

MS in Health Informatics PRAC Report – 2022-2023

I. Program Summary

Health Informatics is an interdisciplinary field that studies and pursues the effective use of biomedical data, information, and knowledge for scientific inquiry, problem-solving, and decision-making, motivated by efforts to improve human health. 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 Luddy School of Informatics, Computing, and Engineering, previously known as the School of Informatics and Computing (SoIC), IUPUI, covering the academic year (AY) 2022-2023.

In January 2015, the American Medical Informatics Association (AMIA) joined the Commission on Accreditation for Health Informatics and Information Management Education (CAHIIM) as an Organizational Member. A Health Informatics Accreditation Council was established to revise CAHIIM's curriculum requirements and accreditation standards for health informatics master's degree programs. In 2019, AMIA approved and CAHIIM accredited the Health Informatics master's degree program at Indiana University Indianapolis.

The field of health informatics lies at the intersection of health, information science and technology, and social/behavioral science. Graduate students are expected to acquire working knowledge spanning these three domains, as they define and shape health informatics practice. Students must demonstrate expertise in the complex application of social, behavioral and information science and technology to health.

The M.S. in HI degree program has a fully online and on-campus delivery modalities and multiple accelerated degree pathways from the B.S. in Health Information Management (HIM), BS in Biomedical Informatics (BMI), BS in Health Sciences, as 4+1 degrees. 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 efficiency and support decisions made by administrations and executives.
- Health Information Management – the storage, processing, reporting and management of health information.
- Imaging Informatics – The bridge between information science, computer science and health care imaging.
- Devices for monitoring rehabilitation and recovery.
- Public Health Informatics – the application of information technology for public health

Between 2020-2023, the BHI Department added two new tenure-track Assistant Professors in Health Informatics: Hee-Tae Jung and Yan Zhuang, plus a full-time Lecturer Zeyana Hamid. This expanded faculty aims to strengthen research advising and support thesis completion for students in the MS in Health Informatics program.

The relatively new interdisciplinary field of Health Informatics focuses on translational research, using computational approaches. It transforms health data into scientific discoveries that enhance our understanding of life science and improve patient care. Given the specialized nature of the degree, no national rankings exist for the program.

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 36-credit M.S. in Health Informatics integrates multidisciplinary knowledge affecting healthcare delivery and outcomes. Along with our CAHIIM-accredited B.S. in Health Information Management and B.S. in Biomedical Informatics programs, it represents one of only 5 fully accredited BS-MS-PhD pathways nationally. We helped shape national baccalaureate competencies based on our curriculum. Using established master’s competencies, the AMIA Baccalaureate Education Committee crafted undergraduate competencies to ensure appropriate overlap in health informatics knowledge and skills. This aims to equip graduates with essential competencies for professional endeavors.

Many of our program learning outcomes align with CAHIIM and AMIA Baccalaureate Education Committee recommendations. Additionally, we tailored the program since many incoming students have undergraduate health sciences backgrounds like medicine, dentistry, pharmacy, and nursing.

Graduates work on the frontlines of medicine, shaping electronic health records, ensuring health information privacy/security, and helping clinical teams adopt new technologies to serve more patients. They work in hospitals, medical offices, insurance companies, government agencies, and health IT companies. Demand has rapidly increased with expanded EHR adoption and value-based care reimbursement models requiring quality data.

Enrollment in the M.S. Health Informatics program has grown steadily over the past decade from 84 students in Fall 2020 to 332 in Fall 2023, representing a 38.2% Compound Annual Growth Rate. Factors likely driving growth include rising demand for healthcare informatics professionals and the program’s strong reputation.

