# MS in Health Informatics PRAC Report – 2019-2020

**I. Program Summary**

The Program Review and Assessment Committee (PRAC) report focuses on the Master of Science (MS) in Health Informatics (HI) program, which is hosted at the Department of BioHealth Informatics at the School of Informatics and Computing, IUPUI. Health Informatics is the interdisciplinary field that studies and pursues the effective uses of biomedical data, information, and knowledge for scientific inquiry, problem solving and decision making, motivated by efforts to improve human health.

In January 2015, AMIA joined the Commission on Accreditation for Health Informatics and Information Management Education (CAHIIM) as an Organizational Member. The Health Informatics Accreditation Council (HIAC) was established and initially charged with revising the existing CAHIIM Curriculum Requirements document and the "Accreditation Standards for Masters' Degree Programs in Health Informatics." In 2019, the MS in HI program received accreditation by the Commission on Accreditation for Health Informatics and Information Management Education (CAHIIM) and approved by the American Medical Informatics Association (AMIA).

The discipline of health informatics exists at the confluence of three major domains: Health, Information Science and Technology, and Social and Behavioral Science. Graduate students from our program are expected to have working knowledge of these three domains as these domains define and affect the practice of health informatics. The graduate student is expected to demonstrate the knowledge, skills, and attitudes that exist in this most complex domain: Social, Behavioral, and Information Science and Technology Applied to Health.

The M.S. in HI degree program has a fully online and on-campus delivery modalities and two accelerated degree pathways from the B.S. in Health Information Management (HIM), as a 4+1 degree. Along with the MS, the program also supports 5 graduate certificate programs on (1) Clinical Informatics; (2) Public Health; (3) Health Information Management and Exchange; (4) Health Information Security; (5) Health Information Systems Architecture. Students in the MS HI program study and do research with faculty on areas such as:

- Clinical Informatics – the application of information technology in clinical practices
- Clinical Business Intelligence – the use of information in healthcare organizations to improve revenue, bring efficiencies and support decisions made by administrations and executives.
- Health Information Management – the storage, processing, reporting and management of health information
- Public Health Informatics – the application of information technology for public health

In the 2018-2020, two new HI tenure-track Assistant Professors joined the BHI Department, and one full-time Professor of Practice, to bolster student research advising potential in Health Informatics Master of Science Program, including more support for students interested in thesis completion.

The Health Informatics program is a relatively new interdisciplinary field and focuses on translational research that uses computational approaches to transform health data into scientific discoveries that help us better understand the life science and improve patient care. No national ranking for such a program exists because of its degree of specialization.

**II. PURPOSES, REPUTATION, ASPIRATIONS:**

*Estimate of the program's national ranking based upon numbers of graduates, subsequent placement of graduates, level of support, or other criteria appropriate to the discipline.*

The M.S. in Health Informatics is a 36-credit-hour program that integrates multidisciplinary knowledge that affects the health, safety, and effectiveness of those working and being cared for within the system of health care delivery. The MS in HI program and the feeder BS in HIM program are both accredited by CAHIIM, which is a unique BS-MS-PhD pathway that is among only 5 other fully accredited programs in the nation. Along with the BS in Biomedical Informatics program, the pathway program is unique in the Midwest and in the nation. Much of our competencies and program learning outcomes are defined by our accreditation body (CAHIIM), but we have some customizations to the program, as a majority of our incoming students come from an undergraduate health sciences background such as medicine, dentistry, pharmacy, nursing etc.

Our graduates creating technologies used on the front lines of medicine, shaping electronic health record and clinical information systems, ensuring privacy and the security of health information, and helping clinical teams use digital devices and new technologies to serve more patients. They work on a wide array of projects in hospitals, doctors' offices, insurance companies, government agencies, and health IT software companies. The demand for our graduates has increased rapidly in the last few years, as EHR adoption has scaled and reimbursement to healthcare providers is dependent on the quality of care that can be shown through data to payors.

There are 101 students currently in the program, which has picked up a very healthy growth trend of approximately 20-25 new students every year (including fall and spring admits), and with cohort of prospective students bound to grow rapidly.

