The Full Spectrum of Biomedical Informatics Education at Oregon Health & Science University*

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Summary

Objectives: The growing use of health information technology in operational settings, along with the maturation of the discipline of biomedical informatics, requires reorganization of educational programs in the field. The objective of this paper is to provide a context and description of the biomedical informatics education program at Oregon Health & Science University.

Methods: The details of the program are provided.

Results: The paper describes the overall program and its component curricula.

Conclusions: OHSU has developed a program that caters to the full spectrum of those who will work in the field, allowing education tailored to their career goals and needs. The maturation of Internet technologies also allow most aspects of the program to be delivered on-line. The informatics field must step up to the challenge of educating the best workforce to achieve our goals for the optimal use of HIT.

Keywords

Medical informatics, bioinformatics, health and biomedical informatics, education, distance learning

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Introduction

The educational programs in biomedical informatics at Oregon Health & Science University (OHSU) are based on a foundation of the "full spectrum" of informatics [1]. Our education and research programs in informatics span the spectrum described by Shortliffe [2] from the cell and molecular (bioinformatics) to the patient (medical informatics) to the population (public health informatics) level. We consider our core discipline to be (unqualified) informatics, which is the field concerned with the intersection of people, information, and technology. This notion distinguishes informatics from computer science and the domain-specific disciplines. Informatics researchers and practitioners apply the principles of computer science and other disciplines in specific domains, such as public health, medicine, nursing, and cell and molecular biology.

An individual considering spending part or all of his working time in health and biomedical informatics may find the decision of what career path and/or educational program to choose somewhat daunting. This reflects the fact that a) informatics is still a maturing discipline, b) there is no standard curriculum, program accreditation, or individual certification, and c) the role of information technology (IT) in health and biomedicine is still evolving. Nonetheless, these are exciting times for the informatics field, with the growing recognition of the need for better use of IT in clinical settings [3] as well as biomedical research [4]. They also present considerable challenge for effective education in the field [5].

The Practice of Informatics

With the growth of health IT (HIT) use has come redefinition of informatics practice [6]. We agree with the general categories outlined by Covvey et al., who attempted to define job competencies for different types of practice [7]. Their categories included academic/research and applied/professional practitioners (along with the competencies needed for clinical and biomedical research practitioners, which we omit from this discussion). We believe there is an additional category of practice seen increasingly in clinical settings, which is the local expert or liaison who provides a bridge between the IT staff and clinical users, representing the user community. An increasing amount of research points to the value of user engagement in the success of HIT projects [8, 9]. Table 1 shows these categories with a description of their focus and sample job titles.

We acknowledge that the lines between these categories are fuzzy. The informatics leader at a large medical center may well need (or desire) the breadth of training of an academic informatician. Likewise, the local expert in a community hospital or large clinical practice may also want to have additional training at or near the level of an informatics professional. The amount of expertise among the levels, especially between expert and professional, may really be more of a continuum, with the expert advancing to the professional level as his or her career develops.

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Building Blocks of the Curriculum

The programs at OHSU have been developed in a building-block fashion. That is, coursework completed at the basic levels can be carried forward to more advanced levels. While all of the programs at OHSU are currently at the graduate level, i.e., require a bachelor's degree, we are currently exploring undergraduate educational programs. Figure 1 shows an overview of our programs in the context of the building-block approach. Students can enter at any level but always have the option of carrying coursework forward to the next level.

Another recent development at OHSU is the establishment of two "tracks" for all of our degree programs. The original curriculum, with its focus on clinical informatics, has become the medical informatics track, while a new track focused on computational biology has become the bioinformatics track. Congruent with our view that both medical informatics and bioinformatics are part of the larger biomedical informatics field, there is overlap in curriculum and student interaction across the tracks.

The core of the curriculum of our master's and PhD programs is the "knowledge base". This core plus a master's thesis or capstone comprise our master's degree, while additional courses in advanced research methods, a cognate area, and a dissertation comprise our PhD curriculum. The knowledge base is organized around several domains as shown in Figure 2. Each domain has one or a few required courses, a group of courses from which a specified number of credits are required (which we call *k of n*), and pure electives. Students may take additional electives outside the domains as long as they are graduate-level courses of some relevance to informatics.

OHSU is also committed to distance learning [10]. We have successfully offered most of our courses and programs on-line for a half-decade. Our program has evolved to the point where on-line and on-campus offerings are considered equivalent and not distinguished on a student's transcript. Distance learning does not mean "distant" learning. We have standardized on a number of technologies that provide high-quality and interactive education. Our courses are not correspondence courses, and require students to keep up with the rest of the class so they can interact in on-line discussion and other activities. Almost all of the course activities, however, are asynchronous, meaning that students can access the material on their schedule as long as they keep up with the overall class.

