Interdisciplinarity *before* Disciplinarity

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Global Change Curriculum and Degree Program

http://www.provost.umich.edu/programs/MLTT/
http://www.globalchange.umich.edu/

What is Interdisciplinarity?

Interdisciplinary courses ***combine*** two or more disciplinary perspectives to create new knowledge.
In these courses, instructors compare and contrast disciplines, and consciously draw from different theories and research methods to address the subject of the course.

The impact of interdisciplinary courses is enhanced when ***team-taught*** by two or more faculty who collaborate on design, teaching and evaluation of students.

This process allows faculty to model intellectual and logistical collaboration for their students, thus training them for the ***collaborative work*** that awaits them in careers after graduation.
It also allows faculty to learn from one another on multiple levels: course content, pedagogical approaches, and classroom interaction.

21st Century Skills

Essential parts of today's college education:
The ability to negotiate multiple perspectives and to make strategic decisions in complex futures.

> "The panel recommends that colleges and universities place new emphasis on educating students to become intentional learners. …Intentional learners are integrative thinkers who can see connections in seemingly disparate information and draw on a wide range of knowledge to make decisions. …Higher education has traditionally sorted … knowledge into disciplines, each of which uses distinctive modes of inquiry that shape the way it sees the world. [But] selfaware, informed learners understand the value of multiple perspectives in gaining a complete picture. [Their] college education favors studying about significant, challenging issues as a way to hone intellectual and practical skills."

"Greater Expectations"
Association of American Colleges and Universities
National Panel Report, 2002
http://www.greaterexpectations.org/

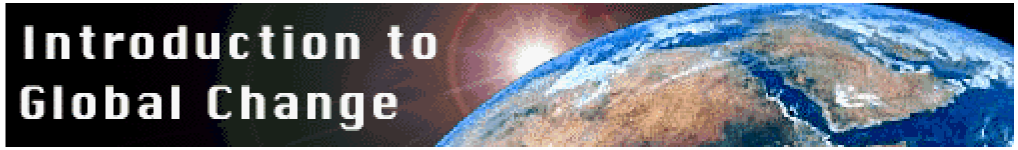
Models of Interdisciplinary Team Teaching

- Collaborative courses where faculty with related expertise co-plan and ***co-teach*** large courses (or smaller ones).
- Integrated lecture courses in which the curriculum is planned and ***coordinated*** by a single faculty leader and with faculty from different units delivering portions of the course.
- Meet-together courses in which two or more separate courses on related topics are scheduled at the same time, with the courses ***occasionally*** holding joint sessions.
- Intergenerational apprentice models in which single courses have instructional activities ***shared*** among faculty, graduate students, and/or post-doctoral students, and advanced undergraduates.
- Learning communities, which are small groups of students and faculty members who work together around a set of common intellectual interests, have multiple opportunities to interact ***inside and outside*** the classroom, and most of them are based in residence halls (living-learning).

The Interdisciplinary, Team-Taught Global Change Curriculum

Objectives

- Improve understanding of *natural and social science* ***underpinnings*** of Global Change.
- Study evolution of natural world and appreciate temporal and spatial ***scales of change***.
- Understand how ***human actions*** are contributing to global environmental change.
- Learn how to develop dynamical models of Earth processes, use spatial data ***analysis***, utilize the internet to gather information.
- Develop capacity to integrate information and technology to *explore for* ***solutions*** *to interdisciplinary problems.*
- Become better equipped to contribute to debate on global environmental change and societal adaptation strategies; *to become an* ***informed citizen*** *and* ***decision maker.***



Global Change 1

- Evolution of the Universe
- Early Earth
- Evolution of the atmosphere
- Natural hazards
- Evolution and tree of life
- Natural selection and speciation
- Cells and energy transformations
- Ecosystems
- Biogeochemical cycles
- Atmosphere-Biosphere interactions

- System Dynamics Modeling (Stella)

- *Natural Science credit*
- *Three faculty*
- *Enrollment: up to 160 (classroom)*
- *Discussion: up to 20 (4 GSIs)*

