Competencies and Curricula Across the Spectrum of Learners for Health Informatics

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References


Hersh, W., 2006. Who are the informaticians? What we know and should know. J Am Med Inform Assoc 13, 166–170. https://doi.org/10.1197/jamia.M1912


Safran, C., 2009. Informatics training for clinicians is more important than hardware and software. Yearb Med Inform 164–165.
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Outline

• Overview of field in context of education
• Competencies for health informatics
• Some curricular activities
• Future directions
Health informatics in context of education

• An interdisciplinary field requiring some level of knowledge and skills in
  – Biomedicine
  – Healthcare
  – Computer science (CS)
  – Math
  – Data science
  – Machine learning (ML)

• With practitioners/professionals at different levels
  – Researchers
  – Developers
  – Implementers
  – Users
    • Clinicians
    • Consumers/patients/citizens

Informatics is not just the sum of math, CS, biomedicine, healthcare, etc.

• While no single aspect of informatics is impertinent to any other field, the interactions of them give rise to unique aspects
• Despite interdisciplinary nature of field, there are unique aspects
• Friedman
  – Fundamental Theorem (2009)
  – What Is and Isn’t Informatics (2013)
• Differences from data science (Payne 2018)
Some of my writings along the way

- Who are the informaticians? (JAMIA, 2006)
- A stimulus to define informatics (BMC, 2009)
- Workforce estimates and demands (ACI, 2010)
- Competencies for medical education (APME, 2014)
- A passion and a calling (IMIA History Book, 2021)

Many learners, with needs and activities

- Informaticians
- Clinicians
- Researchers
- Patients/Consumers/Citizens

- And students in all of the above
Competencies of informatics professionals – over a decade of work

- Core content of clinical informatics (Gardner, 2009)
- IMIA educational recommendations (Mantas, 2010)
- Core competencies for graduate education in biomedical informatics (Kulikowski, 2012)
- Foundational domains of applied health informatics (Valenta, 2018)
- Domains, tasks, and knowledge for clinical informatics subspecialty practice (Silverman, 2019)
- Domains, tasks, and knowledge for health informatics practice (Gadd, 2020)
- UK Clinical Informatics Core Competency Framework (Moulton, 2020)

AMIA informatics practice workforce analysis

<table>
<thead>
<tr>
<th>Health Informatics</th>
<th>Task statements</th>
<th>KS statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain 1. Foundational Knowledge and Skills</td>
<td>NA</td>
<td>31</td>
</tr>
<tr>
<td>Domain 2. Enhancing Health Decision-making, Processes, and Outcomes</td>
<td>11</td>
<td>21</td>
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<tr>
<td>Domain 3. Health Information Systems</td>
<td>26</td>
<td>36</td>
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<tr>
<td>Domain 4. Data Governance, Management, and Analytics</td>
<td>17</td>
<td>28</td>
</tr>
<tr>
<td>Domain 5. Leadership, Professionalism, Strategy, and Transformation</td>
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<td>28</td>
</tr>
<tr>
<td>Total</td>
<td>74</td>
<td>144</td>
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<table>
<thead>
<tr>
<th>Clinical Informatics Subspecialty (CIS)</th>
<th>Task statements</th>
<th>KS statements</th>
</tr>
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<tbody>
<tr>
<td>Domain 1. Foundational Knowledge and Skills</td>
<td>NA</td>
<td>26</td>
</tr>
<tr>
<td>Domain 2. Improving Care Delivery and Outcomes</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td>Domain 3. Enterprise Information Systems</td>
<td>16</td>
<td>33</td>
</tr>
<tr>
<td>Domain 4. Data Governance and Analytics</td>
<td>10</td>
<td>27</td>
</tr>
<tr>
<td>Domain 5. Leadership and Professionalism</td>
<td>9</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
<td>142</td>
</tr>
</tbody>
</table>

(Silverman, 2019; Gadd, 2020)
Fundamental knowledge and skills

- Fundamental knowledge and skills that provide health and clinical informaticians with a
  - Common vocabulary
  - Basic knowledge across all informatics domains
  - Understanding of the environment in which they function, including
    - Individual health
    - Healthcare
    - Public health
    - Research

Role for individual certification?

