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Research and Applications

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Innovation of health data science curricula

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ABSTRACT

Objective: There is a growing need for innovation to prepare a well-trained health informatics workforce with data science and digital technology skills. To meet the workforce demands and prepare students for a career in health informatics, a Health Data Science (HDS) concentration was added to the Master's in Health Informatics (MSHI) program at the University of Illinois at Chicago.

Methods: Four levels of learning were incorporated into the curriculum to prepare students for highly complex jobs in health informatics. Leader interviews, advisory board meetings, and mixed faculty expertise were utilized as inputs to survey and analyze the skills employers seek in the job market. An innovative rapid infusion approach was used to design assessments across the levels of learning that simulate real-world scenarios where these competencies are used.

Results: Course evaluation surveys revealed strong satisfaction with the quality of the course and agreed that the course was intellectually challenging and stimulating. Students reported the 3 most beneficial aspects were: the live lectures, hands-on data research and manipulation, and simulated real-world situations.

Conclusions: This article discusses using a rapid infusion approach to developing active learning assignments designed to build competencies employers are seeking. These competencies also develop creative, divergent thinking with flexible, student-defined solutions. Survey data validates the approach to active learning put into context and made relevant to the learner. The benefit of the concentration is to provide students with the preparation for a successful entry into the Health Informatics field, one of the fastest-growing careers in healthcare.

Key words: Health Informatics, data science, workforce, curriculum, active learning

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LAY SUMMARY

In 2016, a small group of health informatics faculty at the University of Illinois at Chicago analyzed emerging trends in the field and realized that "legacy" curriculum centered around electronic medical record was no longer going to be the innovation path and would serve as a foundational curriculum. This effort resulted in collaborations with the advisory board, employers, faculty, and alumni to design a cutting-edge curriculum in healthcare data science as a track in the Master of Science program, oriented at clinicians and informaticists with technology and mathematical skills to solve real-world challenges in patient care and the larger domain of healthcare that includes technology vendors, pharmaceutical companies, payors, and consulting. We realized that the democratization of healthcare data was opening up new opportunities for a diverse range of students, yet there were no textbooks, best practices, or standards for this niche of informatics to consult. We embarked on an exciting journey using a method we call *rapid infusion* to translate faculty experience and external input into innovative assignments, reflections, and career coaching that prepare students to take on jobs in a variety of high-innovation organizations. A small track offered in 2018 to a few students is the most popular pathway in the program in 2022.

INTRODUCTION

There is a growing need for a well-trained health informatics workforce.[1] According to the US Department of Labor Bureau of Labor Statistics, healthcare will produce more new IT jobs through 2020 than any other industry, with a projected increase of 21%. Many of these jobs will require health informatics training. The Office of the National Coordinator (ONC) for Health Information Technology (HIT) has recommended that health informatics education should include the hands-on experience to build core digital technology skills.[2] Including health data science (HDS) competencies, as a part of the health informatics curricula, is a crucial step toward meeting these workforce demands and preparing students for a career in health informatics.[3,4]

Over the past 5 years, Health Informatics (HI) programs have altered their curricula to offer tracks, certificates, and concentrations that build healthcare analytics and data science competencies.[5–7] This requires programs to define learning objectives and a competency framework for the new curricula. At the course level, an approach to meet the challenge of designing hands-on assignments that build skills sought by employers must be developed. HIT is a heterogenous field where many professional backgrounds are represented,[8] yet there are distinct new trends in HIT where there are tracks toward hands-on technical skills and clinicians involved with translational and population studies.[9] Even at the research degree level, dissertations become specialized toward technical or clinical applications,[10] while both groups must understand integrative concepts to collaborate.[11]

The Topol report estimates that 90% of all jobs in healthcare will require some element of digital skills.[12] Healthcare professionals need to build digital literacy skills to successfully navigate a data-rich healthcare environment. Topol recommends that "health professions need to identify the knowledge, skills, professional attributes and behaviors needed for healthcare graduates to work in technologically enabled healthcare organizations, and then work with educators to redesign the curricula for this purpose."

