Current Approaches and Trends in Graduate Public Health Informatics Education in the United States: Four Case Studies from the Field

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Abstract

Background: Public Health Informatics (PHI) has taken on new importance in recent years as health and well-being face a number of challenges, including environmental disasters, emerging infectious diseases, such as Zika, Ebola and SARS-CoV-2, the growing impact of the Influenza virus, the opioid epidemic, and social determinants of health. Understanding the relationship between climate change and the health of populations adds further complexity to global health issues.

Objectives: To describe four examples of curricula that exist in U.S. based graduate-level public and population health informatics training programs.

Methods: Biomedical informatics educators are challenged to provide learners with relevant, interesting, and meaningful educational experiences in working with and learning from the many data sources that comprise the domain of PHI. Programs at four institutions were reviewed to examine common teaching practices that stimulate learners to explore the field of public health informatics.

Results: Four case studies represent a range of pedagogical approaches to meeting the requirements of three established accreditation/certification agencies relevant to PHI education. Despite their differences, each program achieved the established learning objectives along with a substantive record of student learning achievements.

Conclusion: The overarching goal of empowering learners to serve an active and dynamic role in enhancing preventive measures, informing policy, improving personal health behaviors, and clarifying issues such as quality, cost of care, and the social determinants of health, are essential components of PHI education and training, and must receive additional consideration now and in the future by educators, policy makers, administrators, and government officials.

Keywords: *Public Health Informatics; Health Education; Curriculum; Population Health*

Abbreviations:

PHI: Public Health Informatics

CEPH: Council on Education for Public Health

CAHIIM: Commission on Accreditation for Health Informatics and Information Management Education

CIB: Clinical Informatics Board

AMIA: American Medical Informatics Association

ACO: Accountable Care Organization

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INTRODUCTION

Public Health Informatics (PHI) is defined as the application of informatics to public health research, education, and practice [1-3]. As public health informaticians we study how data and information are captured, managed, used, and shared by people and organizations in the context of population health. This includes management of information by governmental public health agencies as well as engagement of consumers in their personal health and well-being through preventative medicine.

PHI is increasingly important as health and wellness are challenged by environmental disasters, infectious diseases (including the SARS-CoV-2 pandemic), the opioid crisis, and social determinants of health. Understanding the connection between climate change and the health of populations adds further complexity to global health issues. PHI is increasingly relevant given changes in both the health care marketplace and the techniques used to combat the rising number of global health threats. Health systems increasingly seek to automate processes by which clinical teams can manage the health of populations and motivate individuals to pursue healthy behaviors. Informatics serves a critical role in identifying and reporting emerging pathogens that cause infectious diseases across state, national, and international borders [4].

Several graduate-level institutions provide specializations in PHI [5], while a broad range of biomedical informatics programs vary in the number of PHI courses offered. The courses and focus areas seek to motivate instructors, students and future researchers to develop new tools and techniques that will facilitate creative approaches to working with and analyzing large population health data sets, and to inform public health decision-making [6]. Instructors are stimulated to employ creative methods to ensure that students learn about informatics tools and techniques from a variety of perspectives so that the goals, and objectives are accomplished. It also is essential to incorporate a solid curriculum framework for instructional programs to ensure quality, creativity and a substantive scientific focus [7, 8].

In this paper, we highlight the approaches and techniques for educating students in the field of PHI at four different institutions. The review of these varied approaches identifies current trends in PHI education and highlights challenges for those interested in biomedical informatics education. The paper expands on presentations delivered at the 2019 AMIA Informatics Educator's Forum. The review provides an overview of current curricula offerings at each institution, while placing the didactic programs in the context of U.S. accreditation and certification.

METHODS

The project reviewed graduate-level PHI education at the institutions of the authors, four academic informaticians with a special interest in PHI instruction, who teach in programs that represent the breadth of PHI training. Two authors teach PHI in public health programs; one teaches PHI in a nursing informatics program; and one teaches PHI in a biomedical informatics program. Together they reviewed the current state of, and best practices associated with, instruction in the domain of PHI at their U.S. based training programs.

