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Research and Education

The Full Spectrum of Biomedical Informatics Research and Education at OHSU

Abstract: Although the biomedical informatics field is small relative to others in the life and health sciences, the breadth of subject domains, types of research, and occupations is vast. The biomedical informatics program at Oregon Health & Science University exemplifies the breadth in the field. At the center of our full spectrum of activities in informatics, however, is a core philosophy of the discipline that drives our research, educational, and other programs.

Introduction

The Department of Medical Informatics & Clinical Epidemiology (DMICE, http://www.ohsu.edu/dmice) is one of 25 academic departments in the Oregon Health & Science University (OHSU) School of Medicine. As with most academic departments, DMICE engages in a variety of research, educational, and service activities. The department has three "rings" of faculty: a core of 15 faculty with primary appointments in the department, another 24 faculty from OHSU whom have primary appointments in other departments and schools, and 22 faculty external faculty who come from the ranks of companies, health care systems, and academic institutions in the Portland area. All faculty have some form of advanced training or expertise in informatics or clinical epidemiology.

The coupling of the fields of medical informatics and clinical epidemiology in an academic department is not common and may be unique. Although the pairing arose from an artifact of our institutional history, in that both groups matured on the same floor of a single building, the combining of the two fields has actually produced synergistic benefits. Certainly the optimal practice of clinical epidemiology requires advances in information systems led by informaticians. Likewise, the needs of clinical epidemiologists and others who rely on data that is usually generated for other purposes (typically patient care) are effective drivers for the work of biomedical informatics.

History

DMICE arose out of funding to OHSU from an Integrated Advanced Information Management Systems (IAIMS) grant from the National Library of Medicine (NLM) [1]. The establishment and growth of OHSU's informatics program reflected one of the major goals of the "first generation" IAIMS program, which was the development of academic informatics programs. At its inception, the informatics program at OHSU was part of the Biomedical Information Communication Center (BICC) [2]. As with most IAIMS programs, the BICC aimed for more than just academic achievement, as it became the medical information leader for the state of Oregon [3, 4].

The original director of the BICC was J. Robert Beck, MD, who served from 1989 until he left OHSU in 1992. At that time, the Provost of OHSU, Lesley Hallick, PhD, became the acting director of the BICC, while Kent Spackman, MD, PhD, assumed the leadership of the BICC's academic unit, the Division of Health Informatics. Also occurring at that time was the merger of the two formerly separate information technology (IT) departments, one for the academic side of the university and the other for its clinical operations. These were merged into one with continued involvement of the informatics program [5].

As with the rest of the BICC, OHSU's academic informatics program grew and prospered throughout the 1990s. This began in 1992, when OHSU become one of the then-dozen institutions with informatics training grants from the NLM. As with

most training programs at the time, formal coursework was scattered and not a requirement of trainees. However, a recognition of the need to develop more formal learning activities, based on the growing knowledge base of the field, led us to develop courses and degree programs. In 1996, the doors opened to our first degree program, the Master of Science in Medical Informatics. During this time, the number of research grants and publications climbed steadily as well.

While under the auspices of the BICC, the informatics program operated more as an independent center than a traditional academic unit. Faculty had their formal academic appointments elsewhere, typically in the departments that represented either their clinical background or where they administered their research. As our research and education programs matured, there was a growing view that the academic arm of the BICC should be organized into a more formal academic structure.

The approach taken had been used by a number of other new disciplines at OHSU over the years, such as Medical Genetics and Emergency Medicine. This was the formation of a "free-standing division," which was called a "division" but was not formally part of any department. It was essentially an entity that acted like a department, with its own budget and promotion & tenure process. However, being a free-standing division was viewed as an interim status, with the unit ultimately to become its own department or a part of another one. As such, the Division of Medical Informatics & Outcomes Research (DMIOR) was formed in 1997, with myself appointed as Head by the Dean. This was consistent the IAIMS-driven vision of the program [6].

The DMIOR designation enabled the program to flourish [7]. During this time, we established our well-known distance learning program [8]. As a formal academic unit, we were able to take our place in the academic community of the institution. Although we were initially conservative about putting up faculty for promotion, which required approval from the School of Medicine Promotion & Tenure Committee, we have to this day a 100% success rate at academic promotions.

By early in the current decade, however, we longed for a more permanent status. We believed that the interim period had demonstrated the viability not only of our disciplines, but also our ability to run an academic unit. In 2003, we were given departmental status and renamed the Department of Medical Informatics & Clinical Epidemiology (DMICE), with the Dean appointing me as Chair. Ironically, other than a change of name, stationary, Web site, etc., the day-to-day activities of the program were virtually the same. But the name change was vitally important, giving us the recognition of a more permanent stature in the institutional community. In this day and age, nothing is completely permanent in medical schools, but our department is now well integrated into the operation of the university and respected among academic peers.

