What If You Could Start From Scratch: Building an Interdisciplinary Curriculum on a New Campus

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University of Minnesota Rochester
Outline

• Why change?
• Building an interdisciplinary science curriculum
• A case study: UMR
• Challenges and Pitfalls
• Opportunities
The Value of Higher Education

WHY CHANGE?
“PCAST found that economic forecasts point to a need for producing, over the next decade, approximately 1 million more college graduates in STEM fields than expected under current assumptions. Fewer than 40% of students who enter college intending to major in a STEM field complete a STEM degree. Merely increasing the retention of STEM majors from 40% to 50% would generate three-quarters of the targeted 1 million additional STEM degrees over the next decade.”

— Holdren and Lander, 2012
Cost of Education

Tuition has increased well above inflation rates

http://www.changinghighereducation.com/current_affairs/

Student borrowing has sharply increased
Student Experience in Traditional Education

- See, the reason I haven't been writing about lecture for *erm*, let me see... a couple of weeks I think... is, I *can barely remember what was taught in lecture*, and I was actually snoring after 15 minutes every other lecture. But today, it's definitely a record I sat wide awake through 2 of the lectures.

- I followed *Parasitology*. Prof-*dunno-what's-her-name* sped through the lecture handouts, finished more than 5 worms at one go, covering intestinal flukes and liver flukes. I can't remember everything if you ask me now, but at least I do know what the whole thing is about, I just need to read through what I scribbled and hopefully with a click I can memorize everything.

http://bongblongblog.blogspot.com/2007_08_01_archive.html
Student Experience in a Global Learning Community
STEM Persistence

• Research by Chang et al. points to significant predictors for STEM persistence
  — POSITIVE
    • Participation in undergraduate research
    • Studying with other students
    • Joined club/organization related to major
    • Math + Verbal SAT
  — NEGATIVE
    • Aspire to medical degree (vs. Bachelor’s)
    • Worked full-time while in college
    • Faculty interaction

The New MCAT

- New MCAT in January 2015
  - Fall 2012 Freshman class will be Juniors in Spring 2015
- Biological and Biochemical Foundations of Living Systems
- Chemical and Physical Foundations of Biological Systems
- Psychological, Social and Biological Foundations of Behavior
- Critical Analysis and Reasoning Skills
  - Comprehension, Evaluation, Application
  - Incorporation of Information
  - Assessment
    - Passages from the humanities and social sciences
- Scientific Inquiry and Reasoning Skills
  - Scientific concepts, evidence-based reasoning
  - Design and execution of research
  - Data-based and statistical reasoning
CREATING AND SUSTAINING AN INTERDISCIPLINARY SCIENCE CURRICULUM
Global Challenges

- Energy and the Environment
- Global Health
- Water Resources
- Agriculture and Food Security
- International Security
- Population

http://www.ethree.com/

http://www.maredmanito.com/WaterResources.php

http://needtoknow.nas.edu/id/challenges/globalization/

http://sites.nationalacademies.org/International/international_052200
Beyond Traditional “Interdisciplinary”

Understanding not only the complexity of the physical and natural world but also the complexity of human behavior and societies in a culturally diverse world.
Qualities

• Integrated
  – Transfer of knowledge

• Problem solving
  – Analytical skills

• Ability to effectively and critically evaluate information

• Deeper preparation in quantitative and analytical thinking
  – Big data

• Working in diverse and global teams
  – Collaborative skills

• Soft/Transferrable Skills
  – Oral/written communication skills
  – Cultural competence

• Professional
  – Preparedness for the workplace

Photo by: Yuri Arcurs
Structure

• Common lower division curriculum centered around one or two themes
  – First semester needs to level the playing field
  – Cohort model in the first year
  – Meets requirements for cluster of majors
  – Top-down design: SLO, SDO → content
  – Integrated
• Major-specific upper division
  – Capstone
• Delivery based on “new pedagogy”
• Technology-enhanced
• Curricular and co-curricular integration
• Community partnerships
  – Arc of community integration
Sustainability