The goal of the review was to identify common themes among the four examples of curricula that exist in U.S. based graduate-level public and population health informatics training programs, and discuss how instructional programs evolve as population health becomes increasingly important. We defined the desired outcomes of PHI instruction at each institution, explaineded how the outcomes related to accreditation/certification (A/C) issues, and presented each institution's training program objectives, along with the curricula goals and learning objectives for the domain of PHI.

Goal of public health informatics

The discipline of PHI applies information and computer science to enhance public health processes and decision-making [9]. Applications of PHI seek to improve the health and well-being of the populace by enhancing preventative measures, informing policy, and personal health behavior, and clarifying issues such as quality, cost of care, and the social determinants of health [3]. The training programs offered by the four institutions represented in this study, while varying in scope, duration, and orientation, all are committed to achieving these fundamental goals [7].

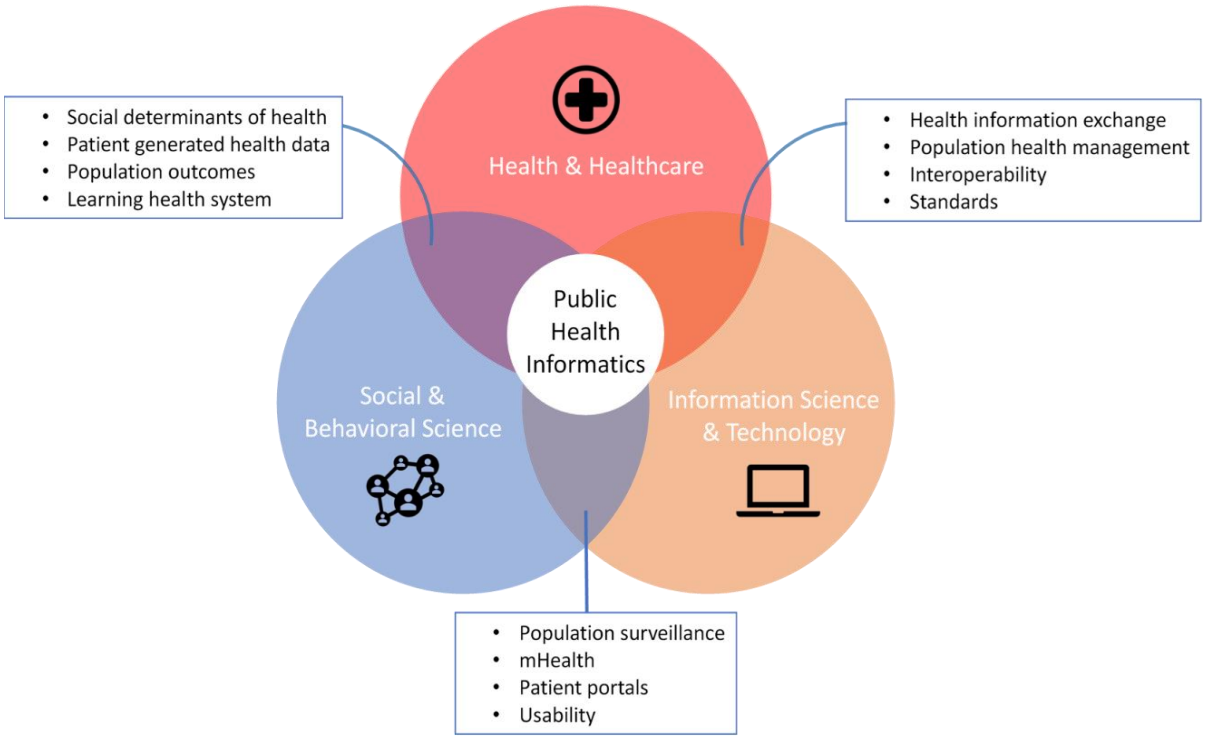

Figure 1. Goals of Public Health Informatics

Accreditation guidelines and unifying themes

Educational training programs should be built upon mission, vision, goals and objectives that can be measured and validated to ensure that quality learning outcomes are achieved [8]. From the perspective of educational objectives this project traced its roots to three influential accrediting bodies for informatics instruction, and certification located in the U.S.: The Council on Education for Public Health (CEPH) [10], the Commission on Accreditation for Health Informatics and Information Management Education (CAHIIM) [11], and the Clinical Informatics Board (CIB) Certification for Physicians in the United States [12].