Individual Programs

The introductory-level program at OHSU is the 10 × 10 Program. Run in partnership with the American Medical Informatics Association (AMIA), this program aims to train individuals at the expert/liaison level. The 10 × 10 moniker comes from a goal to train 10,000 health care professionals in the United States by the year 2010 in basic informatics so they can be local experts representing users in their communities. This course, which is administered by AMIA, is an adaptation of the introductory course in the basic curriculum, with an addition of a 1-2 day in-person session covering additional material in an interactive manner. The course can be used for subsequent credit in the other OHSU programs pending acceptance into the program and successful completion of the course's final examination (which is not required in 10 × 10).

The remainder of the programs are run from OHSU. The Graduate Certificate program focuses on the core of biomedical informatics. After the introductory course (which can be taken directly at OHSU or via the 10 × 10 program), students take more advanced courses in areas such as clinical

Table 1 Categories of informatics practice (adapted from [7]).

Level of Practice	Type of Work	Example Job Titles
Academic/Research	Individual who does research and/or teaching in an academic center	– Professor – Scientist
Applied/Professional	Individual who works in an operational informatics setting for a majority of his or her working time	– Chief Information Officer – Chief Medical or Nursing Officer – Project Manager – Developer – Trainer
Expert/Liaison	Individual who spends part of his or her working time as a local expert and interface with informatics or information technology professionals	– Chief Medical or Nursing Officer – Clinical IT Liaison

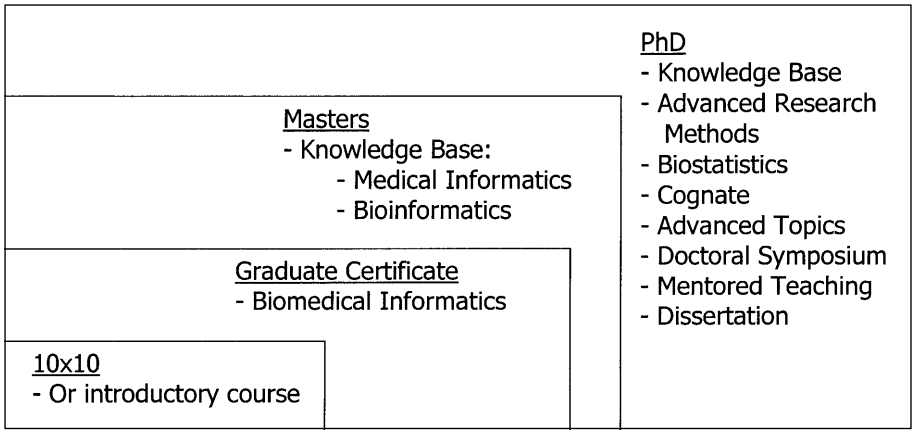

Fig. 1 Building blocks of the OHSU informatics program.

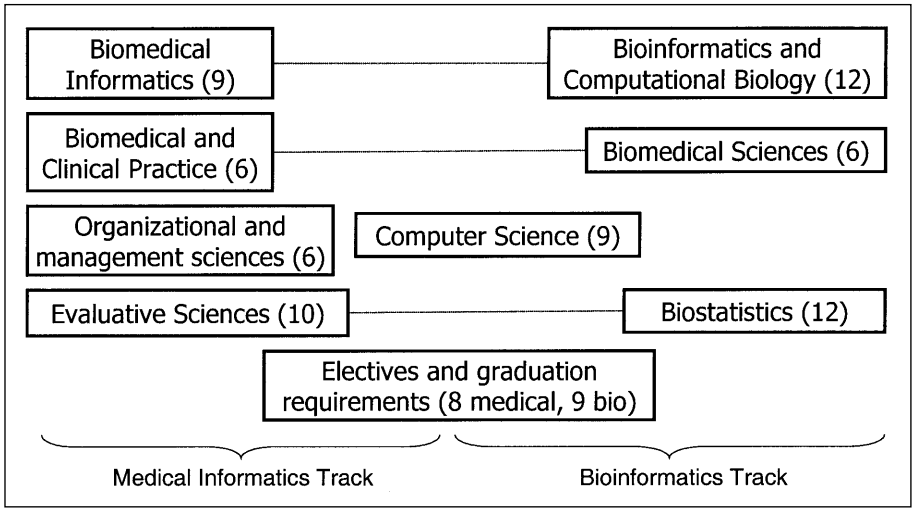

Fig. 2 Domains for the medical informatics and bioinformatics tracks in knowledge base of curriculum. The Computer Science domain is part of both tracks. Number of credits in parentheses.