Global Change 2

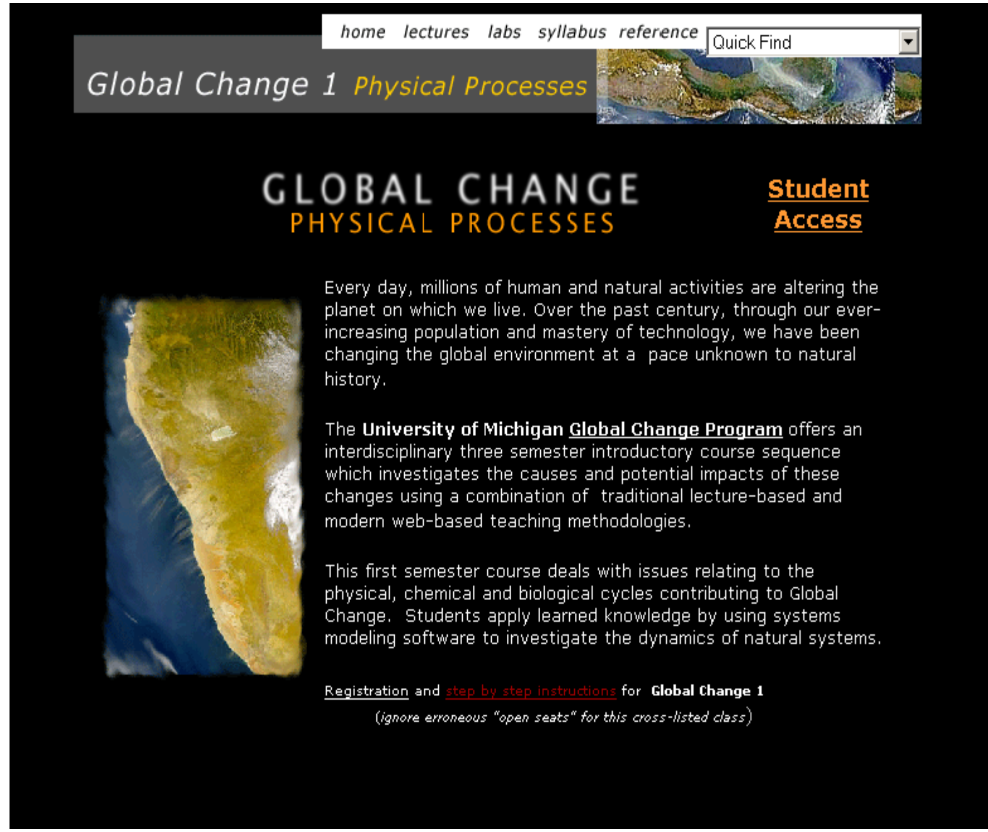
- Population growth
- Detecting global change
- Human impact on resources
- Water and land resources
- Earth's biota
- Global Energy
- Governance
- Sustainable development
- Environmental justice
- Toward a common future

- Spatial data analysis (ArcGIS)

- *Social Science credit*
- *Four faculty*
- *Enrollment: up to 120 (classroom)*
- *Discussion: up to 20 (3 GSIs)*

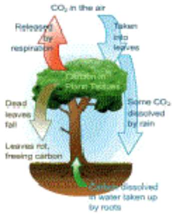
Global Change 1: Physical Processes

- Students investigate physical nature of changes from Big Bang to events of today, dealing with issues relating to natural physical, chemical, and biological cycles contributing to Global Change.
- Students apply learned knowledge by using graphically based, dynamic modeling software program (STELLA) in computer laboratory setting, to investigate systems dynamics and effects on natural systems such as planetary energy balance, natural hazards, (paleo)climate, ozone, biodiversity, and greenhouse warming.