To meet this growing need, an HDS concentration was added to the Master of Science in Health Informatics (MSHI) program at the University of Illinois at Chicago (UIC) in 2018. The benefit of the concentration is to provide students with a successful entry into the HI field, one of the fastest-growing careers in healthcare. Students may use their 4 elective courses (12 credit hours) to complete an HDS concentration. Ultimately, this report: (1) Describes the competencies and learning framework adopted by the MSHI program for a concentration in HDS; and (2) Proposes an approach for innovative curricula development and maintenance that is agile enough to meet student and labor market needs.

The HI field is maturing, leading to the need for updated curricula with the addition of knowledge and skills that employers are now seeking. This provides an opportunity for programs to rapidly address these student and employer needs through innovative curricula design methods. These urgent needs are also supported by new national accreditation standards through The Commission on Accreditation for Health Informatics and Information Management Education (CAHIIM), which now requires a competency-driven curriculum, layering skills, and professional attitudes on top of knowledge-based pedagogy.

UIC faculty in the Biomedical Health and Information Sciences (BHIS) developed a curriculum design method to meet these needs. Traditional approaches based on textbooks can be used to build core background knowledge but cannot keep up with the pace of industry change. Rapid design approaches must be used to develop assignments and assessments that incorporate current content, and the pace of this rapid design must be maintained to keep curriculum and assessment updates in line with job market expectations, given that student and curriculum assessments are intertwined.[13]

Curriculum development for these UIC programs used a rapid infusion approach to teach HDS competencies through active learning assignments, which arguably represent the best method of getting students ready for the job market in the informatics profession where few constants exist.[14] Curriculum innovations such as rapid infusion are needed for programs to adjust quickly to new employer needs and to prepare a workforce for the 21st century that is adaptable to change.

Constructivist theory applied to online teaching and learning of HDS

According to Doolittle, constructivism is a theory about how knowledge is acquired that emphasizes learning in context and creating a learning environment that is adaptive and involves sociocultural and individual processes.[15] Ultimately, constructivism is a learner-centered approach where instructors become facilitators that organize the learning experience, provide an environment for interactive learning, and guide students through the learning process.[16] Learners must do much more than passively receive information: they also actively participate in the construction of knowledge. Critical to the learning process and construction of knowledge is the hands-on application of learning in context of real-life scenarios. Assignments can be designed to provide students with the freedom to explore the

Figure 1. Health data science levels of learning. These are levels needed to prepare students for highly complex jobs, such as healthcare data analyst, and to successfully meet the needs of the health data science labor market. The job market success formula combines hard, soft, and competency-based skills with domain knowledge.

scenarios through choices they make to define solutions in their assignments.[17]

In the design of the HDS concentration, constructivist principles were applied to the development of assignments and student learning activities. These activities encompass several levels of learning (Figure 1).

MATERIALS AND METHODS

Developing the HDS concentration

To design a curriculum with assignments that meet the various levels of learning, we needed to know the hard skills required by employers for an HDS analyst position. A first step was to discover the competencies desired by employers hiring for their analytics teams. Qualitative methods used to identify industry trends and qualifications for jobs in HDS included:

- Participation in professional communities discussing emergent technologies.
- Input from the Health Informatics External Advisory Board that includes 6–8 members representing a variety of segments of health informatics (nursing, physicians, Health Information Management, consulting, payors, students, and alumni). Annual meetings are structured to provide board members with a report on the current state of the program and to obtain their input in regard to gaps and strategic alignment to industry trends. Board members serve for a 2-year term.
- Faculty professional development—practitioners and researchers each contributed valuable knowledge from their work toward curriculum innovation defining competencies that applied across trends.
- Analysis of labor market to understand the skills needed. (Review job listings to determine what skills employers are seeking.)
- Interviews with potential employers, mirroring representation on the Advisory Board by informatics specialty; open-ended but with prepared questions structured around industry demands for skills and attitudes of the job applicants.

A starting list of 20 competencies was created. Employers for clinical analytics teams from several organizations representing patient care, payor, consulting, pharma, and tech domains of healthcare were asked to review and validate that these were competencies they seek when hiring. Employers were then asked if there were any items they seek that were not on the list. To ensure consistency and consensus, follow-up interviews were conducted using the same questions and structured approach, until these conversations revealed no new information and discrepancies. Through an iterative process of interviews and revisions, a set of 50 skills and competencies (Figure 2) was developed and grouped into 4 core knowledge domains (Table 1). Each were then incorporated into 6 new HDS courses. The concentration requires 12 credit hours (4 courses). Students must complete the applied statistics course and the essentials of HDS course (BHIS 540 and 575). Then students may select 2 more courses to complete the concentration. Students are not required to complete all of the 6 newly developed courses.