- Probably more important for implementers than researchers
- Board certification of physicians is important
  - Clinical informatics certification is recognition of field; probably more important for younger entrants
- Role/value of AMIA Advanced Health Informatics Certification (AHIC) – TBD

(Valenta, 2018)
Deeper dive into specific curricula

- OHSU Biomedical Informatics Graduate Program
- Introductory course – including 10x10
- Applied machine learning for clinical informatics students
- Others who “do” informatics and must have competence

OHSU Biomedical Informatics Graduate Program

- Among oldest and largest programs in field – since 1996
- Two majors (formerly tracks)
  - Health & Clinical Informatics (HCIN)
  - Bioinformatics & Computational Biomedicine (BCB)
- Degrees and certificates
  - PhD
  - Master of Science – with and without thesis
  - Graduate Certificate (HCIN only)
- Two fellowships
  - NLM T15 Training Grant
  - Clinical Informatics Subspecialty
- Early adopter of distance learning (in HCIN)
OHSU biomedical informatics core curriculum domains

<table>
<thead>
<tr>
<th>High-Level Competency</th>
<th>Domain Names for Health &amp; Clinical Informatics (HCIN)</th>
<th>Domain Names for Bioinformatics &amp; Computational Medicine (BCB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply core concepts of using data, information, and knowledge to advance health and biomedicine</td>
<td>Health &amp; Clinical Informatics</td>
<td>Bioinformatics &amp; Computational Biomedicine</td>
</tr>
<tr>
<td>Apply knowledge of appropriate area(s) of health and biomedicine to informatics practice and research</td>
<td>Health Care</td>
<td>Biomedical Science</td>
</tr>
<tr>
<td>Apply computing skills to biomedical informatics</td>
<td>Computer Science</td>
<td>Computer Science</td>
</tr>
<tr>
<td>Apply quantitative methods to biomedical informatics</td>
<td>Evaluative Sciences</td>
<td>Biostatistics</td>
</tr>
<tr>
<td>Apply people and organizational knowledge to informatics</td>
<td>Organizational Behavior and Management</td>
<td>N/A</td>
</tr>
<tr>
<td>Apply advanced scholarship to biomedical and health informatics</td>
<td>Thesis/Capstone/Dissertation Requirements</td>
<td>Thesis/Capstone/Dissertation Requirements</td>
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Program has “building block” approach

<table>
<thead>
<tr>
<th>PhD</th>
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<tbody>
<tr>
<td>Knowledge Base</td>
</tr>
<tr>
<td>Advanced Research Methods</td>
</tr>
<tr>
<td>Biostatistics</td>
</tr>
<tr>
<td>Cognate</td>
</tr>
<tr>
<td>Advanced Topics</td>
</tr>
<tr>
<td>Doctoral Symposium</td>
</tr>
<tr>
<td>Mentored Teaching</td>
</tr>
<tr>
<td>Dissertation</td>
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</table>

<table>
<thead>
<tr>
<th>Master of Science</th>
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</thead>
<tbody>
<tr>
<td>Knowledge Base:</td>
</tr>
<tr>
<td>Health &amp; Clinical Informatics</td>
</tr>
<tr>
<td>Bioinformatics &amp; Computational Biomedicine</td>
</tr>
<tr>
<td>Thesis or Capstone/Internship</td>
</tr>
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<table>
<thead>
<tr>
<th>Graduate Certificate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomedical Informatics</td>
</tr>
<tr>
<td>Organization and management</td>
</tr>
</tbody>
</table>

http://www.ohsu.edu/informatics-education
**Places and numbers**

![Map of the United States](image1)

International students from: Argentina, Singapore, Egypt, Israel, Saudi Arabia, Zimbabwe, Thailand, China, South Africa, and others

<table>
<thead>
<tr>
<th>Degree</th>
<th>Total</th>
<th>BCB</th>
<th>HCIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grad Cert</td>
<td>483</td>
<td>0</td>
<td>483</td>
</tr>
<tr>
<td>MS</td>
<td>422</td>
<td>71</td>
<td>351</td>
</tr>
<tr>
<td>PhD</td>
<td>38</td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>943</td>
<td>86</td>
<td>857</td>
</tr>
</tbody>
</table>

**Introductory course**

- Have always enjoyed introducing people to informatics within and outside of field

- Initial effort was graduate-level course
  - 1993 – overview course for Master of Public Health (MPH) Program, PH 549
  - 1996 – became entry course for Master of Science in Medical Informatics Program, MINF 510
  - 2001 – changed prefix when program name changed to Biomedical Informatics, BMI 510
Then came “10x10”

