students

Key Competencies	Sub-Competency Topics
Ethics	<ul style="list-style-type: none"> • Ethics in HI • Privacy, data security and information quality
Healthcare Work practice	<ul style="list-style-type: none"> • The Health Provision Context
Health Information Systems Practical Experience	<ul style="list-style-type: none"> • Work Integrated Knowledge
Data Science	<ul style="list-style-type: none"> • Data Science of HI • Data Analysis to improve care provision
Health	<ul style="list-style-type: none"> • Epidemiology
Health Information Systems	<ul style="list-style-type: none"> • Healthcare Knowledge in HI • Basics of Healthcare and Usability • Health Information Systems Reliability and Logical Use • Patient Centric Development of Digital Solutions • Digital Information Technology in HI • Logical Usability • Nursing and Nursing Technology
Management of Change	<ul style="list-style-type: none"> • Management of Change • Management Framework
Telehealth	<ul style="list-style-type: none"> • Telehealth, Telemedicine, Teleconferencing
Research	<ul style="list-style-type: none"> • Research • Research Disease and Injury Prevention • Prevention and Responding to Infectious Disease
Design	<ul style="list-style-type: none"> • User Experience Design • Interactional Design • Participative and Transformative Systems Design and Implementation
Systems Development Life Cycle	<ul style="list-style-type: none"> • Software Application Development • Back-end Systems • Work and Service Improvement through ICT Systems Development • Systems Theory • Logical Framework and other Frameworks
Multi-professional Project Work	<ul style="list-style-type: none"> • Multi-professional Project Work
Public Health	<ul style="list-style-type: none"> • Introduction to Public Health • Patients, Citizens and Community Centred Healthcare • Social Determinants of Health

3.2.3 Fourth year competencies

In total, 15 key competencies and thirty-four competency topics were identified by the Health Informatics experts as appropriate for fourth year students. Students at this level are capping their knowledge attained from their prior years. They are expected to be able to evaluate, make recommendations and develop health systems that are appropriate in diverse contexts. This is evidenced by the Health Informatics experts

recommending eight competency topics as appropriate for just the fourth-year level study. These were: Impact Assessment of Health Information Technology; Role of Health Professionals in Information Management; Building Blocks of Health; Information Technologies in HI; Digital Health; Usability Testing; Implementation Process; and Implementation Science in Health Services.

Table 3: Suggested Topics and Competencies for 4th Year Students

Key Competencies	Sub-Competency Topics
Healthcare Work practice	<ul style="list-style-type: none"> • Role of Health Professionals in Information Management • The Health Provision Context
Data Science	<ul style="list-style-type: none"> • Data Integrated Care and Ethical Principles • Data Science of HI
Health	<ul style="list-style-type: none"> • Building Blocks of Health • Epidemiology
Health Information Systems	<ul style="list-style-type: none"> • Healthcare Knowledge in HI • Basics of Healthcare and Usability • Health Information Systems Reliability and Logical Use • Patient Centric Development of Digital Solutions • Digital Information Technology in HI • Logical Usability Information Technologies in HI • Digital Health • Usability Testing
Management of Change	<ul style="list-style-type: none"> • Management of Change
Telehealth	<ul style="list-style-type: none"> • Telehealth, Telemedicine, Teleconferencing
Research	<ul style="list-style-type: none"> • Research
Systems Development Life Cycle	<ul style="list-style-type: none"> • Software Application Development • Back-end Systems • Work and Service Improvement through ICT Systems Development • Logical Framework and other Frameworks • Implementation Process • Implementation Science in Health Services
Multi-professional Project Work	<ul style="list-style-type: none"> • Multi-professional Project Work
Public Health	<ul style="list-style-type: none"> • Introduction to Public Health • Social Determinants of Health
Health Information Systems Practical Experience	<ul style="list-style-type: none"> • Work Integrated Knowledge

3.2.4 Diploma competencies

Nine key competencies were suggested for the diploma course. Diplomas differ from degree programs in time and focus. They are offered for a shorter time period and their focus is vocational unlike the degree programs which are academic in focus. These key competencies were broken down into seventeen sub-topics for competencies.