New courses developed for the HDS concentration:

1. 540 Essentials of HDS (required for concentration)—Provides a foundation in data science applied specifically to healthcare. Competencies addressed include data science fundamentals: identifying data sources, integrating datasets, using data to drive strategic plans, and planning analytics projects.
2. 575 Applied Statistics for HI (required for concentration)—Presents statistical foundations for HDS using Minitab and R. The course also provides exposure to common statistical techniques, and interpretation, focusing on healthcare data.
3. 541 Healthcare Data Analytics—Explores the spectrum of data analytics used in healthcare. Students complete exercises to design datasets, interpret and articulate data results needed to transform healthcare delivery and the health of individuals and populations.
4. 542 Artificial Intelligence for Healthcare—Introduction to artificial intelligence and its application in healthcare. Competencies addressed include date exchange standards, supervised, unsupervised, and fuzzy logic.
5. 561 Programming for Health Analytics—Introduces fundamental principles of programming for data science using a popular language like Python. Exposes students to basic programming techniques, data manipulation, and data analysis pertaining to healthcare data.
6. 567 Healthcare Data Visualization—This course introduces fundamental principles of data visualization in healthcare using Tableau and focuses on the effective presentation of health analytics outcomes.

HDS curriculum creation involves consideration of present and future labor markets, along with awareness of other academic programs with similar and emerging offerings. Once developed, a spirit of innovation is required to maintain a fresh and unique curriculum. Table 2 summarizes the factors that we continually review and include in curriculum innovation.

Developing assignments and assessments

Our program has varied but heavily clinical background. Ninety-one percent of students are employed, 38% are clinicians (RN, MD/DO), and another 19% are pharmacists. Twenty-four percent have IT-related jobs in HIT, consulting, product development, and project management. The remaining 19% include administrators and ancillary health professionals. We also educate physicians pursuing a Clinical Informatics subspecialty. Teaching highly complex informatics concepts to healthcare-oriented students is a challenge. Our approach is to design assignments that simulate the real-world work