• Cohort model and common curriculum
  – Reducing choice in the lower division increases 4-year graduation rate and efficiency in delivery
• New faculty model to provide more expert help to students and avoid single-point-of-failure
  – Team approach to design, implementation and delivery
    • Content expert
    • Master Instructors
    • Technology experts
    • Pedagogy experts
    • Student success coaches
• Robust assessment with evidence-based, continuous improvement
• Student Success Coach model
University of Minnesota Rochester

- Established in 2006
  - RHEDC
- Focus on health sciences and biotechnology
- Programs
  - B.S. in Health Sciences (BSHS, Fall 09)
  - B.S. in Health Professions (BSHP, Fall 11)
  - M.S. and Ph.D. graduate programs in Biomedical Informatics and Computational Biology (BICB, Fall 08)
  - (Partnership programs)
- Center for Learning Innovation
  - Academic unit for faculty teaching in the BSHS
Intrapreneurship

• UMR is a startup within a large university
  – University of Minnesota has over 65,000 students and 25,000 employees system-wide

• Startup phase: 2007-2012
  – Set mission, vision, and goals
  – Establish programs
  – Hiring phase
  – Chaos and uncertainty

• Growth phase: 2012-...
  – Focus on integration across academic and administrative units
  – Some restructuring
  – Focus on internal processes and procedures
  – Staying agile while stabilizing the organization
Graduate Program (M.S. and Ph.D.)

BIOMEDICAL INFORMATICS AND COMPUTATIONAL BIOLOGY (BICB)
Our Partners
BICB Objectives

- Establish **world-class academic and research programs** in bioinformatics and computational biology at UM Rochester.
- Leverage the University of Minnesota’s academic and research capabilities in **partnership** with IBM, Mayo Clinic, Hormel Institute and other industry leaders.
- Build academic and research programs that complement southeast Minnesota’s existing leadership roles in **health sciences, biosciences, engineering and technology**.
- Create academic and research programs that provide applications to **economic activities** via innovation, translational research, and clinical experiences.
UMR was founded

BICB program launched

1st M.S. graduate

1st Ph.D. graduate

BICB Faculty and Student Numbers

- Faculty
  - University of Minnesota
    - UMTC: 29
    - Hormel: 4
    - UMR: 1
  - Mayo Clinic: 16
  - IBM: 4
  - Cray, Inc.: 1
  - NMDP: 2
  - Brain Sciences Center: 1
  - Other Affiliates
    - Medtronic (1)

- Over 50 students
- 60% of students work full-time
- 8 graduates since 2011
Fostering Innovation

- “Thesis in Industry”
  - M.S. and Ph.D. research can be conducted at employer’s site or at one of our partners
- Entrepreneurship
  - Required seminar
- Geographically dispersed
  - Technology-enhanced delivery at multiple sites
  - Co-advising across institutions
- e-Learning
  - Utilizing Coursera, MIT OpenCourseware, iTunes U, Academic Earth to fill gaps with free online courses
  - Archived seminar presentations from around the world to serve as colloquium
Undergraduate Program (B.S.)

HEALTH PROFESSIONS (BSHP)
Goals

• Prepare students for health profession careers
• Address identified regional needs in health professions
• Provide pathways for transfer students upon completion of identified lower division coursework
Mayo Clinic

- First integrated group practice
- Private - Nonprofit
- 1,050,000 patients
- 56,100 employees
- Multi-campus
Key Features

- Program is jointly delivered by UMR and Mayo School of Health Sciences faculty
- 2-year certificate programs
  - Echocardiography
  - Sonography
  - Radiography
  - Respiratory Care
- Meets regional need
- Junior admitting
- Same entry requirements for all tracks
  - Students do not decide on track as freshmen
- Shared responsibilities
  - Leveraging each other’s strengths
  - Mayo Clinic: didactic and clinical courses
  - UMR: didactic, partially online courses on
    - Health Economics and Finance
    - Management and Leadership in Healthcare

Simulation Center at Mayo Clinic
Undergraduate Program (B.S.)

HEALTH SCIENCES (BSHS)
Bachelor of Science in Health Sciences

Where can your interest in health sciences take you?

