Community Partnerships for Enhanced Research Experience in Biomedical Informatics

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Abstract—The Department of BioHealth Informatics at the School of Informatics and Computing, Indiana University Purdue University Indianapolis (IUPUI) has successfully built strong collaborations and partnerships with local communities. The partners include but not limited to other higher education institutes, biomedical research institutes, healthcare organizations, pharmaceutical companies, government agencies, and other biomedical technology industries. The department drafted a 5-year strategic plan to foster teamwork and practice with community partners, which benefit both faculty and students. The department also recruited members for the BHI community-based advisory boards with diverse backgrounds and different decision making. The advisory board strengthens our programs to meet the industrial needs, promote faculty interactions with local communities, and increase student employment opportunities. Through the weekly BHI seminar series, including colloquium speakers, Ph.D. student work-in-progress reports, and faculty proposal development, BHI faculty have been successful in building new collaborative projects and secure joint grants. Another significant initiative is the establishment of the BioHealth Informatics Research Center (BHIRC), which systematically promotes collaborations among faculty members, students, and external collaborators. Students have enriched research and learning experience from hands-on experience, application-oriented projects, and internships with local companies. The practices and strategic planning can be extended to other informatics disciplines easily.

Keywords—Community Partnership, Research Collaborations, Hands-on Experience, Research Center

I. INTRODUCTION

Indianapolis, the capital of Indiana State, is known as the Crossroads of America and one of the cities with the most rapid growth in biotechnology and life science [1]. It is also the home of the Indiana University School of Medicine, the only medical school in Indiana and the largest medical school in the U.S. [2, 3]. Indiana University Purdue University Indianapolis (IUPUI), is located next to downtown Indianapolis, the second largest core campus of the Indiana University system, which offers both Indiana University and Purdue University degrees [4].

IUPUI has a track record and is proud of nurturing community partnerships in various disciplines. The U.S. News identified IUPUI as one of the Most Innovative Schools, ranked #57 among all National Universities in 2019 [5]. IUPUI is the leader for cross-disciplinary research and pioneer in biomedical research, surrounded by IU Simon Cancer Center [3], Eli Lilly [7], Corteva Agriscience (previous known as Dow AgroSciences) [8], Indiana Bioscience Research Institute (IBRI) [9], the Cook RegenTec [10], Regenstrief Institute [11], and many others. IUPUI has multiple other research centers and industrial businesses that provide exciting career opportunities in biomedical informatics. For example, Indiana is well-known for its large healthcare exchanges, including the Indiana Health Information Exchange (IHIE) [12] and Michiana Health Information Network (MHIN) [13]. Our programs in biomedical informatics have benefited from the collaborative environments by building strong community partnerships for faculty and students.

The Department of BioHealth Informatics (BHI) is the home to an interdisciplinary group of faculty and students in the four programs: Bioinformatics, Health Informatics, Biomedical Informatics, and Health Information Management. This paper will discuss how BHI has leveraged the surrounding communities and partner institutes to promote interdisciplinary research and enhance student success in the ever-changing biomedical informatics field.

II. OVERALL BHI PROGRAMS

A. Programs and Degrees in BHI:

Our BHI department is in the School of Informatics and Computing (SoIC) [14], which is the first completely new school in the United States devoted exclusively to Informatics and a range of its subdisciplines. SoIC has strong ties with the health and life sciences. Thus, BHI intrinsically has all programs in the interdisciplinary fields.

The mission of BHI is thrived to become the catalyst for excellence in education, research, community engagement, and workforce development in precision medicine, health information technology, and management. It is the home to a dynamic and interdisciplinary group of faculty and students in Bioinformatics (BI), Health Informatics (HI), Biomedical Informatics (BMI), and Health Information Management (HIM) programs. Table 1 listed our programs and degrees offered in the department.

The accelerated B.S. + M.S. programs are created to save time and money for students. The integrated bachelor and master program can ensure advanced students to receive both B.S. and M.S. degrees in five years. Usually, students can apply to the accelerated program at the beginning of their junior years. Upon admission, they can enroll in graduate courses as undergraduate students, with an undergraduate tuition rate, which is usually
TABLE I. THE BHI DEGREES AND PROGRAMS IN LIFE SCIENCES.