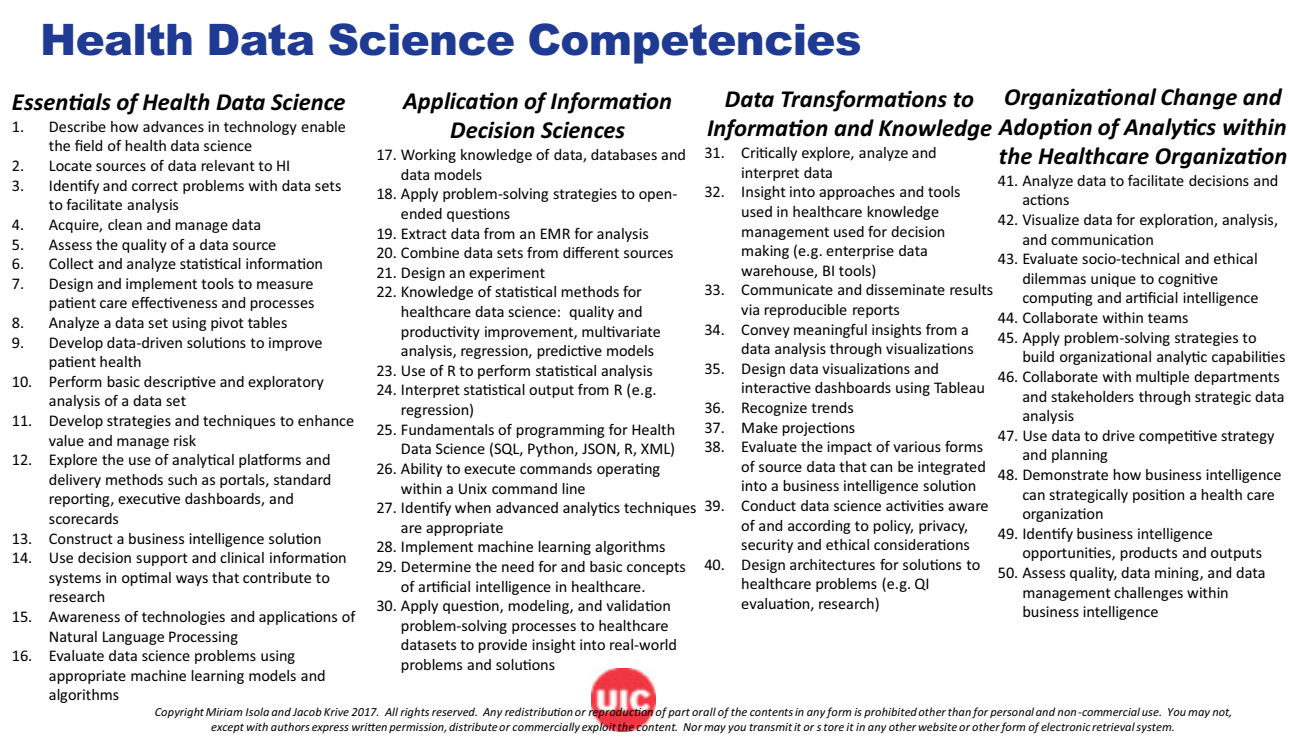

Figure 2. Health data science competencies. This is the detailed listing of all competencies covering technical and soft skills developed by the Health Data Science curriculum.

Table 1. Core HDS knowledge domains

Knowledge domain	Description
Essentials of health data science	Competencies address the foundational knowledge of health data science. Assessments teach students to understand, define and describe concepts, and recognize healthcare problems that can benefit from data science solutions.
Application of information decision sciences	Competencies address the application of knowledge about data, databases, statistics, and programming. Assessments teach students to apply foundational knowledge and develop real-world skills in data science.
Data transformations to information and knowledge	Competencies address analytics and interpretation of results. Assessments teach students to design and develop analytic products and tools to evaluate and communicate results effectively.
Organizational change and adoption of analytics within the healthcare organization	Competencies address the collaboration with stakeholders to make data a strategic asset for the organization. Assessments teach students to make data actionable for decision-making to meet the strategic goal of an organization.

done in industry in the online environment. Student-centered education for HDS was designed to extend across multiple levels of learning to teach critical and divergent thinking, active learning—not just "knowing," but also "doing." However, "doing" in data science involves hands-on technical work with data: discovery, preparation, analysis, processing, and visualization.

These tasks typically require strong computer science and mathematics—a background not generally possessed by the students in health informatics. Therefore, the first challenge was to establish the proper emphasis on technical skills and deliver the hands-on skill set that is in high demand by employers. The HDS concentration focused on clinical data analytics, where a highly prepared professional with domain knowledge in healthcare and technical knowledge in data analysis serves as a liaison between clinicians and technicians in the process of healthcare technology innovation. This role involves a combination of technical depth, medical knowledge, and business awareness. The opportunity for successful graduates is high with abundant job opportunities.

Our next challenge was to maintain academic rigor in the online environment and develop relevant, cutting-edge curriculum that meets employer needs and expectations. Addressing the current labor market needs requires a program to innovate and embrace the role of preparing a qualified health informatics workforce to address the labor market needs.

In the absence of choices for textbooks on healthcare data science at the time of initial course development, the faculty crafted a

Table 2. Summary of factors in HDS curriculum creation and maintenance

Factor	Contributor	Focus
Develop skills	Students	What skills are necessary for graduates to succeed in the targeted jobs?
Student feedback	Students	Feedback from students, as collected via brief weekly reflection assignments, as well as targeted application exercises and academic term evaluations.
Expert and practitioner feedback loop	Experts—job market	Collecting, evaluating, and translating into curriculum input from the Advisory Board and practicing faculty teaching in the program.
UIC versus other informatics and HDS programs	Job market	Understanding of the competitive landscape, in partnership with our program marketing and student advising vendor.
Job prospects, employer expectations, market demands	Job market	Evaluation of the constantly changing job market and employer expectations for skills, obtained through several methods including: Advisory Board, faculty feedback, practitioner feedback, and reports by our program marketing vendor.
		Feedback to faculty from past students reporting their successes, ask for letters of recommendation, and requests for mentoring focused on specific job opportunities.

Figure 3. Rapid infusion cycle—industry demand into the health informatics curriculum. Curriculum infusion cycle begins with faculty experience that influences assessment of the job market demands, opportunities, and trends. This assessment ultimately leads to creation of the highly relevant assignments and projects that prepare students for successful careers in the highly dynamic and rapidly changing fields.

method of building domain knowledge using a flexible approach in selecting resources and materials for the online courses. Selections were frequently updated with articles offered via online databases to students, intermixed with the latest industry reports.