The Bachelor of Science in Health Sciences (BSHS) degree program opens the door to professional school, a graduate education, or a health science career, in addition to many other opportunities.

The areas below represent a sampling of the many health science career opportunities:

**Patient Care**
- Dentist
- Optometrist
- Pharmacist
- Physical Therapist
- Physician
- Physician Assistant
- Veterinarian
- Genetic Counselor
- Occupational Therapist
- Prosthetist (Prosthetics)
- Echocardiographer
- Radiographer
- Respiratory Care Therapist
- Sonographer

**Wellness**
- Chiropractor
- Mental Health Counselor
- Health Coach

**Business**
- Healthcare Administrator
- Health Entrepreneurship
- Medical Device Sales Rep
- Pharmaceutical Sales Rep

**Communication**
- Communication Consultant
- Medical Journalist

**Research**
- Biostatistician
- Food Scientist
- Clinical Researcher

**Laboratory**
- Clinical Laboratory Scientist
- Cytotechnologist
- Molecular Geneticist

**Education**
- Health Sciences Professor
- Medical Historian
- Public Health Educator
- Community Health Educator

**Information Technology**
- Computational Biologist
- Director of Health Information
- Health System Analyst

**Law**
- Health Policy Analyst
- Intellectual Property Attorney
- Regulatory Affairs

Color Guide
- Professional Degree
- Master's or Ph.D.
- Bachelor's Degree and/or Certificate

Discover more at www.r.umn.edu/bshspathways.
Curricular and Co-curricular Integration

- **Academic Program**
  - UMR has no departments: the Center for Learning Innovation (CLI) is the single academic unit to deliver the B.S. in Health Sciences academic curriculum
    - **Vision:** The CLI promotes a learner-centered, technology-enhanced, concept-driven, and community-integrated learning environment. Through ongoing assessment of student achievement, the CLI aspires to personalize learning, establish data-driven research on learning, and continuously improve the curriculum.

- **Capstone**
- **Study Away from Rochester**
- **Student Development**
  - Student Success Coaches
  - Student Life
UMR Model of Education

• Faculty from across disciplines deliver a cohesive and integrated curriculum, the B.S. in Health Sciences, to prepare students for a wide variety of careers in the health sector
• Different roles for faculty and staff in delivery teams
  – Design faculty (T/TT) design, implement, and deliver the curriculum and have a mandate to engage in research on learning
  – Student-based faculty (instructors) implement and deliver the curriculum and serve as tutors
  – IT staff to facilitate technology integration
• Emphasis on translational pedagogical research and comprehensive assessment
• Common lower division curriculum to better prepare students and to respond to new fiscal realities
The Curriculum

<table>
<thead>
<tr>
<th>Public or Private Sector</th>
<th>Graduate School</th>
<th>Professional School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor of Science in the Health Sciences</td>
<td>Capstone: Research Experiences or Courses or Senior Thesis</td>
<td>Capstone: Study Abroad or NSE</td>
</tr>
</tbody>
</table>

Capstone: Health Profession careers or Certificates or Internships

Integration across Curriculum

<table>
<thead>
<tr>
<th>Quantitative Cluster</th>
<th>Physical Sciences Cluster</th>
<th>Life/Health Sciences Cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Sciences and Humanities Cluster</td>
<td></td>
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<tr>
<td>Writing-Integrated Curriculum</td>
<td>Community-Integration and Cultural Experiences</td>
<td></td>
</tr>
<tr>
<td>Student Learning/Development Outcomes</td>
<td></td>
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</tbody>
</table>
The Design

• Top-down design
  – Institutional Student Learning Outcomes (SLO)
  – Module-based learning objectives and concepts
  – Modules are grouped into courses
    • Content flexible
    • Integration across disciplines

• Emphasis is on curriculum, not courses

• Assessment of learning objectives
  – Mapping to SLO

• 120 credits
Transfer of Knowledge through Intentional Integration

• Philosophy and Statistics
  – Statistics focuses on differences between causation and correlation in the context of hypothesis testing; philosophy teaches the tools for applying logic to understanding hypotheses and decision making

