Goals and Learning Objectives for the B.S. in Health Sciences

Bachelor of Science in Health Sciences (BSHS) Curriculum—the Concept

The academic home of the Bachelor of Science in Health Sciences (BSHS) degree program is the Center for Learning Innovation (CLI). Faculty from different disciplines with a research focus on learning will jointly develop and deliver the curriculum. The curriculum will be delivered in an integrated way, which is facilitated by all faculty responsible for the degree program being part of the same academic unit.

The mission of the Center for Learning Innovation is to advance learner-centered, technology-enhanced, competency-based, assessment-driven, and community-integrated education in the health sciences through cognitive science-based, innovative learning approaches. The Center for Learning Innovation is the academic home of the Bachelor of Science in Health Sciences.

We will take a multi-dimensional approach to advance student learning and development along the axes of collaboration (from individual competition to participatory design/constructing knowledge), learning task (from drill and practice tutorials to research), learning development (from passively watching, reading, memorization, imitation to active ownership and engagement), and student development (from passive receivers of knowledge to actively engaged and open-minded citizens and life-long learners). See Figure 1.

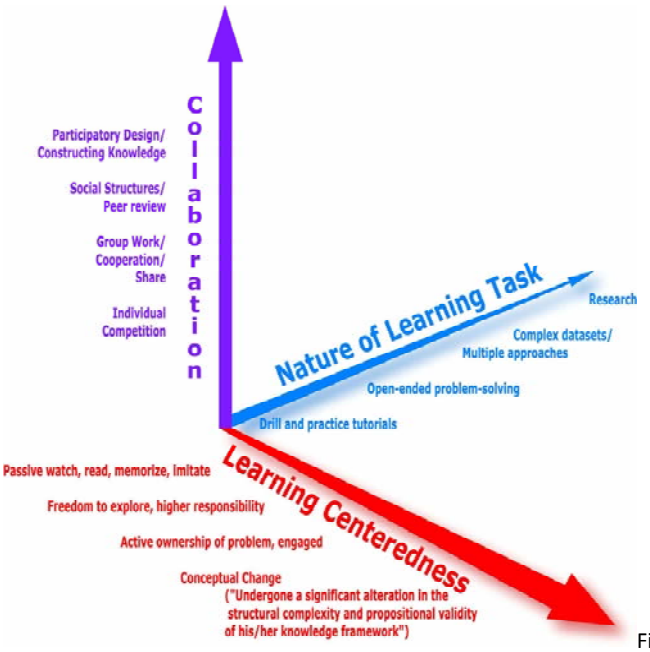


Figure 1: Courtesy of John Jungck (Beloit College)

July 21, 2008

The curriculum is built on Learning Outcomes:

At the time of receiving a bachelor's degree, students

1. Knowledge
    a. have acquired knowledge of human cultures and the physical and natural world
    b. demonstrate ownership of a body of knowledge and skills relevant to the health sciences
2. Intellectual and Practical Skills
    a. will have gained general competency in the integrative abilities of writing, literacy, quantitative reasoning, critical and clear thinking, and communication
    b. can locate and critically evaluate information from a diversity of media
    c. have acquired problem solving skills and modes of inquiry
    d. can transfer their knowledge and skills to solving complex problems
    e. demonstrate preparedness for careers, life-long learning, adaptability, and self-management
    f. can work cooperatively
3. Personal and Social Responsibility
    a. have gained an appreciation of cultural and philosophical diversity
    b. demonstrate an understanding of the role of diverse cultural values and attitudes
    c. understand the role of creativity, innovation, discovery, and expression across disciplines
    d. can discuss science in a cultural and historical context
    e. can articulate and discuss major societal challenges
    f. work within complex human systems
    g. identify and analyze ethical principles and ethically problematic decision making situations
    h. have demonstrated civic knowledge and engagement locally and globally
    i. have acquired international and global awareness

The curriculum is modularized. Modules will build on each other and their relationships will make prerequisites transparent to the student. Each module has clearly stated Learning Objectives that map into the Learning Outcomes, a set of knowledge and skills that include basic facts, concepts, and ideas. Modules are structured to include pre-assessment, formative assessment, and post-assessment. They combine learning objects, short lectures, projects, reading assignments, and other means of instruction to deliver the content. Modules will be clustered into courses that will appear on student transcripts to allow for transfer in and out of the program.

