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A Skills Assessment Pathways-Based Program Assessment Approach in Multidisciplinary Graduate Health Informatics

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Abstract. Multidisciplinary graduate education programs are hard to assess because of interdependent competencies. Students in these programs come with diverse disciplinary undergraduate degrees, and it is critical to identify knowledge gaps among these diverse learner groups to provide support to fill these gaps. Health Informatics (HI) is a multidisciplinary field in which health, technology, and social science knowledge are foundational to building HI competencies. In 2017, the American Medical Informatics Association identified ten functional domains in which HI competencies are divided. Using pre/post-semester knowledge assessment surveys of graduate students (n=60) between August 2021 to May 2022 in one of the largest graduate HI programs in the United States, we identified courses (n=9) across the curriculum that help build HI-specific competencies. Using statistical analysis, we identified three skills pathways by correlating knowledge gained with course learning objectives and used this to modify the curriculum over four semesters. These skills pathways are connected through one or two courses, where students can choose electives or, in some instances, course modules or assignments that link the skills pathways. Moreover, there is a statistically significant difference in how students gain these skills depending on their prior training, even though they take the same set of courses. Gender and other demographics did not show statistical differences in skills gained. Additionally, we found that research assistantships and internships/practicums provide additional skills not covered in our HI curriculum. Our program assessment methodology and resulting curricular changes might be relevant to HI and other multidisciplinary graduate training programs.

Keywords. Program assessment, curriculum design, health informatics, multidisciplinary education

1. Introduction

Multidisciplinary graduate education programs are hard to assess because of interdependent competencies and students come into multidisciplinary programs with different undergraduate degrees [1]. Skills assessments and surveys are some ways to identify the skills that students learn from the coursework [2]. Addressing skill gaps benefits the growth of the school, and it also energizes the staff [3]. Informatics is "a

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discipline focused on the acquisition, storage, and use of information in a specific setting or domain" [4]. Students in Health Informatics (HI) are expected to have knowledge of three major domains (F1, F2, and F3) [5]. These core disciplinary domains (F1) Health, (F2) Information Science Technology, (F3) Social and Behavioral Science, intersecting domains – (F4) Health Information Science and Technology, (F5) Human Factors and Socio-technical Systems, (F6) Social and Behavioral Aspects of Health, and the central intersection of all 3 core disciplinary – (F7) Social, Behavioral, and Information Science and Technology Applied to Health [2]. Finally, overarching competencies include – (F8) Professionalism, (F9) Interprofessional Collaborative Practice and (F10) Leadership.

With environmental disasters and emerging infectious diseases posing several challenges, Public Health Informatics (PHI) has taken on increased importance in recent years [6]. According to a 2022 article by Isola and Krive [7], the field of health informatics is one of the fastest growing in the healthcare industry, and students can prepare themselves for a successful career by concentrating on this field. Additionally, a recent study by Brouat et al. [8] suggests that technology and computer science have improved the quality, efficiency, and delivery of healthcare over the last 70 years. In recent decades, clinical informatics has developed into a broad, multidisciplinary field that requires skills and knowledge that are far beyond other healthcare subspecialties [8]. Furthermore, there is an increasing number of post-graduate programs offered by higher education institutions in a wide range of countries related to BioHealth Informatics and Health Informatics [9]. Across countries, accredited Master of Science in Health Informatics (MS/MSc HI) programs show wide variation in course coverage and competencies [8]. According to McLane et al., the academic and industrial sectors do not align, with practical experience being preferable to specific curricular requirements [10]. Academia and industry must share clarity and understanding of terms to define and advance health informatics education and practice [10]. However, educational organizations need to institute some changes like integrating AI training into training curricula in medical and health informatics [11].

The primary aim is to enhance program assessment via student self-assessment and semester-end surveys and assess skill growth over time. Health Informatics MS at IUPUI is a 36-credit hour program with 9 core courses, a capstone/thesis, and 2 electives. See Table 1 for core course competencies and objectives.

Table 1. Core courses in the program by the competencies and domains.

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
INFO I-501		✓			✓		✓	✓	✓	✓
INFO B-505		✓	✓		✓	✓		✓	✓	✓
INFO B-530	✓	✓	✓	✓	✓			✓	✓	
INFO B-535	✓	✓	✓	✓	✓		✓			
INFO B-518				✓						
INFO B-581	✓	✓		✓	✓		✓			
INFO B-583	✓	✓	✓	✓			✓			
INFO B-626	✓	✓			✓	✓	✓			
INFO B-642		✓		✓	✓					

Curriculum is adaptive and requires us to take a pathways approach to program evaluation. Using statistical analysis, we map skills via self-assessment to reshape the 4-semester curriculum. These skills pathways are connected through one or two courses, where students can choose electives, course modules, or assignments that link the skills pathways. Our program assessment methodology and resulting curricular changes might be relevant to HI and other multidisciplinary graduate training programs.

2. Methods

2.1. Data Collection and Extraction

In Fall 2021 and Spring 2022, validated Qualtrics surveys gathered data. In Spring, 16 students retook the survey, with 15 showing improvement in 20+ skills from Fall. Using Q-Q plots, normalization tests were conducted. Additionally, visualization was generated with Matplotlib and Seaborn.