• Anatomy & Physiology and Humanities
  – History of anatomy and dissection introduces students to the changing historical perspectives on the body and prepares students to participate in the subsequent surface anatomy lab with heightened awareness of personal boundaries and the need to balance objectivity with respect for the human subject
Learner-centered and Personalized I

• Lower division
  – Common curriculum
  – 1st semester designed to enable success and to de-emphasize differences in preparation
    • Organic Chemistry, Philosophy, Statistics, Sociology, Writing Studio
  – Writing-integrated curriculum (WIC)
  – Collaboration
  – Active Learning
  – Communication
  – Career exploration without change of major
  – Transfer of knowledge across disciplines
Learner-centered and Personalized II

• Upper division
  – Specialized courses
  – Capstone (senior year)
    • Planning starts in sophomore year
      – Curriculum with a purpose
      – Promotes 4-year graduation
    • Personalized program to meet career aspirations
      – Research experience
      – Internship
      – Study Abroad
      – Course work
  – Communication
  – Career preparation integrated into the curriculum
BSHS: Career Exploration

- Integration across the disciplines
- Integrated and personalized career exploration
Community-integrated

• Over 120 community members participated in the curriculum in AY 2012-13
• Arc of community engagement
  – Work study and volunteering in the community
  – Community Collaboratory (Junior year)
• Professional Panels
• Industry Engagement Network
• Capstones
  – Research
  – Internships
  – Certificate programs
  – ...
IT as an Academic Unit: Enhancing the Student Experience

- IT reports to Academic Affairs
- IT is not just a commodity
  - From mainframe computers to social media, OpenContent, and mobile devices
- Classroom beyond brick and mortar
  - Access anywhere, anytime
  - Global classroom
- Close interactions between faculty and IT result in products that are used

http://www.issis.org/History_ISSiS_6.htm
Technology-enhanced

• Classrooms are technology-rich and facilitate collaboration
  – 8 Learn Labs with 24-80 seats
• Laptop program allows students instant access to information and online tools
• iSEAL delivers the curriculum and provides access to the entire curriculum at all times
  – Curriculum development tool
  – Assessment tool
  – Real-time data collection
Restructuring Research Software into an Innovative Curriculum Management System

Traditional Campus Course Management System

- Courses separated into distinct sites, do not share curricular materials
- Disciplinary areas separated by department/college
- Software design limits teaching

UMR Center for Learning Innovation iSEAL Curriculum Management System

- Disciplinarians integrate curriculum within one department
- Teaching informs software design
- Material for entire curriculum is stored in iSEAL. Modules and learning objects from different disciplinary areas can be used in course web sites.

Collaborations

- UMR Center for Learning Innovation
- UMR IT/ITV/Classroom Support Services
- UMR Vice Chancellor for Academic Affairs
- UMTC Academic Support Resources
- UMTC Computer Science & Engineering
- UMTC OIT Collaborative for Academic Technology Innovation
- UMTC OIT Enterprise Application Development
- UMTC OIT Virtual Hosting Service

Tools

- CollabNet Subversion
- Hibernate
- iTV
- JUnit
- Request Tracker
- Spring
- UMWiki

Outcomes

- Increasing faculty ownership and engagement
- Increasing U of M awareness of academic analytics
- Currently supporting an enrollment of approximately 150
- 7,000 weekly page views
- 6-minute average visit length
- Will support over 1,000 students by 2017

Support for the iSEAL project has been provided by the Howard Hughes Medical Institute, the McKnight Foundation, and the University of Minnesota Rochester.
Data-driven Research on Learning to Personalize Learning

• Research on learning is primary research area of CLI tenure track faculty

• Personalized medicine provides conceptual framework
  – Different strategies for different groups of students
  – Learning analytics as a tool to develop personalized “Prevention-Diagnosis-Treatment” approach to student success
What’s the Difference?