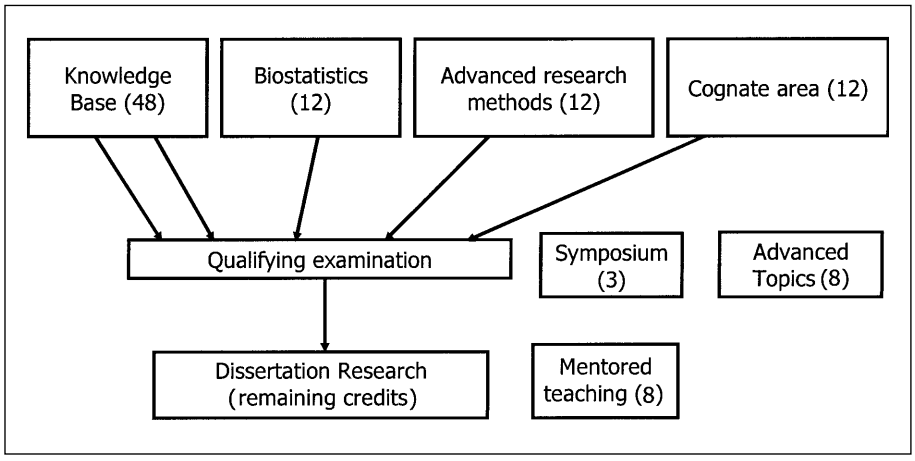

Fig. 3 Components of the OHSU PhD curriculum. Number of credits in parentheses.

systems, information retrieval, and organizational behavior and management. They can also take additional electives as well as pursue practicum projects in their own communities. The Graduate Certificate program requires eight one-quarter (11-week) courses, for graduation.

OHSU offers two master's degree programs, which differ only in their culminating project. The Master of Science (MS) in Biomedical Informatics requires a master's thesis, while the Master of Biomedical Informatics (MBI) is a "professional master's" and requires a less-intensive capstone project. The remainder of the curriculum come from the domains described above. Students can either enter the master's degree programs directly or by advancing from the 10 × 10 or Graduate Certificate programs. Both programs are available on-campus or via distance learning. Students in either program can mix or match on-line or on-campus courses.

The PhD program is a purely on-campus program, although PhD students can take individual courses that are offered on-line. Consistent with the building-block approach, courses taken at lower levels of study are part of the PhD program "knowledge base" and can be carried forward into the program. The PhD program requires additional courses in advanced research methods, a cognate area, and a doctoral seminar, culminating in a dissertation based on independent research (see Fig. 3). All PhD students are supported with a tuition waiver and stipend from a training or research grant.

The 10 × 10 program is administered by AMIA. The Graduate Certificate program has rolling admissions, i.e., students are admitted any quarter to begin classes the following one. The master's and PhD programs, however, only have admissions once a year to begin in the fall quarter. More information about the programs can be found at: http://www.ohsu.edu/dmice/education/

OHSU also offers a fellowship program funded by training grants from the National Library of Medicine (NLM) and Veteran's Administration (VA). Three types of fellowships are available from the NLM training grant:

- predoctoral – stipend and tuition support for some students in the PhD program;
- postdoctoral – for those with doctoral (e.g., MD or PhD) degrees who seek advanced training, with or without a degree (although most pursue a master's degree);
- librarian – a sabbatical-like opportunity for librarians seeking advanced training in informatics, with the option of a degree (typically the master's degree)

The VA fellowship is for postdoctoral clinicians only and has a clinical service component.

The growing use of IT in health and biomedicine has increased the demand for informatics education. One challenge we have is giving students advice on career development and advancement in a field that is only beginning to mature. There are still few jobs that absolutely require a degree in informatics, although we hope this will change in the future. Our programs attract students from a variety of backgrounds, from physicians to other health care professionals (e.g., nurses, pharmacists, etc.) as well as those without any formal health care background at all.

How do our students fare in employment? A general observation has been that what individuals do when they complete the

program is a function of what they did before they entered. So physicians and nurses likely end up in roles that draw on their clinical backgrounds, while those with more of a technology background will end up in roles that draw on that knowledge and skill set. Over time, we hope to see greater emphasis on career development and professional growth issues in the informatics field. This is likely to emerge as the growth of IT applications in health and biomedicine continues and the need for professionals to develop and implement systems increases.

Conclusion

With the growth of IT use in health and biomedicine comes the need for additional people trained in informatics. OHSU has developed a program that caters to the full spectrum of those who will work in the field, allowing education tailored to their career goals and needs. The maturation of Internet technologies also allows most aspects of the program to be delivered on-line. The informatics field must step up to the challenge of educating the best workforce to achieve our goals for the optimal use of HIT.

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