<table>
<thead>
<tr>
<th>Degrees/Programs</th>
<th>BI</th>
<th>HI</th>
<th>BMI</th>
<th>HIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph.D.</td>
<td>X</td>
<td>x</td>
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<tr>
<td>M.S.</td>
<td>X</td>
<td>x</td>
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<tr>
<td>B.S.</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Ph.D. Minor</td>
<td>X</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accelerated B.S.+M.S.</td>
<td>X</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Graduate Certificates</td>
<td>X</td>
<td>x</td>
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<td></td>
</tr>
<tr>
<td>Undergraduate Certificates</td>
<td>X</td>
<td>x</td>
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... cheaper than the graduate tuition rate. These graduate courses will be double-counted towards both degrees. The double-counted classes are limited to four or five courses. Other benefits of the accelerated programs include but not limited to:

- Students will receive both BS and MS degrees at the end of the 5th year.
- Students will be in the job market one year sooner, comparing to the traditional B.S. (4 years) + M.S. (2 years) = 6 years.
- Students will have complementary informatics skills (such as programming and computational skills) and other domain knowledge (such as biology or biomedicine).
- Students will have better employment opportunities and a higher starting salary.
- Students will also have better chances to pursue higher education, such as better chances to be accepted into a Ph.D. or M.D. program.

In the BHI departments, we have two B.S. programs (i.e., HIM and BMI), and two graduate programs (i.e., BI and HI). Thus, we have accelerated programs within our department. In addition, we also have expanded our accelerated programs to other departments and schools, even training programs in different universities. Figure 1 below illustrated the current accelerated program with our M.S. programs. Our B.S. programs also have joint programs with other departments, such as the graduate programs in public policy or epidemiology.

We have also partnered the accelerated programs with other universities, in the Indiana state or other states. For example, we have established the 4+1 program with universities in Delaware and Atlanta. Also, we have created Memorandum of Understanding (MOU) with international partners in China and Indian for expanded accelerated B.S. + M.S. programs. Currently, we have students enrolled from these domestic and international institutes.

Thus, community partnerships are intrinsic in our programs in biomedical informatics. The accelerated program also created the research experience for our students since their early undergraduate study as we have regular meetings with first-year students and sophomores. While introducing accelerated study opportunities, we also present research opportunities for them. Many students start to work on research projects with BHI faculty after the introduction of the accelerated programs.

... B. BHI program features:

Our education aims to provide the students and trainees in all our programs (i) the capabilities to own their future professional careers and (ii) the skills to achieve their future goals. Thus, we are driving to provide our students with the following five distinctive program features for all our education program.

**Rigorous curricula:** Students are expecting to learn different essential informatics skills in the corresponding life science and healthcare fields, to apply to analyze big data in the areas, use in pioneering research, and extend in the industry challenges.

**Cutting-edge research opportunities:** From day one on entering the programs, the students will work closely with world-renown professors in multidisciplinary research, such as projects in data science, big data analytics, drug discovery, genomics, proteomics, Electronic Medical Records, Medicaid data, health information exchange, mobile health applications, and other HIT.

**Extensive industrial experiences:** Students are provided with expanded opportunities for internship, sponsorship and collaborative research through industry connections with bioscience research institutes, healthcare organizations, community health centers, biopharmaceutical partners, and biotechnology companies.

**Student research scholarship:** Motivated students with good academic standing will have a fellowship as a tuition benefit. Additional student assistantships and work-study opportunities are available to students to work as teaching or research assistants.

**Prepare students for the demanded BMI job market:** Our graduates will master both the hardcore informatics skills in life science and soft skills for a professional workspace. The job placement rate for our students is >99% within three months after graduation.

The BMI program empowers our students to address biomedical science and healthcare with big data and IT skills.
III. STRATEGIC PLANNING IN BHI

The ever-increasing complexity of biomedical informatics requires intense collaboration and partnership to achieve faculty and student research success and industrial experience. This section will discuss how the department has leveraged the precious resources in the surrounding communities and partner institutes to promote interdisciplinary research and student education in the ever-changing field of biomedical informatics.

A. Strategic Planning in BHI:

The BHI faculty have worked together to develop a 5-year strategic plan to commit our department to high-quality education, student success, research excellence, and community partnerships. One major development is to enhance the research success and industrial experience for both faculty and students through a community partnership and industrial collaboration.

We have prioritized the top seven strategic areas through community partnerships, each area with its objectives, action items, and expected outcomes for 1-year, 3-year, and 5-year. The related strategies for our faculty research and student work with our local communities are briefly summarized below.

Task 1. Establish a community-based advisory board and formalize it as an integral part of the department.

Task 2. Create the BioHealth Informatics Research Center (BHIRC), which will
- foster constructive dialogue,
- establish productive collaborations,
- give corporate partners unprecedented access to emerging technologies and BHI faculty expertise.