Mission

- education that puts equal emphasis on the quantitative/physical/life/health sciences and the arts/humanities/social sciences to prepare students for careers in the health sciences
- learner-centered, competency-based, assessment-driven, community-integrated
- experiential learning
- meets educational and economic needs of the greater Rochester area, the state of Minnesota, and the nation
- integrates student services for student development

Guiding Principles[1]

1. Emphasis on learning with understanding
2. Integration across disciplines
3. Integration of Student Services into the curriculum
4. Instill inquisitiveness into the student
5. Early exposure to primary literature
6. Emphasis on scientific rigor, analytical thinking, quantitative reasoning, and critical reading
7. Ability to communicate effectively in writing and speech
8. Biochemistry, molecular biology, cell biology, and genetics permeate all areas of the health sciences
9. Emphasis on concepts of physical, and quantitative sciences that are relevant to life/health sciences
10. Computational skills are required for the study of modern biology
11. Engagement in an expansive liberal arts education encompassing literature, languages, the arts, humanities, and social sciences to prepare students for citizenship in society
12. Integrated and continuous assessment to monitor and guide students and to improve the curriculum

Discipline-specific Principles

Biology

1. A one-year biology course is devoted to genetics, cell biology, anatomy, and physiology and emphasizes the unifying principle of evolution by natural selection
2. Human biology is emphasized in the one-year course but not to the exclusion of the patterns and processes of evolution and the evolution of diversity across prokaryotes and eukaryotes

[1] The principles are adapted from (1) the Report of the Working Group on Admission Requirements, Harvard Medical School, August 9, 2004, and (2) Dienstag, J.L. 2008. Relevance and rigor in premedical education. N. Engl. J. Med. 359(3):221-224. Some of the principles are taken verbatim from the report, others are adapted to the specific goals of the BSHS.

3. Deepening of concepts in genetics, cell biology, anatomy, and physiology in subsequent courses
4. Analysis of complex systems in human biology, including principles of systems biology
5. Quantitative reasoning and physical and chemical principles are integrated

Health Sciences

1. Public health and epidemiology
2. Preparation for certificate programs in the Health Sciences
3. Career exploration in the health sciences
4. Economics of health care

Chemistry/Biochemistry

1. A two-year sequence of general and organic and biochemistry will provide the foundation for understanding
2. Organic chemistry and biochemistry are integrated
3. Applying the principles of chemistry to an understanding of diagnostic and therapeutic technologies
4. Relevance to biology

Physics

1. Preparation in biologically relevant areas
2. Applying the principles of physics to an understanding of diagnostic and therapeutic technologies

Laboratory components of science courses

1. Focus on hypothesis-driven and discovery-based labs, problem-solving and hands-on experiences
2. Experimental basis of concepts in chemistry, physics, and biology

Quantitative skills

1. Apply mathematical tools and concepts to an understanding to the human organism in both health and disease.
2. Principles and approaches of statistics and biostatistics
3. Familiarity with computers
4. Explain the importance, use, and limitations of biomedical and health informatics

Analytical and writing skills

1. Writing is integrated throughout the four-year curriculum
2. Expository writing skills

Communication skills

1. Fluency and nuanced facility in English
2. Oral presentation skills
3. Communication competency in a foreign language as preparation for patient care in a global society

Liberal arts education: social sciences, arts and humanities

1. A broad and intellectually rich liberal arts education across all four years of the curriculum
2. Experiences to understand human behavior, appreciate diversity and diverse cultures and philosophies, achieve cultural awareness, and acquire skills for effective citizenship and a habit of life-long learning
3. Ability to identify ethical issues and to evaluate them rigorously from different side, specifically related to the health sciences

Diversity and Internationalization

1. Preparing students to live and work in a diverse community
2. Imbue respect for different cultures
3. International experience through Study Abroad or Clinical Internships Abroad
4. Knowledge about international affairs and other countries and cultures to adapt and respond to challenges and opportunities resulting from an increasing globalization

Community Integration

1. Integration of community experiences into foreign language modules
2. Service learning

Integration of Student Services

1. Career advising
2. Student involvement
3. Leadership development
4. Recreation and other extracurricular opportunities