An essential component of the project was to explore both the unifying themes among these organizations, and the distinctive educational and professional goals promulgated by each association as a means of testing the validity and reliability of their specific mission, vision, goals, and objectives.

The guidelines established by the three accrediting organizations serve as the backbone for the methods section:

- The Council on Education for Public Health (CEPH), a nationally recognized accrediting body, accredits schools of public health and stand-alone programs.
  - CEPH offers the following key benefits to students: Comprehensiveness, rigor, flexibility, qualification, eligibility, to sit for the Certified in Public Health (CPH) exam, opportunities for internships and fellowships, and recognition.

- The Commission on Accreditation for Health Informatics and Information Management Education (CAHIIM) is the globally recognized and trusted accreditation organization for training in these specialties.
  - CAHIIM's mission is to serve the public interest in advancing the value of health informatics and health information management through quality education by establishing and enforcing accreditation standards, recognizing programs that meet the standards, assessing student achievement, respecting educational innovation and diversity, recognizing academic institutions' autonomy, emphasizing the principle of volunteerism and peer-review, and embracing a culture of continuous quality improvement.
- The Clinical Informatics Board (CIB) Certification for Physicians in the United States is based within the American Medical Informatics Association (AMIA) because the organization serves as the core institution for practicing informaticians from across the spectrum of clinical informatics backgrounds and professional clinical performance.
  - AMIA created a code of ethics for the discipline in 2007 to serve as the framework for the development of the core content that defines the knowledge, skills and competencies required for certification to practice clinical informatics.
  - AMIA requested and received administrative board sponsorship for the board from the American Board of Medical Specialties (ABMS) in 2009.

Key curricula goals and learning objectives

CEPH, CAHIIM, and CIB provide cohesion, authority, and validity to PHI programs and courses, while ensuring that students understand the role that public health informaticians serve in applying methodologies from the fields of information science, computer science, statistics, and information technology to public health [6]. Population health also has become an important component of PHI instruction due to the increased importance of the social determinants of health [13].

A review of the curricula being offered by four training programs revealed that the critical issues that inform contemporary public health informatics instruction are: standardization and interoperability of population data, improving the health and well-being of populations, enhancing preventive measures, informing policy and personal health behavior, and clarifying basic issues such as quality, and the cost of care. Each of these issues align with the curricula goals and learning objectives disseminated by CEPH, CAHIIM, and CIB.

In order to evaluate the current presence of introductory public health informatics courses beyond the four targeted PHI programs, we conducted a non-exhaustive search of biomedical informatics focused programs in the United States. The intent was to find a sufficient number of programs to present a well-rounded sample of schools offering at least a master's degree in either biomedical, health, clinical, or public health informatics.

Initially, the search investigated institutions that were registered with AMIA to advertise their informatics programs. Additional programs were added through internet search queries. The approach yielded 98 different accredited schools, with 21.4% (n = 21) offering an introductory course in Public or Population Health Informatics. Inclusion criteria required that the class was focused principally on PHI, and not a survey course of general health or biomedical informatics.

The search focused on identifying only introductory PHI classes, while excluding advanced Public Health Informatics courses. The objective was to provide a better picture of the prevalence of introductory PHI classes, and not skew the results due to one program's investment in additional advanced PHI courses.

Once the courses were identified, additional details were captured to examine whether the classes were offered as elective or required for the degree. We noted if the class was offered in an online only format (Online), in both an on campus and online offering (Campus/Online), or only as an on-campus option (In-Person). Figure 2 depicts the findings from this query. Of the 22 programs, the majority (86%, n = 19) offered their PHI class as a degree requirement; only 3 (14%) listed their class as an elective. Distribution of class offerings was even with 7 courses offered in the on-campus and online option, 6 courses were offered on-campus only, and 9 courses were listed as online only which implies a trend toward offering more PHI classes online.