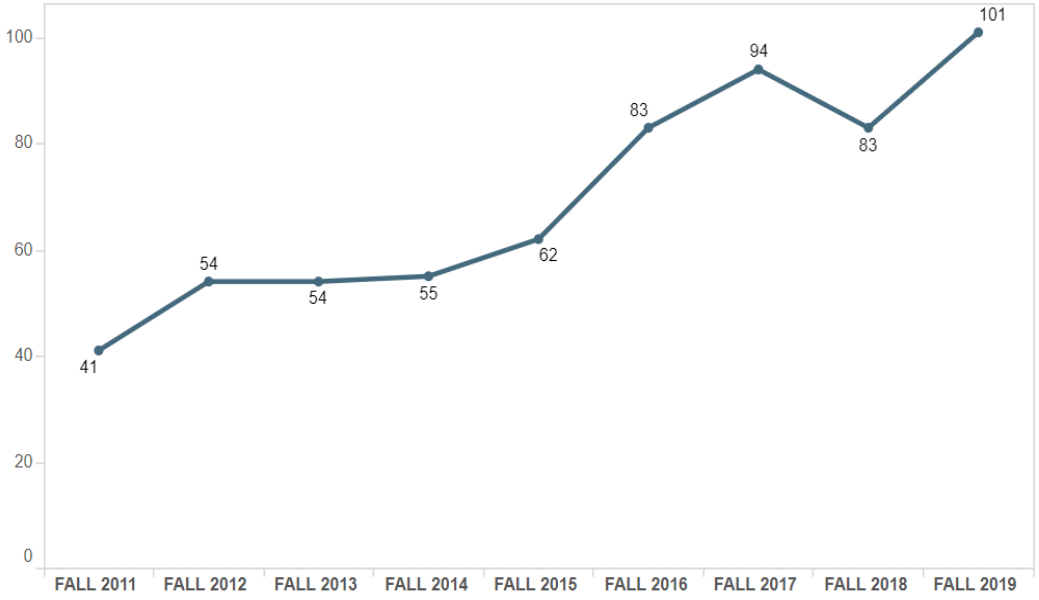



*Figure 1: Unduplicated headcount in MS HI program (Source: IRDS IUPUI)*

Since enrolling the first student in 2003, the MS in HI has graduated 341 students, who went on to secure job positions mainly in the healthcare industry, in both large and medium-sized organizations. The graduation and retention rates are high, with 93.5% of students enrolled during AY 2017-2018 either continuing in the program or graduating. Furthermore, 85% of the students enrolled in the graduate

certificate program choose to pursue the master program upon graduation. The average declared annual salary of relevantly employed graduates was $86,500. Many students usually get promoted in their existing healthcare organizations, after completion of their MS in Health Informatics degrees. Examples of job positions our students have secured include: health data analyst, clinical informatics RN, health scientist, clinical informatics specialist, clinical informatics coordinator, health security specialist, informatics coordinator, application system analyst, population health analyst, clinical imaging analyst, EHR information system specialist.

Our program aspires to be among the top ten in the nation, and among the top 5 in the Midwest, with competing MS in HI programs in major universities, including: University of Wisconsin, University of Pennsylvania, Vanderbilt University, University of Illinois, and University of Washington. We work closely on research opportunities for students in the MS HI program with scientists at the Regenstrief institute, Roudebush VA Medical Center and other health systems in Indianapolis.

**Steps and outcomes for assessments**

The steps are CAHIIM Goals and the Curriculum Map. The target outcome for all steps is:

- The curriculum must, each academic year, offer at least one course that presents such an assignment.
- The above goal is 100% satisfied for AY 2019-20 because every such assignment type is required of at least one course during the year; the level should remain at 100%.
- The students must pass at a level of B- or higher in order to be considered competent at the domain.

<u>Steps for goal: Enhance fundamental professional and interdisciplinary skills of students</u>

- Require students to Analyze problems: Analyze, understand, abstract, and model a specific biomedical problem in terms of their data, information, and knowledge components.
- Require students to produce solutions: Use the analysis to identify and understand the space of possible solutions and generate designs that capture essential aspects of solutions and their components.
- Evaluate the student's ability to implement, evaluate, and refine: Carry out the solution (including obtaining necessary resources and managing projects), evaluate it, and iteratively improve it.
- Encourage students to innovate: Create new theories, typologies, frameworks, representations, methods, and processes to address biomedical informatics problems. INN
- Allow students to work collaboratively: Team effectively with partners within and across disciplines. Assign and grade projects demonstrating that student assures confidentiality of protected patient health information when using health information systems
- Require students to propose/justify decision support systems algorithm to support care delivery during class discussions, practica and/or capstone projects, and assign grades based on student assignment performance.

<u>Steps for goal: Foster the acquiring of skills related to healthcare and the healthcare system</u>

- Let students understand the fundamentals of the field in the context of the effective use of biomedical data, information, and knowledge.
- Encourage students to, for substantive problems related to scientific inquiry, problem solving, and decision making, apply, analyze, evaluate, and create solutions based on biomedical informatics approaches.
- Teach students to apply, analyze, evaluate, and relate biomedical information, concepts, and

models spanning molecules to individuals to populations.
- Facilitate the analysis and evaluation of complex biomedical informatics problems in terms of data, information, and knowledge.

Steps for goal: Educate students in the importance of human and social context with respect to health and technology

- Familiarize students with human-computer interaction (HCI) design and evaluation frameworks such as user experience (UX), user-centered design (UCD), socio-technical systems (STS), and human factors engineering (HFE)
- Require students to demonstrate competency in understanding and evaluating the interactions of organizational structures (business, government, etc.) with healthcare and health information technologies
- Facilitate students' abilities in designing and evaluating patient-centered technology solutions for healthcare

Steps for goal: Retention and maintenance of student population:

- The one-year graduation + retention rate (GRR) of students (i.e., students who did not drop out of the program) for the next surveyed time period (2016-2017) should be kept at or above 86.6%
    - The target benchmark should exceed levels for the last reported period (2014-2015), which evidenced a GRR of 84.6% by 2.0%.
- A 5-year graduation rate (7 is the maximum allowed for completion of the MS degree) of at least 90.0% is noted in the next available report (which documents students enrolling in 2012 and afterwards)
    - Most recent data: The 5-year graduation rate for 2010 enrollees was 90.0%; for 2009 enrollees it was 60.0%. In both cases, all non-graduating students had dropped out of the program.
- 85% of certificate students enroll in the M.S. HI program by the time of certificate completion (this is the approximate proportion of students in spring 2015 proceeding directly to the M.S. HI program after completing their graduate certificate).
- 90% of graduates are placed in a field-related, level-appropriate job position (or doctoral program) within 12 months of graduation.
    - Most recent results: 90% (9/10) of responding graduates surveyed 11 months post-graduation were employed in relevant positions in the HI field.