Next, HDS assignments were developed to build both soft and hard skills. Active learning assignments were derived from the latest industry trends and patient care examples. They were designed to build competencies focused on "doing" and developing divergent thinking with student-defined solutions. These assignments address the latest challenges in the field and encourage innovation and student creativity. Ultimately, assignments required students to develop high-level competencies where they demonstrated the ability to work with ambiguity and apply hard and soft skills to develop solutions for undefined problems. This approach incorporates the levels of learning for preparing students, as pictured in Figure 1.

The challenge of rapidly bringing highly flexible and industry-relevant content into the program required us to apply this rapid infusion approach including the elements outlined in Figure 3. Each course has a unique content, and even though the approach and teaching philosophy behind HDS were co-designed, each faculty member used their own data, knowledge, and experience to design lectures and assignments for course.

1. *Faculty experience*—A balanced combination of the full-time academic faculty and practitioners with advanced degrees who contribute their experience as part-time faculty.
2. *Understand the job market*—Reading job postings to see emerging needs, new job titles, and complex cross-functional skill sets.
3. *Assess opportunities*—Assess opportunities to update curricula and infuse the latest industry developments. Full flexibility to update all learning materials on a routine basis, to maintain relevancy for the rapidly changing professional field and shifting employer expectations.
4. *Predict market trends*—Predicting job market trends and shifts in demand for graduates, thereby being prepared to rapidly update curricula.
5. *Highly relevant assignments*—Assignments that are so relevant to current and future directions in the field that excerpts can be shared with prospective employers. Practical approaches are identified as the most relevant methods of preparing students for industry roles in analytics.[18] Examples of such highly relevant and practical assignments are listed below, and Supplementary Appendix SA provides a more comprehensive compilation of the assignments.
    a. Perform stakeholder and data analysis for a selected healthcare industry niche.
    b. Risk assessment, build a predictive model for population health management.
    c. Build a clinical measure for a complex/chronic medical condition.
    d. Benchmark and visualize organizational performance in clinical quality and patient safety.
    e. Architect/design a mobile health solution for innovative delivery of a new model of patient care.
    f. Analyze a large de-identified patient dataset.
    g. Predict mortality and complications based on patient characteristics mined from a dataset.

h. Construct hypotheses for analyzing a database of potential opioid abuse clinical cases.
i. Design a real-world evidence system for analyzing drug performance using provider care data.

6. *Real-life projects and teams*—Real-life projects that build high-level competency skills, reflect the teamwork approach of the data analytics field, and resemble the dynamic nature of innovation environments in both traditional patient care organizations and entrepreneurial commercial firms.

RESULTS

As of Spring 2021 (<3 years since HDS inception), 26 MSHI graduates have earned the HDS concentration and 40% of incoming students now decide to pursue it. Course evaluation surveys for the first 4 semesters of the Essentials of Health Data Science course (BHIS 540) are reported in Table 3. This is one of 2 required courses for the HDS concentration. Of 135 students enrolled, 103 completed the survey for a response rate of 76%. Global survey items indicated a strong satisfaction with both the quality of the course and agreement that it met the defined learning objectives. In the Fall 2020 semester, the most recent offering of the course with the largest enrollment, 93% of students strongly agreed with this survey item. The same percentage of students also strongly agreed that the course was intellectually challenging and stimulating.

Figure 4 contains results from students that were asked the open-ended question: "What aspect of the course was most beneficial to you?" The open-ended question allowed students to provide answers in their own words. Responses were coded and grouped. Frequency of the answers is reported.

The top 3 categories that students reported as being the most beneficial aspects of the course were: the live lectures (synchronous online lectures delivered by faculty at scheduled times), hands-on data research and manipulation, and simulated real-world situations. Students also reported that having no discussion benefited their learning. This is consistent with the most frequent responses given that students valued interaction with the faculty and hands-on exercises simulating real-world scenarios.