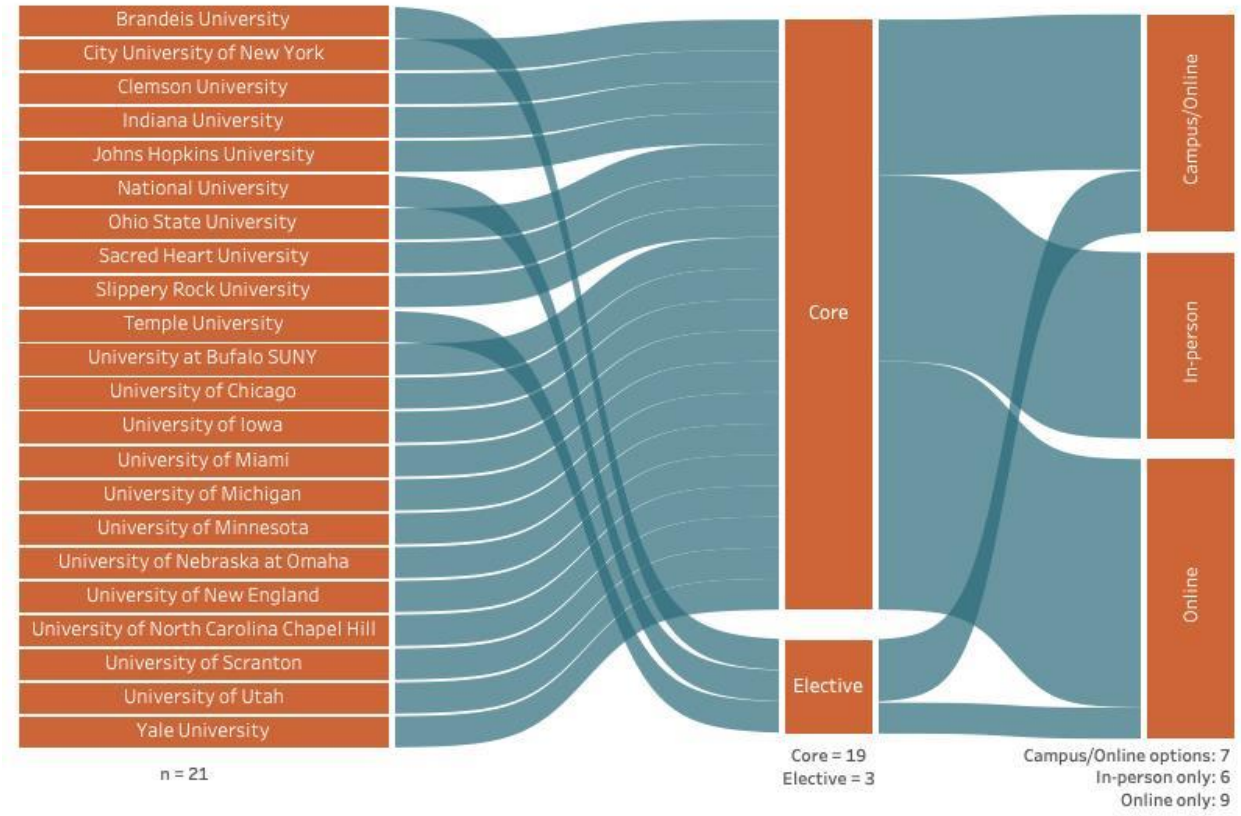

Figure 2. Mapping the identified PHI classes according to their assignment in each school's curriculum (as a core course, or an elective) and how the class was offered (in-person, online, or a combination of the two).

RESULTS

Here we summarize common themes among PHI curricula at four U.S. institutions of higher education. The diversity of available training programs is described, and a commitment to

achieving the same overall learning objectives, that is, to train individuals who are capable of improving the health and well-being of populations, was observed [3].

Descriptions of the Curricula

The University at Buffalo's, SUNY, Department of Biomedical Informatics is a basic science department in the Jacobs School of Medicine and Biomedical Sciences. One PHI course is offered *Clinical Population Research and Public Health Informatics*. The course's learning objectives seek to create a distinctive educational experience by working with domain experts from diverse professional backgrounds who possess broad, in depth knowledge of the field, and a willingness to share their expertise.