Table 4: Suggested Topics and Competencies for Diploma Students

Key Competencies	Sub-Competency Topics
Health Informatics Fundamentals	<ul style="list-style-type: none"> • Introduction to HI
Trends in Health Informatics	<ul style="list-style-type: none"> • Evaluating Health Interventions
Governance	<ul style="list-style-type: none"> • Governance and Policy in HI • Governance and Management of HI
Ethics	<ul style="list-style-type: none"> • Ethics in HI • Ethics of Health Data
Healthcare Work practice	<ul style="list-style-type: none"> • The Health Provision Context

Data Science	<ul style="list-style-type: none"> • Data Integrated Care and Ethical Principles • Data Science of HI • Healthcare Knowledge in HI
Health Information Systems	<ul style="list-style-type: none"> • Basics of Healthcare and Usability • Health Information Systems Reliability and Logical Use • Patient Centric Development of Digital Solutions • Digital Information Technology in HI • Logical Usability
Telehealth	<ul style="list-style-type: none"> • Telehealth, Telemedicine, Teleconferencing
Public Health	<ul style="list-style-type: none"> • Social Determinants of Health
Health Information Systems Practical Experience	<ul style="list-style-type: none"> • Work Integrated Knowledge

3.3 Methods of Upskilling

The respondents were further asked to describe their topics and indicate competencies they would expect the Informatics students to acquire once they have learnt the topic. The descriptions and competencies were coded to form descriptions and competencies for key competencies. The respondents were also asked for recommendations on how IT practitioners in practice may be upskilled to gain these competencies. Recommendations are indicated in Table 5 below.

Table 5: Suggested methods of upskilling for IT Practitioners

Methods of Upskilling
<ul style="list-style-type: none"> • Staggered 3/4 year course • Short Online Course • Summer/Winter schools • Hands-on experiences • Reading • Shared learning experiences with health practitioners

3.4 African Context Perspectives

Additionally, respondent were asked what other characteristics would be important for the African context that they would recommend. They offered the following considerations:

‘The international situation is fast-moving and eclectic. Keeping a watching brief on both political national / international situations and priorities; academics must establish development of high level contacts or getting involved in international, governmental and local policy bodies and initiatives relating to informatics deployment in health, academic goals and capacity and capability’ [Participant 2].

‘Health Informatics must be a recognised speciality in Health’ [Participant 5].

‘Through their hands-on experiences and y reader wider on the topic - prescribing a prerequisite list of articles on topics that have to be read and analysed and presented before admission can be gained. Focus and apply African type of case studies and examples on all course materials. Focus on visionary documents on health and wellbeing – National Development Plan and Digital Health Strategy’ [Participant 7].

‘It is important not to apply one size fits all to the African context because of the peculiar context and varying economies’ [Participant 8].

‘Practitioners should not lose sight of paper based components of systems and work in hybrid environments’ [Participant 11].

‘Much emphasis is on what happens when the students do not have the infrastructure. Offline resources should be considered, podcasts, flash drives, paper not real-time learning’ [Participant 11].

4 Discussion

4.1 Objective 1: To explore competency needs of ICT Students and practitioners for developing Health ICTs with the involvement of healthcare practitioners as part of their work activities in practice

While there is a paucity in literature on Health Informatics Competencies for IT students, there are IT practitioners whose work has been in the health field and are able to determine the domain knowledge that is necessary for IT practitioners to be able to work within the health field. The results from the data collected from the Health Informatics experts indicate that there are several key competency considerations for Informatics practitioners at different levels of study. This may be at 1st year, Diploma, 3rd year and 4th year level. These stages form the critical stages of formative and evaluative learning of an Informatics student's career and have the following characteristic competency needs:

There are seven competencies that the experts felt were necessary for Students who have done either the 3-year course or a Diploma course. These were: Introduction to Health Informatics; Governance and Policy in HI; Governance and Management of HI; Ethics in HI; The Health Provision Context; Healthcare Knowledge in HI; Health Information Systems Reliability; and Logical Use and Patient Centric Development of Digital Solutions. These competencies form core factors that guide in the decision-making process for the implementation of Health ICT systems and eHealth Systems. In both the IMIA and HIT Comp, it is noted that an overview of the Health Informatics Context is necessary, IMIA indicates that this needs to include the evolution of the profession as a discipline. In each domain specific contexts, there are rules that guide in the governance, ethics and context of development of those domains systems. Although the IT domain contains rules that govern the development of ICT Systems, an understanding of the rules in the health domain, enables the development of relevant and sustainable Health ICT Systems. In the 4-year course these competencies, experts suggested should be staggered across the years, indicating that content evolves from a generalised overview in the first year to more specialised content.