- [https://dmice.ohsu.edu/hersh/10x10.html](https://dmice.ohsu.edu/hersh/10x10.html)
- Started when Dr. Charles Safran, former AMIA Chairman, stated need to train one physician and one nurse from each of America’s 6,000 hospitals in informatics (Safran, 2005)
- Original aim to train 10,000 individuals in informatics by the year 2010 (Hersh, 2007)
  - OHSU is largest and most successful offering, with 1000 completing program by end of 2010 and over 3000 by 2022
  - Program continued beyond 2010 based on continued interest and need in US and abroad
  - About 10-15% pursue graduate study, mostly at OHSU

10x10 – milestone of 3000 by 2022
Also translated into Spanish and delivered in Latin America (Otero, 2010)

Lineage and offshoots

BMI 510
Introductory course in OHSU Biomedical Informatics Graduate Program

PHE 427
Subset for PSU Health Studies undergraduates

ONC HIT
Subset for ONC Health IT curriculum

10x10
AMIA standalone continuing education course

HIP 520
Subset for clinical and translational research trainees

BD2K
Subset for NIH Big Data to Knowledge modules
Other numbers – mid-2022

- BMI 510 and predecessors – 1598 since 1996
- Other customized offerings – Mayo Clinic, Kaiser Permanente, Bangkok Hospital, H3ABionet
- Course for medical students early in pandemic – 222 students from 17 medical schools in early-mid 2020
  – Still available to OHSU medical students as an elective

Portions of course material adapted for

- Curriculum development projects
  – ONC Health IT Curriculum
  – BD2K
  – Bridge2AI (?)
- Other courses
  – Undergraduate course in public health program at Portland State U, PHE 427
  – Introductory course for OHSU Human Investigations Program, HIP 520
Content of introductory course

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Overview of Field and Problems Motivating It</td>
</tr>
<tr>
<td>2</td>
<td>Computing Concepts for Biomedical and Health Informatics</td>
</tr>
<tr>
<td>3</td>
<td>Electronic and Personal Health Records (EHR, PHR)</td>
</tr>
<tr>
<td>4</td>
<td>Standards and Interoperability</td>
</tr>
<tr>
<td>5</td>
<td>Data Science and Artificial Intelligence</td>
</tr>
<tr>
<td>6</td>
<td>Advanced Use of the EHR</td>
</tr>
<tr>
<td>7</td>
<td>EHR Implementation, Security, and Evaluation</td>
</tr>
<tr>
<td>8</td>
<td>Information Retrieval (Search)</td>
</tr>
<tr>
<td>9</td>
<td>Research Informatics</td>
</tr>
<tr>
<td>10</td>
<td>Other Areas of Informatics</td>
</tr>
</tbody>
</table>

Teaching modalities

- **Lectures**
  - Voice over Powerpoint – many tools over the years; currently use just Powerpoint exported to MP4
  - Units broken down into 5-8 segments of 20-30 minutes duration
  - Served via Echo360 allowing viewing on computer and mobile devices
  - Also provide PDF handouts of slides and references cited
- **Homework**
  - Multiple-choice questions that aim to apply material
- **Readings**
  - Optional readings from textbook mapped to units (Hoyt and Hersh, 2018)
Discussion forums

• Think of as an online classroom: Speak up, do not feel intimidated, and everyone has something to say
• Instructor “seeds” discussion with 1-2 questions but students encouraged to post their own, including asking about things they do not understand (rather than emailing, at least initially)
• Simple etiquette
  – Messages should be neither too short nor too long
  – Be constructive and respectful
  – Reply to messages in their respective threads
  – Do not copy and paste from Web sites; use own words and provide a link if desired
  – Do not discuss homework questions until one week after due date

Expectations of students

• Complete lectures
  – Course focus is on content in lectures but optional readings provide additional perspective
• Participate in discussion
  – Observe proper etiquette, but do not be afraid to speak up
  – Ask questions about anything unclear in lectures or reading materials
  – Challenge the instructor!
• Complete all assignments by due dates
  – Can occasionally be late but warned not to fall too far behind
Expectations for instructor (cont.)