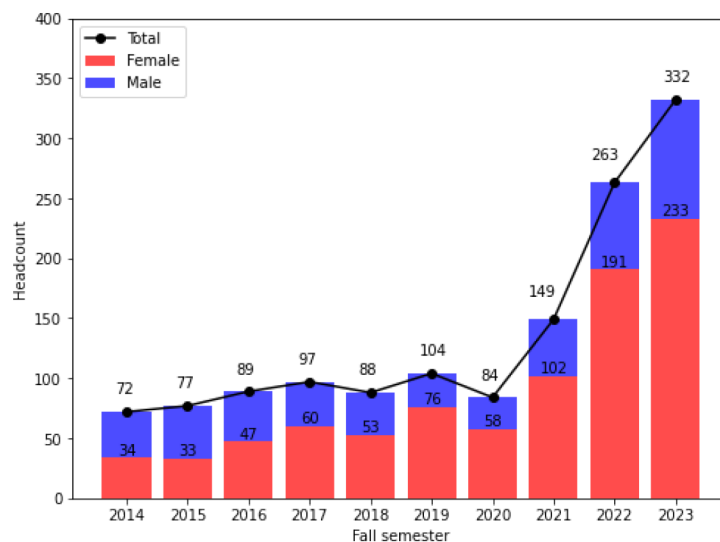


Figure 1: Unduplicated headcount in MS HI program (Source: IRDS IUPUI)

The continued growth of the MS in Health Informatics program is a positive development for both the program and the field of healthcare informatics. The program is helping to meet the growing demand for healthcare informatics professionals, and its graduates are making a significant contribution to the field. Since enrolling the first student in 2003, the MS in HI has graduated 443 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 \$72,000. 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.

Program Goals with Measurable Assessments:

Clear, measurable goals paired with ongoing assessments are crucial for evaluating and improving educational programs (Frye & Hemmer, 2012)¹. The assessment literature emphasizes articulating program objectives, determining appropriate assessment methods, systematically collecting and analyzing data, and then using results to inform program revisions aimed at enhancing student outcomes (Palomba & Banta, 2015²; Suskie, 2009³). For example, in reviewing 10 years of assessment data on student learning outcomes which led to significant positive program changes⁴, including curriculum redevelopment, teaching innovations, and targeted co-curricular activities. Overall, the literature provides extensive evidence that measurable program goals along with regular assessment activities provide data-driven insights to guide meaningful program improvements over time, enabling institutions to better serve their students.

1. Goal: Enhance students' fundamental professional and interdisciplinary skills.

Assessments:

- Require students to analyze, abstract, and model biomedical problems in terms of data, information, and knowledge components. (Added in INFO-B 530)
- Require students to identify solutions and create solution designs. (Changed INFO-B 626)
- Evaluate students on implementing, evaluating, and refining solutions. (Added in many courses in the program)
- Encourage innovation through new theories, frameworks, etc. (Added in INFO-I 501)
- Require collaborative teamwork and ensure confidentiality of protected health

¹ Frye AW, Hemmer PA. Program evaluation models and related theories: AMEE guide no. 67. *Med Teach.* 2012;34(5):e288-99. doi: 10.3109/0142159X.2012.668637. PMID: 22515309.

² Banta, T. W., & Palomba C. A. (2015). *Assessment essentials: Planning, implementing, and improving assessment in higher education*. San Francisco, CA: Jossey-Bass Higher and Adult Education. ISBN-10:1118903323

³ Suskie, L. (2009). *Assessing student learning: A common sense guide* (2nd ed.). Jossey-Bass.

⁴ Purkayastha, S., Patri, A. V., & Yerrabandi, V. (2024). A Skills Assessment Pathways-Based Program Assessment Approach in Multidisciplinary Graduate Health Informatics. *Studies in Health Technology and Informatics*, 310, 1191-1195.