Levels of learning for HDS

To teach HDS in the online environment, the real world is simulated through assignments based on use cases of work done in industry. Students are guided to apply domain knowledge to these real-life scenarios. Examples of assignments include analysis of data, diagraming an architecture for a new product, and evaluating data compared to benchmarks. These activities develop hard skills, such as statistics, data visualization, and data analysis. The latest research into specific data science skills leading to success in the profession indicates that a combination of business intelligence, technical skills, and analytical skills is necessary to form a profile of a good job candidate.[18] But new knowledge is also constructed through group projects, discussions, and personal reflections on the learning experience and how it will apply to the work they will do in health informatics. These activities require soft skills, such as effective communication, teamwork, and adaptability.[19] Interactive, student-centered activities expose students to multiple perspectives and interpretations which are then reflected upon, creating deeper learning. Lack of these soft skills is considered to be one of the primary reasons for modern data science project failures—inability to relate to audience and business activities the audience is engaged in Ref. (20). Ultimately, students become competent with the ability to be flexible, think critically, solve undefined problems, and exhibit divergent thinking. These are the skills necessary for success in the 21st century, shared among all STEM professions.[21]

Table 3. Overall satisfaction with course

	Strongly agreed that the quality was excellent, it met the defined learning objectives	Strongly agreed that it was intellectually challenging and stimulating
Spring 2019 $N = 8$ of 12	88%	88%
Fall 2019 $N = 16$ of 22	94%	94%
Spring 2020 $N = 20$ of 25	95%	90%
Fall 2020 $N = 28$ of 38	93%	93%

All the levels of learning are needed to prepare students for highly complex jobs such as healthcare data analyst and to successfully meet the needs of the HDS labor market (Figure 1).

As an example, the highly complex job of a healthcare data analyst/clinical informaticist entails the following:

1. *Domain knowledge*—Understanding the factors and variables leading up to demand for data and its analysis in support of operational management, quality innovation, technology enhancement, and clinical excellence initiatives. Additionally, the ability to research and translate necessary information to application in the healthcare domains.
2. *Soft skills*—Ability to present highly complex information to varied audiences consisting of clinical, technical, and general business professionals and executives. Also, ability to visualize complex information and explain it in accessible ways. Called "Power Skills," this category includes complex behavioral skills.[22]
3. *Hard skills*—Ability to perform hands-on data retrieval and analysis tasks, as well as data visualization, light programming, and benchmarking.
4. *Competency skills*—The highest level of learning that synthesizes all the previous levels with the result of demonstrating competency that incorporates "knowing," "showing," and "doing."

Assignments in HDS

Informatics is an interdisciplinary field, and so is HDS as its concentration. While we provide students with hands-on skills demanded by employers, the core strength of this program is incorporating healthcare domain knowledge into analytics curriculum, which is a departure from traditional approaches of presenting students with technical concepts that are industry domain agnostic. Rather than teaching concepts of statistics and computer science via programming and mathematics-oriented assignments, we present real-world healthcare challenges that require the application of mathematics and technology along the way.

DISCUSSION

As anticipated, students reported that the most beneficial aspects of the course were assignments where they applied their knowledge and completed hands-on assignments that simulated real-world scenarios. This can be interpreted as the student's perception that they