The opioid crisis served as the backdrop for guest lecturers including the county executive, the county commissioner of health, and staff of a regional substance use disorder, rehabilitation, and mental health service provider. Each presenter shared their intimate knowledge of the crisis by providing detailed data regarding the shifting dynamics of the crisis, and how their agency collected, analyzed, and interpreted the data being amassed.

Other speakers addressed the role of epidemiology, local environmental disasters, climate change, infectious diseases, such as the Ebola, and as of 2020 the SARS-CoV-2 virus pandemic, consumer health informatics, injury, violence, bioterrorism, population health data sources and the contributions made by clinical laboratory medicine/pathology in using large-scale data to manage information about diseases. Students also received literature search training using Medline, and Endnote. The assignment for the course was to prepare a systematic review on a public or population health informatics topic. The paper prepared by two teams of students was subsequently published.

The University of Minnesota's School of Nursing Doctor of Nursing Practice (DNP) Nursing Informatics specialty offers a Population Health Informatics course with a simulated Accountable Care Organization (ACO) exercise which was incorporated into the curriculum to teach students the use of informatics tools to achieve standardization, interoperability, and data-based decision making in the context of population health. Included in the instructional platform are two working PopHRs which uses heterogeneous data from a geographic public health perspective to connect health determinants with the health of populations.

PopHRs support population health management and public health principles to enable learners to understand whole-person health in the context of all available data for individuals and populations. The PopHR automates extraction, harmonization, linking, and integration of all available data for persons and populations to support population health measurement and monitoring with the goal of improving decision making [14].

Hands-on data experiences accelerate the student's appreciation of major challenges in standardization and interoperability that are essential for the successful advancement of PHI. Because nursing programs require clinical practicum hours for each specialty, students must complete 1,000 practicum hours to graduate. To achieve this requirement a population health informatics practicum course was created to meet 240 of the required hours. The course, which is offered completely on-line in a real practice site, enables students to work together to address a

critical population health informatics problem. The sites have included local and state public health departments and non-governmental entities, including a health services innovation company. As a result of these experiences students demonstrated improved knowledge and skill in population health data, interoperability, and measurement across settings and populations. The over-arching learning objective focused on teaching data-based decision making to support a broad understanding of the role and importance of population health in the context of nursing education and practice. The project established the importance of information technology's (IT) role in enabling improved decision making and reducing costs [15].

Indiana University's Richard M. Fairbanks School of Public Health offers a *Foundations of Public Health Informatics* course to graduate MPH (Masters of Public Health) students as well as a specialized PHI concentration in the MPH program. The foundational course provides core instructional modules that focus on epidemiology, healthcare policy and management, informatics, and data science. The course uses a combination of didactic instruction on core informatics theory with practical, real-world exercises that require students to practice informatics skills. One assignment asks students to use data from a public data source (e.g., census data on education levels) with aggregate disease counts from electronic health records to analyze risk factors, including social determinants. Students gain hands-on experience with a geographic information system as well as an epidemiology information system in the process of capturing, managing, and analyzing their data.

The MPH degree with a concentration in PHI provides the groundwork for engineering data and information systems within health systems, as well as governmental and non-profit public health organizations to support the collection, storage, management, analysis, application and sharing of information to improve population health outcomes. Students learn to think critically about population level data and apply informatics approaches to address significant public health issues [16]. Five PHI courses are offered: *Fundamentals of Data Management*, *Foundations in Public Health Informatics*, *Healthcare Information Systems*, *Information Exchange for Population Health*, and *Population and Public Health*. Students also take courses from the School of Informatics and Computing on the University of Indiana campus, enabling them to further their understanding of methods and techniques from the broader field of biomedical informatics as a component of their training program. Informatics courses are complemented by core public health courses as well as an internship in a public health organization or health system. Capstone projects challenge students to develop, implement, or analyze an information system for a public health organization or health system.

The University of Omaha's School of Health and Kinesiology offers a public health undergraduate degree, which has a graduation requirement of completing a PHI course. This brought the discussion full-circle by introducing the importance of standards and accreditation. Thereby ensuring that educational programs are based on quality indicators that will develop students who are capable of delivering excellence in practice, research and service.