www.globalchange.umich.edu/globalchange1

Experiential Learning – GC1 Laboratories



The Global Carbon Cycle

LAB EXERCISE 11

02/13/02

format for printing

Background Material for this Lab: 11/19 Carbon Cycle Lecture

Introduction

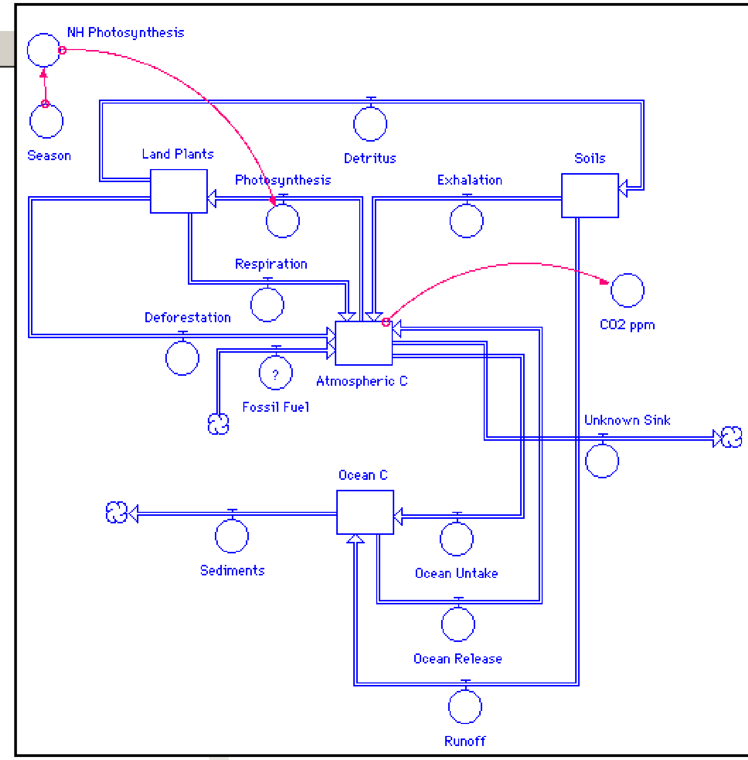
Precise records of past and present atmospheric CO2 concentrations are critical to studies attempting to model and understand the global carbon cycle and possible CO2 -induced climate change. Researchers have attempted to determine past levels of atmospheric CO2 concentrations by a variety of techniques, including direct measurements of trapped air in polar ice cores; and indirect determinations from carbon isotopes in tree rings, analysis of spectroscopic data, and measurements of carbon and oxygen isotopic changes in deep-ocean sediments. The modern period of precise atmospheric CO2 measurements began during the International Geophysical Year (1958) with Keeling's (Scripps Institution of Oceanography) pioneering determinations at Mauna Loa, Hawaii, and at the South Pole. The Mauna Loa record remains the single most valuable CO2 time series.

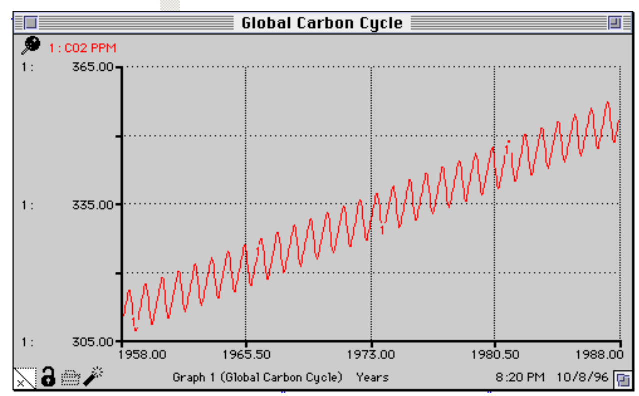
In this lab exercise we will do the following:

1. Import the Mauna Loa CO2 data and graph them against time using Microsoft Excel.
2. Build a STELLA model of the global carbon cycle in order to understand natural and anthropogenic processes in this cycle.
3. Develop future carbon cycle scenarios and analyze them to determine possible effects on global climate change.