**III. PROGRAM PROCESSES**

The program may be completed in two years by a full-time student. Part-time study options are available for domestic students. However, international students and any students funded directly by the School of Informatics and Computing (in the form of an assistantship or fellowship) must complete the program in two years.

To assist faculty with curriculum and program assessment, the SoIC has compiled a large archive of rubrics available for modification and use by faculty. The school also has worked with Information Management and Institutional Research (IMIR) to adopt a new plan for regularly monitoring high-level benchmarks such as retention rates, graduate-school acceptance rates to higher graduate study, and percentages of students employed post-graduation.

The School also began a focused two-year review of all its Informatics graduate programs using the Principles of Graduate and Professional Learning (PGPL). The first assessment projects were conducted in 2010-11, and the PGPL have since then been incorporated in all courses to articulate assessable

learning outcomes, opportunities for students to achieve the necessary learning, and solid assessment rubrics. The PGPL assessment data are used to review course content, delivery methods and assignments if warranted. Proposed changes are discussed in HI faculty meetings.

The program is annually assessed for and updated based on:

1. Curriculum fit to the educational and industry standards:
    a. Appraisal of changes in job market and placement and update course curricula as needed. The emergence of "Big Data" initiated the development of INFO B585 Analytics of Biomedical Data.
    b. Review of the content of each course and look for overlaps in knowledge coverage between courses. The goal is to preserve the curriculum as comprehensive unit and not a collection of courses. A review in 2017-18 revealed that INFO B535, B582 and B642 were covering the same contents in 3 lectures; the overlapping content was adjusted to fit the focus of the course. Additional course content was added based on the gap analysis
    c. Instructional and didactic principles will be revised based on student and faculty feedback. The program caters to different types of learners and adjusts the delivery to different teaching platforms, content and learning outcomes. (a revision of the current instructional design of the online classes was done in 2019-2020).

2. Faculty performance
    a. Annual faculty reporting on performance in teaching, research and service.
    b. The focus of the teaching evaluation is:
        i. quality and rigor of classroom instruction.
        ii. involvement in course/curriculum/lab development/redesign.
        iii. proposals for teaching enhancement.
        iv. breadth of instructional activities.
        v. involvement in final project/capstone advising
    c. Review of student course evaluations and grades. Consequent planning to address issues and/or improve future delivery of the course(s).
    d. Setting teaching goals for upcoming academic years (3-year plan)

3. Program outcomes
    a. Student job and continuing education placement data. The current job placement in the field is about 64%, a goal is set to improve that with 2% every year until we reach 85%.
    b. Feedback of employers on graduate performance. The employers and recent grads reported a weakness in technical skill; the course INFO B573: Programming for Science Informatics was added to the curriculum.
    c. Institutional review through mandatory PRAC reports. The PRAC rubric (attached) assesses the program learning outcomes, assessment methods used and findings, and remedial actions taken in response to the findings.

4. Student satisfaction
    a. Course evaluations: These are conducted every semester for every course, and gauge student satisfaction with course content, instructional design and performance of instructors and teaching assistants. Revision of course and teaching method is mandatory when unsatisfactory rating (<2/4).

    b. Appropriate revision of content and assessments are proposed to enhance student learning experience across the curriculum.

5. Advisory Board and community feedback are considered by the faculty when updating the curriculum.

**Program Content**

***a. Distinctive characteristics of the program; Structure, breadth, and depth of curriculum.***

The program content includes three specifics:

- The MS in HI program is divided into two recommended tracks – professional track and thesis track, depending on which we have a set of recommended courses, which complete the 36-credit hour requirement.

**Course Schedule & Plan of Study – Fall admission**

**PROFESSIONAL TRACK**

| FULL-TIME STUDENT - PLAN OF STUDY [2] | | |
|---|---|---|
| **Semester** | **Year 1** | **Year 2** |
| **Fall** | B501 Introduction to Informatics<br>B530 Foundations of Health Informatics[1]<br>B505 Informatics Project Management | B626 Human Factors/Biomedical analytics<br>Elective[3]<br>Elective [3] |
| **Spring** | B581 Health Informatics standards and terminology<br>B535 Clinical Information systems[1] [6]<br>B583 Privacy and Security | B691 or B584 Project[7] / Practicum<br>Elective [3]<br>B642 Clinical Decision Support systems[1] |
| **SUMMER** | As needed [5] **Arr -** Faculty | As needed [5] **Arr -** Faculty |