- information (Changed in INFO-B 583).
 - Require justifying clinical decision support systems (Changed in INFO-B 642).
2. Goal: Foster skills related to healthcare and the healthcare system.
Assessments:
 - Apply fundamentals of the field to use of biomedical data, information, and knowledge.
 - Apply, analyze, evaluate biomedical informatics approaches to solve substantive problems.
 - Analyze and evaluate complex biomedical informatics problems in terms of data, information, and knowledge.
 3. Goal: Enhance students' fundamental professional and interdisciplinary skills.
Assessments:
 - Teach human-computer interaction (HCI) and user-centered design frameworks.
 - Evaluate interactions of organizational structures with healthcare technologies.
 - Facilitate designing patient-centered technology solutions.
 4. Goal: Maintain student retention and graduation rates.
Assessments:
 - One-year retention rate of 86.6%.
 - Five-year graduation rate of 90%.
 - 85% of certificate students enroll in the MS program.
 - 90% job placement within 12 months.
 5. Goal: Gather student feedback and satisfaction.
Assessments:
 - Semester-end satisfaction surveys (surveys sent since 2021 – article under review)
 - Graduating student exit interviews (collaborating with career services)
 - Analysis of program influence on student outcomes (published) ⁵
 6. Goal: Encourage research and publications
Assessments:
 - Research projects incorporated into curriculum.
 - Implementation of novel, real-world approaches.
 - Encouragement of project publications. (Count such publications).
 7. Goal: Instill learning approach through training.
Assessments:
 - Integration of certifications (from CITI for ethical research - biomedical, clinical practices)
 - Training in tools like SAS, Excel, Python, SQL.

⁵ Purkayastha, S., Patri, A. V., & Yerrabandi, V. (2024). A Skills Assessment Pathways-Based Program Assessment Approach in Multidisciplinary Graduate Health Informatics. *Studies in Health Technology and Informatics*, 310, 1191-1195.

III. PROGRAM PROCESSES

Students can complete the full-time program in two years. Domestic students have part-time options, but international students and any students with school funding must finish in two years.

To support curriculum and assessment, the School of Informatics and Computing (SoIC) compiled modification-friendly rubrics. With Information Management and Institutional Research (IMIR), SoIC adopted new benchmarks for regularly monitoring retention, graduate school acceptance, and post-graduation employment.

Assessment Efforts Related to DEI Strategic Plan: The MS in Health Informatics program is committed to advancing diversity, equity and inclusion (DEI) through targeted assessment efforts aligned with the school and campus-wide DEI strategic plan. Key initiatives include:

- Evaluating student demographic data and academic outcomes to identify any equity gaps in recruitment, retention and degree completion. Findings are informing targeted interventions. *(completed in Dec 2023)*
- Auditing course content and pedagogy to assess the extent to which DEI perspectives are meaningfully integrated. Faculty will use insights to enhance inclusive teaching practices using resources from ACUE and diversify curricular materials. *(ongoing – will be completed in May 2024)*
- Surveying students on classroom climate and sense of belonging. Results will guide professional development to strengthen faculty cultural competence and ability to foster inclusive learning environments. *(ongoing – will be completed in May 2024)*
- Tracking diversity of guest speakers and community partners engaged in the program. Proactive steps will be taken to provide students with exposure to diverse informatics professionals and to collaborate with organizations serving underrepresented populations *(ongoing – department colloquia 3-4 times a semester).*

The program enrollment shows the program has become largely international in the last few years.

Table 1: Enrollment sex and race-ethnicity distribution

STUDENT ENROLLMENT DATA FOR HEALTH INFORMATICS AND HEALTH INFORMATION MANAGEMENT PROGRAMS AT IUI.

Semester	Program	Total Enrollment	No. of Females	No. of Males	Female race-ethnicity	Male race-ethnicity
Fall 2022	Health Informatics (graduate)	263	191	72	1 African American, 3 Asian, 1 Hispanic/Latino, 174 International, 3 Multiracial, 9 White	69 International, 3 White
Spring 2023	Health Informatics (graduate)	274	198	76	1 American Indian, 4 Asian, 184 International, 2 Multiracial, 7 White	71 International, 1 Multiracial, 1 Unknown, 3 White
Summer 2023	Health Informatics (graduate)	133	100	33	1 African American, 2 Asian, 95 International, 2 White	33 International
Fall 2023	Health Informatics (graduate)	332	233	99	3 African American, 6 Asian, 1 American Indian, 215 International, 1 Hispanic/Latino, 2 Multiracial, 5 White	4 Asian, 1 Hispanic/Latino, 91 International, 1 Unknown, 2 White

Assessment Efforts Related to Global Learning and Internationalization: Preparing graduates for success in the global health informatics field is a strategic priority. Assessment efforts supporting this goal include:

- Inventorying courses for global/comparative content and intercultural learning opportunities. Gaps identified will drive curriculum enhancements to deepen global perspectives.