Part 1: Graphing Mauna Loa Data using Excel

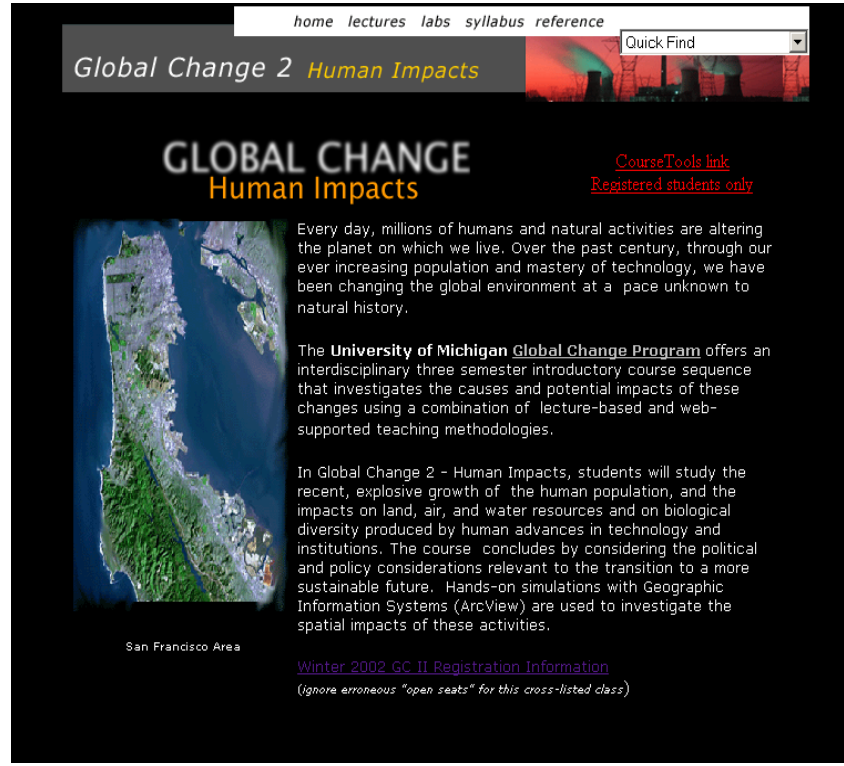
- Log into the Global Change Course Tools page.
- Download the carbon dataset from "selected course resources" on the main page. Open this data in the full Excel program (not the browser plugin) by saving the data to your H:/ drive first and then opening the file in Excel as delimited and tab separated data.





Global Change 2: Human Impacts

- Students study effect of economic and social systems on natural physical, chemical, and biological dynamics of our planet.
- Students use hands-on simulations using ArcGIS to investigate spatial patterns and impacts. What are human impacts? What national and international initiatives mitigate effects of global change? Solutions?
- The course places activities and discoveries of student's discipline in context of human experience and role of humans in managing Earth. This course places role and activities of science in context of what we know about our planet around and how we can develop plans for managing our world.



www.globalchange.umich.edu/globalchange2

Experiential Learning – GC2 Laboratories

Global Change 2 Labs

Lab 6: Global Water Resources

Updated 2/10/02

Format for printing

This exercise will provide a spatial examination of global water resources, withdrawals and predicted future water needs, using ArcView GIS. You may need to refer your *Guide to Basic ArcView Features*.

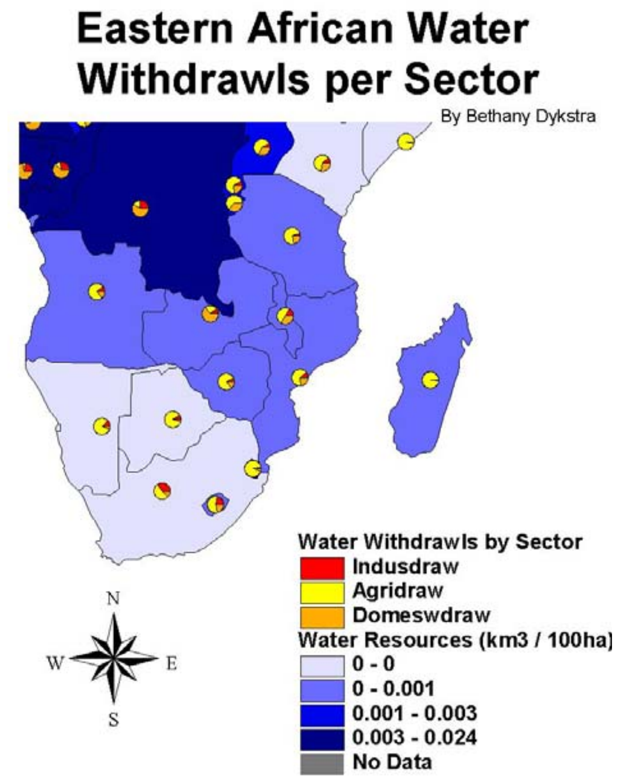
> Before completing this exercise, you should familiarize yourself with global water resource issues by reading a short chapter entitled "Freshwater Trends: Will Future Needs be Met?" *(http://www.wri.org/wr-96-97/wa_txt3.html)* in WRI's *World Resources 1996-97: The Urban Environment (http://www.wri.org/wr-96-97/96tocful.html).*