**Course Schedule & Plan of Study – Fall admission**

**THESIS TRACK**

| FULL-TIME STUDENT - PLAN OF STUDY [2] | | |
|---|---|---|
| **Semester** | **Year 1** | **Year 2** |
| **Fall** | B501 Introduction to Informatics<br>B530 Foundations of Health Informatics[1]<br>I575 Informatics Research design | B585 Biomedical analytics<br>B518 Statistics for Biomedical informatics<br>Elective [3] |
| **Spring** | B581 Health Informatics standards and terminology<br>B535 Clinical Information systems[1] [6]<br>Elective [3] | B691 Thesis [7]<br>Elective [3]<br>B642 Clinical Decision Support systems[1] |
| **SUMMER** | As needed [5] **Arr -** Faculty | As needed [5] **Arr -** Faculty |

[1] Courses offered online.
[2] This plan of study is only intended for full-time student. Part-Time students should take whatever courses are available each semester.
[3] Select from Elective Course list. Students should also check each semester for new or other course offerings of interest.
[4] Some elective courses may have prerequisites; so students should check with instructors before enrolling.
[5] Students may use the summer for a variety of purposes, e.g., preparation for their thesis or project research, elective courses, etc.
[6] Course is cross listed with courses offered by other schools such as nursing and Library Sciences.
[7] B691 can be taken over several semesters including summer in 1 or 2 credits but 3 credits must be accumulated in the last semester.

- An independent study is recommended for students, to cover their specific interests, that might not be covered as part of the course work. This is usually an industry internship, or student-directed research project (INFO-B551).
- A Final Capstone Project or Thesis (INFO-B691) enables students to apply in a research or professional practice setting the knowledge learned in the course towards a final HI project (theoretical, experimental or applied in nature) in collaboration with research site, and guided by the academic supervision of an HI faculty member.

***b. How has the department curriculum responded to new directions in the discipline?***

- Several graduate courses have been assessed using the principles of graduate and professional learning. Appropriate revision of content and assessments have been made to enhance student learning experience across the curriculum.
- The primary gap as reported by students is the lack of "hands-on experiences"; actions are being taken by the department to resolve this issue by providing virtual EHR laboratories. The faculty have implemented the LibreHealth EHR, an open-source EHR system with the National Health and Nutrition Examination Survey (NHANES) data included in the EHR. This EHR is used in B535, B513 and the B585 courses in the MS in HI program.
- The need to train the health informatics workforce in data analytics has resulted in implementation of the DHIS2 – Health Management Information System that has been in use in over 65 countries around the world by federal and state governments in the countries. Our students use sample databases from many of these countries and perform data analytics.
- The practicum and internship offerings are also remediating the issue identified. Overall, the job placement of our graduates is high and anecdotal comments from graduates and employers on the program are favorable. Syllabi are updated each year based on faculty review and graduate student feedback. Syllabi are also reviewed to ensure the learning outcomes match the most current updates in health information technology and professional requirements.

***c. Curricular philosophy: What is the philosophy that has driven the establishment of the core, elective, and minor (i.e., minors offered for students in other departments) curricula?***

Our curriculum is closely aligned to the HI discipline curriculum requirements defined by the CAHIIM accreditation requirements. We have undergone a curricular review for the accreditation and that has helped align our program outcomes with the CAHIIM requirements. These cover the following curricular components:

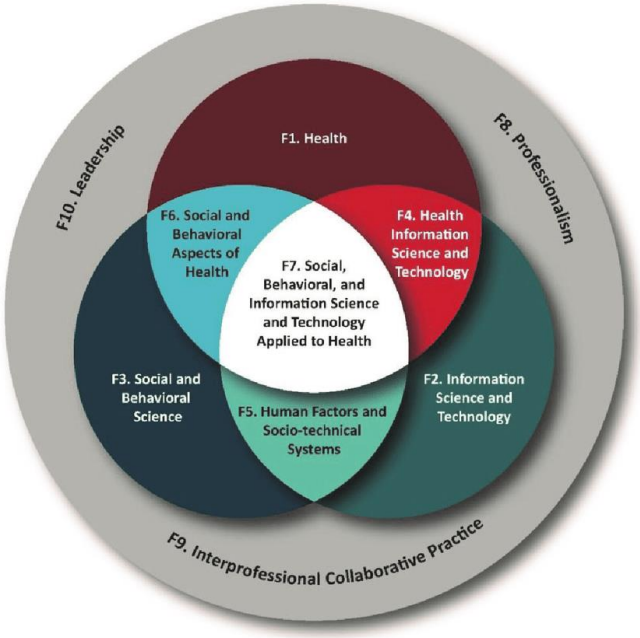



*Figure 2: CAHIIM Health Informatics Competencies*

We strive to offer a comprehensive yet deep preparation that touches the fundamental methodological and theoretical areas of the field, with an emphasis on the professional knowledge needed to succeed in the industry and selected research and application areas connected to the strengths of our faculty.

**d. Course Evaluation**

We have taken a data science/informatics approach to evaluation of the courses. We analyze the curriculum by relating the Program Outcomes (PO) with the Course Learning Outcomes from the 6 core courses, and then map the outcomes and any missing gaps to achieve the CAHIIM competencies.