- Evaluating student participation in study abroad, international internships/fieldwork, and virtual global learning experiences. Data will be used to expand high-impact global opportunities and student support.
- Assessing global competency outcomes via instruments like the Global Perspectives Inventory. Results will shape curricular and co-curricular strategies to build key global skills and mindsets.
- Monitoring international student enrollment trends and academic performance. Insights will catalyze tailored supports to boost international student success and enhance the intercultural dimensions of program offerings.

Systematic assessment focused on DEI and global learning will enable the MS in Health Informatics program to make data-informed improvements that prepare all students for leadership in an increasingly diverse and globally interconnected field. Strategic investments in these areas will be critical to maintain program quality and relevance.

In 2010-2011, SoIC conducted a focused two-year review of all Informatics graduate programs using the Principles of Graduate and Professional Learning (PGPL) framework. Since then, PGPLs articulate assessable outcomes, learning opportunities, and assessment rubrics for all courses. Resulting data guides possible content, delivery, or assignment changes. Proposed course alterations are discussed among Health Informatics faculty, in monthly program faculty meetings. These meetings are separate from monthly departmental meetings.

The program is annually assessed for and updated based on:

1. Faculty performance
 - a. Annual Reporting: Faculty submit annual self-evaluations of their performance across teaching, research, and service domains. Evaluations require faculty to provide evidence-based reflections on the quality, effectiveness, and continuing development of their work in each area over the past academic year.
 - b. Multiple data sources evaluate faculty teaching effectiveness, including:
 - i. Classroom instruction quality - Rubric-based evaluations of in-person and recorded lectures assessing clarity, engagement, content delivery, and more.
 - ii. Course development - Examples of new courses, redesigned courses, refreshed course content with justification and objectives.
 - iii. Enhancement proposals - Data-driven proposals for enhancing student comprehension, participation, critical thinking, assessment methods, adoption of new techniques/technologies, and other aspects of teaching.
 - iv. Instructional breadth - Courses taught outside primary domain, novel assignments/activities demonstrating range of instructional skills.
 - v. Project advising - Numbers of final projects/capstones advised; project quality; student evaluations of advising.
 - c. Student Evaluations: Analyze and respond to end-of-semester student course evaluations and grade distributions by: identifying teaching issues; planning and implementing improvements; documenting how changes seek to directly enhance student comprehension and skills development based on feedback.
 - d. Teaching Plans: Faculty propose 3-year teaching goals setting objectives for courses taught, advising, instruction methods, content development, and pedagogical skills in their areas requiring growth and/or innovation. Reviewed to align individual teaching goals with program needs.

2. Curriculum fit to the educational and industry standards:

- a. Review of the content of each course and look for overlaps in knowledge coverage between courses. The goal is to preserve the curriculum as a comprehensive unit and not a collection of courses. A review in 2021-22 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. An ongoing analysis is resulting in 3 academic tracks that will be offered to students starting from Fall 2024.
- b. Changes were brought to INFO-B 626 Human Factors Engineering for Health Informatics, with an advanced approach towards leveraging human factors engineering, evaluating and addressing health informatics issues, critique related articles, and drafting a research proposal on contemporary challenges.
- c. Incorporating the use of Electronic Health Records (EHR) throughout the curriculum via the SEIRI SSG initiative (2022-2023) for courses INFO-B535, INFO-B642, INFO-B530, INFO-B512 and INFO-B518. This improved the usage and understanding of the EHR systems.
- d. Introduction of Dental Informatics- DENT-R 978 certification and collaborative courses was done in (2022-2023).
- e. Variations made to INFO-B518, Applied Statistical Methods for Biomedical Informatics, with integration of an in-class examination and detailed project building for an improved course understanding (2023 onwards).
- f. Changing the policy for being eligible to do a Practicum - INFO-B584 only in the last semester of the entire course.
- g. Capstone projects have changed to allow group projects instead of just individual presentations.