Task 3. Promote faculty and student research activities with community partners and impact the community, nation and globe through civically engaged research, service and community outreach.

Task 4. Advocate research commercialization and research entrepreneurship through applied, translational and transformative research.

Task 5. to improve the quality of student experiential learning and integrate research, which will
- redesign the practicum courses, internship programs, and capstone projects with our community partners.
- Promote student research development, entrepreneurship, and innovation

B. Faculty Involvement in Integrated Research and Education:

The faculty in the department conduct groundbreaking, externally funded research in the areas of bioinformatics, systems biology, computational biology, omics technology, clinical and health informatics, systems interventions, and community health research. All our research track faculty are expected to be responsible for student mentoring and integrated research and education. For example, all research faculty must demonstrate scholarly records with students, exhibited by student co-authored high-impact peer-reviewed publications.

All faculty members are actively involved in undergraduate and graduate mentoring. The BHI faculties have been motivated to contribute to the educational mission of the BHI degree programs. Many faculties are experts in active learning strategies and have successfully integrated teaching with research.

The BHI faculties have been active in serving many health and biomedical informatics research initiatives. They have been engaged in expanding the department research scopes. For example, they have formed a cross-disciplinary team to develop multidisciplinary research projects and training programs in the health and life sciences.

C. Increase research collaboration opportunities:

To promote external collaborations, we have several new initiatives. The faculty and staff in the BHI department have improved the policies and practices to foster partnerships with external collaborators. We recognize and appreciate the contributions of external collaborators. We also appreciate the collaborative effort in the annual faculty review and promotion procedures to encourage team efforts. One way is to provide adjunct (courtesy) appointments for external collaborators to partner with BHI faculty on research projects and student training.

We formalized the departmental seminar series, which fell into four different categories. One is the bi-weekly BioHealth Informatics Colloquium Series, which has brought national research leaders in bioinformatics, biomedical informatics, health informatics, and computer science research and practices to the IUPUI campus. IUPUI students, faculty, staff, and university partners and members of the Indianapolis community, have benefited from these presentations and discussions with the speakers. Many following-up collaborations have formed from these presentations and related studies.

The second seminar series is the monthly Ph.D. student work-in-progress research presentations. Faculty and other Ph.D. students will provide feedback and suggestions on the projects. Collaborations among Ph.D. students and other attendees have started based on some presentations, which also resulted in joint publications.

The third seminar series is the monthly research proposal development for faculty. Senior and established faculty members helped and supervised junior faculty on proposal development. These events and collaborations have boosted team spirit.
The last seminar series is topic-concentrated interactive lecture series, organized each semester based on the emerging issues. For example, in fall 2019, we have a set three-lecture series on commercialization and entrepreneurship. It introduced practical and industrial aspects of biomedical technology to our research-oriented faculty and researchers, with speakers from the technology transfer office and local industrials. Several faculty members filed intellectual property disclosures. A few of them resulted in patents. One patent is under negotiations for licensing to a startup biotechnology company.

IV. COMMUNITY-BASED BHI ADVISORY BOARD

The department and our faculty enjoy close collaborations with other researchers on our campus and other universities, and local and national research institutions. The collaborations help us to serve better to the partnering communities. To promote community partnership and industrial collaboration, we have one departmental initiative to form a department advisory board with members of diverse backgrounds.

A. The BHI Advisory Board:

The advisory board members come from local biomedical communities, healthcare organizations, biotechnology industries, bioscience research institutes, pharmaceutical companies, health informatics services, healthcare information technologies, and hospitals and community health centers. The goals and expectations of the advisory board include but not limited to:

- Build a strong and enduring community-academic collaboration through the BHI Advisory Board.
- Guide, nurture and ensure that the BHI department produces workforce with skills that will fulfill today’s community needs and foresee the requirements of tomorrow in a global economy.
- Evaluate, critique, and promote the BHI curricula and programs by providing professional experiences and directions.
- Encourage the professional development of the faculty by providing summer employment and sponsoring research centers.
- Assist student job placement for both full-time and summer internships.

We have carefully balanced to make sure we have representatives from different sectors of the communities to have a diversity of the board and to receive feedback from different perspectives. It is also important to satisfy the requirements of accredited programs for the program specific advisory boards. Both our health informatics master program and our HIM bachelor programs are accredited by CAHIIM [15].