- Create an environment of learning and objective inquiry
- Maintain high availability
  - I am there to serve; students are not wasting my time
  - Best method of initial contact is email
  - Can talk via video or phone as needed
- Lectures
  - Quality is very good but not perfect
  - I am not a talking head
  - I try to convey my view of informatics, getting into the details but never losing the big picture
  - One of my best compliments ever
    - “I like that Dr. Hersh pauses and makes mistakes and corrects himself ... It shows he is thinking about what he is saying instead of reading off a paper.”
- Discussion
  - I will read (and reply if appropriate) to all postings

Course in applied data science and machine learning for clinical informatics students

- Growing need for all to understand data science and ML beyond the “wranglers and modelers”
  - Including those without math and programming background for traditional ML courses
- Especially
  - Informaticians who implement and evaluate systems
  - Clinicians whose work will be impacted by them
  - Patients and consumers, especially those impacted by biased data and algorithms
- Elective now but likely to become a required course
New course for clinical informatics students with modest math and programming background

**Course Material**

- Broad Survey of Topics Related to the Machine Learning Model Lifecycle in Health Care

**Hands On Class Project**

(Concurrent with course material)

- Data Preparation (Python programming)
- Model Development (RapidMiner)

Future belongs to visual programming tools? Using RapidMiner, considering Orange
Course outline

• Overview of biomedical data science
• Overview of biostatistics, ML, and AI
• Critical assessment of machine learning literature – both development and implementation
• Introduction to data sources and programming languages
• Data preparation
• Data exploration
• Using RapidMiner: 6 ML algorithms (kNN, logistic regression, decision trees, random forest, support vector machines and simple neural networks)
• Model implementation
• Ethical considerations

Learning activities

• Weekly voice-over-Powerpoint lectures
• Readings
  – Hoyt and Muenchen, *Introduction to Biomedical Data Science*, Lulu.com, 2019
  – Selected articles
• Programming and modeling skills development
  – Weekly assignments in Python or RapidMiner
  – Necessary skill development for application to each phase of class project
Class project

- Longitudinal project starting early in course
- Choice among datasets
  - Synthea
  - NHANES
  - MIMIC
  - Or bring your own – with caveats
- Incrementally explore, develop model, and evaluate performance

Others who “do” informatics

- Physicians and medical students – first addressed by AAMC Medical School Objectives Project (1998)
- Patients – 58% of US adults look online for health information and 35% attempt to diagnose illness in that manner (Fox, 2013)
- Clinical and translational scientists (Valenta, 2016)
- Next-generation research scientists (Moore, 2019)
- Nurses (Forman, 2020)
Informatics and health professions education

• “Search engine as essential as stethoscope” for clinical practice (Glasziou, 2008)

• “Informatics training for clinicians is more important than hardware and software” (Safran, 2009)

• Health informatics is a “required skill for 21st century clinicians” (Fridsma, 2018)

• Competencies (Hersh, 2014; Hersh, 2020), curricula (Hersh, 2017), and challenges (Welcher, 2018)

OHSU MD clinical informatics curriculum

Strategies

• EHR from Day One
  – Routine part of learning, practice
  – Weekly case info in EHR

• “Boards or wards” mantra
  – Preclinical only if needed for the boards or the wards

• Tailor to weekly curriculum content
  – Relevant and necessary
  – EHR data, knowledge sources

• Blend material into weekly content
  – Cotton ball in water glass

• Spiraling – return periodically to build on earlier material

Methods

• Early lecture – Information is Different Now That You’re a Doctor
  – Incremental skill building

• Weekly Clinical Informatics Pearls
  – Clinical Skills Labs
  – Combine skills into clinical tasks

• Traditional large group lectures

• Embedding and stealth teaching

• Informatics assessments
  – Weekly homework
  – Simulation lab

• Clinical experiences applications
  – Telemedicine, population health

• Intersession focused activities
Parting words of wisdom

• No matter how focused your work in informatics (e.g., machine learning or NLP researcher), it is important to have big picture, e.g.,
  – Operations of healthcare system – good and bad
  – EHR – alert fatigue, burnout, etc.
  – Clinical decision support – benefits and shortcomings
  – Data standards and interoperability
  – Data and algorithm bias
• Likewise if you are an informatics “generalist,” still must understand what new methods and technologies aim to do, e.g., ML, AI, etc.

Parting words of wisdom (cont.)

• We must teach the right knowledge and skills to the appropriate audience
• We “own” the downsides to the EHR, biased data and algorithms, etc. – so we must teach about the good and bad
• Teaching is fun and rewarding!
Thank you!

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