Building Connections Between the Sciences and the "Real" World:

Integrating science into the general education curriculum for non-majors

Workshop Facilitators

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Overview: Science for the non-science majors at Arcadia

- Brief introduction to our session.
- How Arcadia University is engaging non-science majors in science as part of our new University Curriculum.
- Discussion where we can work together to develop new ways of engaging non-science majors in science, following the ways that Arcadia has begun to engage students.

Discussion: What non-science majors need to learn?

- Why do nonmajors need science?
- Learn to distinguish between science and pseudo science, art religion, ways of knowing the world
- Critical thinking problem solving
- Data collection – what that means
- Where to look online – good from bad
- Science literacy
- Scientific method source for new information
- Science critical to solve world problems like petro dictators, global warming, food shortage
- Not to fear science!
- Funding for science is important
- Quantitative reasoning – interpreting data
- Scientists are not bad people – not scary, not all male
- How to read science newspaper articles
- Science can't provide all the answers

Discussion: What non-science majors need to learn?

- What are our goals for what they should learn?
- Able to evaluate evidence to debunk fallacies
- Basics of how the world works
- Better personal decision making
- Applies scientific method and problem solving skills
- Basic calculations
- More informed voters
- Science can't prove anything
- Learn how to use technology
- Science works in a political, social context – society shapes science and vice versa
  - Science is a HUMAN endeavor
- Make good observations
- Statistics can be manipulated
- How to be skeptical
- Confidence in posing questions
- Comfortable about science
- Learn about theories and history

Discussion: What non-science majors need to learn?

- How does this influence what types and how much science they should be taking?
- A lot! A part of every gen ed course
- Depends on how well designed the course is for non-majors – 9 credits of well-designed courses that address the non-science is excellent – context of institution and who is teaching
- Link into their discipline
- Elementary education – needs to be able to teach some parts of all science
- Critical thinking – integrating science with critical thinking classes, philosophy
- Include experiential learning, a lab or something to experience how to do the problem, make it real
- Do we need separate courses for majors/non-majors? Shouldn't science majors have all of these ways of knowing as well? What should an intro course look like for ALL students. Traditional – fill their head with "stuff". Where do they form the connections? What are our goals? Physics for future senators? Existing paradigms make it difficult to change all of this. Overall issues. Need to challenge the paradigm. Should be available for all – empowering, relevant.
  - Philosophy of science in intro or capstone. Majors are interested in the non-major courses! Course on scientific inquiry, integrate in all possible majors – may encourage non-science majors to switch
  - Inquiry based is better for everybody

Discussion: What non-science majors need to learn?

- How is what non-science majors need different than what a science major needs?
- Math? Qualifications are different. Lose students if not prepared.
- Students do not know how to study. The science major may have already learned how to study science, already been successful. Non-science have not found a way of studying, no method of study. Differences in reading science text compared to other text. Different ways of learning. Different lens.
- Lingo, jargon, need more for science majors.
- Same sex education – non-majors may be intimidated with the majors.
- Depends again on the emphasis of the course. If focusing on "factoids" …. You can level the playing field by focusing on specific topics that are new to all students (such as theory of relativity in a physics class). Talk about it in a conceptual way, to level the playing field – everybody has the same chance to be successful. What is the balance and content? Other skills? Understanding process, nature, limits of science.
- Difference – major is an introduction. Non-major – introduction and capstone combined. Focus more on the trees (perhaps). Consequences for the structure.

Arcadia University

- Suburban campus
- 12 miles from Center City Philadelphia
- 2073 Undergraduate Students
- 1528 Graduate Students

The problem: Science Requirements in the previous curriculum

- *[The program was overhauled for a variety of reasons but we're just focusing on the science part.]*
- Two courses in laboratory science from biology, chemistry, physics, astronomy, geology, or interdisciplinary science. The two science courses do not have to be from the same discipline.

The Solution:
A New Integrated Undergraduate Curriculum

- “Arcadia’s new Undergraduate Curriculum provides a distinctively global, integrative and personal learning experience that prepares you to contribute and prosper in a diverse and dynamic world.”

- *http://www.arcadia.edu/academic/default.aspx?id=13102*

At Arcadia, Every Student:

- **Pursues** a Major
- **Participates** in Curricular Experiences
- **Explores** Areas of Inquiry
- **Develops** Intellectual Practices

Complete a major from 45 fields of study including:

Accounting	Acting	Arts/Fine Arts
Biology	Business Administration& Economics	Chemistry
Chemistry& Business	Communications	Computer Science
Computer Technology	Criminal Justice	Education
English	Health Administration	Interdisciplinary
International Business and Culture	International Studies	Liberal Studies
Management Information Systems	Mathematics & Actuarial Science	Modern Languages
Philosophy	Political Science	Science Illustration
Sociology	Spanish	Theatre Arts

