NYUSteinhardt
Steinhardt School of Culture, Education, and Human Development

New York University
Steinhardt School of Culture, Education and Human Development
Department of Teaching and Learning

Concepts in the Sciences

Instructors:

Pamela Fraser-Abder

Jason Blonstein

Mary Leou

Catherine Milne

Robert Wallace

Allen Mincer

Participating faculty will come from NYU Faculty of Science, scientists and educators at AMNH and other non-formal institutions. Involving scientists in this development will expose them to the level of understanding of science required by the Regent exam. Mentor teachers at host schools, recent science education graduates as well as current students will provide input as to the appropriate and relevant content for the site

COURSE STRUCTURE

The course will meet for four semesters. During the first semester faculty will work with mentor teachers and scientists to develop the logistics and online components for the following semesters. The online components will include the science content required to teach the Regents curriculum, laboratories activities, lesson units and plans and Regents exams. Course participants will meet with faculty at the beginning of the semester and twice during each semester. They will work online to complete the content and laboratories activities and will then complete the Regents examination for the content area studied. On successful completion of that area they will be allowed to move to the next area. In order to successfully complete the course each participant must successfully complete all content areas.

- **Purpose and Importance**

Science is an interdisciplinary subject. Consequently, for high school teachers to have a depth of understanding in only one of the major scientific disciplines limits their capacities to work in other areas and to make the required links among content areas. We find our teachers graduate with knowledge in only one specific area and lack the fluidity needed in our present and future science classrooms.

A partnership between the science education faculty and the faculty of the College of Arts and Sciences will serve to strengthen these connections as well as to heighten the consciousness of faculty in CAS about the requirements of the NYS Regents curriculum and the depth of understanding that is needed for students to be successful in high school science courses.

This course will meet the needs of pre-service teachers to have content knowledge of all the science requirements in the K-12 classroom.

- **Connections with ongoing curriculum development**

  We recognize the need to expand the content knowledge of all our pre-service and in-service teacher and to provide them with the content required by the Regents exam. This course will be a key component of our new program and will ensure that all students exit the program having been exposed to the breadth and depth of high school science requirements. **The course will provide graduate students with the foundational content knowledge with which to apply instructional strategies explored in their methods and curriculum courses.**

UNDERPINNINGS

This web based course is predicated on the fact that one of the challenges prospective teachers face is understanding of how scientific content is dependent upon the nature of scientific models and theories. This course will address this issue by focusing on the nature of a scientific theory, the role of scientific theories and models in science, and the relationship between scientific theories, scientific models and scientific concepts. Our main goal is to support beginning science teachers to understand that concepts are nested in scientific theories and models. It is from theories that concepts acquire language and meaning.

Our organizing framework is that the evidence that has led to the development of scientific theories and models constitute the 'big ideas' of this course and it is from them that concepts emerge.

Another challenge is their lack of understanding of how science is conducted in those fields that are outside of their area of certification. Scientists who work in the field (field biologists, ecologists, geologists, astronomers, etc.) have to use different approaches than scientists who work in the laboratory. Both approaches need to understand what comes from the other.

Participants are introduced to the content of the NYS Science Core Curricula from this theory/model-based organizing perspective. The course will result in the creation and maintenance of an evidence based web site. This web site will provide the required background for the content that is the basis of the NYCDOE scope and sequence for middle school as well as the Physics, Chemistry, Biology and Earth Science for the appropriate Regents courses. This background list will be linked to;

> Tested lesson plans (many developed already at NYU by TLQP, TOC and Petrie fellows and other students and part of other web offerings), Videos that tie the laboratory explorations to the required content, non-formal resources that have been developed through NYU's connection to museums and research centers in the city, and close ties with ongoing research in NYU research laboratories.

This will provide a bridge between real science in the city with the expectations of the Regents based curriculum.

New York City now has a spiral curriculum, addressing all science subject areas within one year in grades K through eight. Since New York State required certification is in one specific content area, this proposed course expansion will provide teachers with the content needed to teach a spiral program in grades 6-8 and will give the 9-12 science teachers the tools required to understand content that is not in their area of certification.

Integrating this into our existing program will ensure that our current and future graduates leave the program better prepared to help our urban students participate and achieve in science at the secondary level

<u>Examples of Big Ideas to be addressed</u>

Big Ideas In Science

• Science progresses by the development of models that describe a process that then can be tested by studying nature.
• Science presumes that those that practice science are ethical and are willing to encourage studies that might negate important models. This has not always been true but in the long run the method of sharing the approach to an experiment with others who try to duplicate it lead to improvements in our understanding of how nature works.
• Science does not resort to magic or supernatural powers to explain natural phenomena.
• Science progresses by attempts to answer questions or the testing of models for how nature works. Math is often important to this process but it is not always necessary.
• Laboratory studies simplify nature so that a single cause and effect may be investigated, along with a control. Most of what we know in science cannot be studied in this way so other approaches are used.
• Science cannot determine what is “true.” It can only prove things false. Truth is something that has been tested over time and has not yet been refuted.