**PO1:** Analyze problems: Analyze, understand, abstract, and model a specific biomedical problem in terms of their data, information, and knowledge components.
**PO2**: Produce solutions: Use the analysis to identify and understand the space of possible solutions and generate designs that capture essential aspects of solutions and their components.
**PO3:** Implement, evaluate, and refine: Carry out the solution (including obtaining necessary resources and managing projects), evaluate it, and iteratively improve it.
**PO4**: Innovate: Create new theories, typologies, frameworks, representations, methods, and processes to address biomedical informatics problems.
**PO5**: Work collaboratively: Team effectively with partners within and across disciplines.
**PO6:** Understand the fundamentals of the field in the context of the effective use of biomedical data, information, and knowledge.
**PO7**: For substantive problems related to scientific inquiry, problem solving, and decision making, apply, analyze, evaluate, and create solutions based on biomedical informatics approaches.
**PO8**: Apply, analyze, evaluate, and relate biomedical information, concepts, and models spanning molecules to individuals to populations.
**PO9**: Analyze and evaluate complex biomedical informatics problems in terms of data, information, and knowledge.
**PO10:** Apply, analyze, and create data structures, algorithms, programming, mathematics, statistics.
**PO11:** Apply, analyze, and create technological approaches in the context of biomedical problems.
**PO12:** Apply and evaluate methods of inquiry and criteria for selecting and using algorithms, techniques, and methods to solve substantive health informatics problems.

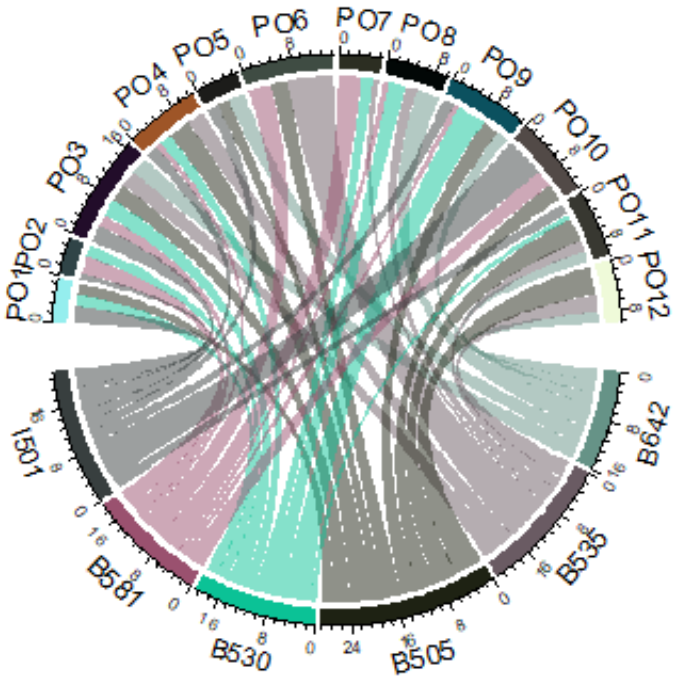
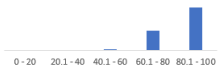
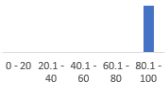
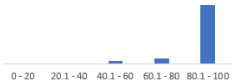
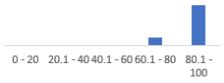
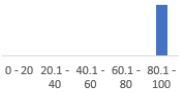
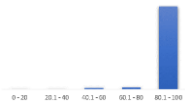
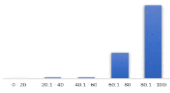
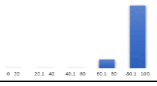
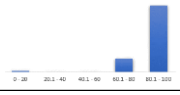
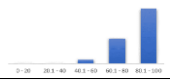
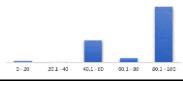
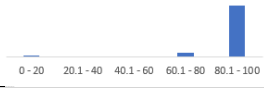
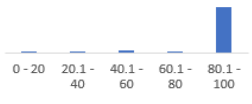
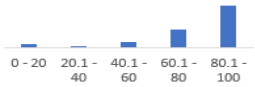
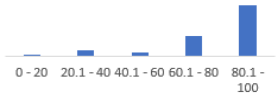
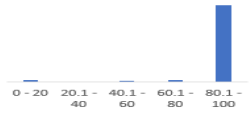
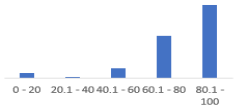
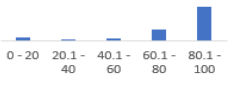



*Figure 3: Relationship between the Course Learning Outcomes and HI Program Learning Outcomes*

Further, by looking at each course in Canvas and looking at the assignments and other assessments for each course and compared with the learning outcomes for each student. By applying statistical methods to analyze the data, we are able to identify the gaps where instructors need to focus on particular content and then improve the instruction in those gaps in the course. The following below section shows the analysis for the 6 core courses. Similar analysis has been done for the electives too. This data-based approach is showing promising gains and student learning in the learning outcomes with gaps in improving in the last 2 years. The following is an analysis of 3 courses – B581 – Health Info Standards and Terminology, B535 Clinical Information Systems and I501 – Intro to Informatics.