From a methodological perspective quality education for public health professionals is based on the competencies established by CEPH. Eight competencies define the essential expectations of a public health informatics professional: (1) evidence-based approaches; (2) knowledge and understanding of public health and health care systems; (3) planning and management to promote health; (4) policy; (5) leadership; (6) communication; (7) inter-professional practice, and (8)

systems thinking [10]. A PHI professional is expected to be capable of selecting, analyzing and interpreting, quantitative and qualitative data for conducting public health research, developing policies, evaluating outcomes, and engaging in sound professional practice. A variety of ideas, strategies and techniques are provided for conducting dynamic, interesting and educationally sound online courses, such as, 5-10-minute mini-lectures, embedding questions or recaps between the lectures, using the learning system's discussion board to help make the content relevant, and incorporating TED talks, YouTube videos, case studies, and system demonstrations.

DISCUSSION

We examined trends in PHI education across U.S. institutions of higher education offering instruction in biomedical informatics. One-fifth (21%) of institutions with a biomedical informatics program provide at least one course in PHI. The majority of these courses are required for degree completion, even if the specialty or concentration is not focused on PHI. In addition, we conducted an in-depth review of four representative programs that summarize the breadth of educational offerings in biomedical informatics training. All four programs train their students on how informatics can be leveraged by health systems to enhance preventive measures, inform policy, improve personal health behaviors, and clarify issues such as quality, cost of care, and the social determinants of health, which we conclude are essential components of PHI training [3]. Our review also reinforced the principle that PHI is evolving towards population health across governmental public health agencies and health delivery systems, highlighting that instructional programs must keep pace with the changing dynamics in the discipline while maintaining a commitment to meet accreditation standards and offer students instruction that meets market expectations and needs, all while stimulating learners to pursue creative, new scholarly challenges [6,7].

Educational strategies to support and enhance instruction in PHI benefit from the advancement of instructional technology, which led to a variety of new modalities and contributed to a re-engineered perception of the field. Incorporating a case-based curriculum exposed students to a diverse set of experts, resulting in an improved understanding of the potential contributions to the health of the public that informatics is capable of making. The use of simulation technology fostered a new appreciation of the value of informatics tools in achieving standardization, and interoperability, while hands-on data experiences for students accelerated their perception of the major challenges that exist in attempting to achieve standardization and interoperability. Despite the difficulties, these learning modules reinforced how essential both elements are for the successful advancement of PHI beyond the classroom. The incorporation of inter-professional hands-on population health informatics simulation training in which students generate, share, and analyze clinical data within a fictitious ACO using a shared data model, further reinforced the value of incorporating state of the art practices into the curriculum.

Whether PHI training is offered within an informatics program or as part of a public health program, the key goal is to use systems and methods from information science, statistics and computer science, and apply these techniques to the practice of public health informatics. The objective is to provide a foundation for engineering data and information at the population level, and emphasizing within health systems, whether academic, governmental, or commercial, the need to learn how to collect, store, manage, analyze, apply, and share information to improve population health outcomes [17]. This is one of the most important skill sets to be achieved by learners. Public

health programs remain challenged to instill an interest in developing informatics skills among their students at all levels of training.

Of preeminent importance to this discussion is the need to achieve standards that will meet the accreditation requirements and competencies established by CEPH, CAHIIM, and CIB for various public health and informatics programs, and to cultivate students who are capable of delivering excellence in practice, research, education, and service.

CONCLUSIONS

While challenges continue to face public health informatics educators, we remain vigilant in our goal to overcome the obstacles to train the next generation of PHI professionals to access, use, analyze, apply and share data to improve the health of the public [17]. We are further committed to educating the public on the value and contributions of informatics methods and strategies to strengthen public and population health efforts in public agencies and private health systems. An ongoing focus on incorporating analytical approaches in artificial intelligence, machine learning, data visualization, and information exchange, will support the development of advanced research in the domain of public health informatics.

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COMPETING INTERESTS

The authors have no competing interests to report.

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