Contextual orientation of the content of the competencies according to suggestions from the experts is health oriented. The competencies suggested had three characteristics: (1) A broad overview of the health domain context; (2) An overview of the Health System of the context, for example the Road to Health System that is used in South Africa; and (3) Health ICT Systems Software Modules. This is indicated by the suggestions for example of in Data Analysis to improve care provision, and in the Systems Development Life Cycle there is for example Patient Centric Development of Digital Solutions. Within the Systems Development Life Cycle the Backend competency was explicitly indicated in the HIT Comp with examples of Health Level 7 and Health Information Exchange being described and discussed. However, in the African Context experts mentioned the District Health Information Systems2 (DHIS2) and Open HIE as backend systems that are necessary for Students to know.

The competencies suggested are centred around Health Informatics Data, Data Management and Health Practise Workflows. These competencies characteristics complement the IT student's knowledge, as in order to develop systems for a context, domain knowledge on the data and the decisions made on that data is important. IT practitioners core work is in the implementation of systems, this not only requires the development of the IT artefact that will be used in the context, but also includes the data and information contained in the artefact. Mantas and Hasman (2017) note that this would ensure implementation of resilient Health ICT Systems. In order to have good data and information quality, having some domain knowledge, would guide IT students and practitioners on eliciting software requirements, software and process modelling,

Competency topics suggested were on ICTs in Health, however there were some Health Knowledge competency topics that the experts mentioned. These included content in Health, Health Workflow practice, Public Health and Epidemiology. This indicates that within the Health Field there are some Health knowledge topics that an IT student or practitioner would need to know. Although the IMIA framework has Health Specific Knowledge for IT practitioner, these are centred around the workflow practice of the health practitioner and are recommended for the IT practitioner to have an introductory knowledge of the topics. Topics like Public Health are not recommended although they are present. It has been traditionally assumed that IT practitioners do not need any Health knowledge and require only domain experts to be able to develop and suggest ICT systems within the health context. The expert's suggestion of these topics shows that this is not the case. As there is a paucity of Health practitioners, and an excess of work that they need

to do, having IT practitioners that are knowledgeable with some Health knowledge, lessens the burden of time spent on collaboration for the development of artefacts. This is also noted by Martikainen et al.,[1]. IT practitioners have been noted to work in the Health Domain in the roles of Data Capturers, Developers, Support, and Entrepreneurship. Having Health domain Knowledge may provide opportunities for more roles that IT practitioners can play, especially for those who are not scientifically strong.

4.2 Objective 2: To explore how Informatics education can be designed to incorporate healthcare domain knowledge in the training of ICT practitioners.

For problem-based education like in Health Informatics Education, where transdisciplinary characteristics need to be considered, there are important design factors that need to be considered. As one expert noted that the notion of one size fits all does not apply for Health Informatics Education, as there are varying needs, the “particular context and economies”. Considerations on education would need to be done to determine the best method of administering a course for diverse student backgrounds. When asked to recommend a method of administering a Health Informatics Course for IT students, experts suggested six methods. These were: (1) Through a regulated 3- or 4-year course; (2) Short Online Course; (3) Winter or Summer School; (4) Hands on Experience; (5) Reading; (6) Shared learning experience with experts. Other than the regulated course and Winter and Summer Schools, the other four methods accommodate the IT practitioner, whose work practice does not allow for time off. This provides IT practitioners who are working with opportunities to upskill themselves within a particular domain.

On the focus, objective and depth of content of a course, it is noted that the following contextual characteristics are of importance: (1) Keeping a note of both national and international political situations and priorities, aid in keeping abreast with the contextual changes that affect the domain and relevancy of the Health Informatics Education Offering.

(2) In the African Context, course content should “focus and apply African type of case studies and examples”, this makes the content visually meaningful to the students. The African health context provides a platform for the development of HIS artefacts that can be used in remote areas. In the African context eHealth, telehealth and mHealth are the common systems that IT practitioners implement especially for remote area contexts. Kokol et al [36] notes that this is the strength domain of IT practitioners working Health contexts, while Health Informatics is a strength for Health practitioners. Case study examples provides Informatics Students with an understanding of the process of implementing relevant artefacts within the context of Health.