| INFO B581 (Health Info Standards and Terminology Analysis | | | | | |
|---|---|---|---|---|---|
| **Learning outcomes** | **Grade distribution (Aggregate)** | **% student meeting LO (>=80 points)** | **% student meeting LO (2018)** | **% student meeting LO (2019)** | **% student meeting LO (2020)** |
| Discuss the principles of data and knowledge structures in healthcare |  | 68.08510638 | 57.5 | 68.25396825 | 73.68421053 |
| Analyze the underlying design of applications in healthcare and explain how data is interchanged |  | 100 | 100 | 100 | 100 |
| Demonstrate how standards are implemented technically and organizationally |  | 86.5248227 | 97.5 | 96.82539683 | 57.89473684 |
| Defend and judge the appropriate use of a standard and terminology for interoperability |  | 84.39716312 | 85 | 88.88888889 | 76.31578947 |
| Assemble standards and showcase interoperability between two disparate healthcare systems. |  | 100 | 100 | 100 | 100 |
| | N | 141 | 40 | 63 | 38 |

| INFO B535 (Clinical Information Systems) | | | | | | |
|---|---|---|---|---|---|---|
| **Learning outcomes** | **Grade distribution (Aggregate)** | **% student meeting LO (>=80 points)** | **% student meeting LO (2017)** | **% student meeting LO (2018)** | **% student meeting LO (2019)** | **% student meeting LO (2020)** |
| LO1: Analyze the state of the science and current research issues related to (1) informatics applications for delivering and managing healthcare information in distributed environments and (2) clinical decision support/clinical guidelines. |  | 95.42 | 85.7 | 91.8 | 97 | 100 |
| LO2: Characterize nursing knowledge representation in system design, and human computer interface issues (hardware, software, end user). |  | 71.90 | 85.7 | 93.8 | 59.7 | 60 |
| LO3: Assess organizational challenges in the selection, integration and implementation of clinical information systems and develop strategies to meet these challenges. |  | 87.58 | 100 | 91.8 | 92.5 | 66.67 |
| LO4: Apply evaluation methodologies to support design, development and implementation of clinical information systems. |  | 81.70 | 85.7 | 73.4 | 88 | 80 |
| LO5: Analyze the issues related to security of information in clinical information systems in light of current standards, Federal regulatory requirements, and related organizational policies. |  | 64.05 | 28.5 | 71.4 | 52.8 | 73.3 |
| LO6: Analyze the impact of information technology on delivery of clinical information and work redesign in the clinical enterprise. |  | 66.67 | 71.4 | 65.3 | 59.7 | 83.3 |
| | | N=153 | N=7 | N=49 | N=67 | N=30 |

| INFO I501 (Intro to Informatics) Analysis | | | | | |
|---|---|---|---|---|---|
| **Learning outcomes** | **Grade distribution (Aggregate)** | **% student meeting LO (>=80 points)** | **% student meeting LO (2017)** | **% student meeting LO (2018)** | **% student meeting LO (2020)** |
| 1. Differentiate between research fields, theoretical concepts, epistemologies, and qualitative and quantitative methods. |  | 87.2483 | 92.5373134 | 81.3559 | 86.9565217 |
| 2. Analyze critically and speak publicly about field-specific scholarly research, projects executed in class, and data management issues. |  | 93.2886 | 100 | 89.8305 | 82.6086957 |
| 3. Design, implement, test, and debug extensible and modular programs involving control structures, variables, expressions, assignments, I/O, functions, parameter passing, data structures, regular expressions, and file handling. |  | 77.1812 | 92.5373134 | 72.8814 | 43.4782609 |
| 4. Apply software development methodologies to create efficient, well-structured applications that other programmers can easily understand. |  | 75.8389 | 71.641791 | 76.2712 | 86.9565217 |
| 5. Analyze computational complexity in algorithm development. |  | 61.745 | 80.5970149 | 45.7627 | 47.826087 |
| 6. Investigate research questions and designs by loading, extracting, transforming, and analyzing data from various sources. |  | 63.0872 | 56.7164179 | 84.7458 | 26.0869565 |
| 7. Test hypotheses and evaluate reliability and validity. |  | 94.6309 | 94.0298507 | 96.6102 | 91.3043478 |
| 8. Implement histograms, classifiers, decision trees, sampling, linear regression, and projectiles in a scripting language. |  | 55.7047 | 46.2686567 | 61.0169 | 69.5652174 |
| 9. Decompose and simulate systems to process data using randomness. |  | 67.7852 | 68.6567164 | 62.7119 | 78.2608696 |
| 10. Employ supervised and unsupervised machine learning for functional approximation and categorization. |  | 49.6644 | 62.6865672 | 40.678 | 34.7826087 |
| | N | 149 | 67 | 59 | 23 |

## 2. Student Support

*a. How and when are research advisors selected for graduate students?*

For course advising, the advising to the students operates at two levels:

1. *Graduate Program Advising and Orientation*: the graduate program coordinator engages with students to orient them from admission to graduation to fulfill the necessary verifications and requirements to maintain academic standing, including grade requirements, full-time/part-time status, support for international students and liaison with the Office of International Affairs (OIA), degree and course transfers, credit transfers, and leave of absences.