Capstone Experiences

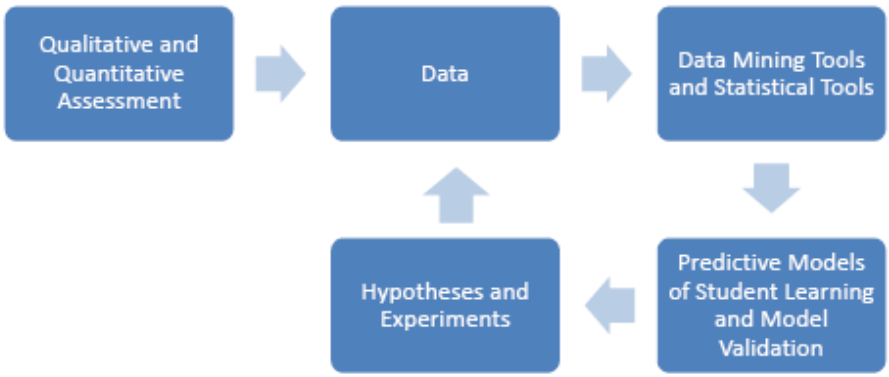
1. Independent research
2. Certificate programs in Health Professions

The Research Mission of the CLI

The mission of the Center for Learning Innovation is to advance learner-centered, technology-enhanced, competency-based, assessment-driven, and community-integrated education in the health sciences through cognitive science-based, innovative learning approaches.

The CLI will serve as a laboratory for learning. Because the CLI has control over the entire 4-year curriculum, the CLI will be in a unique position to address learning across disciplines and to advance personalized learning. The tenured/tenure-track faculty in the CLI will develop a research program in the area of cognition and student learning, supported by learning informatics. We expect the expertise of CLI faculty to range from cognitive science, to education research, and disciplinary education. While not every faculty member will have expertise in all three areas, we expect to build a team of faculty who will collectively through collaboration advance the knowledge of cognitive processes in learning and to implement insights from cognition and learning into the delivery of the curriculum. As we design and build the research program, we will continuously assess the balance of faculty expertise to build a team of faculty to achieve our research aspirations. We expect to collaborate with researchers from other institutions as well.

The diagram below explains the iterative process of discovery. The curriculum is built on Student Learning and Development Outcomes that will be assessed through qualitative and quantitative methods. Much of the research, especially in the initial stages of the development of the CLI and the BSHS curriculum will focus on building these methods of assessment. The assessment component will yield a rich set of data that will be analyzed using data mining and statistical tools (the components of learning informatics) with the goal of building predictive models of student learning. These models will allow us to formulate hypotheses and design experiments to test and refine our models.



While students are heterogeneous and come from diverse backgrounds, we base our research on the premise that over time patterns of student learning behavior will emerge from our data, resulting in predictive models of student learning. These models will allow us to personalize learning. For instance, based on a student's profile (high school performance, motivational attitudes, performance in other

parts of the curriculum, etc.), we might be able to predict with some certainty where a student might experience difficulties, namely, poor performance in one part of the curriculum might be correlated with poor performance in other parts of the curriculum. This allows us to build a better support structure for students by intervening before a student fails.

A critical component in building this research area is data on student learning and development. To this end, the CLI is developing a data base to capture all interactions of students with the various learning objects. These will include time spent on task, time of day, responses, errors, competencies passed, and competencies failed. The database will store all papers, including previous versions written by the student. In general, the database will attempt to store in its raw form much of the actual student work that can be reasonably captured digitally. The learning database will store all annotations made by faculty and student advisors. In addition, the data base will have information on student profiles, attitudes, development, career aspirations, students' metacognitive strategies, etc. More information on assessment will be provided below.

This data base will be part of a comprehensive assessment system that we call iSEAL for intelligent System for Education, Assessment, and Learning. iSEAL will consist of the data base, ways for students and instructional staff to interact with the data (in secure and appropriate ways to protect privacy of students), and tools for analysis. We envision this system to allow students to monitor their progress and for instructional staff to track students. In addition, iSEAL will provide ways to continuously assess and improve the quality of the curriculum.

Faculty will seek extramural funding for this research. Examples of NSF programs to which we either already applied or are planning to apply for funding are Course, Curriculum and Laboratory Improvement (CCLI: NSF 08-546) and Research and Evaluation on Education in Science and Engineering (REESE: NSF 08-585). In a proposal to the CCLI program [PI: Neuhauser (UMR), co-PI Kumar(CS&EE, UMTC)], we proposed to build a set of data mining tools to analyze this rich data set. Because of the similarity of the data we are expecting to collect to data that has been collected in genomics research, we will be able to utilize existing data mining tools and adapt them to our needs.