Answer questions 1-7 in CourseTools and submit it to your GSI by the next lab session *(seven points)*. Submit your final map layout by saving it to your GC2 Web WorkSpace *(three points)*.

- Map your I drive at the atlas account a **\\atlas.ccs.itd.umich.edu\class-data** and start ArcView GIS for Windows NT.
- Before you begin, save your project to your GC2 directory on the mapped Atlas drive (../GC2/<uniquename>/saved_work/). **Save intermittently as you are working.**

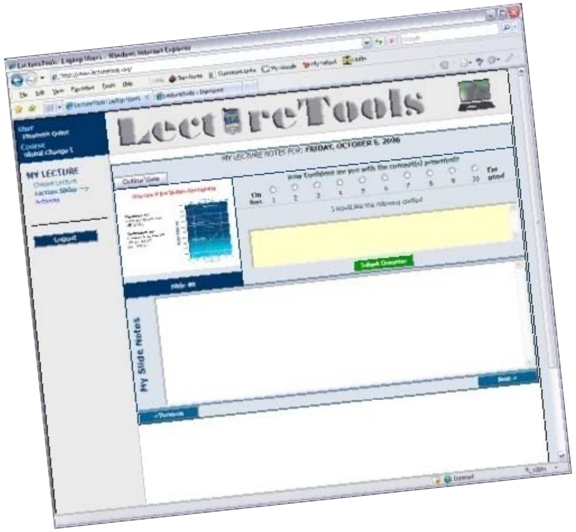
1. Create a new view and name it **Global Water Resources** (change the name field in View Properties). Then add the theme entitled **wtrland.shp** from theLoad the legend found in **I:/uniquename/lab_data/lab6** directory. This specially prepared theme includes the standard water.shp (**water resources**) data fields with the fields from **landuse.shp** (**landuse)** in one theme. The water resources theme contains data on freshwater resources and withdrawals for each country, which is of primary interest for this lab exercise. Detailed explanations of these data may be found in the *Summary of Available WRI Data* on the winter labs web page.

2. Create a graduated color legend, using **Wresource** (total km^3 of annual internal renewable



Active Learning in Class

- Science teaching traditionally relies on presentation delivered as ***monologue***, albeit spirited.
- Advent of extensive lecture notes and slides on Internet leave students with ***little incentive to attend class***, much less participate.
- Even most stunning of images or movies, while motivating, offers students only ***passive participation in their learning*****.**
- There is little expectation for students to ***critically think*** through arguments being developed in class.
- The ***Interactive Classroom***