2. *Plan of Study Advising*: from the time of admission, the Department Chair and assistant provide general guidance to the students on the pre-defined program plan of study, organization of the course load for each semester, selection of the electives and suggestions to contact specific faculty for specific interests or projects.

For research advising, the following process is followed:

- Upon admission, faculty review the self-reported technical and research skillset and the personal statement that students have submitted in their application package
- Based on this information, by the beginning of the first semester, faculty express to the assistant to the Chair their preference for engaging students in research projects based on the current faculty research agenda, the student's interest and skillset
- Faculty and students are matched, with the opportunity to re-assess performance and fit anytime during the semester (and certainly every semester).

*b. Description of how graduate students are advised for placement*

Students are encouraged to do internships that better prepare them for a professional career. Human Computer Interaction Graduate students can take advantage of experiential learning opportunities as elective credits throughout their program for up to six credit hours. The student is required to work a minimum of 45 clock hours per credit hour. It is in these internship environments where they are able integrate knowledge and theory learned in the classroom with practical application and skills development in a professional setting under the supervision of a mentoring supervisor and course instructor.

For each Internship, the student will turn in weekly journal entries and a written report describing the activities in which the intern was involved in while working at the organization. In previous semesters, students have interned at a number of organizations both in and outside of the state of Indiana (including Lilly, IU Health, Regenstrief Institute etc.).

*c. Description of processes to help graduate students learn to teach*

Admitted master students are vetted and selected to serve as Research or Teaching Assistants based on the interests of the students, their self-report skillset and the needs of the department. Routinely, since the first semester of admission, every full-time MS student is assigned a teaching or research assistantship (funded by the department) to assist faculty in either the HIM, Bioinformatics or Health informatics program and a faculty research mentor or faculty teaching mentor (the course instructor) who directly supervises their work. Most MS-HI students are assigned a Teaching Assistantship of 10 hours per week. Specific attention is paid every semester to monitor the teaching performance of the teaching assistant by engaging faculty in assigning to students increasingly challenging teaching roles (from grading, to class supervision, preparation and logistics, to student interaction, tutoring, coaching and lecturing) and providing feedback to the student and to the Chair. Students are encouraged to take advantage of the Center for Research and Learning on campus to hone their communication and teaching skills.

## IV. LEARNING OUTCOMES

### 1. Program-Level Student Learning Outcomes

| Upon completion of the MS in HI program, students will: | RBT[1] | PGPL[2] |
|---|---|---|
| 1. Analyze problems: Analyze, understand, abstract, and model a specific biomedical problem in terms of their data, information, and knowledge components. | 4 | 1, 2 |
| 2. Produce solutions: Use the analysis to identify and understand the space of possible solutions and generate designs that capture essential aspects of solutions and their components in a healthcare setting. | 5, 6 | 1, 2, 4 |
| 3. Implement, evaluate, and refine: Carry out the health informatics solution (including obtaining necessary resources and managing projects), evaluate it, and iteratively improve it. | 5, 6 | 1, 2 |
| 4. Innovate: Create new theories, typologies, frameworks, representations, methods, and processes to address biomedical informatics problems | 6 | 2, 4 |
| 5. Work collaboratively: Team effectively with partners within and across disciplines and health depts. | 3 | 3 |
| 6. Understand the fundamentals of the field in the context of the effective use of biomedical data, information, and knowledge. | 2 | 2 |
| 7. For substantive problems related to scientific inquiry, problem solving, and decision making, apply, analyze, evaluate, and create solutions based on biomedical informatics approaches | 3, 4, 5, 6 | 1, 2 |
| 8. Apply, analyze, evaluate, and relate biomedical information, concepts, and models spanning molecules to individuals to populations. | 3, 4, 5 | 1, 2 |
| 9. Analyze and evaluate complex biomedical informatics problems in terms of data, information, and knowledge | 4, 5 | 2 |
| 10. Exhibit sound judgment, ethical behavior, and professionalism in applying biomedical concepts and value-sensitive design to serve stakeholders and society, especially in ethically challenging situations | 2–6 | 4 |
| 11. Apply and evaluate methods of inquiry and criteria for selecting and using algorithms, techniques, and methods to solve substantive health informatics problems. | 3, 5 | 2 |

***Careers***

The School of Informatics and Computing's career services data provided the following data about the graduates from the MS in HI program, which met our envisioned goals:

| Year | Total count | Placeable | Placed | Knowledge Rate(%) | Median Salary |
|---|---|---|---|---|---|
| **2016-'17** | 29 | 29 | 25 | 86 | 65000 |
| **2017-'18** | 27 | 26 | 21 | 85 | 68500 |
| **2018-'19** | 47 | 47 | 31 | 66 | 68000 |

[1] RBT: Revised Bloom's taxonomy

[2] PGPL: Principles of Graduate and Professional Learning (1. Knowledge and Skills Mastery; 2. Critical Thinking and Good Judgment; 3. Effective Communication; 4. Ethical Behavior)

Salary media

**Informatics Nurse**: According to PayScale, the average salary for an informatics nurse is $66,552 per year, with an average reported salary range of $51,353 to $89,022. The highest paid informatics nurses reside in Houston, according to PayScale data, where the average reported salary is $74,000 per year.