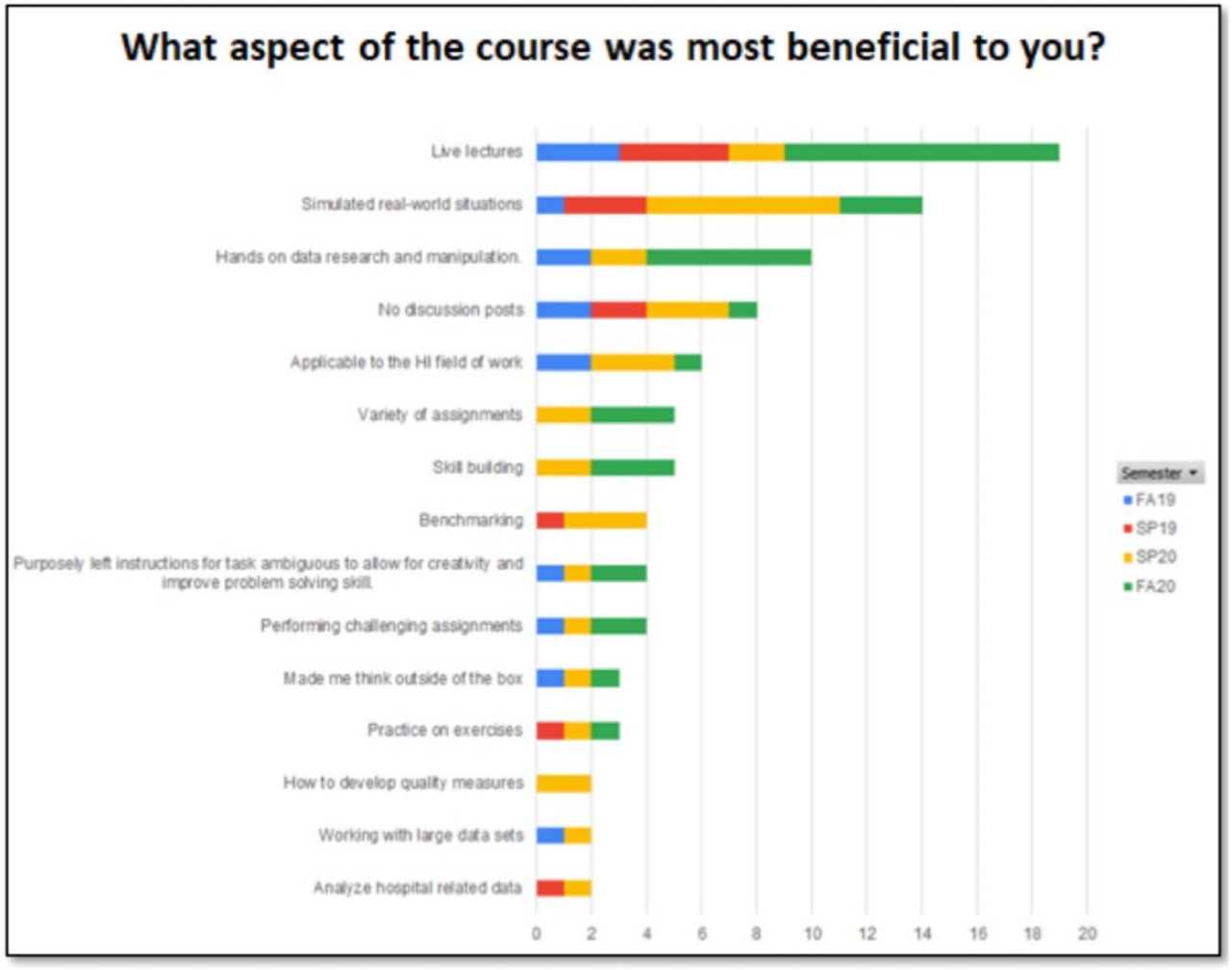

Figure 4. Most beneficial assessments. Summary of the open-ended question asking students to select the most beneficial aspects of the course revealed that direct interaction with faculty, real-world problems, hands-on exercises, practical applicability to the health informatics field, and reduced focus on asynchronous interaction were several of the top features. This question on the course survey shows how faculty involvement and real-world challenges, in combination, support learning in a dynamic field that experiences high demand for new job market entrants.

did gain skills that they would use as they complete academics and go on to look for health informatics jobs.

Universities must embrace the role of talent provider. This means innovating new curricula that meet labor market needs. Faculty with strong ties to industry can inform the relevancy of the curriculum to teach real-world skills that are in high demand by employers. Methods for maintaining the curriculum through ongoing study of the labor market and engaging practitioners as advisors ensure that the curriculum remains aligned with industry needs. We utilize multiple approaches to engage practitioners: relying on Advisory Board members for key strategic decisions, using industry contacts to validate new in-demand skillsets, and employing faculty with industry experience. These faculty can bring their experience to bear designing live lectures, hands-on assignments, and interactive student experiences—all the methods identified as high-impact practices in the online education.[23]

Preparing students for jobs

While curricula are a critical component, faculty can also provide value through supporting students as they transition from being students and build their HI careers by advising students on career questions. Of the 26 MSHI graduates with an HDS concentration, 10 contacted faculty to request mentorship and advice on preparing for job interviews. These examples illuminate the type of guidance needed from faculty to help students translate their knowledge, skills, and competencies into labor market requirements.