Curricular Experiences

First Year Experience

Global Connections Reflectio

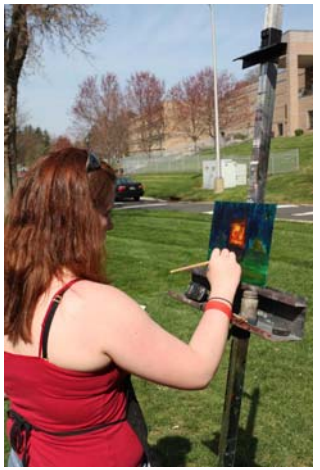
University Seminars

Senior Capstone Project

Exploration of four Areas of Inquiry

Natural & Physical World

Creative Expression



Self and Society

Cultural Legacies

Develop Five Intellectual Practices

Writing

Quantitative Reasoning

Global Connections

Visual Literacy

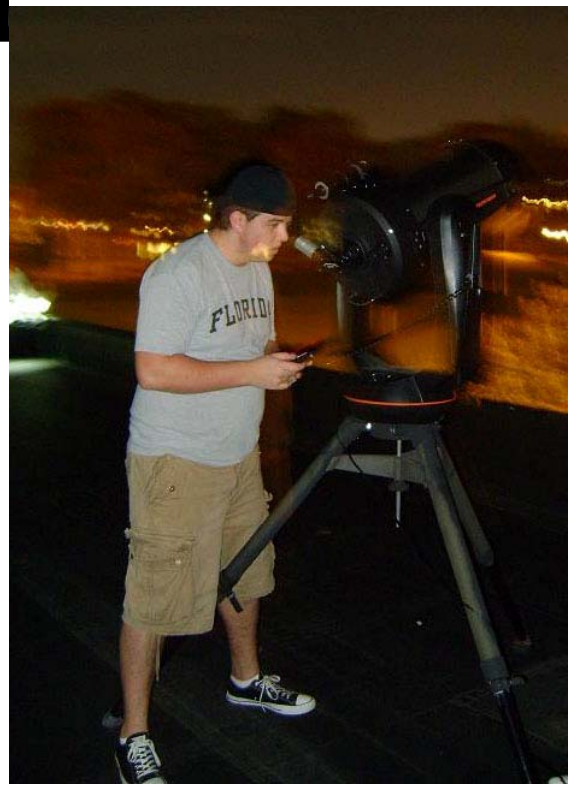
Modern Languages

Examples of Science-Based Courses for Non-Majors at Arcadia

- **The Night Skies of Pennsylvania**
  - First Year Seminar
- **Visualizing Sustainability: Contemporary Art and Environmental Science**
  - University Seminar
- **Scientific Ethics**
  - University Seminar

The Night Skies of Pennsylvania

Goal: Students will understand the skills, attitudes, and basic knowledge possessed by amateur astronomers. They will begin to think of themselves as amateur astronomers.



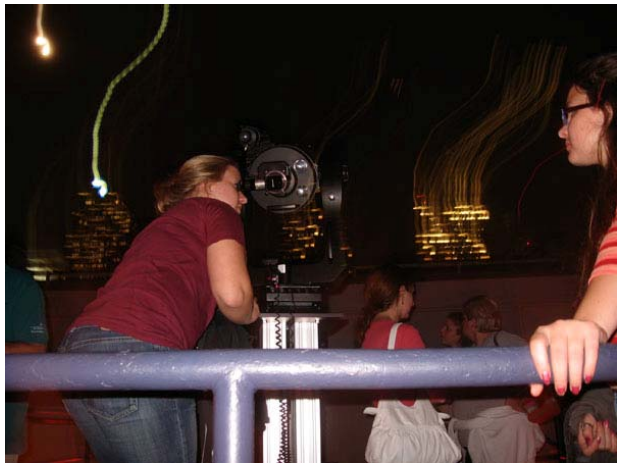
The Night Skies of Pennsylvania

Explore observational topics of personal interest

Find and review resources for amateur astronomers

Speak with amateur astronomers

Visit observatories and planetariums



The Night Skies of Pennsylvania

Culminating activity and project: Arcadia Observing Night and Star Party Plan

The Night Skies of Pennsylvania

- Differences from an Intro Astronomy Course

Traditional Intro Astronomy Course	The Night Skies of Pennsylvania
• Covers a large number of concepts	• Explores fewer concepts
• Limited relevance to students' lives	• Connects to students' abilities and interests
• Limited application of knowledge to open-ended problems	• Application of knowledge and skills to open-ended problems
• Students may work cooperatively	• Students must work cooperatively as a community
• Assessed primarily on conceptual understanding	• Assessed on concepts, skills, and attitudes

Visualizing Sustainability

- Satisfies Multiple Requirements
  - University seminar
  - Areas of Inquiry: creative expression, natural & physical world
  - Intellectual Practices: visual literacy, global connections

- Goals:
  - Understand conventions of contemporary art and the relationship between contemporary art and science.
  - Develop the ability to visualize scientific data and information through the use of advanced technology.
  - Create works of art in which the content of the work is explicitly tied to scientific analysis of sustainability.
  - Understand concepts of sustainability.
  - Understand the impacts of daily choices on the environment, biodiversity, and human health.
  - Understand the connectivity and unity of life, including topics from evolution and ecology.
  - The overarching goal of the course is to have students become educators - so that they have the ability to articulate the impacts of societal choices and environmental concerns to others.