• Faculty/instructors/staff: *making change*
  – Experimental culture with opportunities to fail
  – Teaching teams with new faculty model
  – Curriculum (vs. a set of courses)
  – Curricular/co-curricular integration
  – Translational pedagogy
  – Learning analytics

• Administration/structure: *enabling change*
  – Experimental culture with opportunities to fail
  – Teaching teams
  – Partnerships with community
  – Academic programs, enrollment management, Student Development, IT, Library, and Student Services in a single administrative unit
  – Research on learning as the vision
  – Infrastructure for active learning and learning analytics
  – Professional development
  – Institutional *Finish in Four* campaign
Scaling Up

CHALLENGES AND PITFALLS
Pitfall: Culture

- Universities will need to change and overcome their conservatism
  - Traditional faculty model
  - Mentoring (or lack thereof)
  - Administrative structures as barriers for collaboration
  - Collaborative environments are largely unfamiliar to faculty
  - Faculty resistance to change—remember, not everyone needs to change
  - Resistance to collaborating with industry/private sector

- Responding to changing student body
  - More diverse
  - Changing values
  - Changing needs (Higher Education Research Institute, UCLA)
    - To prepare for graduate/professional school
      - 34.9% in 1971
      - 57.7% in 2006
Pitfall: Disciplinary Departments

• An interdisciplinary major requires cooperation across colleges
  – Agreement on requirements
    • Faculty curriculum committee across colleges
  – Agreement on curriculum
    • Using existing courses versus building new courses
  – Agreement on budget
    • University budget models can be a major barrier
  – Agreement on who teaches and how it counts
Pitfall: Lack of Faculty/Staff Support

- Change is difficult, even for those at the cutting edge of innovation
- Faculty/staff need time
  - Developing a curriculum versus a set of courses takes even more time
- Faculty/staff need professional development to learn how to
  - collaborate across disciplines
  - develop an integrated and technology-enhanced curriculum
  - facilitate versus teach
  - engage students in active learning classrooms
  - promote learning
  - translate pedagogical research into the classroom
  - build on diversity
  - assess students
  - manage conflict
Pitfall: Technology is the Solution

• Technology can facilitate delivery and increase efficiency but it is NOT a panacea
• Technology is expensive and needs to be well supported
• Not every student has high-speed internet access
• Laptop program versus virtualization
• Technology-enhanced curriculum requires experts in academic technology
Scaling Up

OPPORTUNITIES
Opportunity: Democratization of Knowledge

Academic Earth

MITOpenCourseware

Coursera
Opportunity: Social Networking

• Old Hierarchical Model—pushing information
  – Knowledge dissemination from expert (instructor) to layperson (student)
  – Limited access to sources of information

• New Participatory Model—posting and pulling information
  – Communication
  – Sharing
  – Collaboration
  – Instructor becomes facilitator of learning

Alberts & Hayes 2003. Power to the Edge
Opportunity: New Pedagogy

• MOOCs and the disruption
  – MOOCs are “narrated textbooks” with integrated social media
  – Top quality online courses are available for free
  – Inter-generational, inter-cultural, inter-geographic
  – Employers may prefer students with MOOC experience
  – Increased efficiency of delivery
• Video lectures/MOOCs are enablers for the flipped classroom
  – Video lectures can free faculty from telling the same story every semester
  – Faculty can use the valuable classroom time for collaborative work that deepen students’ knowledge and skills and encourage critical thinking
  – Decentralization of knowledge and information
  – Consistent with networked society
  – Potential for inter-campus collaborations
Opportunity: Learning Analytics

- Use of statistical and data mining tools to academic data sets with the goal of revealing trends and patterns, running scenarios, and building predictive models to improve student success through evidence-based interventions.

- Two levels of granularity
  - Institutional
  - Curriculum
Opportunity: Employer

- Employer priorities are well-aligned with student learning/development outcomes
  - Innovation
  - Complex problem solving
  - Critical and analytical thinking
  - Communication
  - Collaboration
  - ...

- Partnerships to successfully transition students to the workplace
Opportunity: Community

- Community members can enrich education
  - Work study
  - Volunteering opportunities
  - Internships
  - Professionals in the classroom
    - Mock interviews
    - Career exploration
  - Future employment