The board members are the leaders in the corresponding organizations, either administrative or in charge of recruiting activities. Some of the board members are also alumni of our programs. Most of the board members have interacted or hired our students. Thus, the board members know our program well.

B. Semin-annual BHI-Advisory Board Meetings:

We have board meetings twice a year, one in the spring semester and one in the fall semester. As illustrated in Figure 2, other than the advisory board members, the department will have faculty attending, and student representatives who are active in student organizations.

During the advisory board meeting, the department usually will update the programs and departments, especially on curriculum changes, new initiatives, or challenges we are facing. The student representatives will also present their views of the programs, students' concerns, and questions to the board members.

The board members will then first provide feedback on curricula and training programs from the employers’ perspectives. It helps our training programs meet the educational standards and the demands of industry, profession, and job markets.
They usually provide specific input on student career readiness. They will give us suggestions on what the markets expected our students to possess when they hire them, which we should teach the students. They also pointed out the non-IT skills that our students lack, such as communication capabilities, summary skills, or other interpersonal skills.

Based on the suggestions, we prioritize and implement the advice from the board meetings. For instance, in our last advisory meeting in fall 2019, the advisory provided feedback on the specific programming languages needed in the job markets. Based on the new trends in programming skill requirements in the workplaces, some board members suggested Python [17, 18], while others suggested R [19, 20, 21] for biomedical informatics. Another topic brought up by the advisory team is the student professional behaviors in the working environment. They pointed out the common problems or mistakes. Our educational programs have been focusing on technical skills and domain knowledge, but we had not paid much attention to professional behaviors yet.

The debates on the programming languages motivated us to research what the job market needs by looking at the skill requirements of active opening positions in different programs. Fig. 3 illustrated the position requirements from over one-hundred position descriptions in bioinformatics and biomedical data analytics from Indeed.com [22]. The word cloud image demonstrates that, for programming languages in bioinformatics, Python is the most frequently required skills for the bioinformatics fields. The survey results also showed that scripting languages, such as shell commands in Linux and Unix, are also continuously needed in the market.

To satisfy the market requirements for our graduates, we have performed curriculum enhancement. To give an example, for our course on programming in biomedical science, we updated the course contents with more focus on Python programming and its applications in biomedical informatics. Based on Python, the course also briefly introduced other widely-used programming languages, including Perl, R, and shell programming in Linux and Unix. Similar course improvements have been performed on other programs, such as health informatics and HIM.

In summary, the BHI community based advisory board strengthens our programs to serve the community better with translational research, and to prepare our students to meet the industrial needs through application-oriented research experience. It helps us to obtain feedback from professional partners. Currently, we have made the advisory board meetings an integral part of the department to promote and support the growth of the department. The BHI advisory board also helps to encourage faculty interactions with local communities and increase student employment opportunities.

V. STUDENT CLUBS

We have initiated several activities to promote productive internal and external collaborations to enhance faculty and student research improvement. Internally, we have created opportunities to foster constructive dialogue among faculty and students. One example is to form the student clubs, one per each program, entirely led by students. Fig. 4 illustrated the first bioinformatics student leadership group when it was first created in 2017. The club has an annual election for the leadership, decided and organized by the current student leadership team.

Each club has a designated faculty supervisor, who is for administrative purposes. The faculty supervisor also makes sure of the financial support of the club activities, such as food coverage or space rentals, if needed. The faculty is also the contact person if there are any suggestions from the club.
student clubs are also from one way to address the concerns about student professional behaviors. Through club activities, students have improved their management and communication skills, as well as leadership experiences.

The student clubs have created many activities to diversify students’ activities and promote student research experiences. The following sections will use the bioinformatics student club as an example for community partnerships. Fig. 4 illustrated one event for the students to demonstrate the bioinformatics student expertise and experience to faculty and students in other programs, the family of students, and visiting researchers from nearby institutes. The top shows the club members talk to attendees with fliers and poster demonstrations. The bottom panel was one illustration used by the club members to confer the students’ creative activities and innovative ideas.

The student clubs have many similar outreach activities in other campus and local events. Since its establishment in mid-2017, the club has promoted various events. Each fall, club members will call and form a Bioinformatics Club team, and joined the Indianapolis canal boat racing. They will set up a table for the school’s lawn party to recruit new club members. They successfully built an official Facebook page with thousands of followers.

Another unique movement by the bioinformatics student club is the production of the club tutoring sessions, where club members learn from each other. One example is that the club leaders arranged special sessions on academic topics, such as programming or database management. Advanced students tutored students with limited skills in these areas. They also organized game nights to have fun life in addition to studying. They held park picnics to enjoy the local attractions. They also had other social events to share the different cultures and food varieties for students from various countries.