Transforming the Classroom

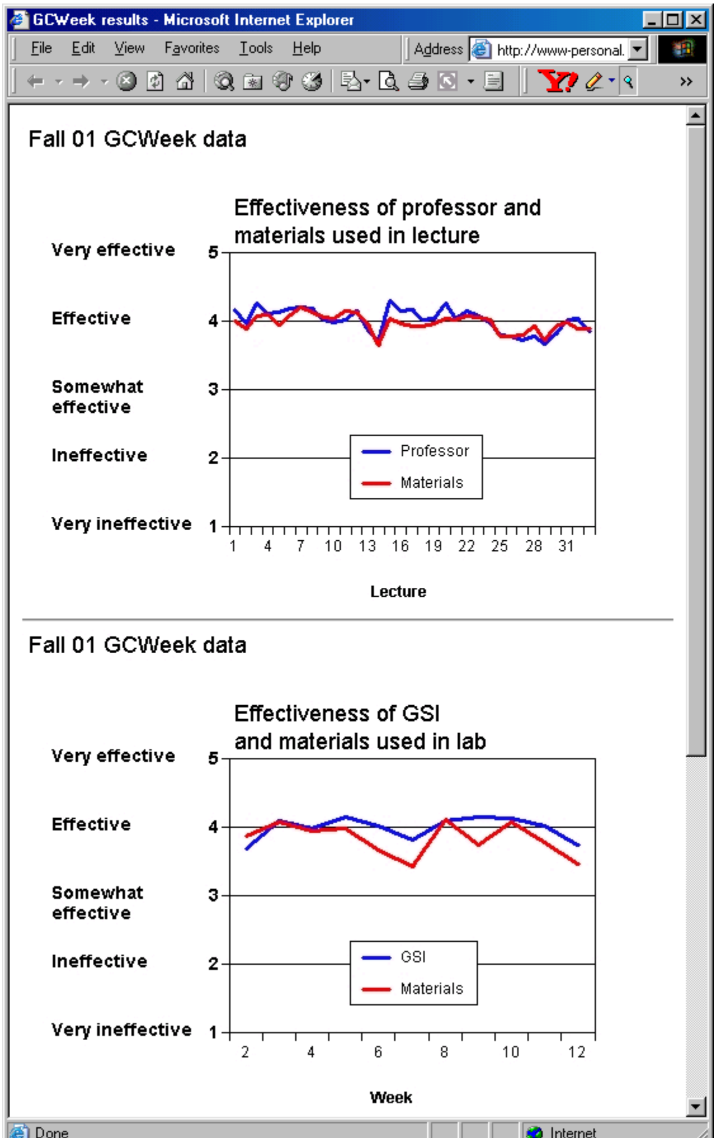
Enhance student ***engagement*** in large classroom settings.

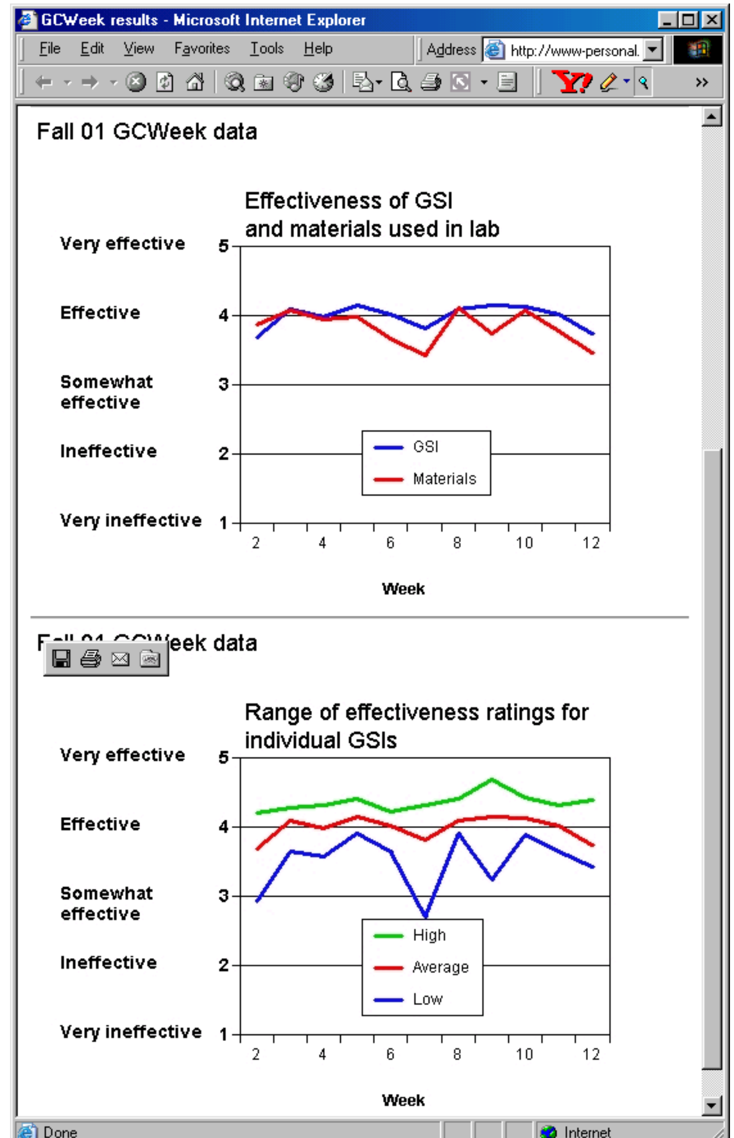
Encourage ***inquiry*** and ***critical thinking***.