- A student received an invitation for an in-person interview and was required to present a project of his choice to demonstrate ability to design and manage complex healthcare technology applications. In partnership with a faculty member, he modified an assignment in HDS curriculum to fit specifics of the firm's core product model ultimately receiving a job offer.
- Another student initiated an account with a reputable academic institution to gain access to medical data coding and analysis tools. She applied to a job that matched the degree/track she was studying and presented relevant assignments from the HDS curriculum that involved medical data and eventually secured a job offer.
- A student was unsure whether to apply for a position that involved a specific vendor database product. With guidance from the faculty, she translated her academic competencies to learning

the specific vendor product. Faculty coaching helped her translate her competencies to the opportunity.
- Finally, clinicians—physicians, nurses, and pharmacists—transitioned to leadership and technology liaison jobs in medical informatics, using the hands-on experience and soft skills they gained in the HDS concentration.

These examples demonstrate how efforts to link the MSHI program directly to job market needs created tangible opportunities for students.

Understanding HI work and roles

To help students prepare for the job market, self-reflection assignments were incorporated into the program. Weekly reflection assignments require students to answer a few questions about their learning experience with each unit. These exercises help them identify and name the skills they gained. The reflections also help faculty to understand student perceptions, areas of difficulty, and greatest learning takeaways. This enables faculty to address issues and rapidly modify the curriculum. Even in a distance learning environment, these reflection exercises facilitate communication between faculty and students, and maintain the currency and relevancy of the course materials.

Flexibility, agility, and creativity

To spark creativity among students and prepare them to solve undefined problems on the job, the instructions for some assignments are kept "intentionally vague." This encourages students to ask questions, explore new ideas, and become agile and creative in bringing together elements from different sectors of the healthcare industry. Such an approach also prepares students for health informatics jobs with a variety of employers. Innovation firms experiment, explore multiple paths and change directions many times to arrive at new discoveries.

The goal in preparing the health informatics workforce is for students to function in any of these environments, whether the goal is clinical quality or unstructured innovation. To take advantage of the full spectrum of what health informatics work is, students must have the ability to cross multiple sectors of the healthcare industry, easily going between vastly different organizational structures. Ultimately, the program prepares students for the limitless array of opportunities in the healthcare industry.

CONCLUSIONS

Student success in academia and the job market requires a complex subject such as HDS to include a wide array of pedagogical methods and assessments focused on different levels of learning. Furthermore, to be successful, the program must incorporate opportunities for students to practice real-world scenarios which help them see the connection between the curriculum and the work of a health informatician and be able to articulate how what they learned aligns with the labor market requirements.

Innovation is an iterative process of trial and error that requires foundational knowledge, persistence, and relentless drive to pursue new objectives. Both the work and the professional role of health informaticians are changing. Preparing students for the profession where new knowledge becomes old quickly and where redefinition of skills is ongoing requires nontraditional pedagogical methods to keep up with the pace of change. Therefore, rapid infusion of the latest requirements in the job market into the curriculum is necessary to continue preparing qualified and market-ready students.

This pedagogical approach prepares students to obtain jobs with employers from small life sciences innovation firms to large healthcare conglomerates to community service organizations. Despite their scope and focus, these employers are all searching for leaders who can innovate to create and institutionalize change.

AUTHOR CONTRIBUTIONS

MI's contributions to this manuscript include: co-development of health data science competencies, design of the courses and assignments, analysis of the course evaluation data, development of Tables 1 and 3 and Figure 2, drafting sections of the manuscript and editing the entire manuscript, and completing the submissions of the manuscript. JK's contributions to the manuscript include: co-development of the health data science competencies, design of the courses and assignments, development of Tables 1 and 2 and figures, compiling assignment examples under Supplementary Appendix SA, and drafting sections of the manuscript and editing the entire manuscript.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *JAMIA Open* online.

CONFLICT OF INTEREST STATEMENT

None declared.

GLOSSARY TERMS

Health Data Science: *Health Data Science* is the *science* and art of generating *data*-driven solutions through comprehension of complex real-world *health* problems, employing critical thinking and *analytics* to derive knowledge from (big) *data*.

Centre for Big Data Research in Health UNSW Sydney: https://cbdrh.med.unsw.edu.au/what-health-data-science#:~:text=Health%20Data%20Science%20is%20the,knowledge%20from%20(big)%20data.

DATA AVAILABILITY

The data that are sharable and underlying this article are available in the article and/or in its Supplementary Material. The more detailed information regarding students and members of the Advisory Board mentioned in this manuscript cannot be shared due to privacy concerns.

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