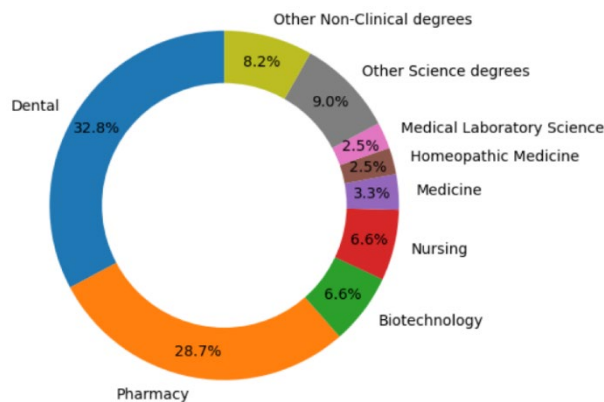


Fig. 2. Education background of students in the HI program at IUI

Interdisciplinary nature of our student body in Figure 2 is reflective of the Health Informatics field. The majority of students in the program come from dental and pharmacy backgrounds, representing 32.8% and 28.7% of the student population, respectively. This high representation of dental and pharmacy professionals highlights the growing recognition of the importance of health informatics in these fields. Other notable categories include biotechnology (6.6%), nursing (6.6%), and other science degrees (Bachelor of Science, BS in Life Science, BS in Applied Nutrition, BS in Public Health, Chemistry, and Zoology, etc.) (9.0%), reflecting the

interdisciplinary nature of the program. The presence of students from medicine (3.3%), homeopathic medicine (2.5%), medical laboratory science (2.5%), physiotherapy (1.6%), radiography (1.6%), and optometry (0.8%) demonstrates the wide-reaching impact of health informatics across various healthcare disciplines. Additionally, students come from non-clinical backgrounds (8.2%), such as computer engineering, healthcare management, mathematics, statistics, etc., emphasizing the need for diverse skill sets in health informatics. The distribution of degrees among students in the Health Informatics program at IUI underscores the program’s ability to cater to the unique needs of healthcare professionals from various specialties, preparing them to leverage informatics tools and techniques to improve patient care and outcomes in their respective fields.

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. Challenges to the program:
 - a. There were significant challenges associated with providing a course in Natural Language Processing (NLP).
 - b. Academic misconduct in terms of use of ChatGPT are difficult to tackle, with there being varied conflicting understanding about ChatGPT and its hallucinations.
6. Advisory Board and community feedback are considered by the faculty when updating the curriculum. The Health Informatics advisory board meets annually in April each year.

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	B626	Human Factors/Biomedical analytics
	B530	Foundations of Health Informatics ¹	Elective ³	
	B505	Informatics Project Management	Elective ³	
Spring	B581	Health Informatics standards and terminology	B691 or B584	Project ⁷ / Practicum
	B535	Clinical Information systems ¹⁶	Elective ³	
	B583	Privacy and Security	B642	Clinical Decision Support systems ¹
SUMMER	As needed ⁵		As needed ⁵	
	Arr - Faculty		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	B585	Biomedical analytics
	B530	Foundations of Health Informatics ¹	B518	Statistics for Biomedical informatics
	I575	Informatics Research design	Elective ³	
Spring	B581	Health Informatics standards and terminology	B691	Thesis ⁷
	B535	Clinical Information systems ¹⁶	Elective ³	
	Elective ³		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:

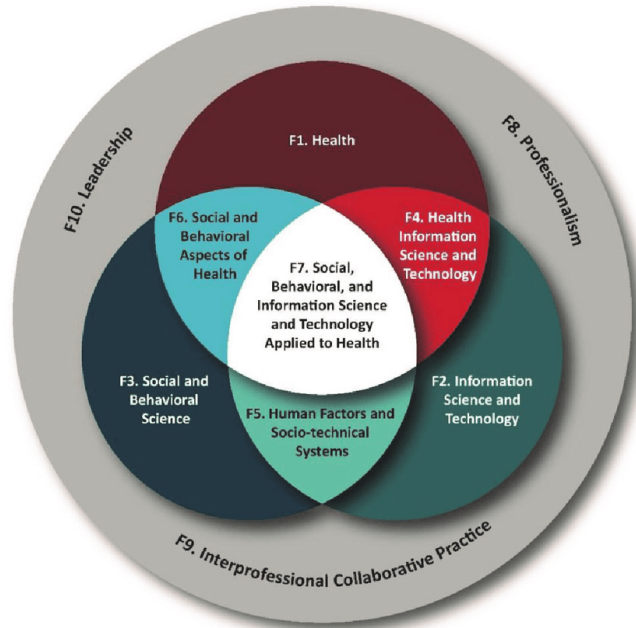


Figure 2: CAHIIM Health Informatics Competencies

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.

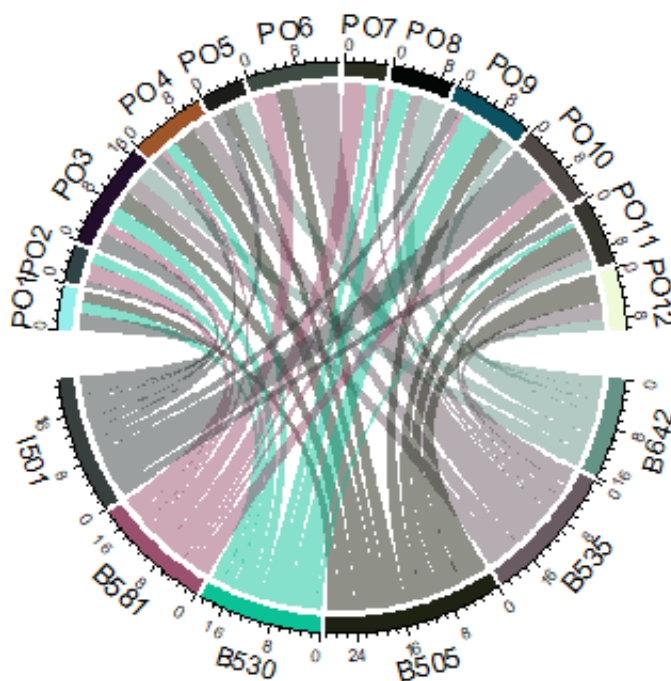
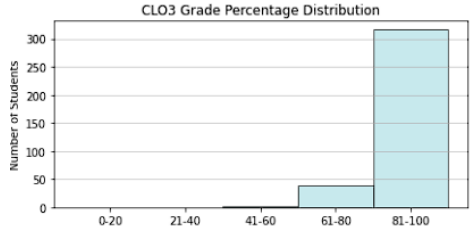
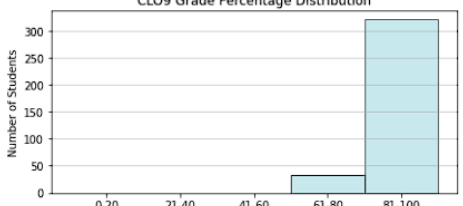
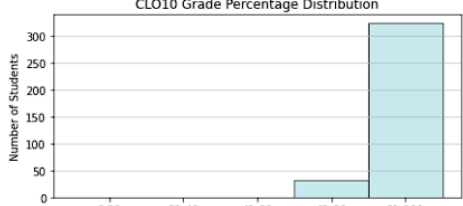


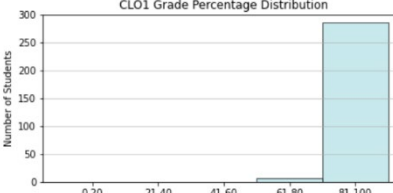
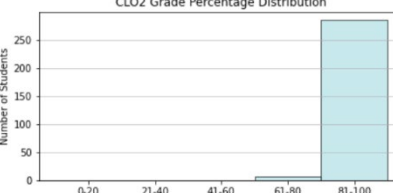
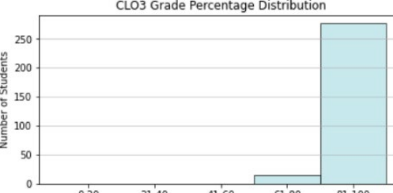
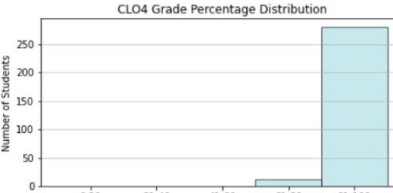
Figure 3: Relationship between the Course Learning Outcomes and HI Program Learning Outcomes