**Health Informatics Specialist:** According to PayScale, the average salary for a health informatics specialist is $61,050 per year, with an average reported salary of $35,449 to $91,618 per year. The highest paid health informatics specialists reside in Chicago, according to data from PayScale, where the average reported salary is $84,000 per year.

**Clinical Informatics Specialist:** According to PayScale, the average salary for a clinical informatics specialist is $68,707 per year, with a reported salary range from $44,541 to $93,373 per year. The highest paid clinical information specialists, according to data from PayScale, reside in Houston and Dallas, with reported average salaries of $90,000 and $72,000 per year, respectively.

**Clinical Analyst:** According to PayScale, the average salary for a clinical analyst is $63,823 per year, with a reported salary range from $40,928 to $88,186 per year. The highest paid clinical analysts live in New York and Phoenix, according to data from PayScale, where the average reported salaries are $85,000 and $76,000, respectively.

**Clinical Informatics Manager:** According to PayScale, the average salary for a clinical informatics manager is $92,819 per year, with a reported salary range of $59,008 to $127,876 per year. Those with nursing informatics, project management, and clinical information systems skills reported average salaries of $100,000, $92,000, and $94,000, respectively to each skill.

List of positions

Examples of recent job position titles our students secured include:

- Health data analyst
- Clinical informatics RN
- Health scientist
- Clinical informatics specialist
- Clinical informatics coordinator
- Health security specialist
- Informatics coordinator
- Application system analyst
- Population health analyst
- Clinical imaging analyst
- EHR information system specialist

Additionally, students have been able to secure fully-funded Ph.D. positions at University of Wisconsin.

List of companies

- IU Health

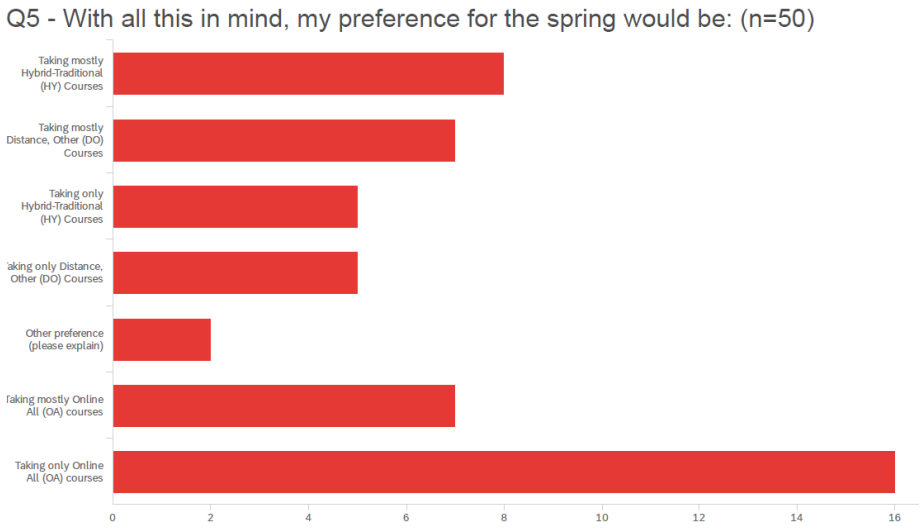
- St. Vincent
- Eli Lilly
- American Health Network
- Epic Systems
- Cerner Systems
- Salesforce

**COVID-19 impact on the MS in HI program**

COVID-19 had an impact on our current as well as incoming students. We have over 70% of our student population coming from outside the US, and visa and consulate restrictions disrupted admissions in our program for the last year or so.

COVID-19 challenge for admitted students: We created a competition, called the COVID-19 challenge, led by Professor of Practice Dr. Gary Schwebach, for the admitted students, who were unable to join the MS in HI program. This engaged the students in our School and helped them to join the Spring 2021 semester. We had 40 out of 80 deferred students originally sign up for the challenge. In Round 1 we had 23 participants. Between Rounds 1-2 we had 5 people drop out citing work and loan application related time constraints. In Round 2 we had 18 students participate. These were all students who had participated in Round 1. In Round 3 we had 11 students participate. 8 participated in Rounds 1-2 and 3 participated in only Round 1 prior to Round 3. As of December 9, 2020, 14 of the 27 MS students who were enrolled in the Spring 2021 MS HI program participated in the Challenge.

Hybrid learning survey: We also conducted a survey of existing students in the program to understand their preferences for on-campus and online learning, and adjusting our strategy for offering hybrid courses. Some survey results [3]are as follows:




[3] https://indiana.sharepoint.com/:b:/r/sites/msteams_45934b/Shared Documents/General/BHI/BHI - Department Share/BHI Dept Meetings/2020-2021/Nov 2 2020/Report - modes of course offerings survey.pdf?csf=1&web=1&e=EOveRX