(3) It is important for informatics students to know and understand the ‘paper-based components’ used within their context of health. These would aid the students in understanding the context of health, the type of data that health practitioners capture as they conduct their praxis and enable them to gain an overview of the activity workflow touch points, the stakeholders that use that data, the user rights to the data, the decisions made using that data and security measures that need to be implemented to protect that data. Content should also include the health documents from the country or context in which the course is to be administered.

(4) Hands on experience is important, and involvement in an initiative either governmental or non-governmental aids in providing platforms from which students can practice their competencies.

(5) For content that is focused on the development of Health Systems, it is important to note that Health IT artefacts have domain specific data standards that they implement for the Systems databases. It is important that Informatics students learn the data standards, and backend components. These differ according to national context as well as context of practice. Common data standards that are particularly used within Africa are the DHIS2, HL7, SNOMED and other components that are used in the development of Health Information Systems Architecture.

5 Conclusion

The study revealed that there is some domain knowledge that is specific for Informatics Students and Practitioners to know. Key competency topics were identified by experts and considered as important for Undergraduate Informatics Students to learn. The suggestion of topics at different academic levels that

could be taught, aids in identifying competencies that could be recommendations for a course that could be offered to Informatics students. Some knowledge in Health Informatics topics further provides interdisciplinary skills to undergraduate students that may not have or otherwise would have had such skills. Having Health domain Knowledge may provide opportunities for more roles that IT practitioners can play, especially for those who are not scientifically strong. Further research involving identification of skills from the Health Informatics practitioners' praxis could be conducted to identify touch points in their workflow, as well as the roles that IT practitioners may play in the Health Field.

6 Limitations

One of the limitations of our study was the small sample size. This was addressed by the fact all participants are highly regarded experts. Limitations on bias towards the field of informatics was addressed by having participants with both informatics and health backgrounds, hence a fair portrayal of the discipline is obtained.

7 Ethics

The necessary ethics clearance was obtained from the Health Informatics experts and the University under which this study was conducted.

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Statement on conflicts of interest

No conflict of Interest

References

- [1] Martikainen S, Kaipio J, Lääveri T. End-user participation in health information systems (HIS) development: Physicians' and nurses' experiences. *Int J Med Inform* [Internet]. 2020;137(February):104117. Available from: <https://doi.org/10.1016/j.ijmedinf.2020.104117>
- [2] Mantas J, Hasman A. IMIA Educational Recommendations and Nursing Informatics. *Stud Health Technol Inform*. 2017 Jan 1;232:20–30.
- [3] Ahmad MM, Musallam R, Allah AH. Nurses and internet health-related information: review on access and utility. 2018;91(3):266–73
- [4] Mahoney DF, Faan BC. The aging nurse workforce and technology Aging nurse workforce. 2011;10(1)
- [5] Farahat TM, Hegazy NN, Mowafy M. Information and communication technologies in primary healthcare facilities in Egypt. 2020;88–95
- [6] Hersh W, Margolis A, Quirós F, Otero P. Building a health informatics workforce in developing countries. *Health Aff*. 2010;29(2):275–8.
- [7] Murphy J, Goossen W, Weber P. Forecasting Informatics Competencies for Nurses in the Future of Connected Health. *Nursing Informatics Post Conference*. 2017
- [8] Wesolowski A, O'Meara WP, Tatem AJ, Ndege S, Eagle N, Buckee CO. Quantifying the impact of accessibility on preventive healthcare in sub-Saharan Africa using mobile phone data. *Epidemiology*. 2015;26(2):223–8
- [9] Health Systems Trust. Health Indicators [Internet]. 2021. Available from: <https://www.hst.org.za/healthindicators>
- [10] Korpela M, Mursu A, Soriyan HA, de la Harpe R, Macome E. Information systems practice for development in Africa: Results from INDEHELA. *IFIP Int Fed Inf Process*. 2006;208:15–35.
- [11] Wright G. Some Thoughts about Health Informatics in Africa. *Eur J Biomed Informatics*. 2018;14(1):75–6
- [12] van Stam G. Framing "ICT Access in Rural Africa." 11th Prato CIRN Conf 13-15 Oct 2014, Prato, Italy [Internet]. 2014;(Ci). Available from:

https://www.researchgate.net/publication/266154055_Framing_%27ICT_Access_in_Rural_Africa%27