Big Ideas In Chemistry

• There are experiments that one can conduct that can allow us to develop models that can help us make predictions about the physical and chemical relationships in nature.
• Experiments about the rates and directions of chemical reactions can be used to develop models to predict the behavior of natural materials in nature as well as in the laboratory.
• There are experiments that have been done that shed light on the nature of thermodynamics.

• It is possible to conduct experiments that allow the development of models for the way that elements bond with each other.

Big Ideas In Biology

• Cells have been discovered and classified in terms of their function in plants versus animals versus bacteria, etc. Experiments have allowed the development of models for the functions of various organelles in a cell. While cells generally seem to come from other cells, there is an interest in science to explore the possibility that the ultimate origin of cells was from inorganic processes.

• There is a body of experimental evidence that can be used to develop a model of homeostasis in the body. This model is important for making predictions about processes in the human body

• The theory of evolution has allowed scientists to make predictions about how life has changed through time as well as about the degree of physical and chemical similarities of animals and plants. This theory also allows for the development of "model" organisms that can be used to study biological processes that can not be directly studied in humans.

• Evidence gained through the study of ecosystems allows the development of models that can be used to make predictions about how changing one part of a system may affect another part of the system.

• The experiments that have led to an understanding of the structure of DNA has led to the development of models for how reproductive material is passed from one generation to another.

• Chemical experiments that have revealed the structure of the genome have opened up new studies of organisms that are likely to change our whole understanding of how life functions at a molecular level.

• The discovery of enzymes that can break DNA strings in controlled ways allowed scientists to ask questions about how the genome affects heredity in ways that could never be done before.

Big Ideas In Earth Science

- It is possible to gather information from the earth's crust and upper mantle to develop a theory of plate tectonics and sea floor spreading.
- The present is the key to the past and the rules of superposition provide ways to interpret earth history as well as develop models that may be used to make predictions.
- It is possible to use information/observations from the earth to make predictions about the nature of the solar system.
- Measuring weather data over a period of time allows the development of models that can be used to predict the weather over short periods of time as well as to predict future changes in the climate.
- Rocks and minerals contain information about their origin and history. Most of what we know about earth history (and even the solar system history) comes from the analysis and interpretation of information that comes from rocks and minerals.
- The visible light and other and other parts of the electromagnetic spectrum can be used to develop models for the origin of the universe, as well as predict the nature of the evolution of stars.
- The collection of information from space (electromagnetic energy, information from probes, etc) to make predictions about the likelihood of the presence of appropriate conditions to support life elsewhere.
- Understanding earth systems allows the development of models that allow the development of ideas that can be used to solve problems such as energy use, air pollution, water pollution, preservation of natural resources, effective recycling of natural materials, waste treatment, etc.

Big Ideas in Physics

- It is possible to conduct experiments that will allow us to develop models of the structure of the atom, including theories about the most elements parts of matter.
- It is possible to use data from space to develop theories about the presence of black holes, dark matter and dark energy.
- Experiments with simple machines, electromagnetism, thermodynamics, etc can be used to develop amazing technologies.

Big Ideas in Environmental and Ecological Studies

- Some of the important models come from the biology and earth science ideas.
- Data gathered from environments in the city can be used to modify and improve models for systems development that have been based on more rural settings – e.g. street tree studies can contribute to the modification of the need for technological solutions for environmental problems.
- Many solutions to environmental problems require cooperation among different countries.
- Predictions based upon global models may be different from those that are based upon local situations.
- Individuals can have positive, or negative, impact on environmental phenomena.

It is possible to apply mathematical ideas to natural phenomena to allow one to make predictions that can be tested through experimentation.

The outcome of this course is the Steinhardt Education Resource Center. (Temporary Title)

The website developed in 2008 and not updated since can be found at:
http://steinhardt.nyu.edu/teachlearn/science/resources/

The website is updated as lesson plans are submitted. There is a system for submitting lessons digitally that is run through www.surveygizmo.com. This allows all of the lessons to be submitted online, in the same format as one another, thereby easing the processes of updating the site, and reading through the lessons Each lesson will be reviewed by a scientist and science educator team before being officially updated to the website.

Each lesson plan is then linked to a blog page that allows the users of the site to comment on the submitted lesson plans, allowing them to suggest modifications and tell other users what worked and what didn't work about the lesson. In this way the lesson plans can be constantly modified and don't become set in stone once they are uploaded to the web. Teachers who are planning on using a lesson from the site can then look through the comments to see if there are any tips from other teachers who have done the lesson that may make the lesson go smoother in their own classrooms.

On completion the site will be available to all NYU graduates and students both at NYU and residents in the NYU program.

ASSIGNMENTS

Course assignments will include:

1: A critical analysis of the Regents examinations and Core curricula to identify the associated concepts and the evidence used to support these concepts.

2: Each student will be expected to successfully complete Regents exams in fields that are not their major.

3: Contribution to the website of work completed in their other content courses. Students will be expected to develop experiments that will allow their students to test some of the predictions made by models that have been developed in their fields of specialization. These experiments will probably be developed from their internships as well as their work with the scientists in the Department of Teaching and Learning.

They will also be asked to develop sample questions for a Regents style exam that more explicitly deals with the fact that “content” is not fact but is dependent upon the models that are being tested.