Research Activity of DMICE

Although the DMICE educational programs require a substantial time commitment from the faculty, we are strongly committed to research. We certainly maintain the philosophy that educators at the graduate level must be accomplished experts in the areas in which they teach. As such, all DMICE faculty lead research programs, some of them substantial in terms of time and funding.

Like most informatics programs, the research activities of DMICE reflect a broad spectrum of research in the field that are driven by the interests and accomplishments of individual researchers. Although most prominent in the area of medical (clinical) informatics, we also carry out research across the full spectrum of informatics, including bioinformatics, consumer health informatics, and public health informatics. Despite the diversity of research areas, there are a number of underlying threads throughout our activities. Most prominent among them are a focus on evaluation and the related area of usability. Although we are as enthusiastic as any informaticians about technology, we view it essential that informatics applications be properly evaluated in their intended settings for their intended uses.

One area of research strength emanates from my own research in information retrieval, which focuses on access to knowledge-based information [9]. Although focused initially on the development of systems and their evaluation for clinicians [10], recent work has shifted to the bioinformatics side [11]. This shift demonstrates, in my opinion, that bioinformatics and clinical informatics have considerable core similarities. Yes, the two fields work with different types of data and different users, but many of the underlying principles, such as the need for usability, standards, and so forth, are the same.

Another major focus at OHSU is qualitative research and related work in the use of information and tools in context. Joan Ash is well known for her work in the adoption of computerized physician order entry [12] and the unintended consequences of health care IT systems [13]. Paul Gorman has done work looking at information use and seeking by health care professionals [14]. Other areas

of research at OHSU include:

- SNOMED [15]
- Bioinformatics [16, 17]
- Patient decision-making [18, 19]
- Accuracy of menu-driven data entry systems [20, 21]

Although this review of research has focused on the informatics side of DMICE, we cannot ignore the complementary research accomplishments of our clinical epidemiology colleagues. Much of their research is focused on systematic reviews (sometimes called evidence reports). DMICE houses one of the 13 Evidence-Based Practice Centers (EPCs) funded by the Agency for Healthcare Research & Quality (AHRQ). Their many reports have been published in a variety of top medical journals, including *Annals of Internal Medicine* and *Journal of the American Medical Association*.

Of course, the direct proximity of the clinical epidemiology faculty has provided opportunities for collaboration. For example, when AHRQ released a call for an evidence report on the efficacy of telemedicine, the DMICE EPC was well-suited due to its nearby informatics expertise [22, 23]. Another project from the clinical epidemiology faculty but with strong informatics aspects is the Clinical Research Outcomes Initiative (CORI) [24]. CORI provides a sold informatics application (gastrointestinal endoscopy reporting, with aggregation of data across patients and sites) that feeds clinical epidemiologic studies.

Informatics Education in DMICE

Like many research-oriented graduate programs, we initially viewed our educational programs as aimed at a small cadre of research-oriented students who would go on to become researchers similar to us. Along the way, however, we discovered that there was a need for more than just researchers in the field, and our students led us to discover the need (and a marketplace) for a curriculum to meet the needs of those interested in applied or professional informatics. We also developed an interest and enjoyment in teaching informatics skills to clinicians, who were enthusiastic about the new technology but not skilled enough to take advantage of it in their practices.

Years after we undertook these different levels of education, an analysis of roles and skills of informaticians was published by Covvey et al. [25, 26], providing a framework for us to better organize our educational activities. As shown in Table 1, we have developed a full spectrum of informatics education programs designed to meet the needs of diverse groups. We share the views of Covvey et al. that it is essential to shape the education program based on the career goals of the student.

Our first educational program was our NLM-sponsored Postdoctoral Fellowship, which was awarded in 1992. When first awarded, our training grant was limited to postdoctoral fellows, since we did not have a doctoral program that could accommodate predoctoral fellows. Postdoctoral fellows could still take courses at OHSU and other local universities, and even obtain degrees such as a Master of Public Health. But it was clear that our growth as an academic program required us to have formal coursework and degree options, especially as the informatics field was developing its own base of knowledge, scientific literature, and experience.

We decided to make our first degree program a Master of Science. Planning for the degree began in 1994, with the program matriculating its first students in 1996. Our original conception of the program was that it would be a small program of 4-6 students per year that aimed, like most programs in existence at the time, to produce informatics researchers who would assume faculty positions at academic institutions. Along the way, however, our students changed our thinking. With the maturation of informatics and its

Table 1. Categories of informatics practice and education

Category	Types of Jobs
Research/Academic	- Informatics researcher and/or te
Applied/Professional	- Chief Information Officer - Chief Medical/Nursing Informat Officer - System Developer - Trainer
Practical/Clinical	- Health care professional - Biomedical researcher

applications, there were many students who did not desire to be researchers, but instead aimed to work at the applied/professional level. We also received many more applicants, and ended up enrolling many more students, than we originally anticipated.