- [13] Fernández E. Innovation in Healthcare : Harnessing New Technologies Innovation in Healthcare : Harnessing New Technologies. 2017;2017(2)
- [14] Avgerou C. Information systems in developing countries: A critical research review. *J Inf Technol.* 2008;23(3):133–46
- [15] Lawler J, Joseph A. Entrepreneurial Health Informatics for Computer Science and Information Systems Students. 2014;12(January):27–41
- [16] Longenecker HE, Campbell SM, Landry JP, Pardue H, Daigle RJ. A Health Informatics Curriculum Congruent with IS 2010 and IMIA Recommendations for an Undergraduate Degree. 2012;10(April):15–32.
- [17] Herselman M, Botha A. Strategies , Approaches and Experiences : Towards building a South African Digital Health Innovation Ecosystem. 2016.
- [18] Roach S, Sahami M. CS2013: Computer Science Curricula 2013. Vol. 48, Computer. 2015. 114–116 p.
- [19] Murić G, Abeliuk A, Lerman K, Ferrara E. Collaboration Drives Individual Productivity. 2019;3(November).
- [20] Sharp H, Plonka L, Taylor K, Gregory P. Overcoming Challenges in Collaboration between Research and Practice : The Agile Research Network. 2014;10–3.
- [21] Svensson A. Challenges in Using IT Systems for Collaboration in Healthcare Services. 2019;
- [22] Mihalas GI. Evolution of Trends in European Medical Informatics. 2014;22(1):37–43.
- [23] Ngafeeson M. Healthcare Information Systems : Opportunities and Challenges Encyclopedia of Information Science and Technology , Third Edition. 2014;
- [24] Sittig DF, Bates DW. Current challenges in health information technology – related patient safety. 2020;(2).
- [25] Heeks R. Health information systems : Failure , success and improvisation. 2006;
- [26] Tscholl DW, Handschin L, Rössler J, Weiss M, Spahn DR, Nöthiger CB. It ’ s not you , it ’ s the design - common problems with patient monitoring reported by anesthesiologists : a mixed qualitative and quantitative study. 2019;1–10.
- [27] Campbell SM, Pardue JH, Longenecker HE, Barnett H Les, Landry JP, Circle A. Treating the Healthcare Workforce Crisis : A Prescription for a Health Informatics Curriculum. 2012;10(June):35–46.
- [28] Gadd CS, Steen EB, Caro CM, Greenberg S, Williamson JJ, Fridsma DB. Domains, tasks, and knowledge for health informatics practice: Results of a practice analysis. *J Am Med Informatics Assoc.* 2020;27(6):845–52.
- [29] Bernstam E V., Tenenbaum JD, Kuperman GJ. Preserving an integrated view of informatics. *J Am Med Informatics Assoc.* 2014;21(E2):1–2.
- [30] Matney SA, Langford LH, Staggers N. Are nursing informatics competencies good enough? *JBI Evid Synth.* 2021;19(4):747–8.
- [31] Valenta AL, Berner ES, Boren SA, Deckard GJ, Fridsma DB, Gadd C, et al. Perspective AMIA Board White Paper : AMIA 2017 core competencies for applied health informatics education at the master ’ s degree level. 2018;25(October):1657–68.
- [32] Shaw T, Blake R, Hübner U, Anderson C, Wangia-Anderson V, Elias B. The Evolution of TIGER Competencies and Informatics Resources | HIMSS. Healthc Inf Manag Syst Soc [Internet]. 2017; Available from: https://www.himss.org/library/evolution-tiger-competencies-and-informatics-resources%0Afile:///Users/beatrice_cutie/Downloads/The Evolution of TIGER Competencies and Informatics Resources FINAL 10.2017.pdf
- [33] Mantas J, Ammenwerth E, Demiris G, Hasman A, Haux R, Hersh W, et al. Recommendations of the International Medical Informatics Association (IMIA) on Education in Biomedical and Health Informatics. *Methods Inf Med.* 2010;49(02):105–20.
- [34] Bruggeman B, Tondeur J, Pynoo B, Struyven K. Experts ’ Insights About Blended Learning Implementation : What Teacher Attributes are Relevant ? 2018;(2011).
- [35] Mothupi MC, Knight L, Tabana H. Improving the validity, relevance and feasibility of the continuum of care framework for maternal health in South Africa: A thematic analysis of experts’ perspectives. *Heal Res Policy Syst.* 2020;18(1):1–14.
- [36] Kokol, P., Saranto, K., & Blazun, H. (2018). eHealth and health informatics competences: A systemic analysis of literature production based on bibliometrics. *Kybernetes*, 47, 1018-1030.