In total, 60 students responded to the Spring 2022 survey and 47 to the Fall 2021 survey. Among these respondents, 16 students took it for the second time for whom we could compare the skills growth across semesters. Furthermore, the dataset was divided into two datasets: 'new' being the results of the survey that was taken by students during the spring semester, and 'old' being the results of the survey that was taken by students during their fall semester. Initially, to compare the old and new datasets, we needed to ensure that there were similar columns in both our datasets.

2.2. Survey Structure

The self-assessment survey contains a total of 28 questions, of which 19 are on a 5-point Likert scale - 0 represents "don't know now but interested in learning"; 1 represents "no experience"; 2 represents "could get by with help from others."; 3 represents "some ability"; 4 represents "strong ability". The survey took an average of 22 mins to complete after the outliers were removed. Further, the skills (total skills = 94) were categorized as follows [12]: Soft skills (n=23), Basic tech skills (n=15), Advanced tech skills (n=41), Health-related skills (n=8), and Logical skills (n=7). Skills in each category were averaged for a score per student for each semester and association tests were performed between category average and the courses taken.

2.3. Statistical Testing

Two coherent groups of data from the two semesters were later divided into five groups and average skills per group per student. Hence, we performed a Kruskal-Wallis one-way analysis of variance for identifying the variance for the 16 students in their old skills and new skills.

2.4. Data Visualization

Figure 1 compared the average skills across semesters. We performed exploratory data analysis in pandas and data visualization with Cufflinks. Line charts and bar charts comparing the skills of the common students between the surveys and the new students were discussed among the faculty.

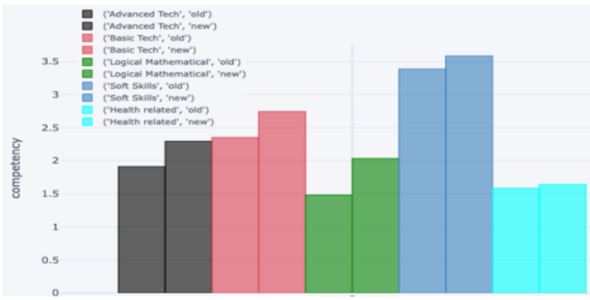

Figure 1. Comparing skills over time.

3. Results

Our analysis has helped improve the curriculum by adding modules into introductory courses to develop these skills. On average, the students had improvement in 30.73 skills out of the 94 skills that we measured (n=15).

A pathway showing the skills covered in each course overlayed with the skills gained by the students, was produced based on the statistical analysis. This data science-approach, highlighting only statistically significant improvement in skills based on merging course learning outcomes, self-assessment, and a skills catalog in the discipline is rarely seen in program evaluations in Health Informatics. Figure 2 shows an example product for the advanced tech skills tree and how they are linked with each course.

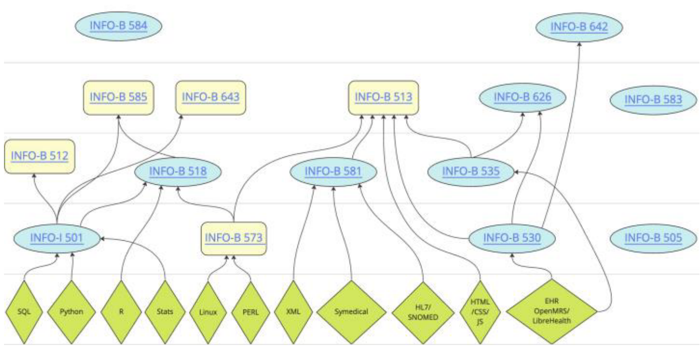

Figure 2. Course-based skills map for advanced tech skills.

Additionally, our analysis highlights the need to add courses early in the program that can improve soft skills among our student population. Table 2 highlights significant improvements in advanced tech and logic skills among repeated respondents, showcasing meaningful inter-semester differences.

Table 2. Kruskal-Wallis results comparing the improvement in average skills per category.

Old vs New	p-value	$\chi2$ at 2 degrees of freedom
Soft skills	0.49366	0.46853
Basic tech skills	0.11930	2.42637
Advanced tech skills	0.05698*	3.62307
Health-related skills	0.52399	0.40601
Logic skills	0.00384**	8.35714

4. Discussion

There is a shortage of skilled personnel within the field, primarily due to universities not producing enough graduates in the field [13]. Many institutions do not offer or have a curriculum for this course, which is why this happens [13]. Our work is to evaluate if such a curriculum meets its objectives of building skills in the students based on self-assessment and not traditional approaches. Such assessments might help get concrete student self-assessment and improve the curriculum to meet the needs of the discipline after students graduate from the program.

5. Conclusions

Data analysis of the end-of-the-semester skills survey showed that there is a noticeable increase in certain skills. Therefore, it can be concluded that the Department of BioHealth Informatics at Indiana University Purdue University Indianapolis has been successfully working towards the improvement of the skills of its students. Moreover, the research questions for future researchers to work on could be: "What courses are the scholars willing to opt for in the future and why?"

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