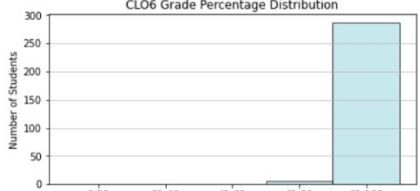
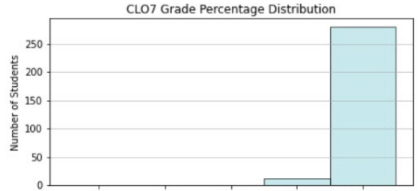
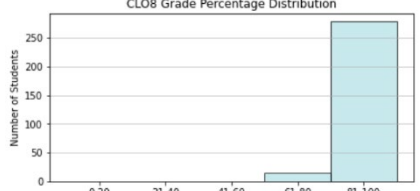
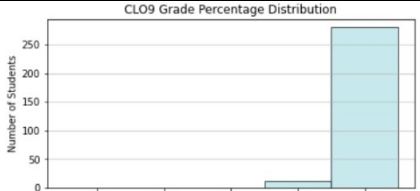
Further, by looking at each course in Canvas and looking at the assignments and other assessments for each course and compared with the learning outcomes for each student. By applying statistical methods to analyze the data, we are able to identify the gaps where instructors need to focus on particular content and then improve the instruction in those gaps in the course. Table 2 and Table 3 show the analysis for the 2 core courses. Similar analysis has been done for the electives too. This data-based approach shows promising gains and student learning in the learning outcomes with gaps in improving in the last 2 years. The following is an analysis of 2 courses – I501 – Intro to Informatics, B518 - Applied Statistical Methods for Biomedical Informatics.

INFO I501 – (Intro to Informatics) Analysis				
Learning Outcomes	Grade distribution (Aggregate)	% students meeting LO (>=80 points)	% students meeting LO (2021)	% students meeting LO (2022)
1. Differentiate between research fields, theoretical concepts, epistemologies, and qualitative and quantitative methods.		89.44%	92.42%	87.50%

<p>2. Analyze critically and speak publicly about field-specific scholarly research, projects executed in class, and data management issues.</p>	 <p>CLO2 Grade Percentage Distribution</p>	90.85%	90.90%	92.10%
<p>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.</p>	 <p>CLO3 Grade Percentage Distribution</p>	87.68%	89.39%	88.15%
<p>4. Apply software development methodologies to create efficient, well-structured applications that other programmers can easily understand.</p>	 <p>CLO4 Grade Percentage Distribution</p>	91.20%	90.15%	92.76%
<p>5. Analyze computational complexity in algorithm development.</p>	 <p>CLO5 Grade Percentage Distribution</p>	87.68%	91.66%	87.50%
<p>6. Investigate research questions and designs by loading, extracting, transforming, and analyzing data from various sources.</p>	 <p>CLO6 Grade Percentage Distribution</p>	90.85%	89.39%	92.76%
<p>7. Test hypotheses and evaluate reliability and validity.</p>	 <p>CLO7 Grade Percentage Distribution</p>	89.44%	88.63%	90.13%
<p>8. Implement histograms, classifiers, decision trees, sampling, linear regression, and projectiles in a scripting language.</p>	 <p>CLO8 Grade Percentage Distribution</p>	88.73%	87.12%	92.10%