Use of interactive response systems requires rethinking of lecture approach and goals.

- Student ***multitasking*** (listening, note taking and activities) encouraged, capitalizing on today's skills.
- Include ***hands-on*** activities in lecture room setting.
- Willing to teach in more ***lively classroom*** setting.
- "Teach Less, Learn More"

Regular Assessment of Lectures and Labs





The Interdisciplinary Global Change Minor Degree
Philosophy and Goals

- highly interdisciplinary, ***seamlessly*** crossing disciplinary boundaries.
- provide a broad ***understanding*** of complex issues involved in global change and global sustainability (Earth as a system).
- enable students to use ***quantitative tools*** in approaching global change issues, including Stella (dynamic modeling), ArcView (spatial analysis) and Excel (data).
- offer a "***front-loaded***" minor, to engage students in their first years of study.
- ***Minor*** degree involves three interdisciplinary (lower-level) course courses and two (upper-level) disciplinary courses.
- Offer an ***alternative*** to disciplinary liberal arts education by offering early interdisciplinarity:

"Interdisciplinarity before disciplinarity"

Faculty Barriers

- Compared to discipline-centered course with single instructor, team teaching across disciplines requires more ***resources*** -- time and energy for intellectual and logistical planning, as well as greater development of course materials.
- Most faculty do not know where to find the ***information and expertise*** about team teaching and interdisciplinary learning.
- Individual faculty have concerns about how interdisciplinary team teaching may impact their tenure and promotion. The current ***reward system*** is not geared to supporting interdisciplinary team teaching.
- Faculty who team teach across departments or schools and colleges face ***administrative and bureaucratic barriers*** involving credit for teaching, course administration, compensation, and workload, among other topics.
- Faculty and graduate student instructors face a variety of ***student issues***, e.g., teaching students with disparate backgrounds and interests and overcoming student enrollment issues caused by distribution requirements or lack of interest in interdisciplinarity within participating units.

Sustainability of Interdisciplinary Offerings

- ***Recognition*** of faculty effort:
  - creation of interdisciplinarity institute/center that identifies and distinguishes faculty and their courses, and offering an intellectual environment to engage with like-minded colleagues.
  - modest monetary commitment to support classes, which can be used for partial GSI support, assistance, research, etc.
- ***Dedicated*** evaluation and assessment, recognizing differences with traditional offerings.
- ***Large*** classes (80+) offer visible offering.
- Adjusting ***budgetary*** models (institution level).
- Increased teaching ***credit*** (unit level).
- Identifiable role in ***promotion*** decisions.
- High-level administrative ***advocate***.

Conclusions

- Interdisciplinarity, inquiry-based learning and early capture of a student's interest create an attractive ***alternative*** to today's mostly disciplinary undergraduate education.
- Early interdisciplinary experience aids students in ***planning*** their subsequent university careers and affects their choice of a major.
- Interdisciplinary courses are ***complementary*** offerings that do not replace existing disciplinary courses.
- The diversity in faculty expertise and cultures enhances the interdisciplinary approach, while also ***enriching*** faculty experiences.
- The GC example is grounded in the interdisciplinary study of global problems that ***engage*** student interest (e.g., resources, global warming, human development, environmental ethics), that are thematically integrated, and that can be taught from a multi-disciplinary, inquiry-based perspective.