Visualizing Sustainability

- 4 Units: Food, Waste, Water, Fuel
- Each 3 week unit is taught as a seminar (Tuesday) and as a practical lab/studio (Thursday) that incorporates field trips for data collection, screenings of movies, guest speakers, and group project time
- Each unit culminates in an art exhibition where students showcase art projects that illustrate scientific principles at work in a specific experimental context.
  - Based on data collection and hypothesis testing
- We also have a day each unit to explore misinformation in the media.
  - Students need to be able to tell the difference between junk science & good science.
- Sustainability survey – knowledge and lifestyles

Visualizing Sustainability

- Integration of cutting-edge teaching technology
  - Puts course materials at students' fingertips
  - Makes scientific principles immediately relevant in students' lives as they collect data and photographs

- Mobile Device (iPod Touch) and Digital Camera
  - Online Syllabus: http://web.me.com/ausustainability/Envisioning_Sustainability/Welcome.html
  - Podcasts
  - Links to artists, scientists, films, and other online content

Scientific Ethics

- Satisfies Multiple Requirements
  - University seminar:
    - builds connections between the scientific and ethical viewpoints
  - Areas of Inquiry:
    - natural & physical world – scientific perspective
    - cultural legacies – ethical perspectives
  - Intellectual Practices: global connections
    - consider the power and influence that some ethical systems have in influencing the local and global distribution, availability, and impact of technological advances.
- Goals:
  - To have students consider the effect that different ethical systems play in decisions about the acceptance or rejection of the application of scientific principles.

Scientific Ethics - Online

- The course is taught entirely online
  - Topics based on timely issues: Global Warming, Stem Cell technology, etc.
  - Threaded discussion
  - Opinion papers
  - Written debates

- The Good Aspects
  - Students that won't normally speak up in class have the opportunity to fully contribute to the ongoing discussion.
  - Discussion are often more carefully formulated as students have time to think about their responses.
  - Most activities are asynchronous so can be completed when the students have time in their busy schedules.

- The Challenges
  - Some students prefer to speak up in class (although they may be less prepared to do so)
  - Much of the work is completed in small groups that often do not communicate effectively to one another.

Common Themes

- Many areas of inquiry & intellectual practices are covered by these new courses
- The courses are interdisciplinary and integrate through the curriculum
- Students' perspective is really important, e.g.:
  - Strive to help non-science majors to be successful, as well as to get science majors interested in the arts.
  - Increase thelevel of engagement students have in the topics of the course, and help them to see connections.
  - We're getting students out of their comfort zone a bit.

Discussion: How to Engage Students

- How can you design a class where the topic becomes part of who the students are as people?
  - How can we help students feel a connection and ownership of an area of science?
- Our goals are to help students survive in a complex and global society.
  - In what way is group work an important aspect of this type of education?

Your Ideas

- How can you design a class where the topic becomes part of who the students are as people? How can we help students feel a connection and ownership of an area of science?
- Relate to them personally, pollutants, genetics, looking at science fictions
- Science courses designed to be closely related to their everyday life experiences, for example, EM spectrum – microwaves. How does a microwave work? Dangers? Benefits? Learn through real world.
- Person teaching must have a passion for your topic – rub off on students
- Survey students interests at beginning – use that to tie in to tailor the class
- Students involved in a community project – monitor project
- Reflect upon who they are and what is their place in the universe
- Who the students are – microbiology. Course on health, disease, resource for students such as CDC, study-abroad. Focus on small group like a community group.
- Using “I wonder….” statements. Follow-up
- Students don’t like group work – online you can have them meet without physically meeting and you can monitor who is doing the work

Workshops: How to Engage Students

- *Grouped by discipline:*

- Think of the intro course in your area.
  - What is the purpose of that introductory course?
  - Is it for majors and non-science majors?
  - What aspects of this course are important for non-majors to learn?
  - How else could the course be designed to make it relevant for the student, make them an informed citizen, and prepare them to find more information when they need it?

Your Ideas

- Think of the intro course: Purpose? For everyone? Important non-major aspects?
  - How else could the course be designed to make it relevant for the student, make them an informed citizen, and prepare them to find more information when they need it?

Workshops: How to Engage Students

- *Grouped with one person from each discipline:*

- What other topic combinations (interdisciplinary) can we think of that could give non-scientists what they need to function in a global society?

- Come up with a course idea that incorporates your shared knowledge and that considers what the group suggested non-science majors need. How will this course make the students informed and engaged citizens who think of themselves as knowledgeable about science? What types of assignments could you see yourself using?

Your Ideas

- Come up with an interdisciplinary course idea.
  - How will this course make the students informed and engaged citizens who think of themselves as knowledgeable about science?
  - What types of assignments could you see yourself using?

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