With this unique data base, we expect to be able to attract researchers from other institutions. The data base is built to provide different levels of accessibility to protect confidentiality of individual student data and IRB approval will be sought for each research project.

Curriculum Framework

The full 4-year B.S. curriculum will be designed and delivered at UMR by UMR faculty. The lower division curriculum will be mostly shared among students. Liberal education is integrated throughout the four years. The core science disciplines, the life/health sciences, the physical sciences, and the quantitative sciences, will be the disciplinary backbone of the degree program and will form three clusters. A fourth cluster, which will include the social sciences, the arts and humanities, and other components that are important to a liberal education, will complement the natural and quantitative sciences and will be critical to our goal of delivering a strong liberal education.

The four clusters are

- life/health sciences cluster
- quantitative cluster
- physical sciences cluster
- social sciences and humanities cluster

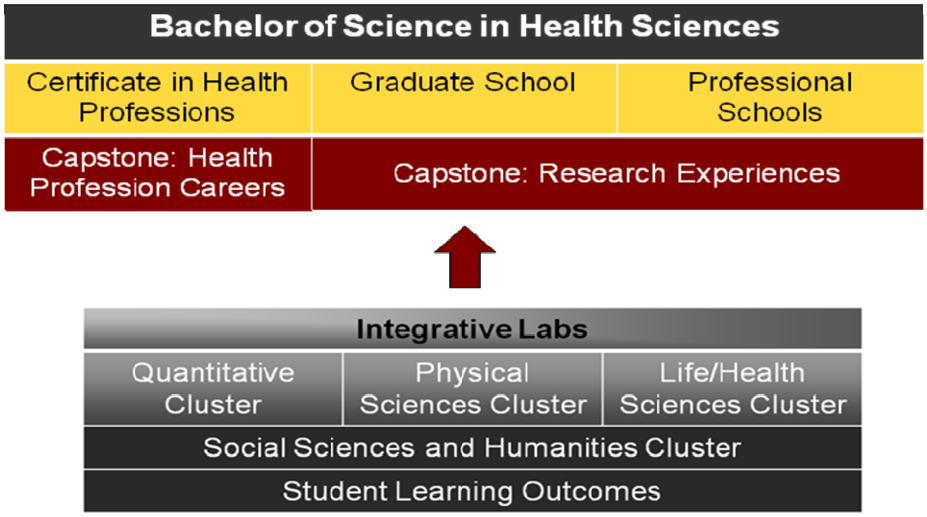


Figure 2: The BSHS curriculum framework.

Learning Design faculty with content expertise in the four clusters and research interest in learning will take the lead in designing the curriculum and will be supported by student-based faculty and postdoctoral fellows. All faculty and staff are expected to participate in the entirety of the curriculum to guarantee a well-integrated curriculum. The delivery of the curriculum will offer opportunities for graduate students and research postdocs to participate in various aspects of the delivery.

The curriculum will be modular. Each cluster will develop well-defined modules with clearly articulated goals and objectives together with explicit assessment methods to measure outcomes. Modules may be shared among clusters to facilitate integration. Each module will list the competencies (learning objectives), knowledge and skills, and ways of assessment. A curriculum map will link the modules

together. In addition to modules, we will create labs where students will integrate their knowledge and skills to complex problems that relate to their career interests. These integrated labs will emphasize analysis, synthesis, and interpretation. Clusters of modules will be defined and will appear on transcripts as courses. We expect that about 50% of credits will come from disciplinary clusters (sciences) and 50% will come from the arts and humanities, and social sciences.

Modules will typically not be taught in the traditional way of 50 minute lectures 2-3 times a week with perhaps a lab component or recitation. Instead, we will develop active learning environments with an integrated assessment component to guide student learning. This will include e-learning, collaborative projects, one-on-one and group tutoring, peer tutoring, community-based projects, oral and written presentations, and career preparation. A factor in student success is the amount of time students spend on task. Especially during the first two years, learning activities will be developed to actively engage students. Through integration of concepts and ideas from different modules, students will learn how to transfer knowledge and integrate across disciplines to solve complex problems.