The bioinformatics club has built a signature event series called Lighten-Up that is very well recognized by the students and faculty. They invited established researchers nearby to give presentations on diverse student research topics. Fig. 6 gave examples of the Lighten-up fliers. The series has successfully

![Fig. 4. The first bioinformatics student leadership group.](image1)

![Fig. 5. The bioinformatics student club has a table at an local event to introduce the student skills and activities. The bottom is one poster display.](image2)

![Fig. 6. Sample activity fliers from the bioinformatics club.](image3)

![Fig. 7. The website to show that the Inclusivity Award to the Bioinformatics Club.](image4)
delivered professional knowledge, skills, and experience to students. It enriches student research activities. One of the Lighten-Up series subjects is "Young generation professor," where a young professor gave a talk on the experience of being a professor in an academic field and how students can successfully prepare to be a professor.

They also invited industrial collaborators and community partners to link their research to real-world needs as guests for the student club events. For example, one session is for entrepreneurship in biomedical informatics, where a successful entrepreneur gave an insight into how students could turn their research results into commercial products. The club also requested the career services people to give lectures on future professional careers and job seeking. The other event focused on recruiting and organizing a student group to participate in the BioCrossroads DataX Bioinnovation Challenge [22], as shown in Fig. 7. One team came out of the club meeting. They submitted a research proposal to the DataX challenge. Although their proposed research project did not win the award (only for the top 2 teams), their project plan was ranked high. The challenge organizations have joint their proposal with one of the top 2 teams to work collaboratively on infant mortality and healthy moms.

The student leaders had made great efforts to strengthen the impact as well as to improve the events. The bioinformatics club has helped bioinformatics students and non-bioinformatics students in any other majors make improvements in both their academic life and career life. The club anonymously gathers suggestions, ideas, and dissent from students and conveys through proper channels to the program faculty or staff. Thus, the club creates a platform for individuals in the bioinformatics community to communicate effectively. Due to the excellent work, the Bioinformatics Club was chosen to receive an Inclusivity Award at the 2019 Student Organization Awards, two out of over 100 clubs [23].

VI. THE BIOHEALTH INFORMATICS RESEARCH CENTER (BHIRC)

Another significant initiative for the BHI department is to establish the BioHealth Informatics Research Center (BHIRC) [21]. The goal of BHIRC is to developing solution-focused partnerships with industry using data analytics. We work with our community partners to combine intelligent data analytics and solutions with industry engagement for transformative improvement in health outcomes through innovative research and industry collaboration.

![Fig. 8. The research scopes and focuses areas of the BHI Research Center.](image-url)
The mission of BHIRC is to promote industrial and academic collaborations by providing solutions based on partner needs. It has three focus thrusts: 1) innovative research and development, 2) active community outreach and collaboration, and 3) practical training and student engagement.

The BHIRC creates practical solutions for bioscience and health data management based on our faculty expertise. BHIRC faculty members have diverse backgrounds and expertise. With the connections through BHIRC, their research is translated into multidimensional biomedical information solutions that solve problems at every level of the biomedical continuum. As shown in Fig. 8, the BHIRC research scopes can be as small at the subcellular levels, such as RNA, DNA, and protein levels, and their data (multi-omics data). It can go up to individual and population health levels. The BHIRC faculty expertise is integrated bioinformatics and health informatics for personalized healthcare and precision medicine.

With the various research projects and diverse research scopes, we have summarized the BHIRC research into six clusters.

1) Precision Medicine & Omics Technology  
2) Cloud Health & Personalized Care  
3) Cancer Research & Biomarker Discovery  
4) Data Integration & System Biology  
5) Smart & Connected Health  
6) Data Analytics & Predictive Modeling

These research clusters help to find the match between faculty expertise with the needs of external collaborations. In less than one year, the BHIRC has setup several collaborative projects with IBRI, IPHCA, the Indiana Department of Health, and others. We foresee the BHIRC will pay an even more essential role in the future for collaborative efforts.

VII. CONCLUSIONS

The ever-increasing complexity of biomedical informatics requires intense collaboration and partnership to achieve faculty and student research success and industrial experience. We have initiated several activities to promote community partnerships among our faculty, students and community partners, locally or internationally. This manuscript has summarized how the department has leveraged the precious resources in the surrounding communities and partner institutes to promote interdisciplinary research and student education in the ever-changing field of biomedical informatics.

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REFERENCES