Another change brought about by student demand was the development of our distance learning program. As the program became established, we received inquiries from many individuals who wanted to study medical informatics but not leave their current jobs. We started our distance learning program with the migration of individual courses into a Web-based framework. We quickly found, however, that not only was their great demand for these courses, but that this new mode of teaching was enjoyable and well-received [8]. This led us to develop our next education program, the Graduate Certificate Program, which was a subset of our master's program that contained the essential core courses of that curriculum.

Distance learning is not the only innovation in our program. We have always recognized the need for professionals in the field, even those who aspire to become researchers, to understand the impact of the larger world upon technology as well as to obtain real-world experience. For this reason, our curriculum has included courses in organizational behavior and management as well as provided the opportunity for practica and internships.

The confluence of two additional issues led to the development of our next degree program, the Master of Biomedical Informatics. One of these issues was the fact that some of our students, no matter how bright or motivated, had difficulty completing a master's thesis. They enjoyed and did well in courses and completed projects, but just had difficult conceptualizing and implementing a year-long research project. The other factor leading to the second master's degree was the desire of some distance learning students to be able to go beyond the Graduate Certificate and obtain a full master's degree. Most of them were applied/professional-oriented as well and we did not necessarily desire to complete a master's thesis. So we developed this second master's degree program that was otherwise identical to the Master of Science but replaced its thesis with a smaller capstone project.

Although our educational programs grew in the applied/professional direction, we never lost sight of meeting the needs of students who did want to become researchers and/or leaders in the field. For this reason, we pursued our early but delayed goal of implementing a Doctor of Philosophy (PhD) program. The PhD program matriculated its first students in 2003. As the first cohort of students came from the ranks of our master's program, we anticipate graduates earlier than might be expected if students were starting from the beginning.

Another guiding approach for all of our graduate programs has been a building-block approach that allows courses taken in one program to apply to others. One way to look at our program is that the courses in the master's degree program constitute the essential knowledge base of graduate education in the field. Since informatics is an integrative discipline, this includes courses in other fields, such as computer science, statistics, research design, organizational behavior, project management, and biomedical sciences. Our Graduate Certificate program is a subset of this knowledge base that contains the essential core of informatics without the related courses. Our PhD program is a superset that adds advanced research methods, a cognate area of study, and a dissertation to the core knowledge base.

We call our programs "full-spectrum" because they deal with the many dichotomies of informatics education. One such dichotomy is bioinformatics vs. medical informatics. Our view is that both branches of informatics are guided by similar underlying principles and our foundational courses take this approach, with more specialized courses providing coverage of specific areas. Another dichotomy is research vs. applied informatics. We take the view that the knowledge base of the master's program is the essential core for both groups, with those desiring to become researchers obtaining additional training from either their prior background (e.g., an MD or PhD degree) or our PhD program. An additional dichotomy is on-campus vs. on-line learning. From our initial embrace of distance learning, we aimed for content to be as similar as possible for the two modalities. As we incorporated more technology into on-campus learning, we found that the distinction between the two has been blurring. We also have increasing numbers of on-campus students who enjoy the convenience of asynchronous learning. We strongly note, however, that our on-line learning experiences are not mere correspondence courses, and in fact that students value what is probably greater interactivity (through discussion boards and virtual groups) of the on-line courses.

A final dichotomy is physician vs. non-physician orientation. Although the largest single demographic group in our program is physicians, there are individuals from many other backgrounds. We are cognizant of the needs and backgrounds of all groups and are sure to accommodate them. We remind all students from the beginning that what one does after

graduation is strongly influenced by his or her background upon entering the program. Physicians and other health care professionals usually take jobs that draw on their clinical background, such as a chief medical information officer or nurse informatician. But there are plenty of roles for non-clinicians, who have been able to use their knowledge of biomedicine gained in the program to be more competitive for jobs in hospitals, companies, and academia.

Our informatics education activities do not ignore the third group in Covvey et al.'s classification, which includes health care professionals and biomedical researchers who use informatics tools in their daily work. We have developed a number of continuing education courses for a variety of users from clinicians to librarians to biomedical researchers. Our longest standing effort has been an annual two-day continuing medical education (CME) course for clinicians attended mainly but not exclusively by physicians. Components of this course have been extracted out for shorter courses and re-oriented to reflect specific clinical disciplines, such as physician assistant studies [27]. A subset of our introductory bio-informatics course has proved very popular with biomedical researchers who increasingly use bioinformatics tools in their research activities.

Future Directions

These are exciting times for biomedical informatics. With the growing call for improvements in health care to be led by medical informatics applications, and the increasing role of bioinformatics in biomedical research discoveries, there are many opportunities for the field. As such, it is crucial for academic programs to step up their activities, not only in blazing the trail through research, but also training the researchers and professionals who will lead and implement in the future. At OHSU, we are dedicated to addressing the full spectrum of this challenge.

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