<p>9. Decompose and simulate systems to process data using randomness.</p>		<p>90.49%</p>	<p>89.39%</p>	<p>92.76%</p>
<p>10. Employ supervised and unsupervised machine learning for functional approximation and categorization.</p>		<p>90.14%</p>	<p>89.39%</p>	<p>90.78%</p>
<p>N</p>	<p>284</p>	<p>132</p>	<p>152</p>	<p>152</p>

<p>INFO B518 - Applied Statistical Methods for Biomedical Informatics</p>				
<p>Learning Outcomes</p>	<p>Grade distribution (Aggregate)</p>	<p>% students meeting LO (>=80 points)</p>	<p>% students meeting LO (2021)</p>	<p>% students meeting LO (2022)</p>
<p>1. Identify and interpret large size health data with missing values</p>		<p>89.44%</p>	<p>96.0%</p>	<p>99.39%</p>
<p>2. Infer and justify small size health data specific to diseases.</p>		<p>90.85%</p>	<p>94.4%</p>	<p>100.0%</p>
<p>3. Correlate massive phenotypic and genotypic data</p>		<p>87.68%</p>	<p>92.0%</p>	<p>96.98%</p>
<p>4. Decide and model population, sampling and hypothesis testing for specific diseases</p>		<p>91.20%</p>	<p>94.4%</p>	<p>96.98%</p>

6. Select and generate regression analysis and other statistical analysis for precision medicine applications		90.85%	96.0%	100.0%
7. Outline and formulate paper presentation		89.44%	94.4%	96.98%
8. Construct and rearrange project design, writing, analysis, and presentation		88.73%	92.8%	96.98%
9. Develop and revise programs to perform data analytics on large, complex datasets in R		90.49%	94.4%	96.98%
N		291	125	166

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 reassess 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 to 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 ⁶	PGPL ⁷
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

⁶ RBT: Revised Bloom's taxonomy

⁷ PGPL: Principles of Graduate and Professional Learning (1. Knowledge and Skills Mastery; 2. Critical Thinking and Good Judgment; 3. Effective Communication; 4. Ethical Behavior)

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	65,000
2017-18	27	26	21	85	68,500
2018-19	47	47	31	66	68,000
2021-22	37	37	38	92	71,000
2022-23	102	102	91	98	72,000

Salary media

Nursing Informatics: According to PayScale, the [average salary for an Nursing Informatics](#) \$83,901 per year per year, with an average reported salary range of \$66,000 to \$105,000. The highest paid informatics nurses reside in Dallas, Texas, Pittsburgh Pennsylvania and Portland, Oregon with 43%, 6% and 0.1% higher than national average respectively.

Health Informatics Specialist: According to PayScale, the [average salary for a health informatics specialist](#) is \$73,148 per year, with an average reported salary of \$49,000 to \$114,000 per year. The highest paid health informatics specialists reside in Washington, DC; according to data from PayScale, where the average reported salary of 39.4% more than national average.

Clinical Informatics Specialist: According to PayScale, the [average salary for a clinical informatics specialist](#) is \$82,423 per year, with a reported salary range from \$62,000 to \$112,000 per year. The highest paid clinical information specialists, according to data from PayScale, reside in Los Angeles, California and Seattle Washington with 19.2% and 18.2% more than average, respectively.

Clinical Analyst: According to PayScale, the [average salary for a clinical analyst](#) is \$75,516 per year, with a reported salary range from \$56,000 to \$97,000 per year. The highest paid clinical analysts live in Nashville, Tennessee and New York, New York with 10.3% and 5.4% higher than average, respectively.

Clinical Informatics Manager: According to PayScale, the [average salary for a clinical informatics manager](#) is \$103,706 per year, with a reported salary range of \$66,000 to \$135,000 per year. Those with nursing informatics, electronic medical record, and clinical information systems skills reported average salaries of \$105,645, \$103,828, and \$101,972, respectively.

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
- Access program manager
- Data Engineer
- Quality Management

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

List of companies

- IU Health
- St. Vincent
- Eli Lilly
- American Health Network
- Epic Systems
- Cerner Systems
- Salesforce
- Regenstrief Institute
- Anthem
- Franciscan Health
- Mayo Clinic
- Independent Blue Cross